Union Pacific Rules

Track Welding Rules and Procedures

Effective May 2, 2016
Includes Updates as of May 2, 2016
PB-21321

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100.1: Employee Responsibilities

Following instructions that differ from the Union Pacific Railroad standards, FRA guidelines and rules outlined in the track welding rules could be potentially harmful to the safe operation of the railroad and must be brought to the attention of the Manager of Track Welding.

Where Union Pacific Railroad rules are more restrictive than the FRA, Union Pacific Railroad rules will be followed.

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100.1.1: Carry Instructions

Welding managers and supervisors, track managers and supervisors, track inspectors, track maintenance foremen, track welders and helpers and grinder operators must have a current copy of the track welding rules as described in this document: Track Welding Rules and Procedures for Inspecting, Welding, and Grinding of Rail and Track Components, and readily available.

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100.2: List of Assigned Duties

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100.2.1: Electric Welding

- Repair battered or chipped rail ends.
- Repair worn or damaged rail bound manganese turn-out frogs.
- Repair worn or damaged bolted rigid frogs.
- Repair worn or damaged self-guarded manganese frogs.
- Repair spring frogs (only as allowed in rules).
- Repair crossing frogs.
- Repair switch points (only as allowed in rules).

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100.2.2: Thermite Welding

- Install standard gap welds - various manufacturers.
- Install wide gap welds - various manufacturers.

- Install head repair welds - various manufacturers.

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100.2.3: Electric Flash-Butt Welding

- Operate In-Track Welders.

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100.2.4: Oxy-Fuel Equipment Operation

- Operate all oxy-fuel cutting equipment.
- Operate all oxy-fuel heating equipment.

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100.2.5: Abrasive Wheel Cutting and Grinding

- Operate all grinding equipment used for preventive grinding.
- Operate all grinding equipment used in track welding repairs.
- Operate all abrasive saws used to cut rail.

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100.2.6: Reporting

- Complete all timekeeping and production reports as required.
- Complete "Cut-in/Cut-out" and "Service Failure" reports, if applicable.

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100.2.7: Other Duties

- Tamp ties, as necessary, for repair longevity and safe train operation.
- Replace and /or tighten track and frog bolts as part of repair or when necessary for safe train operation.
- Install replacement rail and insulated joint plugs as required before welding.

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100.3: Qualifications - Welders/Helpers

- Must meet Commercial Drivers License (CDL) and Department of Transportation (DOT) requirements for specific position.
- At least one employee at the work location must be qualified under FRA 217 (a)(b).
- Must be qualified by Manager of Track Welding or Welding Supervisor to use oxy-fuel and welding equipment.
- Employees must be qualified to perform job specific welding processes.
- Qualification will consist of training and skills assessment.
- Qualification period is 3 years as required by Union Pacific Railroad.
- Prior to qualification, employee may work under the direct supervision of a qualified employee.

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100.3.1: Re-qualification

- Every 3 years, employees shall be re-qualified in the use of oxy-fuel, welding equipment and welding processes.

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100.4: Rail Identification

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100.4.1: Rail Branding

Branding appears as the raised letters on the rail web and identifies the rail weight and section, manufacturers name, the year and the month rolled.

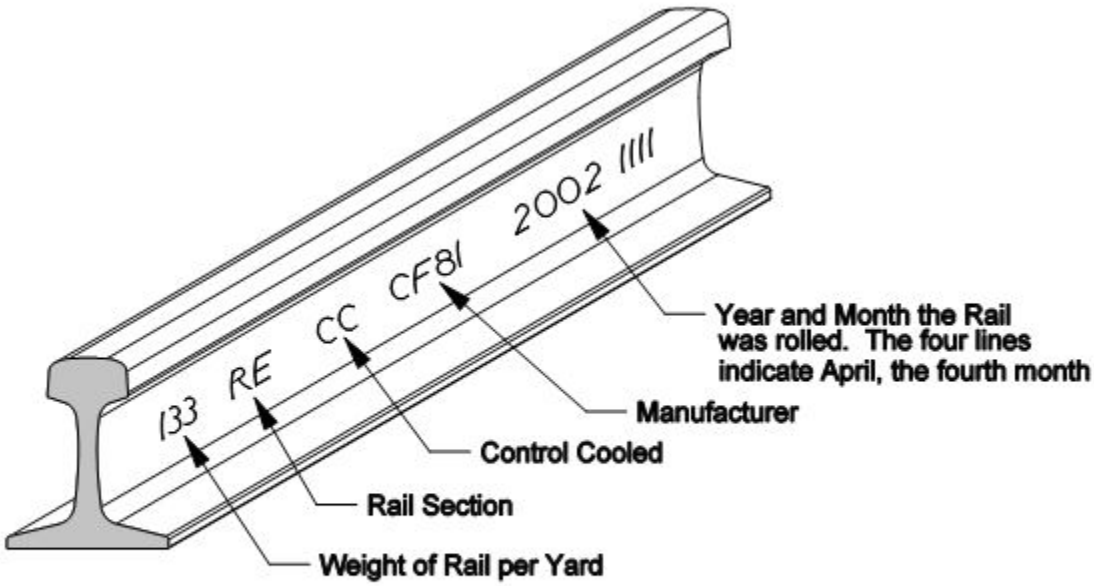

Figure 100A *Rail Branding*

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100.4.2: Rail Stamping

Rail stampings are imprinted characters on the web of the rail opposite the branding side.

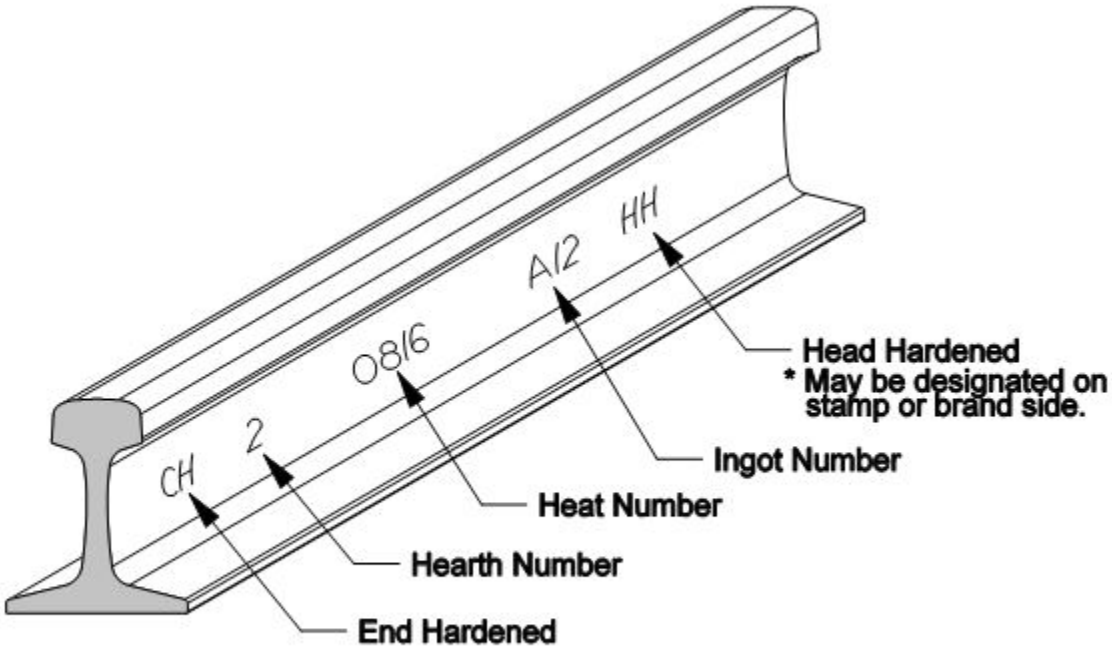

Figure 100B *Rail Stamping*

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100.4.3: Hydrogen Elimination

During the rail manufacturing process, hydrogen is removed to reduce internal defects. Table 100A identifies the process used during hydrogen elimination.

Table 100A Hydrogen Elimination Process

Branding	Process
CC	Control cooled
CH	Control cooled and end hardened
BC	Control cooled blooms
VT	Vacuum treated
OP	Other practices

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100.4.4: Rail Chemistry Identification

Rail chemistry determines specific maintenance and welding requirements.
(Refer to Table s 100B and Table 100C to determine whether rail is alloy or non-alloy)

Table 100B Alloy Rail

ALLOY RAIL		
Manufacturer Branding	**Stamping**	**Chemistry/Type**
CF&I	CROMO	Chrome/Molybdenum
CF&I	HI SI	High Silicon
W-P (WHEELING PITT)	WR	Chrome/Silicon
W-P (WHEELING PITT)	CR	Chrome/Silicon
KLOCKNER-AL	Blank	Chrome/Vanadium
KRUPP-AL	Blank	Chrome/Vanadium
TYHSSEN-AL	Blank	Chrome/Vanadium
STH	Blank	Chrome/Vanadium

Table 100C Non-Alloy Rail

NON-ALLOY RAIL		
BETHLEHEM STEEL	FT	Fully Heat Treated
BETHLEHEM STEEL	HH	Head Hardened
BETHLEHEM STEEL	MH	Standard Strength
BRITISH	FT	Head Hardened
CF&I (HH on glued tag)	IS	Head Hardened
CF&I	H	Head Hardened
CF&I	DH390	Head Hardened
CF&I	IS	Standard Strength
CF&I	SS	Standard Strength
COLORADO	Blank	Standard Strength
HAY (HAYANGE)	Blank	Head Hardened
ILLINOIS	Blank	Standard Strength
INLAND	Blank	Standard Strength

ISG (INTERNATIONAL STEEL GROUP)	Blank	Standard Strength
ISG HH (INTERNATIONAL STEEL GROUP)	Blank	Head Hardened
KLOCKNER	Blank	Standard Strength
KRUPP	Blank	Standard Strength
MT (MITTAL USA)	Blank	Standard Strength
MT HH (MITTAL USA)	Blank or IS or HH	Head Hardened
MMRA	Blank	Standard Strength
MMRA HH	Blank	Head Hardened
NIPPON	DH340	Head Hardened
NIPPON	DH370	Head Hardened
NIPPON	HE370	Head Hardened
NIPPON	HE400	Head Hardened
NIPPON	HEX	Head Hardened
NKK	NHH	Head Hardened
NKK	SP	Head Hardened
NKK HH	Blank	Head Hardened
PST (PENNSYLVANIA STEEL TECH)	Blank	Standard Strength
PST HH (PENNSYLVANIA STEEL TECH)	Blank	Head Hardened
RMSM	DH390	Head Hardened
RMSM or ERMS	SS	Standard Strength
RMSM or ERMS	IS HH (IHHS)	Head Hardened
RMSM	HCP	Head Hardened
RMSM or ERMS	OPC	Head Hardened
RMSM or ERMS	Blank	Standard Strength
SDI (STEEL DYNAMICS)	Blank	Standard Strength
TENNESSEE	Blank	Standard Strength
THYSSEN	HH	Head Hardened
THYSSEN	Blank	Standard Strength
TZ (CZECH)	SS	Standard Strength
W-P (WHEELING PITT)	MH	Standard Strength

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100.5: Component Installation

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100.5.1: Component Installation - Marking

The installation date should be marked with a "white" metal marker on the following track components:

- Frogs
- Guard Rails
- Spring Frog Retarders
- Switch Points
- Stock Rails
- I-Bonds

The installation date will be used to verify warranty claims and track component longevity.

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100.6: Reference Marks

Placing rail reference marks is a method of controlling the amount of rail added or subtracted in CWR territory. Reference marks must be utilized prior to cutting CWR for any reason.
In the case of a rail separation, pull-apart , defect repair, other rail change out and track panel installation, reference marks should always indicate the original distance between the marks before the rail break or pull-apart occurred.

The types of reference marks that are used to manage the CWR events are:

- Spanning reference marks: Used for service failures, pull-aparts, detector car defects, track panels less than 80'. Refer to Section 7 (7.9.3 Placing Spanning Reference Marks) in the Engineering Track Maintenance Field Handbook (ETMFH).
- Pull back reference marks: Used for rail change out greater than 80' or less than or equal to 360' and track panels greater than 80' or less than or equal to 360'. Refer to Section 7 (7.9.4 Placing Pull Back Reference Marks) in the Engineering Track Maintenance Field Handbook (ETMFH).
- Match marks are used when rail change out is greater than 360'. Refer to Section 4 - (4.5.1A Monitor Rail Movement) in the Engineering Track Maintenance Field Handbook (ETMFH).

For complete instructions including examples, refer to the current version of the Engineering Track Maintenance Field Handbook.

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100.7: Rail Bond Wire

Remove rail bond wires by grinding only.

- Use of a chisel or hot cut to remove rail bonds is prohibited.

Do not electric arc weld bond wires onto rail.

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100.8: Torch Cut Rail Ends and Bolt Holes

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100.8.1: Torch Cut Rail Ends

Torch cut rail ends must be re-cut with a rail saw before train movement is allowed.
Thermite or electric flash butt welding of torch cut rail ends is prohibited.
Rail ends cut with an oxy-fuel torch will be trimmed back no less than 1/4 inch if done within 15 minutes of the initial torch cut.

- All indication of torch cut must be removed.

If rail end cannot be re-cut with a rail saw within 15 minutes of the torch cut, an additional 2 inches of rail must be removed to get beyond the thermal heat cracks.

- A single rail end must be cut square both vertically and horizontally.
- Rail ends being thermite welded that have a combined deviation of more than 1/8 inch must be re-cut.

Visually inspect rail ends for split web and other defects after saw cutting.

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100.8.2: Torch Cut Holes

Rail with torch cut holes are prohibited in any track.
Any hole cut in rail must be cut back with a rail saw no less than 2 inches from the torch cut.

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100.9: Deburring Bolt Holes

Bolt holes must be deburred and beveled immediately after drilling is completed using the appropriate grinding tool.

- Bolt holes must be deburred before rail ends are welded.
- Visually inspect all bolt holes for cracks before welding.

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100.10: Guardrails

Follow these guardrail repair requirements:

- Do not weld a guardrail face in the field.
- Replace worn or damaged guardrails.
- Use shop repaired or reconditioned guardrails in any track only after they have been inspected and approved for use.

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100.11: Electric Arc Welded Rail Ends

On main tracks and siding's, rail ends that have been previously electric arc welded are prohibited from being thermite welded on rail manufactured after 1975 and on alloy rail.

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101.0: SAFETY

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- 101.2: Respirator Requirements
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- 101.17: Equipment Safety

101.1: Personal Protective Equipment (PPE)

Track welding rules may be more restrictive than stated in Safety Resource Manual. (Refer to Table 101A)

Table 101A Personal Protective Equipment

	Electric Arc Welding	Oxy-fuel Cutting/Heating	Thermite Welding	Abrasive Cutting and Grinding
Goggles (1)		x (2)	x (3) (4)	x (7)
Face Shield (1)		x (2)	x (3) (4)	x (7)

Safety Glasses	x	x	x (3) (4)	x (7)
Welding Hood (1)	x			x **
Hearing Protection	x	x	x	x
Leather Welding Gloves	x	x	x (8)	
Work Gloves			x (8)	x
Welding Jacket (5)	x	x	x	x
Respirator (6)	x	x		x
Leggings *		x		x

Minimum Requirements

(1) Refer to Rule 101.4 Eye Precautions for proper shading.

(2) Wrap-around face shield with goggles or safety glasses (one must be shade #5).
(Mono-goggle XTR shade #5 with safety glasses can be used as an alternative)

(3) Wrap-around face shield with goggles or safety glasses (one must be shade #5) when monitoring thermite weld preheat and pouring process.

(4) Wrap-around face shield with goggles or safety glasses are required for removing molds and cleaning weld.
(This includes the mono-goggle XTR with safety glasses)

(5) Welding sleeves may be worn in place of jackets to protect arms (including thermite breakdown).

(6) Refer to current respiratory policy in the Safety Resource Manual for minimum requirements.

(7) Wrap-around face shield with goggles or safety glasses (shade #5 lens must NOT be worn).

(8) Leather welding gloves are required while removing the clamp, jackets, and slag pan.
(Gloves are required while packing the molds)

* Both leggings are required to be worn.
** Approved welding hood with grind mode can be used as an alternative to required eye protection when abrasive grinding.

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101.2: Respirator Requirements

Respirator use requirements apply to welders performing hazardous activities or tasks.

Information on the Union Pacific Respiratory Protection Program can be found in the Safety Resource Manual - Section E. This section provides information on job tasks requiring the use of respirators. Respirators must be selected from the current UPRR Safety Resource Manual, Section E - Appendix B and the ORR Safety Products Catalog.

- These two documents can be accessed online through the UPRR employee homepage under Work Place Safety at:

http://home.www.uprr.com/emp/operating/she/safety/index.shtml

Employees performing activities or tasks that require a respirator must at least wear the minimum level of respiratory protection listed under the Minimum Respirator Type column in the respiratory protection policy. A respirator offering a higher protection factor is listed under the Other Approved Respirator Types column.

Carbon Arc Cutting (CAC) and welding repairs on frogs, crossing diamonds or other track components containing more than 2% manganese require use of a respirator. If a half-face air-purifying respirator is used, a track fan (380-0085 axial blower) must also be used. If a powered air-purifying respirator (PAPR) is used, the track fan is not required but is recommended for better visibility

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101.3: Hearing Protection

Approved hearing protection must be worn when using powered equipment including:

- Electric arc welding
- Abrasive wheel cutting or grinding
- Oxy-fuel or other fuel-gas equipment
- Pneumatic tools
- Hydraulic tools
- Gasoline powered tools

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101.4: Eye Precautions

All persons performing or observing welding, cutting and heating operations must wear proper eye protection and other personal protective equipment. They must not look at an oxy-fuel flame or electric arc unless properly protected and must warn others against looking at the flame or arc.

Refer to Table 101B below to determine minimum shade requirements of eye protection performing track welding, heating or cutting operations.

Table 101B Minimum Shade Requirements

Welding Operation	Minimum Lens Shade
Shielded metal arc welding electrodes	

• Up to and including 5/32 inch diameter • 3/16 to 1/4 inch diameter • 5/16 to 3/8 inch diameter	10 12 14
Flux-cored arc welding (5/64 inch wire)	12
Carbon Arc Cutting/Gouging - for most applications • Large diameter carbon electrodes	12 14
Oxy-fuel welding, cutting ahd heating	5

Cracked filter glasses (lens shade) must be replaced immediately. Shade numbers of filter plates are not additive. For example, a Number 6 and Number 8 filter do not have the same effective density as a Number 14 filter.

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101.4.1: Shielding from View

Welders must warn others to protect their eyes and use shields to prevent injuries and fires.

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101.5: Proper Clothing

When electric arc welding, carbon arc cutting, or oxy-fuel cutting; heating or welding; wear approved hearing protection, approved footwear, leather welding gloves and flame resistant clothing.

- Protects the skin from infrared and ultraviolet radiation and covers the arms.
- Reduces the possibility of catching fire.
- Has all buttons and snaps fastened.
- Has sleeves and pockets secured against sparks or slag.
- Is free of oil or grease.
- Is without cuffs.

Also wear, at a minimum, an approved full welding jacket or welding sleeves with approved welding vest.
When using a PAPR welding helmet, the shroud must be attached to the welding helmet and functional.

Additional protective outerwear such as leather aprons, leather leggings, spats, welding jackets or welding sleeves shall be worn for any application where clothing or body is in danger of being exposed to sparks or hot slag. Arms must be covered;

short sleeved shirts are not acceptable.
All buttons on jackets must be buttoned. Sleeves and pockets must be secured against sparks or hot slag.

When abrasive wheel cutting or grinding, arms must be fully covered with an approved welding jacket or welding sleeves.

Do not carry lighters or matches during hot work operations.

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101.6: Cleaning Work Area

Do not use gloved or bare hands to brush slag or metal from material being welded or cut.

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101.7: Fire Protection

Follow instructions in the UPRR Fire Protection Policy and Guidelines document and the Engineering Department Fire Prevention Plan, which are available in the Safety Resource Manual.

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101.8: Protecting Timber Structures

Before leaving the work site, the employee in charge must ensure that no fire or fire hazard exists.
If fire risk is high when completing the hot work task, you must adhere to all requirements as written in the Engineering Fire Prevention Plan which includes:

- If a potential fire hazard exists, one person must remain at the job site for at least 2 hours after work is completed to watch for signs of smoke or fire.
- This person must have at least 5 gallons of water, a round-nose shovel and communications capable of calling for help.

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101.9: On-Track Safety

Refer to Chief Engineer Instruction Bulletin 136.

This bulletin explains the On-Track Safety requirements for all roadway workers. The instructions in this bulletin conform to the FRA regulations for roadway worker protection. The purpose of this bulletin is to prevent accidents and injuries from railroad cars, locomotives, and roadway machines striking roadway workers and machines.

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101.10: Equipment Condition

Inspect all equipment and ensure it is free of defects and in proper working condition.

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101.11: Weather Restrictions

Electric arc or thermite welding in extremely wet weather is prohibited.

- Do not run welding cables or electric cords through water or allow lying in standing water.
- Do not wear wet gloves while operating electrical equipment.

An approved welding tent with a solid top can be used as long as weather and wind restrictions are met.

- In light rain, sleet, snow or mist.
- In light wind conditions as long as tent can be maintained in place and function as intended.

Note: Mesh top tent without solid top cover in place cannot be used in wet weather conditions.
Note: A welding tent will not be used for cutting, grinding, or welding on track components containing more than 2% manganese.

ESCO welding tent store stock item number: 380-7895
IRS welding tent store stock item number: 380-7890

If ground is covered with snow; all snow must be removed from welding and disposal areas before starting the thermite welding process.

- Do not begin the thermite weld process during light rain, sleet, snow or mist unless entire process can be protected from the wet weather.
- All precautions must be taken to avoid injury and defective weld, if welding process is already in progress.

An anemometer is required to determine wind speed

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101.12: Fire or Explosive Potential

Welding, cutting or heating on piston heads, hollow castings, or containers such as drums, barrels or tanks is prohibited.

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101.13: Abrasive Wheels

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101.13.1: Shipping and Inspection

- When abrasive wheels are received, the original shipping container must be inspected for damage or moisture.
- If container damage is observed, the abrasive wheels must be inspected. Any abrasive wheel that is damaged or suspected of being damaged must not be accepted and/or put into service.

Do not use abrasive wheels if they are:

- Chipped, cracked, warped or broken
- Water or oil soaked

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101.13.2: Handling

- All abrasive wheels are breakable and therefore care must be exercised in handling and storage to prevent damage.

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101.13.3: Storage

Abrasive wheels shipped on pallets may remain stored on pallets until ready to be used.

- Abrasive wheels in storage must not be exposed to water or other solvents.
- Abrasive wheels in storage must not be exposed to temperature or humidity conditions that cause condensation on the wheels.
- Suitable racks, bins or boxes shall be provided to store the various types of abrasive wheels.
- Abrasive wheels in storage shall be rotated so oldest wheels will be used first.
- Most abrasive wheel manufacturers recommend a shelf life of two years for properly stored abrasive wheels.

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101.13.4: Operating Abrasive Tools

- Wear all required PPE. (Refer to Tables 101A and 101B).
- Adhere to all Union Pacific fire prevention policies when operating abrasive wheel equipment. This includes using spark guards as necessary and having the minimum number of round nose shovels and water as per the fire prevention plan.
- Spindle speed of grinder or rail saw must be checked periodically to ensure it is operating at its optimum and that it does not exceed the maximum operating speed marked on the abrasive wheel.
- Hydraulic powered cutting and grinding equipment and hydraulic power sources shall be periodically tested to ensure proper hydraulic pressure and flow.
- Blotters must be used between flanges and abrasive wheel/stone surface to ensure uniform distribution of flange pressure. Flanges must be the same size.
- The blotters shall cover the entire contact area at the wheel/stone flanges.
- Only Union Pacific approved abrasive cut-off wheels and grinding stones may be used. The RPM rating of abrasive wheels/stones must meet or exceed the RPM rating of the power equipment that is being used.

- Prior to using a new abrasive wheel, operator must free spin for one minute. During this period of time, the operator must check the machine for excessive vibration. Should there be excessive vibration, the machine must not be used until the cause is identified and corrected.
- When abrasive wheel/stone is cold, apply grinding force gradually and uniformly to prevent thermal shock which may cause wheel to break.
- Abrasive wheel/stone must be at full speed before contacting metal.
- Do not handle rail saw or grinder in such a way that will damage abrasive and cause it to break apart.
- Do not operate grinders or rail saws without the proper guards or shields. Immediately report and replace broken or missing guards or shields.
- Rail must be supported at area of cut to prevent binding which will slow the speed of rotation and lead to glazing of the abrasive wheel.
- Compressive forces must be relieved to prevent pinching and glazing of the abrasive wheel.

All abrasive wheels shall be used only on machines provided with safety guards with the following exception:

- Mounted wheels, 2-inch and smaller in diameter used in portable operations (i.e. bolt hole deburring grinding stone).

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101.13.5: Observe Work Zones

Adhere to the following work zones when operating abrasive wheel equipment.

Any employee not operating cutting or grinding equipment must not stand closer than 15 feet from equipment.

- Rail Saws - Do not stand or walk in front of rail saw while in operation.
- Grinders - Do not stand or walk in path of sparks.

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101.13.6: Abrasive Wheel Types

Abrasive cutoff wheels and grinding stones have limitations and must be handled and used with care to prevent damage and potential injury.
Listed below are some abrasives most widely used in the Engineering Department.

- Type 1 (8 x 1/8 x 5/8) straight slotting wheels have diameter, thickness and hole size dimensions and grinding should be performed on the periphery (outer edge). This does not preclude their use for applications such as slotting rail ends where it is recognized that a limited amount of side corner grinding will be performed. Extreme caution should be exercised not to use excessive side pressure. (See Figure 101A)

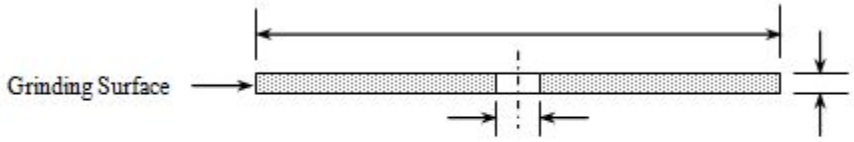

Figure 101A *Type 1 Straight Slotting Wheel*

- Type 27 wheels are provided as both 7 inch and 9 inch grinding discs manufactured with flat grinding rims or faces and are designed for side grinding, when used at a slight angle to the work piece. (See Figure 101B)

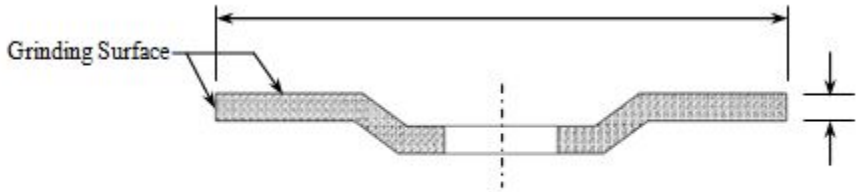

Figure 101B *Type 27 Depressed Center Wheel*

- Type 18 plug wheels are cylindrical in shape with either a square or curved grinding end. Plug type wheels are mounted by being screwed onto a threaded machine spindle so that mounting surface end seats firmly against an unrelieved, flat back-up flange. (See Figure 101C)

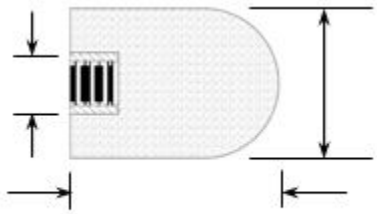

Figure 101C *Type 18 Plug Wheel*

- Type 1 straight stones are provided as an 8 x 1 and grinding is intended to be performed on the outer edge. No side loading of the stone although the outer edge corner is sometimes used to remove excess metal and contouring. (See Figure 101D)

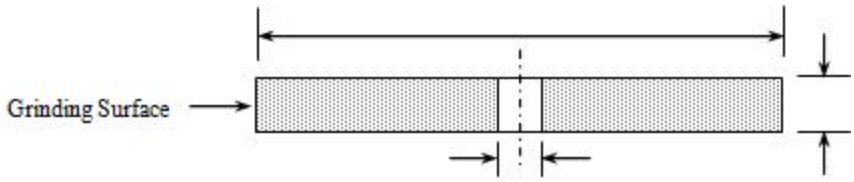

Figure 101D *Type 1 Straight Stone*

- Type 6 cup stones are generally used for finishing to remove surface metal on track components such as frogs, rail ends, thermite and electric flash butt welds. (See Figure 101E)

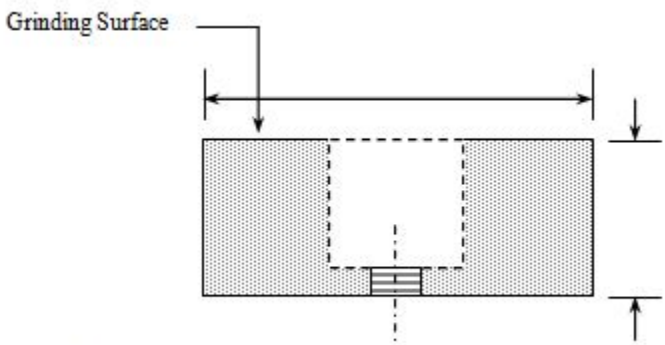

Figure 101E *Type 6 Cup Stone*

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101.14: Cutting Damaged Rail

When cutting twisted rail, unsecured rail suspected of being damaged or other damaged steel sections, take precautions to prevent personnel from being struck by severed sections. Special equipment such as long length oxy-fuel cutting torches and burning bars are available for this operation and should be used.

1. Use available resources to restrain rail prior to cutting..
2. Do not cut joint bar bolts on twisted rail.

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101.15: Cutting Rail in Compression (tight rail conditions)

Certain conditions cause the rail to expand, requiring rail to be removed with an oxy-fuel torch.

- Compressive forces exist when rail temperature exceeds installed neutral temperature.

When cutting rail, use the following procedures:

1. Locate the area that shows noticeable tight rail condition.
   a. This can be identified by rail lifting out of plates, ballast bunching, consecutive number of high spikes, rail appears to be kinking, one rail is straighter than the other, deviation in track gage, rail crowding tie plates, ties skewing and anchors moving.
2. If track is already buckled, make cut beyond the buckled area.
3. Make torch cut prior to removing rail fasteners and rail anchors. (Rail must be secured)
4. Use the following procedure to safely torch cut rail under high compressive forces:

   Use of H-pattern – (See Figure 101F)
   (a) Remove rail head first.
   (b) Remove both sides of base.
   (c) Remove remaining web portion cutting from top to bottom only.
   (Removing the rail head and both sides of the base first, then removing the web last will reduce the chance of excessive vertical or lateral movement)

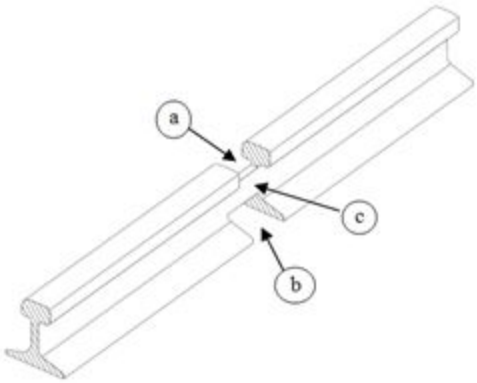

Figure 101F *H-Pattern*

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101.16: Hydraulic Safety

Hydraulic systems must store fluid under high pressure. Four kinds of hazards exist:

- Burns from the hot, high pressure spray of fluid.
- Bruises, cuts or abrasions from flailing hydraulic lines.
- Injection of fluid into the skin.
- Leaking hydraulic fluid may erupt into flames if a source of ignition is present.

Frequent inspections and maintenance of the hydraulic system can prevent injuries. When performing an inspection, so the following:

1. Visually inspect hose condition; look for damage and signs of leaks before the system is energized.
2. Be sure all line connections are tight and lines are not damaged; escaping oil under pressure is a fie hazard and can cause personal injury.

    - Seepage must be corrected immediately.

When a leak is suspected, do the following:

1. Run a piece of wood, cardboard or mirror along the hose to detect the leak. Do not use hands, gloved or not, for this purpose.

Keep contaminants from hydraulic oil and replace filters periodically.

- Safe hydraulic system performance requires general maintenance.

Pressure relief valves incorporated into the hydraulic system will avoid pressure buildups during use.

- Do not remove pressure relief valves.
- Only authorized personnel can adjust pressure relief valves.

To prevent ruptures, do not incorporate a low-pressure component, coupler, hose or fitting on a high-pressure system. Hydraulic system must be checked and maintained to ensure proper flow and pressure.

Systems should be checked:

- Annually
- When tools are not performing properly.
- When any part of the hydraulic system has been repaired.

Gallons Per Minute (GPM) hydraulic flow requirements vary based on the type, model and age of the tool. Refer to the manufacturer's operator manual for pressure and GPM requirements for each specific tool.

Do not operate tools at flow rates outside manufacturer's specifications.

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101.17: Equipment Safety

Portable power tools, machinery and equipment must not be operated without the required safety guards. All belts, shafts, gears and other moving parts on machinery must be fully enclosed and guarded.

Maintain equipment in proper working condition and follow all maintenance requirements for that specific equipment.

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102.0: ELECTRIC WELDING

- 102.1: Welding and Cutting Processes
- 102.1.1: Shielded Metal Arc Welding (SMAW)
- 102.1.2: Flux Core Arc Welding (FCAW)
- 102.1.3: Flash Welding (FW)
- 102.1.4: Carbon Arc Cutting (CAC)
- 102.2: Welding Current - Measurement
- 102.2.1: Currents
- 102.2.2: Types of Welding Power
- 102.2.3: Duty Cycle
- 102.3: Electrodes / Electrode Holder
- 102.3.1: Approved Products
- 102.4: Electric Welding Equipment
- 102.4.1: Power Source Setup
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- 102.4.3: Electric Welding Eequipment Inspection
- 102.4.4: Qualified Mechanic or Electrician
- 102.4.5: Polarity and Range Finder Switches
- 102.4.6: Cable Insulation and Connectors
- 102.4.7: Cable Repairs
- 102.4.8: Protect from Electrical Shock and Moisture
- 102.4.9: Unwind Cables
- 102.5: Ground Connection
- 102.5.1: Ground Connection Precautions
- 102.5.2: Ground Cable Clamp
- 102.5.3: Jump Starting
- 102.5.4: Location and Inspection of Welding Cables

102.1: Welding and Cutting Processes

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102.1.1: Shielded Metal Arc Welding (SMAW)

Shielded Metal Arc Welding is frequently referred to as stick or covered electrode welding. Stick welding is among the most widely used welding processes.

The flux covering the electrode melts during welding. This forms the gas and slag to shield the arc and molten weld pool. The slag must be chipped off the weld bead after welding. The flux also provides a method of adding deoxidizers, and alloying elements to the weld metal.

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102.1.2: Flux Core Arc Welding (FCAW)

Flux Core Arc Welding is frequently referred to as wire welding. FCAW welding is a commonly used high deposition rate welding process. The filler wires that are used in FCAW are tubular, and the core is filled with a mixture of mineral flux and powder. This is a self-shielding process that is also called "Innershield". Shielding gases are formed from the inner flux as the welding metal is deposited and like the SMAW process, is used to shield the arc and molten weld pool. Wire is continuously fed from a spool. FCAW welding is therefore referred to as a semiautomatic welding process.

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102.1.3: Flash Welding (FW)

(Electric Flash-Butt Welding)

A resistance welding process that produces a weld at the rail end surfaces of a butt joint by a flashing action and by the application of pressure after heating is substantially completed.

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102.1.4: Carbon Arc Cutting (CAC)

Thermal cutting using an arc for melting the metal, and a stream of air to remove the molten metal. This process is used to remove defective metal from manganese track components.

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102.2: Welding Current - Measurement

- Voltage (volts) is the measurement of electrical pressure, in the same way that pounds per square inch is a measurement of water pressure. Voltage controls the maximum gap the electrons can jump to form the arc. A higher voltage can jump a larger gap.
- Amperage (amps) is the measurement of the total number of electrons flowing, in the same way that gallons is a measurement of the amount or volume of water flowing. Amperage controls the size of the arc.

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102.2.1: Currents

The three different types of current used for welding are;

- Alternating Current (AC).
- Direct Current Electrode Negative (DCEN) also known as Direct Current Straight Polarity (DCSP).
- Direct Current Electrode Positive (DCEP) also known as Direct Current Reverse Polarity (DCRP).

In Direct Current Electrode Negative, the electrode is negative and the work is positive. Electricity flows from the electrode to the work piece producing a high electrode-melting rate and increasing penetration. (See Figure 102A)

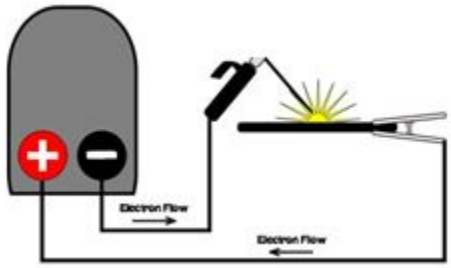

Figure 102A
DC Electrode Negative (DCEN) - Straight Polarity (DCSP)

In Direct Current Electrode Positive, the electrode is positive and the work is negative. Electricity flows from the work piece to

the electrode producing less heat in the work piece and providing the best welding arc characteristics. (See Figure 102B)

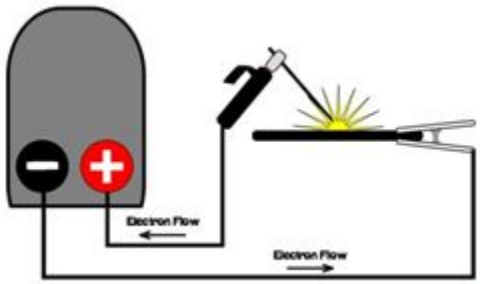

Figure 102B
DC Electrode Positive (DCEP) - Reverse Polarity (DCRP)

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102.2.2: Types of Welding Power

Constant Voltage (CV) – The arc voltage remains constant at the selected setting even if the arc length and amperage increase or decrease. Recommended for wire feed.

Constant Current (CC) – The total welding current (watts) remains the same. This type of power is also called the Drooping Arc Voltage (DAV), because the voltage will change with different arc lengths while only slightly varying the amperage.

The SMAW process requires a CC arc voltage setting. The SMAW machine's voltage output decreases as current increases. This output power supply provides a reasonably high open circuit voltage before the arc is struck. The high open circuit voltage quickly stabilizes the arc. The arc voltage rapidly drops to the lower closed circuit level after the arc is struck. Following this short starting surge, the power (watts) remains almost constant despite the changes in the arc length. With a CV output, small changes in the arc length would cause the power (watts) to make large swings causing the welder to lose control of the weld. (See to Figure 102C)

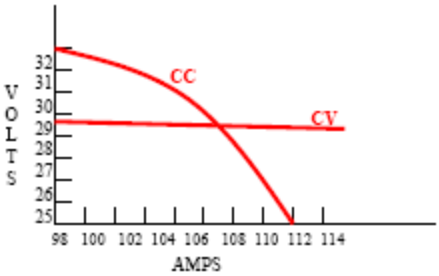

Figure 102C CV/CC Characteristics

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102.2.3: Duty Cycle

The Duty Cycle is the percentage of time a welding machine can be used continuously at its maximum setting based on 10 minutes. A 60% duty cycle means that out of every 10 minutes, the machine can be used for 6 minutes at the maximum rated current. When providing power at this level, it must be cooled off for 4 minutes out of every ten minutes or equipment damage may result.

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102.3: Electrodes / Electrode Holder

- When not welding, make certain no part of the electrode circuit is touching the work or ground.
- Accidental contact can result in electrical shock, signal damage or cause over-heating and create a fire hazard.
- Stick electrodes must be removed from their holders when not in use. Stick electrode holders and wire feeder guns, shall be placed or protected so that they cannot make electrical contact with employees or conducting objects.
- Do not dip electrode holder in water to facilitate cooling. If electrode holder is over-heating it is usually due to improper amperage rating, loose connections, or dirty contacts with electrode.
- Stick electrodes and welding wire must be stored where they can be kept free of moisture.

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102.3.1: Approved Products

Use only approved products within specified welding parameters as listed in Tables 102A, 102B, 102C, 102D and 102E.

Table 102A Rail Steel

Item Number	Approved Electrode	Welding Parameters
460-1512	Postalloy RailTuff 3/16" Stick	170 - 225 Amps
460-1690	McKay M-932 1/4" Stick	290 - 310 Amps
460-1091	Railbuild 540 3/16" Stick	170 - 200 Amps
460-1124	Railbuild 540 1/4" Stick	210 - 230 Amps
460-6901	Railbuild 540 5/64" Wire	28-29 volts/ 280 Amps

Table 102B Manganese Steel

Item Number	Approved Electrode	Welding Parameters
460-1042	Frogbuild 3/16" Manganese Stick	180 - 200 Amps

460-1047	Frogbuild 7/32" Manganese Stick	200 - 220 Amps
460-1100	Lincoln Frogmang 3/16" Manganese Stick	175 - 215 Amps
460-1101	Lincoln Frogmang 1/4" Manganese Stick	235 - 280 Amps
460-6915	Frogbuild 575 5/64" Wire	28-29 volts/ 280 Amps
460-6905	Lincoln Frogmang 5/64" Wire	28-29 volts/ 280 Amps
460-1036	Postalloy FrogTuff 5/64" Wire	28-29 volts/ 280 Amps

Table 102C Stainless Type (to seal vertical cracks)

Item Number	Approved Electrode	Welding Parameters
460-4060	Postalloy 1/8" Stainless Stick	120 Amps
460-1043	Postalloy 5/32" Stainless Stick	140 Amps

Table 102D Mild Steel

Item Number	Approved Electrode	Welding Parameters
460-3158	E7018 3/32" Stick (50#)	70 - 110 Amps
460-3113	E7018 1/8" Stick (50#)	90 - 160 Amps
460-3201	E7018 3/16" Stick (50#)	180 - 300 Amps
460-3245	E7018 1/4" Stick (50#)	300 - 400 Amps

Table 102E Carbon Arc Cutting

Item Number	Approved Electrode	Welding Parameters
460-0223	Arcair 5/32" x 12" (round)	90 - 150 Amps
460-0268	Arcair 3/16" x 12" (round)	200 - 250 Amps
460-0312	Arcair 1/4" x 12" (round)	300 - 400 Amps
460-0357	Arcair 5/16" x 12" (round)	350 - 450 Amps
460-0401	Arcair 3/8" x 12" (round)	450 - 500 Amps
460-0445	Arcair 3/8" x 5/32" x 12" (flat)	250 - 300 Amps
460-0490	Arcair 5/8" x 3/16" x 12" (flat)	300 - 500 Amps

Note: Do not exceed 500 Amps while CAC

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102.4: Electric Welding Equipment

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102.4.1: Power Source Setup

On power source equipment that has a run/idle switch, switch must be placed on "run" when welding.

Equipment reference tables are intended to help the equipment operator in determining the proper setting when using stick electrodes and are estimates only. Power source meters should be checked periodically to ensure accurate readings. (Refer to appendices 1-8)

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102.4.2: Wire Feed Equipment

Wire feed welding equipment is an efficient and recommended process to repair track components.

- When using wire feed equipment to repair track components, equipment must be used on the CV (Constant Voltage) setting if power source is capable.
- Power source condition and age impact amperage and voltage, and must be taken into consideration during setup.

The wire size standard on the Union Pacific Railroad is 5/64 inch and it is important to ensure that the correct drive rolls are being used.

Wire spool must be removed after each use, placing the spool back in the plastic bag and then in the box. This not only protects the wire, spool and equipment from damage but it is also reduces the weight of the feeder when loading or unloading from the truck.

- A new wire spool weighs 30 pounds. Together, the feeder and spool weigh approximately 65 pounds.

To mount the spool and make connections:

1. Remove retaining ring and align the small hub pin with corresponding hole on the spool.
2. Clip any kinks from the wire and mount the spool onto the hub.
3. Open the pressure assembly by flipping up the adjustment knob and carefully thread the wire through the wire guides until two or three inches of wire protrudes from the machine.
4. Flip down adjustment knob and secure the spool with retaining ring.

5. Carefully insert wire into feeder gun, then connect gun to the feeder.
6. Plug in the feeder gun trigger cable, connect feeder grounding plug if not permanently attached to feeder, then connect feeder ground clamp to power source ground clamp.
7. Connect power cable to the wire feeder and start power source.

Wire installation is made easier by laying out the gun in as straight a line as possible.

When welding, always clip 1-inch of the wire before depositing the next weld bead.

The Miller X-treme VS-12 wire feeder has dip switches that must be set properly to show amperage output reading.

Remove front panel of wire feeder to gain access to the dip switches and ensure dip switch No. 2 is opposite the others. (See Figure 102D)

- Refer to the owner's manual for instructions.

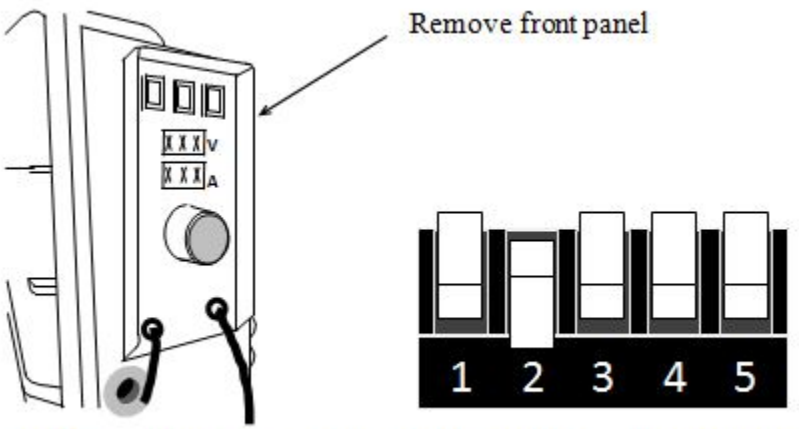

Figure 102D *Miller X-treme VS-12 Wire Feeder Panel/Dip Switches*

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102.4.3: Electric Welding Eequipment Inspection

Inspect portable welding machines, wire feeders, cables, cable reels and connecting plugs monthly. Inspections must include:

1. Equipment condition.
2. Damage or wear.
3. Operating properly (gauges, switches & controls).
4. Insulation (cables, connectors, electrode holders, ground clamps).

Use the appropriate form 24248 to record the inspection information, including the inspection date, gang#, if defect is found, employee signature, corrective action (if applicable) for later review by a welding supervisor.

Completed forms must be sent to the track welding manager.

Form 24248 can be accessed on the UP web under the HR Craft Training page ordered through the online requisition system

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102.4.4: Qualified Mechanic or Electrician

Only a qualified mechanic or electrician is permitted to make repairs or internal adjustments to electric welding equipment.

Exception: Welders may make routine operating adjustments. Refer to owner's manual for scheduled maintenance.

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102.4.5: Polarity and Range Finder Switches

To avoid arcing and damage, do not change settings on the amperage range selector switch or polarity output selector switch while machine is operating under welding current load.

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102.4.6: Cable Insulation and Connectors

Electrode and ground cables must be insulated throughout their entire length. Use 3/0 approved cable and approved cable connections with insulated covering. (Sustained overloading will cause cable failure and result in possible electrical shock or fire hazard)

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102.4.7: Cable Repairs

If cables or cable ends must be repaired, turn off power and use lockout/tagout procedures. Disconnect the cable at the first joint and coil the cable to prevent it from being reconnected while under repair.

- Always use same size cable when making connections.
- Always use approved insulated welding cable connectors to make all connections. The capacity of the connector must be at least equivalent to that of the cable.
- Cables cannot be damaged or repaired within 10 feet of the electrode holder or ground clamp

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102.4.8: Protect from Electrical Shock and Moisture

Protect yourself from possible dangerous electrical shock. The electrode and work (or ground) circuits are electrically "HOT" when the welder is on.

- Do not permit contact between "HOT" parts of the circuits and bare skin or wet clothing.
- Wear leather welding gloves that are dry and free of holes.
- Insulate yourself from the work and ground by using dry insulation when wet conditions are present.
- Maintain the electrode holder, work clamp, welding cable and welding machine in good, safe operating condition.
- When using the welding machine as a power source for mechanized welding, the above precautions also apply for the welding wire, wire reel, welding head or nozzle.
- Do not loop or coil electrode cables around the body.
- During inclement weather, electrical welding equipment must be properly protected from moisture.

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102.4.9: Unwind Cables

Unwind entire length of cables from the reels when welding.

- Failure to do so creates heat buildup resulting in damage to welding cables and equipment.
- High welding currents in coiled cables will create a magnetic field that reduces the welding output.

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102.5: Ground Connection

When performing electric arc welding on rail, crossing pads, gage plates or other track components, apply the ground clamp to that particular part being welded.

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102.5.1: Ground Connection Precautions

- Do not permanently bond the welding ground lead to any rail, steel building or other structure.
- Fixed electrical welding equipment must be permanently grounded on the service side to the ground system.

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102.5.2: Ground Cable Clamp

Ensure ground cable clamp provides good mechanical and electrical contacts by grinding the contact area to a shiny surface.
A poor ground connection will cause excessive heat buildup, which can damage welding cables and equipment, create an arc between
the ground clamp and attached metal resulting in cracks, or cause burns.
Do not handle ground clamp or electrode holder with bare hands.

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102.5.3: Jump Starting

Do not jump start vehicles or equipment directly from welding machine.

- Jump starting vehicles or equipment is allowed only if power source is equipped with a jump-start kit.

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102.5.4: Location and Inspection of Welding Cables

Do not lay cables over rails.
When welding on individual track components or switch components, e.g., insulated switch plates, turnout frogs, rail ends, switch points etc., place welding cables under the rail.
Ensure grounding clamp is placed on the same component to be welded on.

- Never place ground clamp across an insulated joint or track device separated by insulation such as insulated gage plates.

When laying cables under the rail, ensure cables are not contacting the rail base or any other area of the rail.

- If necessary clear out sufficient ballast under the rail to increase clearance.
- Contact between the welding cable and rail may shunt the track and cause excessive current to travel through the rail to the signal cabinets and houses, and could lead to damaged signal components.
- Use a thick non-conductive material, such as a rubber mat placed between the rail base and welding cables to prevent electrical arcing and limit the influence of current leakage.

Inspect welding cables prior to each use.

- Only cables in proper working condition may be used.
- Inspect welding cables for hardened, cracked, split, cut or missing insulation which may allow current leakage. Do not use cables if any of these conditions are present.

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103.0: OXY-FUEL EQUIPMENT

Chapter Introduction

Employees must read and understand all rules associated with the proper setup, use and storage of oxy-fule equipment. Rules in this chapter, if applicable, apply to both oxy-fule and fule-gas operations.

- 103.1: Personal Protective Equipment (PPE)
- 103.2: Authorized to Use Oxy-fuel Equipment
- 103.3: General Instructions
- 103.3.1: Repairs or Alterations
- 103.3.2: Equipment Condition
- 103.3.3: Ventilation
- 103.3.4: Fire or Exposive Potential
- 103.4: Welding Gas Description
- 103.4.1: Oxygen
- 103.4.2: Liquid Oxygen
- 103.4.3: Acetylene
- 103.4.4: Propane
- 103.5: Cylinders
- 103.5.1: Cylinder Construction - Oxygen (See Figure 103B)
- 103.5.2: Cylinder Construction - Liquid Oxygen (See Figure 103C)
- 103.5.3: Cylinder Construction - Acetylene (See Figure 103D)
- 103.5.4: Exposure to Excessive Heat
- 103.5.5: Storing Cylinders
- 103.5.6: Working With Cylinders
- 103.5.7: Transporting Cylinders
- 103.5.8: Empty Cylinders
- 103.5.9: Leaking Cylinder
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- 103.6: Hot Metal Precautions
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- 103.7.3: Connections and Adaptors
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- 103.8: Cylinder Valves

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- 103.11.3: Use of in-line Pressure Gauges
- 103.11.4: Cutting and Welding Attachments and Tips
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- 103.14.1: Igniting Oxy-acetylene Torch
- 103.14.2: Extinguishing Oxy-acetylene Torch
- 103.14.3: Igniting Oxy-propane Torch
- 103.14.4: Extinguishing Oxy-propane Torch
- 103.15: Tip Charts
- 103.16: Draining the System

103.1: Personal Protective Equipment (PPE)

Task	**Required PPE**
Oxy-fuel Cutting and Heating	Hard hat, hearing protection, dual eye protection as follows: 1. Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or 2. Mono-goggle XTR shade #5 with safety glasses can be used as an alternative. leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.

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103.2: Authorized to Use Oxy-fuel Equipment

Only authorized employees are permitted to use oxy-fuel equipment. Welding, cutting and heating will be done only by or under the direct supervision of a qualified employee and comply with manufacturer's instructions.
Qualification:
To be initially qualified to use oxy-fuel equipment, employees must:
1. Be properly trained in the use of such equipment, completion of an exam and skills assessment performed by a Manager of Track Welding, Welding Supervisor or Welding Instructor.

Employees must re-qualify every three (3) years via Computer Based Training (CBT) and demonstrate their skills with the welding management employee.

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103.3: General Instructions

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103.3.1: Repairs or Alterations

Do not make repairs or alterations to cylinders, valves or torches. Defective regulators, gauges, torches or other equipment must not be used and must be returned to designated point for repair. Hoses showing indication of leaks, burns, worn places, or evidence of damage from flashback or other defects must be repaired or replaced.

- Hose repair can be made in the field with the approved crimping ferrules but no more than 2 splices are allowed for any length of hose.
- Use of tape, wire or hose clamps to repair hose is prohibited.
- Splices must be removed prior to initial use on the next day or shift, or hose must be replaced.
- If hose is damaged beyond repair, it must be replaced.

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103.3.2: Equipment Condition

Inspect all equipment before use and verify it is free of defects and in proper working condition.

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103.3.3: Ventilation

Work in well ventilated areas. Exposure to lead, zinc or other welding fumes requires use of an approved respirator. Spray or dust respirators are not suitable and must not be used.

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103.3.4: Fire or Exposive Potential

Welding, cutting or heating on piston heads, hollow casting, or containers such as drums, barrels, or tanks is prohibited.

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103.4: Welding Gas Description

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103.4.1: Oxygen

A. Oxygen is a colorless, tasteless, odorless gas that is slightly heavier than air.
B. It is non-flammable but will support combustion with other elements.
C. The presence of pure oxygen will drastically increase the speed and force with which burning takes place.
D. Oxygen is required to support any burning process. It is combined with a "fuel" gas to produce the desired operating flame.
E. Always refer to oxygen as "oxygen", never as "air". Combustibles should be kept away from oxygen, including the cylinder, valves, regulators, and other hose apparatus. Oxygen should never be used in any air tools.
F. Oxygen must not be used for compressed air, as a source of pressure or to "dust" clothing.
G. Do not allow oil or grease to come in contact with oxygen.
H. Oil or grease in the presence of oxygen may spontaneously ignite and burn violently or explode.
I. Oxygen cylinders and apparatus should not be handled with oily hands or oily gloves.
J. Do not allow oil or grease to touch regulators, valves or connections.

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103.4.2: Liquid Oxygen

A. Liquid oxygen is pale blue and extremely cold. Although non-flammable, oxygen is a strong oxidizer.
B. Liquid oxygen is a cryogenic liquid. Cryogenic liquids are liquefied gases that have a normal boiling point below -238°F (-150°C). Liquid oxygen has a boiling point of -297.3°F (-183.0°C).
C. Because the temperature difference between the product and the surrounding environment is substantial—even in the winter—keeping liquid oxygen insulated from the surrounding heat is essential. The product also requires special equipment for handling and storage.
D. Oxygen is often stored as a liquid, although it is used primarily as a gas.

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103.4.3: Acetylene

A. Acetylene is a colorless, flammable gas composed of carbon and hydrogen, manufactured by the reaction of water and calcium carbide.
B. Acetylene, when used with oxygen, produces the highest flame temperature of any of the fuel-gases, approximately 6,300º F.
C. Because acetylene is stored as a liquid, the cylinder will only work properly if the tank is used in the upright position.
D. Using or storing the tank in any other position can be extremely dangerous.
E. Although acetylene is stable under low pressure, if compressed above 15 psi it becomes unstable.
F. Avoid exposing filled cylinders to heat, furnaces, radiators, open fires, or sparks (from a torch).
G. Avoid striking the cylinder against other objects and creating sparks.
H. To avoid shock when transporting cylinders, do not drag, roll, or slide them on their sides.
I. Acetylene must not be drawn off in volumes greater than 1/7 of the cylinder's rated capacity.

J. If higher volumes are needed, use a manifold system of sufficient size.

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103.4.4: Propane

A. Propane is a hydrocarbon (C_3H_8) and is sometimes referred to as liquefied petroleum gas, LP-gas or LPG. It is nontoxic, colorless and virtually odorless and heavier than air.
B. Propane is produced from both natural gas processing and crude oil refining, in roughly equal amounts.
C. As with natural gas, a strong identifying odor is added so the gas can be readily detected.
D. If liquid propane leaks, it vaporizes and dissipates into the air.

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103.5: Cylinders

A sticker located near the top of the cylinder identifies the cylinder's contents.
(See Figure 103A)

Figure 103A *Non-flammable marker*

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103.5.1: Cylinder Construction - Oxygen (See Figure 103B)

A. A typical oxygen cylinder is made of steel and has a capacity of 220 cu ft at a pressure of approximately 2250 psi.
B. Attached equipment consists of an outlet valve, a removable metal cap for the protection of the valve, and a low melting

point safety fuse plug and disk.
C. The cylinder is fabricated from a single plate of high-grade steel with no seams and is heat-treated for maximum strength.
D. Because of their high pressure, oxygen cylinders undergo extensive testing prior to their release for work, and must be periodically re-tested thereafter.

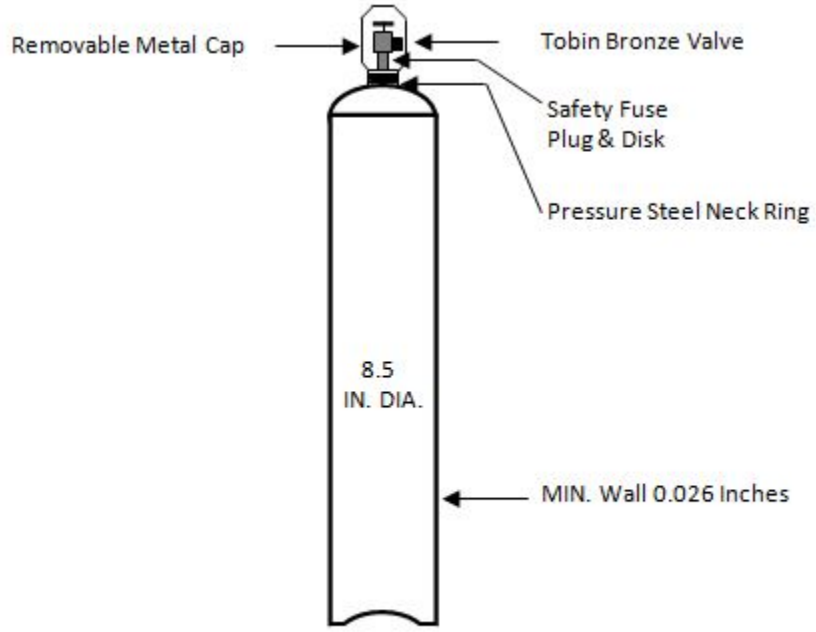

Figure 103B *High Pressure Oxygen Cylinder*

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103.5.2: Cylinder Construction - Liquid Oxygen (See Figure 103C)

A. Liquid storage is less bulky and less costly than the equivalent capacity of high-pressure gaseous storage.
B. The cryogenic tank is constructed, in principle, like a thermos bottle.

- There is an inner vessel surrounded by an outer vessel.
- Between the vessels is an annular space that contains an insulating medium, from which all the air has been removed.
- This space prevents heat from coming in contact with the liquid oxygen stored in the inner vessel.

C. The temperature of the liquid oxygen is approximately -300º Fahrenheit.
D. It remains in a liquid state until the gas "Use Valve" is opened. Opening the "Use Valve" draws the liquid oxygen through coils, which allows the liquid to expand and change into a gas.

E. Liquid oxygen cylinders build up pressure as they sit idle. The cylinder will automatically start to release the pressure or bleed off when the cylinder pressure reaches 250 psi.

F. Cylinders with the highest psi regulator reading should be used first.
G. Care must be taken not to drop liquid oxygen cylinders.
H. Liquid oxygen cylinders must remain upright or in a vertical position.
I. In the event a liquid oxygen cylinder is dropped, tipped over, or abused, do the following:

- Slowly raise the cylinder to a vertical position.
- Open the vent to release any excess pressure and leave the valve in the open position.
- Remove the liquid product from the vessel as soon as possible.
- Inspect the cylinder before returning it to service.

J. Prior to applying the oxygen regulator to the liquid oxygen cylinder, slightly open the "Use' valve to clear the valve stem and then close. Position the oxygen regulator on the "Use" valve and tighten.

Note: Since the "Use" valve stem is fairly long, it must be supported with a gloved hand.

K. The "Use" valve may then be opened slowly for use.
L. Never open the "Liquid" valve.

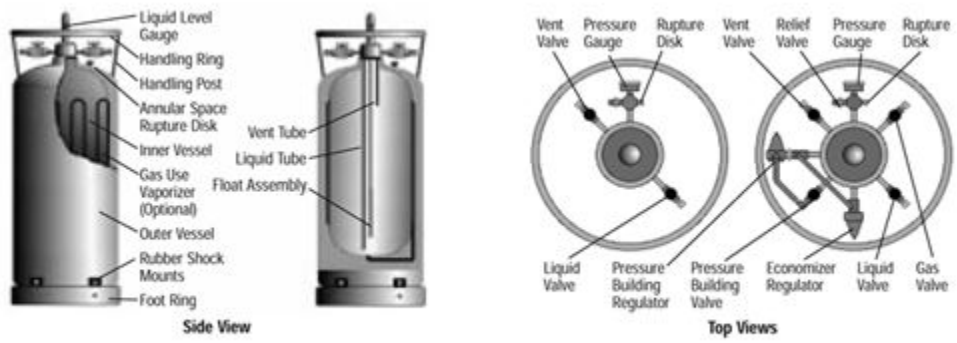

Figure 103C *Liquid Oxygen Cylinder*

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103.5.3: Cylinder Construction - Acetylene (See Figure 103D)

A. To decrease the size of the open spaces in the cylinder, acetylene cylinders are filled with porous materials such as balsa wood, charcoal, corn pith, or portland cement.
B. Acetone, a colorless flammable liquid, is added to the cylinder until about 40 percent of the porous material is saturated.

- The porous material acts as a large sponge, which absorbs the acetone, which then absorbs the acetylene.
- In this process, the volume of acetone increases as it absorbs the acetylene, while acetylene, being a gas, decreases in volume.
- Fuel-gas cylinders are identified with a flammable sticker attached near the top of the cylinder.

(See Figure 103E)

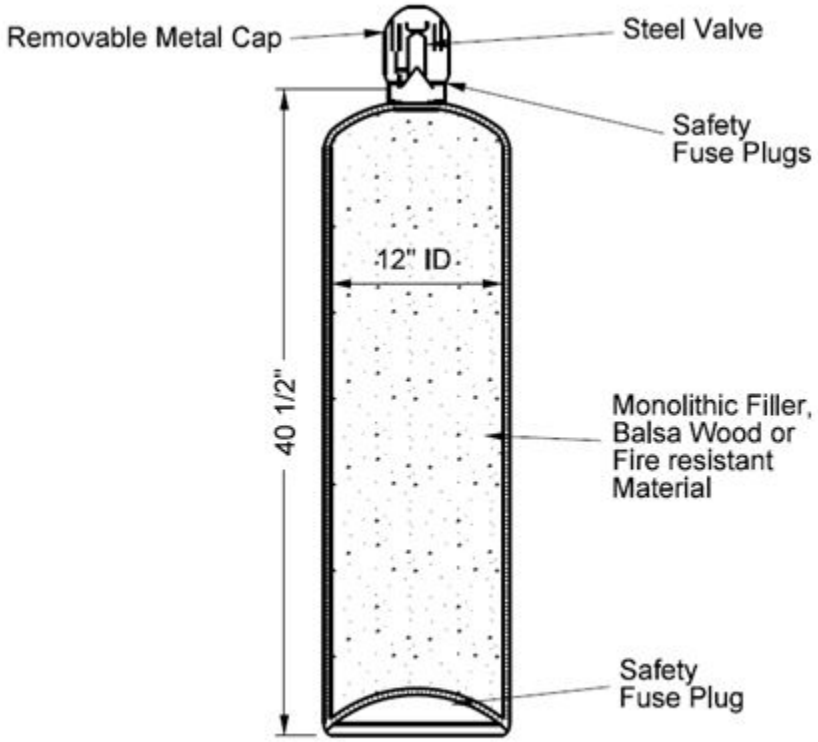

Figure 103D *Acetylene Cylinder*

Figure 103E *Flammable Marker*

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103.5.4: Exposure to Excessive Heat

Do not allow cylinders to be exposed to sparks, hot slag, open flame and other sources of excessive heat.

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103.5.5: Storing Cylinders

When storing oxygen and fuel-gas cylinders:
1. Handle cylinders with extreme caution to avoid dropping and damaging valves.
2. Separate oxygen cylinders from fuel-gas cylinders.

- Maintain a minimum distance of 20 feet.

  or

- Place a barrier of noncombustible material that is at least 5 feet high and has a fire resistance rating of at least 30 minutes between the oxygen and the fuel-gas cylinders.

3. Store oxygen and fuel-gas cylinders in an upright position on approved racks that are properly secured. Keep valve ends up. Cylinders must be secured, whether they are being transported or placed into storage.
4. Store cylinders in cool, well ventilated buildings away from elevators, stairs and passageways, when possible. Place them near exits for easy removal in case of fire.
5. Store cylinders in the open when the cylinders can be protected against freezing or direct sunlight.
6. Do not smoke or use matches, open-flame lights or torches in buildings where cylinders are stored. "No Smoking or Open Flames" signs must be posted on all visible sides.
7. When not in use, all outlet valves should be kept tightly closed, even though cylinders are considered empty. Valve caps must be kept in place.
8. Oxygen and fuel-gas cylinders, connections and appliances must be kept free from oils and greases. Do not handle cylinders with oily hands or gloves. Keep the cylinders away from combustible materials (e.g., oils, paints, shavings and other flammable materials).

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103.5.6: Working With Cylinders

When working with cylinders:
1. Do not place cylinders where they may become part of an electrical circuit. Avoid placing cylinders near wires and electrical welding circuits.

2. Do not strike an arc on or tap an electrode against a cylinder.
3. Oxygen and fuel-gas cylinders must be used in an upright position.
4. Do not throw, drop or otherwise roughly handle cylinders.
5. Do not leave cylinders standing upright unless they are secured to a suitable support with a chain or other holder.
6. Ensure compartments on work trucks are properly vented to the outside.
7. Block cylinders lying on the ground to prevent rolling.

Cylinders may be lifted by a crane, derrick or hoist only when a company-approved lifting device *(sling)* is used, and employees have been instructed on its use.
Note: Use of an electric magnet to lift cylinders is prohibited.

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103.5.7: Transporting Cylinders

When transporting gas cylinders;

1. Remove regulators and apply standard caps before transporting oxygen or fuel- gas cylinders, unless valves are covered by a Department of Transportation (DOT) approved safety cap or device designed for that purpose.

- An approved safety cap or device protects the cylinder valve and allows regulators to remain attached to the cylinder valve.
- Certain fuel-gas cylinders have recessed valves that are protected therefore don't require a safety cap.
- Hoses must be drained of gases and regulator adjustment screws turned counter-clockwise to close regulator diaphragm.

2. Caps need not be applied to complete a single series of welding operations while on company property.

3. When transporting oxygen and fuel-gas cylinders in tool cars or enclosed compartments, ensure proper ventilation is provided.

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103.5.8: Empty Cylinders

When cylinders are empty;
1. Close the cylinder valve before disconnecting the hose. Valves must remain closed when cylinders are not in use.
2. Apply standard caps to empty cylinders.

3. Remove bottom half of tag, where provided (red on fuel-gas cylinders, green on oxygen cylinders).
4. Separate empty cylinders from full cylinders.
5. Promptly exchange empty cylinders at the supply point.

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103.5.9: Leaking Cylinder

When a leaking cylinder is discovered;

1. Move it to an open area away from possible sources of ignition until the cylinder is empty.
2. Mark the cylinder, indicating the defect, so the supplier can take necessary corrective action.

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103.5.10: Changing Cylinders

Before a regulator is removed from a cylinder valve, the cylinder valve must be closed and the gas released from the regulator.

1. Drain both hoses, one side at a time, to remove any possible gas mixture.
2. Turn pressure-adjusting screw counter-clockwise to ensure no pressure on regulator diaphragm.

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103.6: Hot Metal Precautions

When cutting, use approved spark shields to prevent sparks, hot metal or severed sections from contacting cylinders, hose, cable or other flammable material. Do not lay object or material to be heated, cut or welded across a cylinder or on concrete.

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103.7: Regulators

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103.7.1: Proper Regulator

Do not use a regulator with a gas not intended for that regulator.

Each oxygen/fuel-gas cylinder or station must have a shut off valve and be controlled with a pressure reducing regulator to obtain the recommeded test pressures. Regulators must have operable gauges. Use of regulators without gauges is prohibited.

Each oxygen / fuel-gas cylinder or station must have a shut off valve and be controlled with a pressure reducing regulator to obtain the recommended test pressures. Regulators must have operable gauges. Use of regulators without gauges is prohibited.

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103.7.2: Single/Two Stage Regulators

The single-stage regulator has one reducing station and reduces the cylinder pressure of a gas to a working pressure in one step. When using a single-stage regulator, small adjustments are required to maintain a specific operating pressure as the cylinder pressure decreases.

The two-stage regulator has two reducing stations. The first station is usually preset at 200 psi and is not adjustable by the operator, which then flows into the second reducing stage.

An operator will not need to make adjustments to maintain operating pressure until the cylinder pressure drops below 200 psi. There is no safety advantage between the single-stage and two-stage regulator.

The regulator mechanism has a nozzle through which the high-pressure gas passes, a valve seat to close off the nozzle, and balancing springs. Some types have a relief valve and an inlet filter to exclude dust and dirt. Pressure gauges are provided to show the pressure in the cylinder or pipeline and the working pressure. (See Figure 103F)

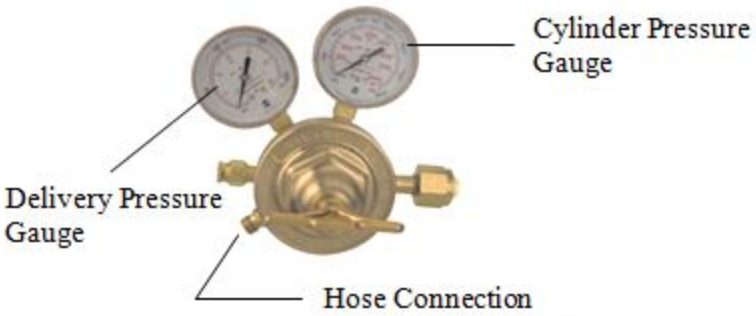

Figure 103F *Oxygen Regulator*

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103.7.3: Connections and Adaptors

Do not force connections. If the thread does not run easily, usually the wrong sized regulator is being applied. Use a standard adapter between the cylinder and the regulator if required. "Tee" or "Y" type connectors are prohibited.

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103.7.4: Connecting Regulators

Before connecting regulators to cylinders, welders must open the cylinder valve slightly to blow out any foreign matter.

- The valve should be opened approximately one-quarter turn and closed immediately.
- Do not open a fuel-gas valve near other welding work or near sparks, flame or other possible sources of ignition.

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103.7.5: Protecting Regulators

Protect regulators when not in use by:

- Closing cylinder valves.
- Draining hoses at the torch.
- Releasing pressure on the diaphragm.

Prevent a gas mixture from accumulating in the hose when either hose is being relieved of pressure by closing the valve of the other hose. This will prevent flashback, which could damage the torch, hose or pressure regulator.

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103.8: Cylinder Valves

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103.8.1: Opening Cylinder Valves

Pressure adjusting screws must be fully released before attaching regulator to cylinder. If regulators are already attached to cylinders, relieve pressure on adjusting screws before opening cylinder valve. When opening a cylinder valve, stand to one side, away from the gauge faces and the front of the regulator. Where a special wrench is required, it must be left in position on the valve stem while the cylinder is in use, in the event fuel-gas flow must be quickly turned off in an emergency.
Return the cylinder to the vendor if oxygen valve cannot be opened by hand. Do not use a hammer or wrench to open an oxygen cylinder valve.

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103.8.2: Oxygen Cylinder Valve

Most oxygen cylinder valves are double seated and are designed to be used in the fully open or fully closed position. Valve may leak if only partially opened.

- Place hand around oxygen cylinder knob, not on top of it when initially opening valve.

Slowly open the oxygen cylinder valve until the high pressure gauge indicates full pressure, then fully open the valve.

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103.8.3: Acteylene Cylinder Valve

Acetylene cylinder valves are of a single seat design.

- Do not open an acetylene cylinder valve more than 1-1/2 turns. This will allow the cylinder valve to be quickly shut off in case of an emergency.
- Leave the T-wrench on the acetylene cylinder valve stem in case an emergency arises.

Do not place tools or other items in the recessed top of a cylinder as this may damage the safety plugs or interfere with quickly closing the valve.

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103.8.4: Propane Cylinder Valve

Propane cylinder valves are double seated and are designed to be used in the fully open or fully closed position. Valve may leak if only partially opened.

- Slowly open the propane cylinder valve until the high pressure gauge indicates full pressure, then fully open the valve.

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103.8.5: Closing Valves

Valves of cylinders and stations on piped and manifold systems must be closed when not in use. When work is stopped or completed, or when the operator leaves the equipment, valves must be operated to relieve pressure on regulators and hoses.

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103.8.6: Clogged Valves

If ice or snow clogs fuel-gas cylinder valves, use warm or medium hot water to thaw them. Do not use boiling water, since it may loosen fusible plugs. Do not use any type of flame to thaw fuel-gas cylinder valves.

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103.9: Torch Valves

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103.9.1: Torch Valve Operation

Ensure torch valves are open when changing or adjusting pressure on regulators so gauges indicate actual operating pressures.

- Do not exceed pressures authorized for welding or cutting.

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103.10: Hoses

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103.10.1: Hose Description and Use

Hoses are provided with connections that allow proper attachment to regulators and torches.

- Fuel-gas hose fittings have left-hand threads which are identified by notches.
- Oxygen hose fittings have right-hand threads.

When using oxy-fuel equipment, use only equipment designed for the gas being used. When not in use, oxygen and fuel-gas hoses must be properly stored to prevent damage.

Oxygen and fuel-gas hoses must be inspected prior to each use. Hoses with leaks, wear or other defects must be repaired or replaced.
Connecting more than one length of hose together is not desirable, but when necessary, all connections must be tight.
Hoses must be protected from being stepped on, run over, kinked or tangled.
When lengths of oxygen and fuel-gas hose are taped together for convenience and to prevent tangling, not more than 4 inches out of 12 inches shall be covered by tape.
Two common hose types are:
1. Grade – "T": This hose is considered a multi-fuel hose. Different fuel-gases, i.e., acetylene, propane, natural gas, propylene and others can be used but not used alternately through the same hose.

Grade – "T" hose is manufactured in different diameters and has a flame resistant layer that won't sustain a fire.

- Track welders are required to use 3/8 inch ID Grade – "T" hose.

2. Grade –"R": This hose is manufactured for use with acetylene fuel-gas only.
Grade –"R" hose resembles Grade –"T" hose, but will deteriorate from the inside out if an alternate fuel-gas passes through the hose. An "R" grade hose does not have the same flame resistant layer.

Information, including hose type and diameter is stamped along the entire length of hose when manufactured. These stamped markings will wear off over time but may still be visible near where it is attached to regulators or hose reels.
Color-codes for hose are:
Red - Combustible gases
Green - Oxygen
Hose must be used only with the gases for which it is intended.
Hose length and diameter will affect stated pressures for equipment used.

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103.10.2: Hose Connections

Blow out new hose, with gas for which the hose will be used, to remove residue. In assembling hose connections, only crimp ferrules will be used.

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103.11: Torches

Torch handles and attachments must be maintained in good condition and carefully handled. When not in use, valves must be closed and torch stored in a safe place.

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103.11.1: Handle

Track welders must use a Victor HD310c or equivalent torch handle when performing welding duties. A Victor 315c or equivalent will not provide the required volume needed for thermite welding and must not be used. (See Figure 103G)

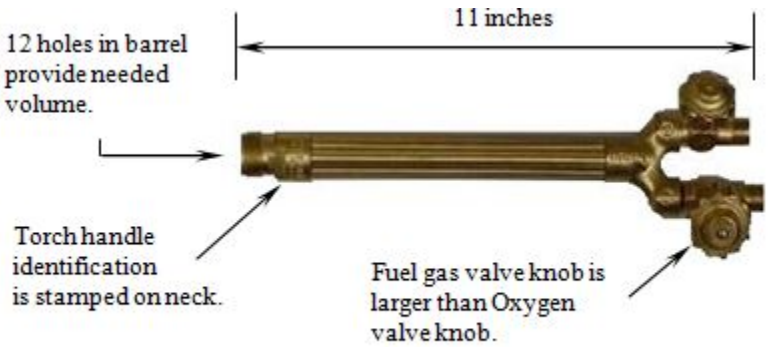

Figure 103G *Victor HD310c Torch Handle Identification*

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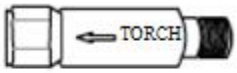
103.11.2: Flashback Arrestors

Ensure approved flashback arrestors are applied at the torch.

- Flashback arrestors are available in two types - torch mount or regulator mount.
- Ensure that the proper flashback arrestor is applied.
- Proper stamping can identify specific arrestor type.(See Figure 103H).
- Flashback arrestors extinguish a fire within the torch, preventing the fire from spreading back toward the cylinders.
- A flashback may occur due to dirty tips, lack of adequate fuel-gas pressure for tip size being used, or fuel-gas cylinders nearly empty. Should a flashback occur, determine its cause and correct before resuming operations.
- If a flashback occurs, immediately shutoff the oxygen valve on the torch handle if welding, or the cutting attachment if cutting.



Torch Mount

Figure 103H *Flashback Arrestor*

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103.11.3: Use of in-line Pressure Gauges

In-line gauges must be installed into oxy-fuel system when thermite welding. Gauges wil be installed between the torch handle and flashback arrestors.

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103.11.4: Cutting and Welding Attachments and Tips

Use proper torch and tips designed for the fuel-gas; e.g., Acetylene, Propane, Natural Gas, MAPP, etc.
(See Figure 103I)

- Acetylene cutting tips are one piece and have a flush end.
- Propane gas tips are a two piece design and have a recessed end.(The recessed end helps trap propane gas long enough to ignite)

Acetylene Cutting Tip

Propane Cutting Tip

Figure 103I *Cutting Tips*

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103.11.5: Torch Precautions

When working with torches:

- Ensure that the gas stream is not directed toward yourself or others.
- Keep the flame and sparks directed away from personnel, flammables, and equipment.
- Torch should be momentarily purged prior to lighting to ensure flow of oxygen and fuel-gas.
- Do not use the torch as a hammer, scraper or for other than its intended purpose.

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103.12: Equipment Setup

When setting up welding and cutting equipment, it is important that all operations be performed systematically. The following set-up procedures will assure safety to the operator and the apparatus.

Note: Comply with instructions stated in the fire prevention plan when using oxy-fuel equipment.

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103.12.1: Cylinder Use

When working with gas cylinders:
1. Place the oxygen and fuel-gas cylinders on a level floor (if they are not mounted on a truck), and tie them securely to a work bench, post, wall, or other secure anchorage to ensure the cylinders remain upright.
2. Remove the valve protecting caps.
3. Open the fuel-gas valve for an instant, then close to blow out any dirt or foreign matter that may have accumulated during shipment or storage.
4. Open the oxygen gas valve for an instant, then close.

Note: Do not stand facing cylinder valve outlets when opening cylinder valves

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103.12.2: Pressure Regulators

1. Check the regulator fittings for dirt and obstructions. Also check threads of cylinders and regulators for imperfections.
2. Connect the fuel-gas regulator to the fuel-gas cylinder and the oxygen regulator to the oxygen cylinder. Use an appropriate wrench and tighten the connecting nuts to prevent leakage.
3. Ensure there is no pressure on the regulator adjusting screws by turning counter-clockwise.
4. Check hose for defects including burns, nicks and bad fittings.
5. Connect the red hose to the fuel-gas regulator and the green hose to the oxygen regulator. Secure connecting nuts tightly to ensure leak-proof seating.

Note: Fuel-gas hose connections have left-hand threads and are notched for identification.

6. Open the cylinder valves slowly. Read the high-pressure gauges to check the cylinder gas pressure.
7. Connect the red fuel-gas hose to the flashback arrestor mounted on the torch handle. Connect the green oxygen hose to the flashback arrestor mounted on the torch handle.

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103.13: Leak Test

The system must be tested for leaks:

- Prior to initial use each day or shift.
- When combination torches have been converted or altered.
- When the torch equipment is suspected of being damaged.
- When a flashback has occurred.
- When new torch equipment is installed.

When checking the system for leaks, do the following:

1. With the oxygen cylinder valve open, adjust the oxygen regulator to deliver 20 psig.
2. With the fuel-gas cylinder valve open, adjust the fuel-gas regulator to deliver 10 psig.
3. Ensure the oxygen and fuel-gas control valves on the torch handle are closed.
4. Close the oxygen and fuel-gas cylinder valves.
5. Turn the adjusting screws counterclockwise one turn.
6. Observe the gauges on both regulators for 2 minutes. If the gauge readings do not change, the system is leak tight. If there is a leak, use an approved leak detection solution or soap and water to locate it.

a. If the High Pressure gauge reading decreases, a leak is present at the cylinder valve or inlet connection.Perform the following steps:

- Tighten the inlet connection after releasing pressure from the regulator.
- If the inlet connection continues to leak, have the regulator repaired by a qualified repair technician.
- Never tighten a cylinder valve.
- If the cylinder valve is leaking, remove the regulator from the cylinder and place the cylinder outdoors.
- Notify your gas supplier immediately.

b. If the Low Pressure gauge reading decreases, a leak is present at the regulator outlet connection; within the hose; at the torch inlet connection; or at the control valves on the torch handle.Perform the following steps:

- After the pressure has been released from the system, tighten the regulator outlet connection and the torch handle inlet connection.
- If these connections continue to leak, have the regulator or torch handle repaired by a qualified technician.
- Replace leaking hoses.
- Tighten or replace connections where leaks are found.

After testing the system and verifying that no leaks exist, the equipment may be used.

Use the appropriate form 24249 to record the inspection information, including the inspection date, gang#, if defect is found, employee signature, corrective action (if applicable) for later review by a welding supervisor.

Completed forms must be sent to the track welding manager.

Form 24249 can be accessed on the UP web under the HR Craft Training page or ordered through the online requisition system.

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103.14: Igniting and Extinguishing Torch

Use only a standard friction lighter to ignite all oxygen/fuel-gas equipment or fuel-gas equipment.

When igniting a torch, never point the torch toward others or flammable materials.
A lighted torch must not be:

- Laid down.
- Passed from one person to another.
- Kept in your hand when climbing.
- Left unattended

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103.14.1: Igniting Oxy-acetylene Torch

To properly ignite an Oxy-acetylene torch, use the following sequence:

1. Open the acetylene valve on the torch handle and ignite the gas.
2. Adjust flame so that the black carbon smoke disappears.
3. Introduce oxygen and adjust to a neutral flame.

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103.14.2: Extinguishing Oxy-acetylene Torch

To properly shut down an Oxy-acetylene torch, use the following sequence:

1. Shut off the oxygen valve on the torch handle.
2. Shut off the acetylene valve on the torch handle.

By following this sequence, both sides of the system are checked for leaks.

1. If a "pop" is heard, the oxygen valve is leaking.
2. If a small flame is still burning on the tip of the torch, the acetylene valve is leaking.

Tighten the leaking valve with a wrench or take to a qualified repair facility.
Note: Shutting off the acetylene valve first will create a "pop" every time and result in soot being blown back into the torch.

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103.14.3: Igniting Oxy-propane Torch

To properly ignite an Oxy-propane torch, use the following sequence:

1. Slightly open the propane valve.
2. Open the oxygen valve about 1/4 turn (slightly more than the propane valve).
3. Ignite the torch, adjust to a neutral flame.

Note: When igniting the torch, if there is a gap between the torch tip and the flame, too much propane is present. Extinguish the flame by closing the propane valve first, then closing the oxygen valve and start over.

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103.14.4: Extinguishing Oxy-propane Torch

To properly shut down an Oxy-propane torch, use the following sequence:

1. Shut off the propane valve at the torch handle.
2. Shut off the oxygen valve at the torch handle.

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103.15: Tip Charts

Use appropriate tip chart for fuel-gas type being used. (Refer to Table 103A)

Table 103A Oxy-fuel Tip Chart

Tip Size	Oxygen (PSIG)	Fuel-Gas (PSIG)
Thermite Preheating Tip	60	15
#3 Cutting Tip (propane)	40/45	5/9
#4 Cutting Tip (propane)	40/50	8/12
#5 Cutting Tip (propane)	45/55	8/12
#3 Cutting Tip (acetylene)	40/45	5/10
#4 Cutting Tip (acetylene)	40/50	5/11
#5 Cutting Tip (acetylene)	45/55	6/12

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103.16: Draining the System

When work is complete, the oxy-fuel system must be drained and equipment properly stored.
Drain one side of the oxy-fuel system at a time as follows:

1. Ensure all valves on the torch handle are closed.
2. Close both valves on the cylinders.
3. Open the oxygen valve on the torch handle to exhaust oxygen from the hose, close valve.

4. Release the pressure on the oxygen regulator by turning the pressure adjustment screw counter clockwise.
5. Open the fuel-gas valve on the torch handle to exhaust fuel-gas from the hose, close valve.
6. Release the pressure on the fuel-gas regulator by turning the pressure adjustment screw counter clockwise.

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104.0: EQUIPMENT

- 104.1: Equipment Description
- 104.1.1: Rail Saws
- 104.1.2: Grinders
- 104.1.3: Hydraulic Rail Pullers
- 104.1.4: Wire Feeders

104.1: Equipment Description

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March 1, 2007

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104.1.1: Rail Saws

A rail saw can be powered by gasoline, hydraulic or electric. When operating a rail saw:

- The guide support arm must be used when cutting rail (freehand cutting is prohibited).
- Warn others that you are about to begin cutting rail.
- Personnel are prohibited from standing in front of the rail saw while cutting rail.
- Required Personal Protective Equipment (PPE) must be used when operating a rail saw.
- Inspect equipment regularly to ensure it is operating safely and efficiently.
- Do not fuel gasoline powered rail saws closer than 20 feet from where the rail is to be cut.

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104.1.2: Grinders

- Straight Shaft Grinders - A straight shaft grinder can either be hydraulic or electric, and with the appropriate abrasive wheels can be used for many purposes. This can include maintenance grinding, removing metal flow, slotting and welding preparation. This type of grinder is not recommended for finishing rail or component surfaces.

- Angle Grinders - An angle grinder can either be hydraulic or electric and is used primarily to finish grind rail and component surfaces and radii. This type of grinder can also be used in maintenance grinding, removing metal flow and welding preparation.
- Profile Grinder - A profile grinder can either be hydraulic, gas or electric and is used primarily to grind thermite welds and flash butt welds. This type of grinder, if designed for the task, can also be used to grind the surface of rail ends and frogs.
- Switch Grinders - A switch grinder can either be hydraulic, gas or electric and is designed for maintaining turnouts by removing metal flow and restoring radius on stock rails, switch points and frogs.
- Frog Grinders - A frog grinder can either be hydraulic or electric and is used to grind frog flange-ways and running surfaces after weld repairs. This type of grinder can also be used for maintenance grinding, including removing metal flow and restoring radius.
- Web Grinder - A web grinder is generally powered by hydraulics and is designed to grind the web and base of both thermite and electric flash butt welds.
- Bull Nose Grinder - A bull nose grinder is designed specifically to de-burr and chamfer (bevel) bolt holes. Separate bull-nose grinding stones are available and can be used on portable hand tools or impact tool with appropriate adaptors.

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104.1.3: Hydraulic Rail Pullers

A rail puller is used to pull rail together at pull-aparts, service failures or while installing thermite welds.
Review and be familiar with manufacturer's operating and maintenance manuals before operating equipment.

- If manuals are not available, contact your supervisor to obtain a copy.

Daily inspection and maintenance is required to ensure rail puller is in safe operating condition before each use.
Perform daily maintenance as follows:

- Jaws have been cleaned with a wire brush.
- Pivot areas have been lubricated.

Annual maintenance is required to ensure proper operation of the rail puller. When disassembling, only remove one corner at a time.

- Only trained employees are allowed to complete this process.

Disassemble and clean all four corners of the rail puller as follows:

- Remove latch pin and tie rod from swing arm.
- Remove swing arm from bracket.
- Remove rail jaw from swing arm.

Properly clean all pivot surfaces with brake cleaner, wire brush, wire wheel or flap wheel and wipe clean with a towel. Lubricate all pivot surfaces with anti-seize before reassembly.
Ensure rail puller jaws are installed with the arrows pointing towards the center of rail puller.
Any time a rail puller is used, caution must be taken and only authorized personnel are permitted to operate equipment.

- All other individuals must not be near rail puller when in operation.
- No one is allowed to be near the ends of the rail puller when under pressure and standing at the end of a rail puller under pressure is prohibited.

Follow these procedures when using a rail puller:

- Low rail joints must be raised and ties tamped before setting rail puller on the rail.
- Remove by grinding, any raised lettering on the rail or other protrusions where jaws will contact rail.
- Remove dirt or grease from this area using a wire brush or torch if necessary. Clean and inspect the jaws for conditions that could reduce gripping.
- Pre-align rail ends to be welded to an approximate crown before pulling.
    - Alignment plates must be used for aligning rail.
- Remove enough rail anchors or fasteners to allow the rail to move the required distance to complete the pull. Removing anchors or fasteners allows the rail to move freely and not over exert the rail puller.
- If the desired pull cannot be achieved, release the rail puller, remove additional anchors or fasteners and pull again.
- Do not strike any portion of the rail puller or track structure while the rail puller is under load, including removing or applying rail anchors or fasteners.
- Striking the rail puller or track structure may cause the rail puller to lose grip.

In addition, follow these instructions when using the old style RPE 120 Simplex Rail Puller with removable wedges.

- Ensure safety guards and rod latches are in place and functioning properly before use.
- Do not use a rail puller if guards or latches are missing or damaged.
- Clean and inspect the wedges for conditions that could reduce gripping.
- Apply a light coat of oil or grease to the backside of wedges that contact the bracket.This will help when removing the expander.
- Insert the wedges with the teeth facing the rail.
- Store rods and wedges properly to prevent damage.

A rail puller should be used on closure welds when one or more of the following conditions apply:

A. The rail temperature is lower than the rail laying temperature.
(Refer to standard drawing 0045 to obtain rail-laying temperature)

B. The reference marks indicate that you are adding rail.

C. A decrease in rail temperature may occur during the welding process, such as rapidly changing weather conditions.

When working in close proximity to another gang using a rail puller, permission must be obtained solely from the Manager of Track Welding to use the second rail puller on the same rail.

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104.1.4: Wire Feeders

Wire feeders are connected to the welding machine by the positive electrode cable and allow electric arc welding to be performed when making repairs to track components or welding pieces of metal together. Approved wire feeders for track welding must have 5/64" drive rolls, set to indicate amperage instead of inches-per-minute and run on Constant Voltage (CV) if welding machine has the capability.

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105.0: WELDING RAIL ENDS

- 105.1: Personal Protective Equipment (PPE)
- 105.2: Purpose of Welding Ends
- 105.3: Alloy Rail Precaution
- 105.4: Use Proper Stick and Wire Electrodes
- 105.5: Prepare for Welding
- 105.6: Determine Weld Length
- 105.7: Remove Defective Material
- 105.8: Preheat and Maintain Inter-Pass Temperature
- 105.9: Apply Weld
- 105.10: Post Heat
- 105.11: Temporary Rail Ends Buildup
- 105.13: Slot Rail Ends
- 105.12: Surface Grind Rail Ends

105.1: Personal Protective Equipment (PPE)

Task	Required PPE
Abrasive Grinding	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel /Fuel-gas Heating	Hard hat, hearing protection, dual eye protection as follows: *1.* Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or *2.* Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Electric Arc Welding	Welding hood properly shaded with hard hat (unless using the approved non-hard hat PAPR welding hood), hearing protection, safety glasses, leather welding gloves, welding jacket or welding sleeves, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.

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105.2: Purpose of Welding Ends

The purpose of welding rail ends is to:

- Correct rail end batter.
- Repair chipped rail ends.
- Fit a good section of rail next to a worn section of rail.

Do not weld rail ends to:

- Correct drooped ends or surface bent rail.
- Compensate for worn joint bars, loose bolts or poor track surface.
- Repair engine burns (wheel burns) or crushed heads
- Defect must be replaced with at least a 15 ft. rail.

Do not weld gage face of rail.

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105.3: Alloy Rail Precaution

Preheating and postheating procedures are different for alloy and non-alloy rail. Chrome-vanadium and chrome-moly rails are extremely sensitive to rapid cooling. Additional care must also be used when working with alloy rail, including:

1. Not installing alloy rail as replacement rail.
2. Not over heating (bluing) alloy rail when drilling or cutting.
3. Using sharp drill bits of the proper size and lubricant when drilling bolt holes.
4. Not performing arc welding on alloy rail when the ambient temperature is below 32° F.

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105.4: Use Proper Stick and Wire Electrodes

Use only the following approved stick and wire electrodes when welding. (Refer to Table 105A)

Table 105A Rail Steel

Item Number	Approved Electrode	Welding Parameters
4601512	Postalloy RailTuff 3/16" Stick	170 - 225 Amps
4601690	McKay M932 1/4" Stick	290 - 310 Amps
4601091	Railbuild 540 3/16" Stick	170 - 200 Amps
4601124	Railbuild 540 1/4" Stick	210 - 230 Amps
4606901	Railbuild 540 5/64" Wire	28 - 29 Volts/ 280 Amps

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105.5: Prepare for Welding

Prior to welding rail ends, prepare the joint as follows:

1. Surface the joint by tamping ties on each side of the rail joint.
2. Install and/or tighten bolts as necessary.
3. Replace joint bars where necessary.
4. Disassemble Poly-Portec or similar insulated joints and install standard joint bars prior to welding. (Re-install insulation after weld cools).

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105.6: Determine Weld Length

If both rails are on the same plane and rail is battered or chipped, follow these instructions: (See Figure 105A)

1. Build rail to a level surface matching existing rail beyond batter or chip.
2. Do not end weld directly over a bolt hole.
3. Do not weld beyond the outermost bolt hole.
4. To check for true rail end batter, use a straightedge independently on each rail.

- If rail is damaged beyond outermost bolt hole, the rail must be replaced.

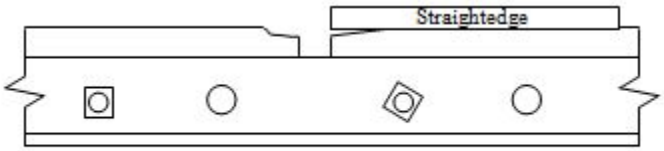

Figure 105A *Chipped or Battered Rail End*

If one rail is on a lower plane than the abutting rail:

1. Place a straightedge on the high rail and extend the end of the straightedge out above the low rail.
2. Measure the distance between the straightedge and the low rail.
3. Determine the length of the weld on the low rail by dividing the measurement (in thousandths of an inch) in step 2 by 0.012 inch. (See Figure 105B)

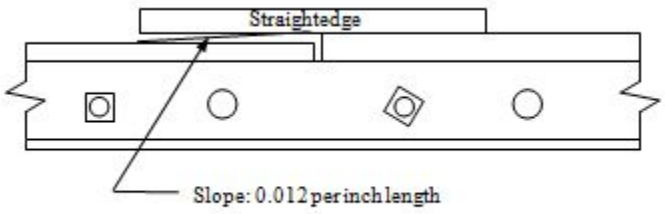

Figure 105B *Marking Joints for Length of Ramp*

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105.7: Remove Defective Material

Use a grinder to remove all fatigued, spalled or otherwise defective material.

(Do not use carbon arc cutting or oxy-fuel cutting for this purpose)

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105.8: Preheat and Maintain Inter-Pass Temperature

Use of a teleweld or other approved rail end heater is recommended for preheat and postheat. Use a temp-stick or pyrometer to measure the rail temperature during preheating.
When using a pyrometer, measurement must be taken at the same spot and distance each time and no farther than 8 inches away.
1. Preheat the entire weld area plus 3 inches beyond the weld area to the required temperature.

- Preheat non-alloy rail to 700° F.
- Preheat alloy rail to 1,000° F.

2. Maintain this temperature (inter-pass temperature) throughout the welding operation by welding beads 3/4 inch to 1 inch wide.
3. If train operations or other occurrences interrupt the welding operation, the rail must be re-heated to the minimum pre-heat

temperature before welding continues.

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105.9: Apply Weld

Apply the ground clamp to a rail anchor. Do not apply to or allow ground clamp to make contact with any part of the rail or joint bar as this may lead to an electrical arc resulting in a fracture.

1. Make weld beads 3/4 inch to 1 inch wide.
2. Weld bead length may be as long as repair area, if necessary.
3. Overlap weld beads 30% to 40%.
4. Remove slag with a chipping hammer after applying each weld bead.
5. Peen each weld bead 2 to 3 times per inch with a 2 lb. Ball-Peen Hammer.
6. Apply longest weld beads on the gage side of the rail. (See Figure 105C)
7. Do not use carbon blocks on high carbon steel - use copper rail end jig if available. This is to help maintain a shoulder on the edge of the rail end.

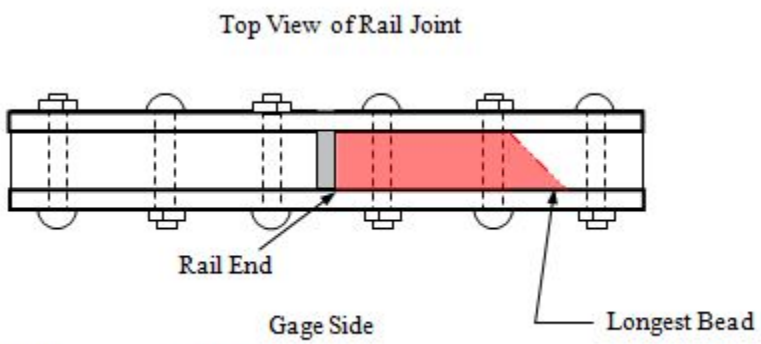

Figure 105C *Weld Bead Pattern*

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105.10: Post Heat

Use a temp-stick or pyrometer to measure the rail temperature during postheating. When using a pyrometer, measurement must be taken at the same spot and distance each time and no farther than 8 inches away.

1. Postheat 1 inch from the end of rail to 3 inches beyond the weld area, to the required temperature.

2. Postheat non-alloy rail to 1,000° F.
3. Postheat alloy rail to 1,200° F.

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105.11: Temporary Rail Ends Buildup

A temporary rail end buildup is used to prevent batter on the higher rail of mismatched rail ends and comply with FRA tread mismatch requirements; e.g. during curve rail or switch component replacement. (See Figure 105D)

Rail preparation for temporary rail end buildup must comply with standard rail end welding procedures including, grinding parent metal, preheating and postheating the same as permanent welds. Failure to properly heat rail ends will result in the formation of brittle martensite and thermal cracking.

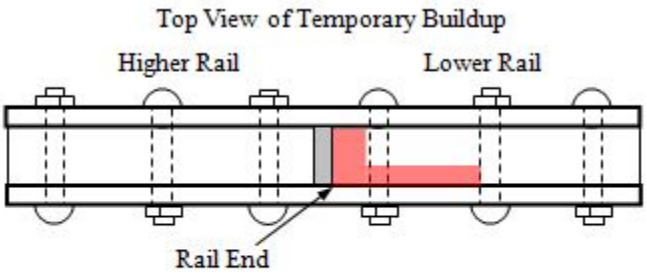

Figure 105D *Temporary Buildup*

Temporary built-up rail ends are not intended to be permanent and should be removed at first opportunity.

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105.13: Slot Rail Ends

(See Figures 105F – 105I)
The RPM rating of abrasive wheels must meet or exceed the RPM rating of the power equipment that is being used.

- Slotting wheel must not be more than 1/8 inch thick.

- The slot should match the contour of the rail end.
- Avoid cutting into or nicking the joint bars.

Open Joints:

- Square the rail end by removing any metal flow by grinding.

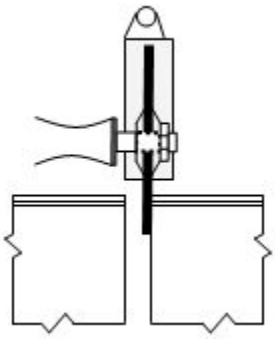

Figure 105F *Squared Rail Ends*

Slot rail ends to the required dimensions.

- Slot the rail end to 1/4 inch to 5/16 inch deep.
- Bevel the rail end to 1/16 inch to 3/32 inch back.

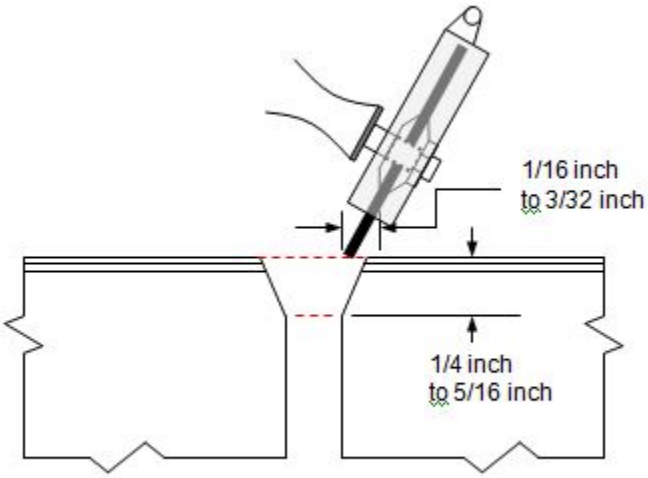

Figure 105G *Open Joint Angle*

Closed Joint:

- Center the slotting wheel between the rail ends of closed joints to remove an equal amount of metal from each rail.
- Slot the rail end to 1/4 inch to 5/16 inch deep.
- Slot to a width of 3/16 inch.

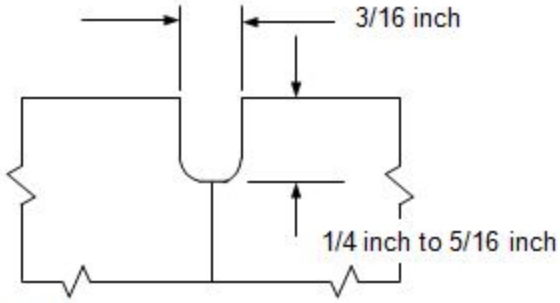

Figure 105H *Closed Joint*

Insulated Joints:

- Remove only flowed metal from rail ends.
- Do not leave a sharp edge on rail end after slotting.
- Avoid cutting the end post as much as possible.
- Do not slot any deeper than necessary to remove flowed metal.

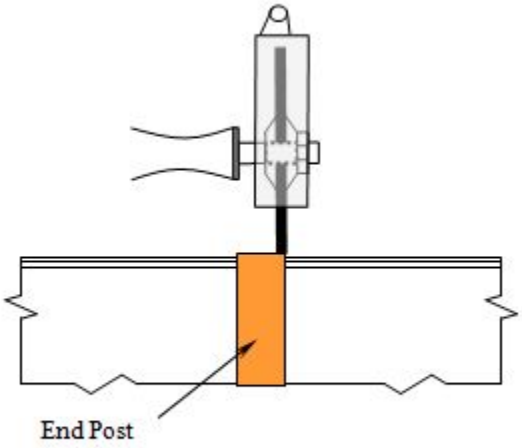

Figure 105I *Insulated Joint*

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105.12: Surface Grind Rail Ends

(See Figure105E)

- Grind the gage and field side of rail ends to match the existing profile of rail (Remove overflow).
- Grind the surface of rail ends level – tolerance is 0.000 inch low to 0.010 high.
- If one rail is lower than the other, after welding, grind a uniform tapered surface from the end of the high rail to the end of the weld repair on the low rail.
- If bond wires are damaged, notify the Signal Maintainer or Signal Operations Hotline.

    - Remove rail bonds by grinding only.

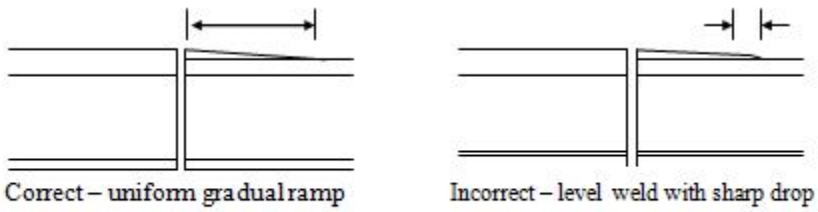

Figure 105E *Grinding Ramp*

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106.0: WELDING SWITCH POINTS

- 106.1: Personal Protective Equipment (PPE)
- 106.2: Switch Point Repair Restrictions
- 106.3: Switch Point Identification
- 106.4: Identify Rail Type
- 106.5: Switch Point Wear
- 106.6: Remove Metal Flow from Stock Rail
- 106.7: Removal of Defective Material
- 106.8: Welding Switch Points
- 106.9: Grind Switch Points
- 106.9.1: Top and End of the Switch Point
- 106.9.2: Gage and Stock Rail Side of Switch Point

106.1: Personal Protective Equipment (PPE)

Task	Required PPE
Abrasive Grinding	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel /Fuel-gas Heating	Hard hat, hearing protection, dual eye protection as follows: *1.* Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or *2.* Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Electric Arc Welding	Welding hood properly shaded with hard hat (unless using the approved non-hard hat PAPR welding hood), hearing protection, safety glasses, leather welding gloves, welding jacket or welding sleeves, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement and use of required fan.

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106.2: Switch Point Repair Restrictions

Do not weld or use repaired switch points in main line switches or siding switches in Class 3 and above tracks.

Note: Maximum posted speed, including main line track or sidings, is determined by the maximum operating speed of the subdivision.

This includes both straight and turnout switch points on mainline and siding tracks.

Welding repair of manganese "Sampson" type switch point inserts (for undercut stock rails) is prohibited.

Heel end of switch points may be welded in all tracks according to procedures for rail end welding in Chapter 105.0 - Welding Rail Ends.

Trains or engines must not operate over switch points being repaired by welding until all pre-grinding, welding, finish grinding and required adjustments are complete. Take the switch out of service until all work is complete.

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106.3: Switch Point Identification

There are two switch point designs:
(See Figures 106A and 106B)

1. Standard (Knife Point) design switch point used with standard full ball rail section stock rail as shown on the left.
2. Samson switch point and stock rail are chamfered on mated surface as shown on the right.

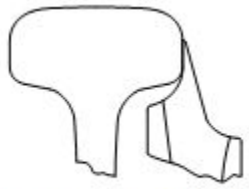

Figure 106A *Standard Knife Point*

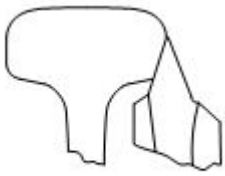

Figure 106B *Samson Point*

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106.4: Identify Rail Type

Rail steel switch points are a full length one piece point and are magnetic.

Manganese switch points are an insert that bolts to the longer carbon steel switch point section and are non-magnetic.

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106.5: Switch Point Wear

If a switch point is worn down or chipped so that the top is more than 7/8 inch below the plane across the top of the stock rail, switch point must be repaired or replaced. (See Figure 106C and Refer to Table 106A)

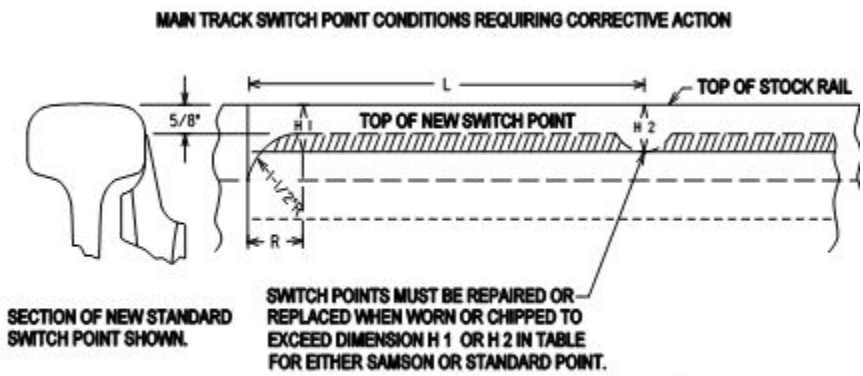

Figure 106C *Switch Point Wear*

Table 106A Switch Point Dimensions

Length of Switch Point	Distance			
	R	**H 1**	**L**	**H 2**
Up to 19' 6"	1-1/2"	7/8"	Over 10"	3/4"
19' 6" or over	1-1/2"	7/8"	Over 16"	3/4"

If a switch point is chipped and has an unprotected vertical surface that is 5/16 inch or wider, 3/4 inch below the top of the stock rail, switch point must be repaired or replaced. (See Figure 106D)

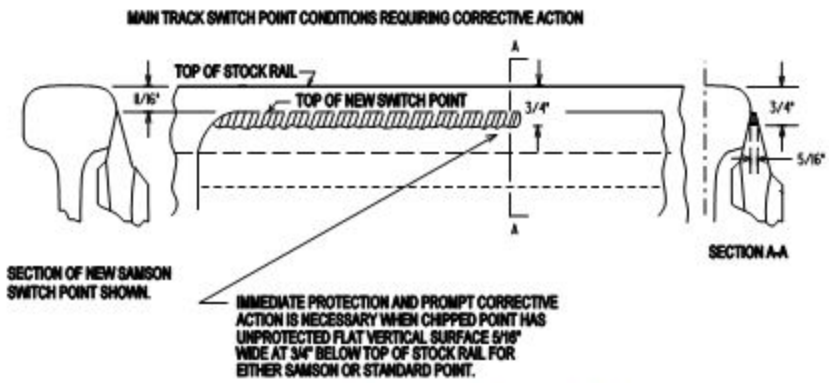

Figure 106D *Switch Point Wear*

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106.6: Remove Metal Flow from Stock Rail

Excessive metal flow will prevent the switch point from properly closing against the stock rail and should be removed where the switch point contacts the stock rail to provide a good fit.
To remove metal flow:

1. Remove all flowed metal from the gage side of the stock rail before welding the switch point as follows:
    a. Start 4 inches ahead of the switch point and grind back toward the heel where the switch point ends contact with the stock rail.
    b. Ensure no sharp projections remain after grinding.
    c. When removing metal flow from stock rails, taper each end of the grind to a minimum of 4 inches in length. (See Figure 106E)

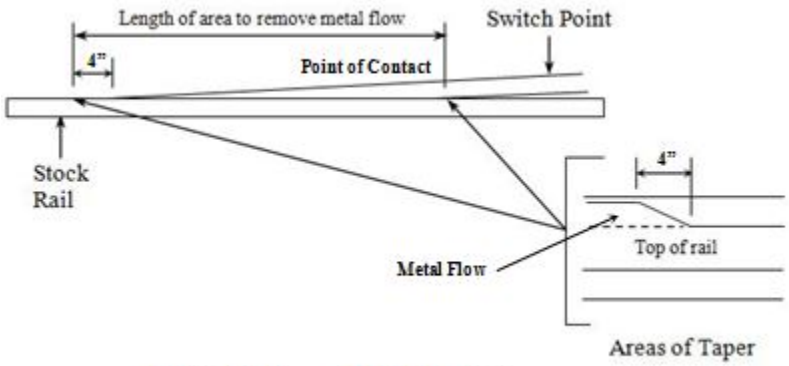

Figure 106E *Areas of Taper*

2. Restore the gage and field side corners of the stock rail to a 5/16 inch to 9/16-inch radius as per standard drawings.

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106.7: Removal of Defective Material

Remove defective material from switch points by grinding only.

- Do not use carbon arc cutting or oxy-fuel torch cutting for this purpose.

When removing defective metal prior to welding repair, create a level surface by grinding the entire weld area flat. **Maximum length of repair shall not exceed 16 inches.**

(See Figure 106F)

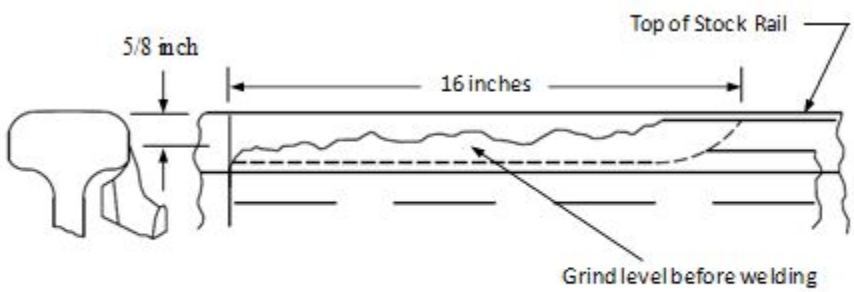

Figure 106F *Switch Point Repair*

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106.8: Welding Switch Points

When welding switch points:

1. On standard carbon rail steel switch points, preheat the entire weld area plus 3 inches past, to 700º F. Maintain this temperature throughout the welding process.

- If temperature falls below the minimum required preheat temperature, steel must be re-heated before welding continues.

2. On manganese steel switch point inserts, do not preheat the steel.

   - Do not allow the temperature of the parent steel to exceed 500º F. Use air to help cool the manganese steel.
   - Use a temp-stick to measure temperature 1/2 inch below deposited metal.

3. Insert a 1/4 inch x 3 inch x 18 inch copper backing plate between the switch point and the stock rail before welding.

   - Switch point must not be in the open position when welding but must be closed against stock rail.

4. Use only the following approved stick electrodes when welding.

   (Refer to Table 106B and Table 106C)

Table 106B Rail Steel

Item Number	Approved Electrode	Welding Parameter
460-1512	Postalloy RailTuff 3/16"	170 - 225 Amps
460-1091	Railbuild 540 3/16"	170 - 200 Amps

Table 106C Manganese Steel

Item Number	Approved Electrode	Welding Parameter
460-1512	Postalloy RailTuff 3/16"	170 - 225 Amps
460-1091	Railbuild 540 3/16"	170 - 200 Amps

5. Begin welding at the tip of the switch point.

   - Once the electric arc is established, move the electrode quickly away from the end of the switch point to avoid melting the tip.
   - Slow the travel speed as the welding progresses away from the switch point tip.

6. Remove all slag before depositing the next layer of weld metal.

   - Do not use a needle scaler on carbon rail steel for this purpose. (Use a chipping hammer only)

7. Peen each bead and clean with a wire brush before applying next weld layer.

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106.9: Grind Switch Points

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106.9.1: Top and End of the Switch Point

Grinding the top and end of the switch point:

1. The tip of the switch point must be 5/8 inch to 3/4 inch lower than the crown of the stock rail. Refer to standard drawings for specific dimensions of various size switch points.
2. Ensure the top of the point tapers back so that the first 8 inches of the point will not carry any load. (See Figure 106G)

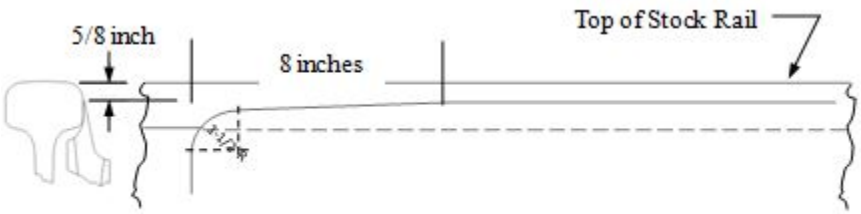

Figure 106G *Finished Switch Point*

3. Grind the end of the switch point to a narrow edge.
    - Do not grind to a sharp edge as this may cause the switch point to crack.
4. Grind off the metal flow on back of the switch point to obtain a close fit between the switch point and the stock rail.
5. Use straightedge frequently to prevent bumps and dips to ensure a uniform finish grind.

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106.9.2: Gage and Stock Rail Side of Switch Point

Grinding the gage and stock rail side of the switch point:

1. Grind the gage side corner to a 5/16-inch to 9/16-inch radius as per standard drawings.
2. Slightly bevel the top of the stock rail side, except the first 10 inches from the end of the point.
3. Slot the rail end at the heel of the switch point.

Check for proper fit between the switch point and stock rail after all welding and/or grinding operations are completed. Note: Apply grease if available, to help extend the life of the switch point.

Always have a Signal Maintainer available when welding or grinding on switches equipped with switch machines, electric locks or circuit controllers.

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107.0: FROGS: GENERAL

Chapter Introduction

The installation date will be written on the frog using a white metal marker for warranty purposes.

- 107.1: Frog Repair Guidelines
- 107.1.1: Clamped Frogs
- 107.1.2: Solid Base
- 107.1.3: Repairs to Specific Frogs
- 107.1.4: Beyond Main Line Switch
- 107.1.5: Chipped or Battered Rail Ends
- 107.1.6: Reconditioned Manganese Frogs
- 107.2: Frog Identification

107.1: Frog Repair Guidelines

When repairing frogs, every effort must be made to complete the welding and grinding process to standard specifications when time permits. If frog cannot be completed as required, wings and point must be at the same height to evenly support the weight of the train. A frog that has been temporarily repaired must comply with FRA regulations or appropriate slow order must be provided.

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107.1.1: Clamped Frogs

Before welding frogs out of track, clamp them to a rigid support to prevent warping.

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107.1.2: Solid Base

Ensure all frogs or other components welded in track are on a solid base and all bolts are tight.

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107.1.3: Repairs to Specific Frogs

A. Rail-Bound Manganese Insert Frogs (RBM)
RBM frogs in all main line, branch line and other track may be repaired by welding.

- Heel leg extension rails are made of carbon rail steel, and on specific frogs can be repaired by welding as outlined in Chapter 105.0 Rail End Repairs and 109.9 Heel Leg Extension Rail.
- Conformal RBM frogs have a 1:20 slope and will be maintained to design specifications for grinding maintenance but welding repairs can be made to accommodate a flat slope.
    - For inspection and maintenance practices, refer to Section 5.0 Turnouts in the Engineering Track Maintenance Hand Book.
- All repaired frogs must be finish ground to meet FRA specifications for surface wear and flangeway clearance.

B. Rigid Bolted Frogs (Carbon Rail Steel)
Do not repair rigid bolted frogs by welding in the field, except on the following tracks:

- Branch line track where the maximum authorized speed is 30 MPH or less as designated by the timetable maximum subdivision speed.
- Sidings, yard tracks and industry tracks beyond the clearance point of the main track switch.

C. Carbon Steel Spring Rail Frogs
Do not repair carbon spring rail frogs by welding except rail ends, forged horn straps and hold-down housing.
See instructions 108.5 Weld Spring Rail Frog Horn for repair guidelines and procedures.

- Bolt on horns and housing will be replaced if broken.

D. Manganese Steel Insert Spring Rail Frogs
Repair manganese insert spring rail frogs by welding according to the requirements in Chapter 109.0.

- Only the manganese casting and carbon steel rail ends are allowed to be repaired by welding.

E. Solid Manganese Self Guarded (SMSG) Frogs
SMSG frogs in all branch line, yard tracks and industry tracks may be repaired by welding.

- Check guard face for excessive wear prior to working on SMSG frog. (See Figure 107A)
- If guarding face requires repair, it must be welded and finish ground before welding the point.
- Switch must be removed from service until the guarding face repair is complete.

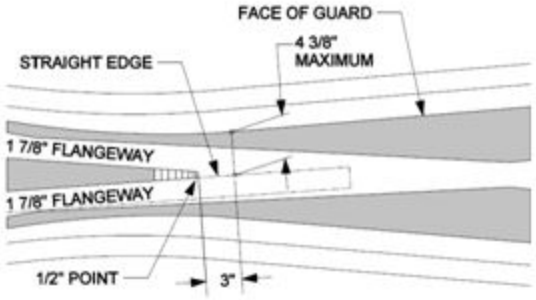

Figure 107A *Measure SMSG Frog*

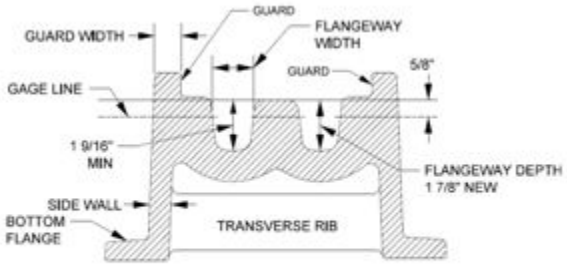

Figure 107B *Cross Section SMSG Frog*

F. Moveable Point Frog

Electric arc welding repair is prohibited on moveable point frogs. Repairs are confined to maintenance grinding only, including slotting to remove metal flow and prevent chipping and cracking.

G. Jump Frog

The flange bearing manganese casting of a jump frog can be repaired by welding to rebuild the flange bearing portion if the wear depth does not exceed 1 inch. 1/4 inch of surface material must be removed to get below the work-hardened metal. At no time can the flange bearing area be higher than its original height. Refer to Chapter 109.0 for repairing manganese steel.

H. Crossing Frogs (Diamonds)

Crossing frogs are made out of a combination of manganese steel and carbon rail steel. The manganese portion of a crossing frog can be repaired in track using the electric arc welding process as stated in Chapters 108.0 and 109.0. Due to the design of a crossing frog, maintenance grinding is required on a regular basis with an emphasis on adjoining parts that require slotting to prevent chipping.

I. One Way Low Speed (OWLS) Crossing Frog (Diamond)

The flange-bearing portion of an OWLS crossing frog is made of manganese steel.

When welding repairs are necessary to build up the worn flange-bearing groove, 1/4 inch of surface material must be removed to get below the work-hardened metal.

- Area of repair must be ground to a clean level surface.
- An approved stainless electrode can be used to seal any hairline cracks. One to three passes will be sufficient.
- Complete the remaining repair with an approved manganese stick or wire electrode.
- Do not heat the manganese casting to above 500º F, which will lead to embrittlement and thermal cracking.
- At no time can the flange bearing area be higher than its original height.

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107.1.4: Beyond Main Line Switch

If a frog is beyond the clearance point of a mainline switch it can be repaired by welding unless; the repair does not comply with instruction 107.1.3 (B) Bolted Rigid Frogs or (C) Carbon Spring Rail Frogs.

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107.1.5: Chipped or Battered Rail Ends

Weld chipped or battered rail ends at the toe and heel of any frog in any track according to procedures for rail end welding in Chapter 105.0 Welding Rail Ends.

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107.1.6: Reconditioned Manganese Frogs

Manganese frogs reconditioned at repair shops are considered *new* frogs.

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107.2: Frog Identification

This section explains how to identify frogs by weight, size and type.

The rail weight and frog sizes are stamped on a tag attached to the heel of the frog or cast into the top of the filler block. If these markings are not clearly visible, determine the size of the frog as follows:

a. With a tape measure mark a 3-inch width across the top of the frog.

b. Mark a 4-inch width across the top of the frog.

c. Measure between marks. The number of inches measured equals the frog number.
(Refer to Figure 107C)

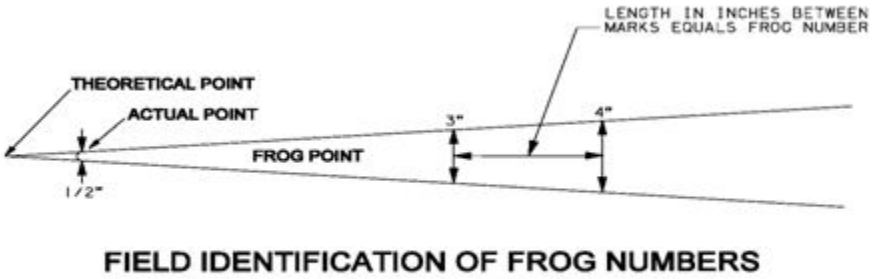

Figure 107C *Frog Size Identification*

- Railbound Manganese Frog (RBM) - The railbound manganese frog has a cast insert for the point section of the frog.

  (Refer to Figure 107D)

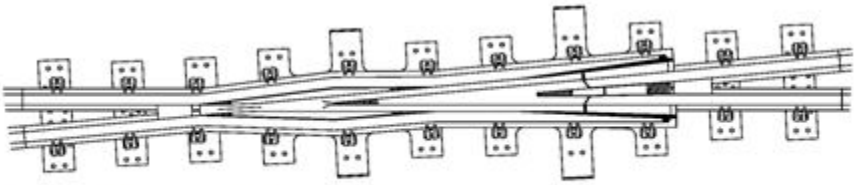

Figure 107D *Railbound Manganese Frog*

- Rigid Bolted Frog - The rigid bolted frog is made entirely of rail steel. (Refer to Figure 107E)

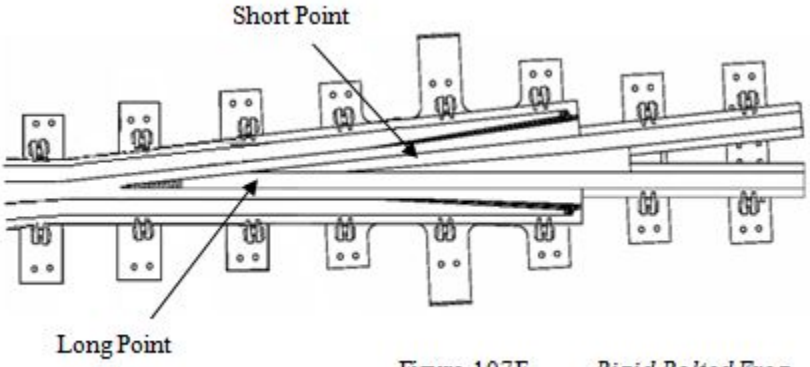

Figure 107E *Rigid Bolted Frog*

- Carbon Spring Rail Frog - The spring frog has a movable wing rail that is held closed against the body of the frog except when pushed open by a diverging movement. <u>Do not weld on the running surface of spring rail frogs except to build up the rail ends</u>.
  (Refer to Figure 107F)

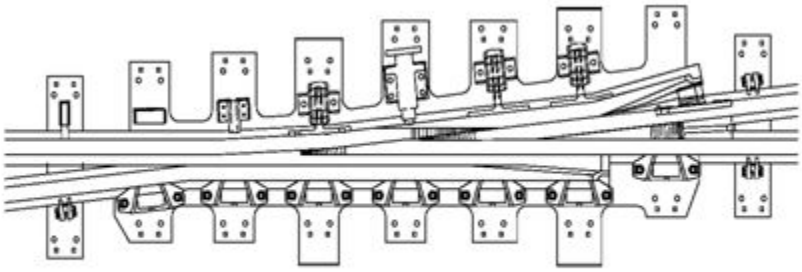

Figure 107F *Carbon Spring Rail Frog*

- Manganese Insert Spring Frog - Similar to the carbon spring rail frog except the point and one running side of the wing are a manganese insert. (Refer to Figure 107G)

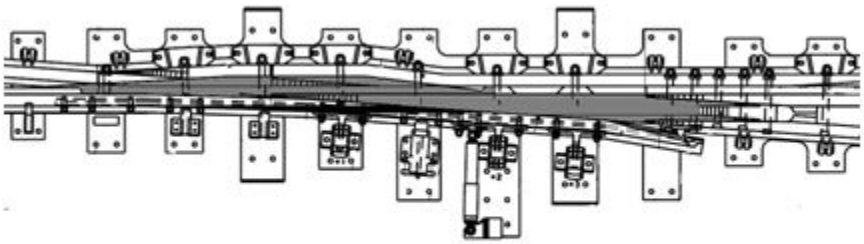

Figure 107G *Manganese Spring Rail Frog*

- Solid Manganese Self-Guarded Frog (SMSG) - The SMSG frog has a body cast in one piece from manganese steel. A raised guard cast into the body protects the frog point from passing wheels, making the installation of a guardrail on the opposite rail unnecessary.
  (Refer to Figure 107H)

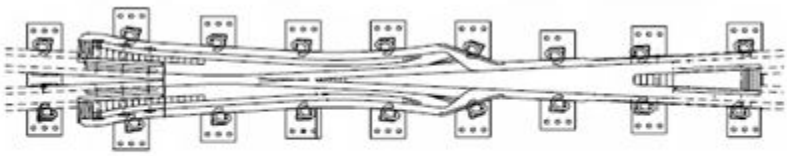

Figure 107H *Solid Manganese Self-Guarded Frog*

- Movable Point Frog (MPF) - The MPF is equipped with a point that is movable in the same manner as switch points. This frog is used in heavy tonnage, high-speed main track where the traffic on the straight and diverging sides of the turnout are comparable. Do not arc weld on MPF frogs. (Refer to Figure 107I)

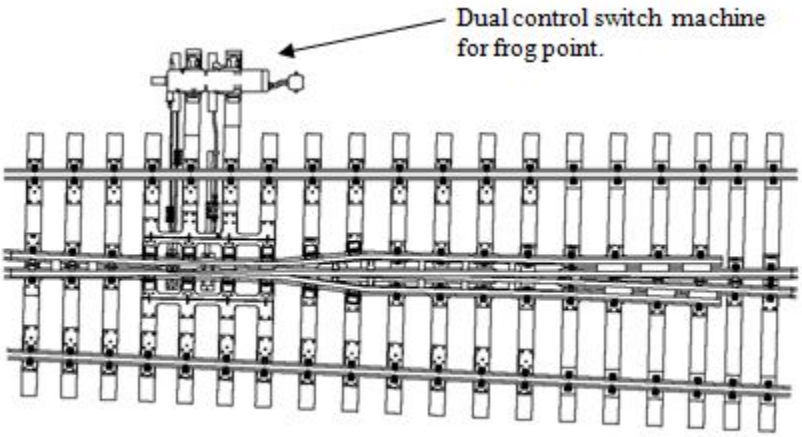

Figure 107I *Movable Point Frog*

- Jump Frog - This frog features a continuous mainline rail and a flange bearing design on the diverging side. Jump frogs are generally installed in turnouts where traffic on the diverging route id minimal and maximum speed on the turnout side is limited to 10 MPH. (See Figure 107J)

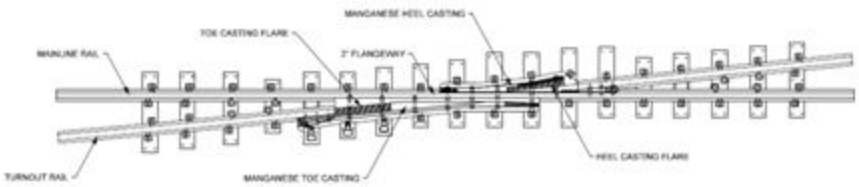

Figure 107J *Jump Frog*

- Railroad Crossing Frogs (Diamonds) – Railroad Crossing frogs allow two tracks to cross over one another at grade. They may be constructed from all rail or with manganese inserts at the locations where the rails cross over each other. (See to Figure 107K)

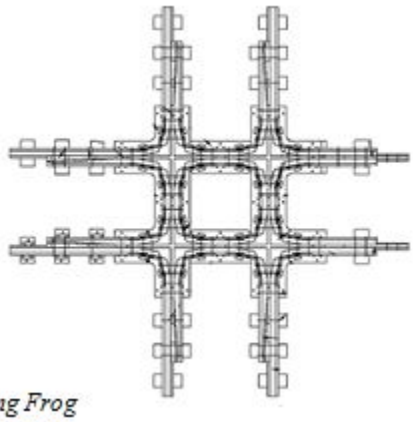

Figure 107K *Crossing Frog*

- One Way Low Speed (OWLS) Crossing Frog (Diamond) - OWLS crossing frogs (diamonds) are made out of manganese steel or a combination of manganese steel and carbon rail steel and allows for a speed up to 79 MPH on the mainline track and a maximum of 10 MPH on the flange bearing track. (See Figure 107L)

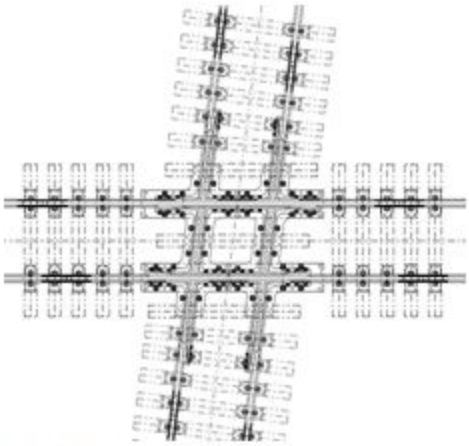

Figure 107L OWLS *Crossing Frog*

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108.0: REPAIRING CARBON TURNOUT AND CROSSING (DIAMOND) FROGS

Chapter Introduction

The following instructions apply to welding carbon turnout (rigid bolted), crossing (diamond) frogs and allowable parts of all carbon steel spring rail frogs.

- 108.1: Personal Protective Equipment (PPE)
- 108.2: Preparing for Welding Carbon Steel
- 108.2.2: Remove Defective Material
- 108.2.1: Use Proper Stick and Wire Electrodes
- 108.2.3: Preheating Carbon Rail Steel
- 108.3: Welding Carbon Steel Turnout and Crossing Frogs
- 108.3.1: Postheating Carbon Rail Steel Turnout and Crossing Frogs
- 108.4: Finish Grinding
- 108.5: Weld Spring Rail Frog Horn

108.1: Personal Protective Equipment (PPE)

Task	Required PPE
Abrasive Grinding	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel /Fuel-gas Heating	Hard hat, hearing protection, dual eye protection as follows: *1.* Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or *2.* Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Electric Arc Welding	Welding hood properly shaded with hard hat (unless using the approved non-hard hat PAPR welding hood), hearing protection, safety glasses, leather welding gloves, welding jacket or welding sleeves, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.

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108.2: Preparing for Welding Carbon Steel

Ensure all bolts are tight before beginning welding repairs.

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108.2.2: Remove Defective Material

Use a grinder to remove all fatigued, spalled or otherwise defective material.

- Do not use carbon arc cutting or oxy-fuel cutting for this purpose.

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108.2.1: Use Proper Stick and Wire Electrodes

Use only the following approved stick and wire electrodes when welding. (Refer to Table 108A)

Table 108A Rail Steel

Item Number	Approved Electrode	Welding Parameters
460-1512	Postalloy RailTuff 3/16"	170 - 225 Amps
460-1690	McKay M932 1/4"	290 - 310 Amps
460-1091	Railbuild 540 3/16"	170 - 200 Amps
460-1124	Railbuild 540 1/4"	210 - 230 Amps
460-6901	Railbuild 540 5/64" Wire	28-29 volts/ 280 Amps

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108.2.3: Preheating Carbon Rail Steel

Use of a teleweld or other approved rail end heater is recommended for preheat and postheat.
Use a temp-stick or a pyrometer to determine the desired temperatures.

1. When using a pyrometer, take readings at the same distance no farther than 8 inches from metal.
2. Preheat the area to be welded plus an additional 3 inches on both sides to 700° F.
3. Do not allow the metal to cool during the welding operation.
4. If welding is interrupted and the metal cools, re-heat the metal to at least 700° F before continuing welding.

Wing Rails:

To preheat wing rails, place the heater on the side of the rail, point the flame toward the junction of the rail head and the web of the rail.

Frog Points:

To preheat a frog point, place the heater on top of the rail.

Ground Clamp Location:

Attach ground clamp to the non-running surface toward the heel of the wing/binder rail. Grind clean where contact will be made between ground clamp and metal to ensure proper grounding.
(See Figure 108A)

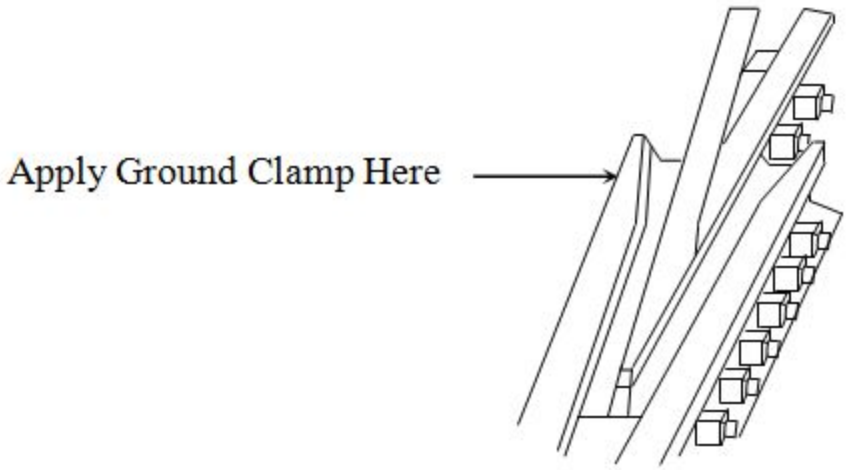

Figure 108A *Ground Clamp Location*

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108.3: Welding Carbon Steel Turnout and Crossing Frogs

When welding turnout and crossing frogs:

1. Use electrodes as follows:
    a. For heavy fill, use a 1/4-inch stick electrode, or wire.
    b. For shallow fill and for feathering out, use a 3/16-inch electrode.
2. Make the weld deposit in successive beads, 3/4 inch to 1 inch wide.
3. Apply each bead parallel to the wing or point until the necessary buildup is obtained.
4. Remove all slag with a chipping hammer before depositing the next layer of weld metal.
    - Use of a needle scaler is prohibited.
5. Peen each bead 2 to 3 times per inch with a 2 lb. Ball-Peen Hammer.

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108.3.1: Postheating Carbon Rail Steel Turnout and Crossing Frogs

Use a temp-stick or pyrometer to determine the desired temperatures. When using a pyrometer, take readings at the same distance no farther than 8 inches from metal.
Immediately after completing a weld repair, postheat the welded area plus an additional 3 inches on each side to 1,000° F.

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108.4: Finish Grinding

Grind all accessible areas of the turnout frog or crossing frog to the rail's proper running surface and contour as follows:
1. Use a frog gauge to determine the correct radius and flangeway clearances.
2. Grind all corners at the top of the turnout frog or crossing frog to a 3/8 – 5/8 inch radius.
3. On turnout frogs, make sure the point at the tip is 1/4 inch lower than the adjacent wings and is sloped upward, so that the point and wings are level at a distance back from the point equal in inches to the number of the frog. (See Figure 108B)

(Example)
Length of slope is 7 inches for a #7 frog

Length of slope is 10 inches for a #10 frog

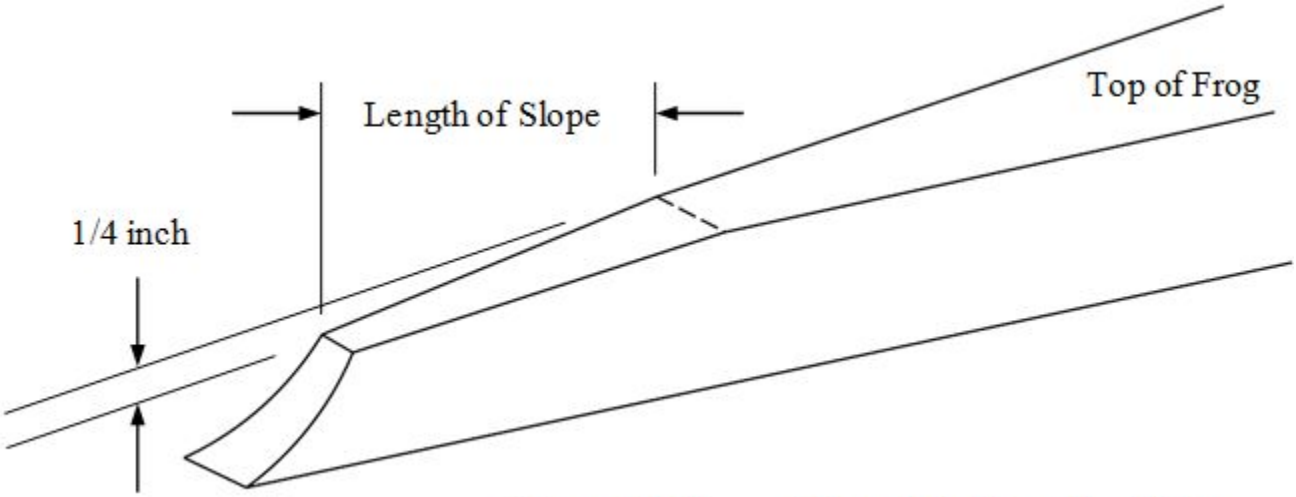

Figure 108B *Frog Point Length of Slope*

All mismatched, battered, or chipped rail ends must be repaired in accordance with rules and procedures in Chapter 105.0 Welding Rail Ends.

Slot all adjoining rail to a depth of 3/16 inch using a 1/8 inch slotting wheel. (See Figure 108C)

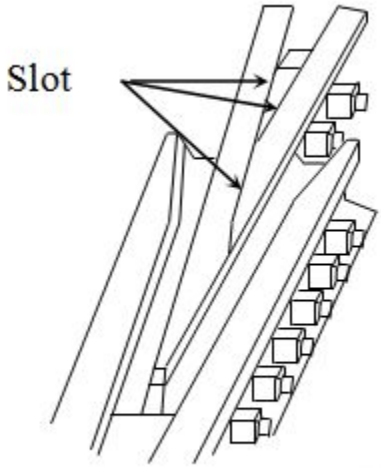

Figure 108C *Areas to Slot*

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108.5: Weld Spring Rail Frog Horn

No electric arc welding is permitted to the body of a carbon steel spring rail frog. Only forged horns and housings are allowed to be repaired by welding.

- Do not weld replaceable bolt on horns.

A. Repair Guidelines

Follow these guidelines when repairing a forged steel horn:
The Manager Track Maintenance must ensure that the ties and surface under the frog are maintained to standards before the frog is repaired.
(See Figures 108D, 108E and 108F)

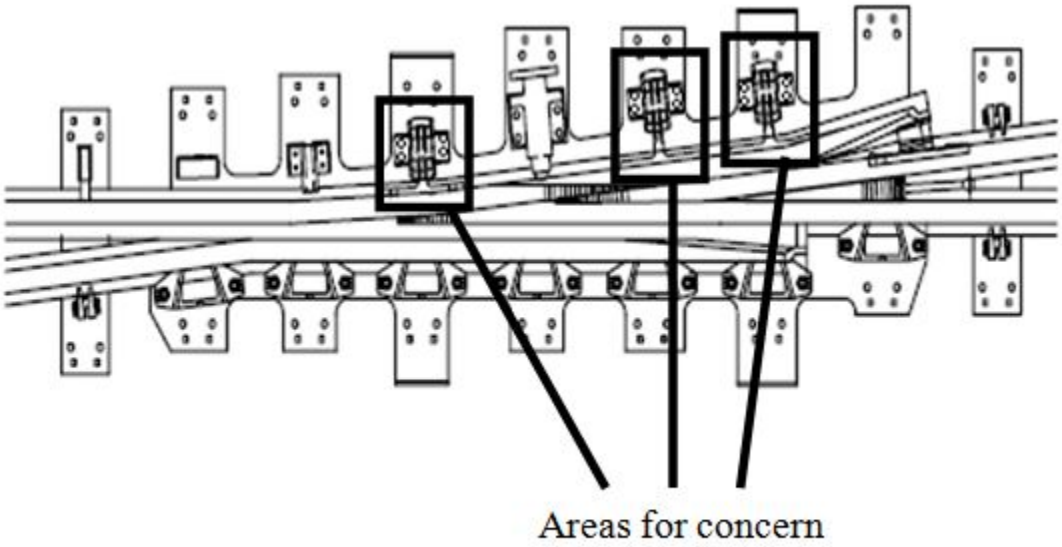

Figure 108D *Spring Frog Horn/Housing Location*

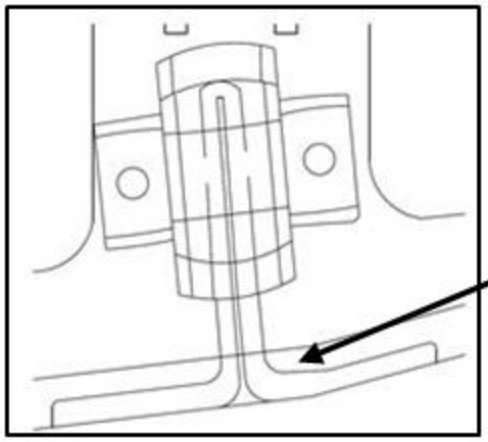

Figure 108E *Spring Frog Problem Areas*

Component and area of concern of the spring frog.

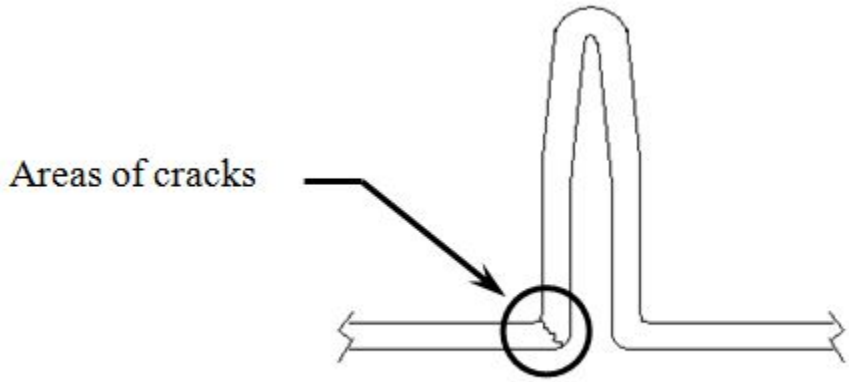

Figure 108F *View Looking Down on Horn*

- If two or more horns or hold down housings need required welding repair, frog should be replaced within 30 days.
- One hundred percent penetration is required.
- Undercutting is not permitted.
- The finishing pass must have a slight crown.
- Horn and hold-down clearances must be within FRA specifications after repairs.
- The employee repairing the frog must meet these requirements and must be qualified by the Manager of Track Welding or Welding Supervisor before repairing the frog. The employee must:
    - Be proficient in using a carbon arc cutting torch to remove the defect.
    - Demonstrate the ability to weld using multi-pass vertical progression up technique.

B. Weld Procedure

Follow this procedure when repairing a forged steel horn:

1. Remove all grease from the area to be welded.

    - Use of an oxy-fuel torch is permitted to remove grease and other contaminants.

2. Remove the crack using arc-air as follows:

a. Ensure a root opening of 1/8 inch to obtain full penetration. (See Figure 108G)

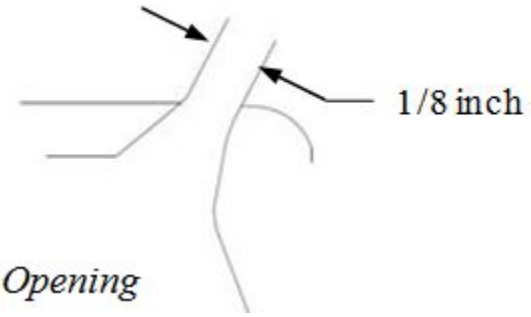

Figure 108G *Root Opening*

b. Ensure that the V-groove is wide enough to permit good electrode penetration.

3. Use a backing plate when clearance permits. (See Figure 108H)

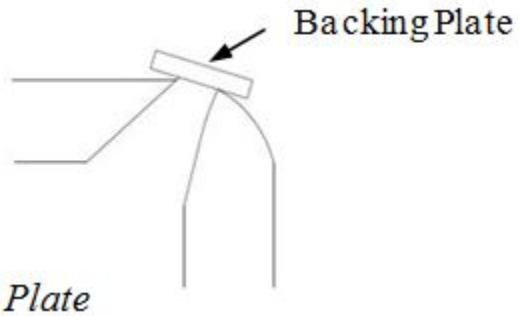

Figure 108H *Backing Plate*

4. Weld as follows:
   a. Use 1/8-inch E7018 electrodes.
   b. Set welding current to within manufacturer's specifications.
   c. Weld with a vertical progression up.
   d. Clean all slag after each bead.
   e. Use a needle scaler to remove slag, if possible.

5. If needed, use a metal tab at the bottom of the groove to start vertical progression up. (See Figure 108I)

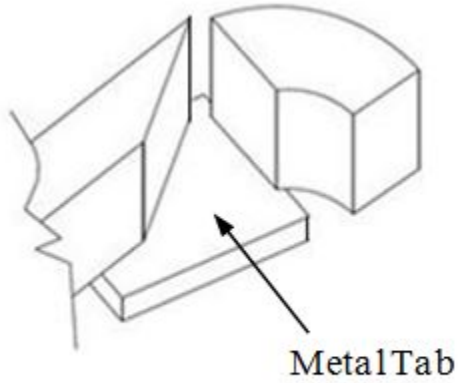

Figure 108I *Metal Tab Position*

6. Remove backing plates if they interfere with spring rail movement.

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109.0: REPAIRING MANGANESE TURNOUT AND CROSSING FROGS

Chapter Introduction

Scope:
The following instructions apply to welding manganese turnout (RBM, insert spring rail) and crossing frogs (diamonds).
Manganese steel exhibits the following characteristics:

- Unlike most steels that soften when tempered at a relatively low temperature, manganese steel becomes brittle and magnetic when heated above 500 F and will fracture easily.
- The outer portion of a manganese casting work-hardens to a depth of approximately 1/8 inch while the inner area remains ductile.
- Manganese steel can work-harden to more than twice its original hardness to approximately 535BHN.
- Until fully work-hardened, manganese steel remains ductile, and it deforms from its original shape when stressed.
- Good non work-hardened manganese steel is non-magnetic.
- Work-hardened manganese steel will have a slight magnetic attraction.

Magnetic properties can be checked with a magnet in the flangeway of the frog.

- 109.1: Personal Protective Equipment (PPE)
- 109.2: Marking Weld Repairs
- 109.3: Purpose of Repair
- 109.4: Work-Hardening
- 109.5: Mark and Remove Defective Material
- 109.5.1: Power Source Setup (CAC)
- 109.5.2: Ground Clamp Placement
- 109.5.3: Remove Work Hardened Material
- 109.5.4: Horizontal Cracks
- 109.5.5: Vertical Cracks
- 109.6: Repairing Manganese Steel Frogs
- 109.6.1: Approved Stick and Wire Electrodes
- 109.6.2: Manganese Buildup Procedures
- 109.6.3: Weld Bead Length and Width
- 109.6.4: Skip and Alternating Methods
- 109.6.5: Maintain Temperature
- 109.6.6: Welding Areas
- 109.6.7: Removing Slag and Relieving Stress
- 109.6.8: Train or Equipment Interruption
- 109.6.9: Finish Grinding
- 109.6.10: Slotting
- 109.6.11: Use of Frog Gauges

- 109.6.12: Follow-up Grinding
- 109.7: Repairs to Carbon Rail Steel Binder Rails
- 109.7.1: Mark and Remove Defective Metal
- 109.7.2: Preheat Carbon Rail Steel Binder Rail
- 109.7.3: Welding Carbon Rail Steel Binder Rail
- 109.7.4: Finish Grind Carbon Rail Steel Binder Rails
- 109.7.5: Postheating Carbon Rail Steel Binder Rails
- 109.8: Manganese Insert Spring Rail Frogs
- 109.9: RBM Heel Leg Extension Rail (Carbon Rail Steel)
- 109.9.1: RBM Frog Heel Leg Identification
- 109.9.2: Instructions for Repair

109.1: Personal Protective Equipment (PPE)

Task	Required PPE
Abrasive Grinding	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn),* work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel /Fuel-gas Heating	Hard hat, hearing protection, dual eye protection as follows: *1.* Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5),* or *2.* Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Electric Arc Welding	Welding hood properly shaded with hard hat (unless using the approved non hard hat PAPR welding hood), hearing protection, safety glasses, leather welding gloves, welding jacket or welding sleeves, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement and use of required fan.

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109.2: Marking Weld Repairs

After welding repairs are made to the manganese insert, place a mark on the base of the rail immediately next to the installation date to indicate number of welding repairs. Use a white metal marker.

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109.3: Purpose of Repair

The purpose of repairing manganese frogs is to:

- Repair broken or chipped areas.
- Restore worn surfaces to acceptable FRA standards.

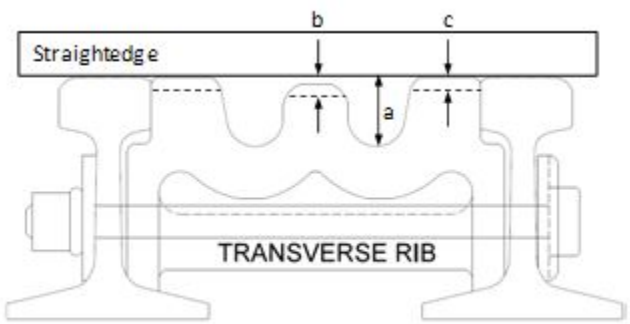

Figure 109A *Frog Wear Measurement*

a) Flangeway depth must not be less than:

    - 1-3/8 inches for class 1 track.
    - 1-1/2 inches for classes 2 through 5 track.

b) If the frog point is chipped, broken or worn more than 5/8 inch down and 6 inches back, operating speed will not be more than 10 MPH. (See Figure 109A)

    - After the first 6 inches, the point is considered the tread portion of frog.

c) If the tread portion of frog is worn down more than 3/8 inch below original contour, operating speed will not be more than 10 MPH. (See Figure 109A)
d) Where frogs are designed as flange-bearing, flangeway depth may not be less than that shown for Class 1 if operated at Class 1 speeds.
e) The flange-bearing casting of a One Way Low Speed (OWLS) crossing diamond or jump frog can be repaired by welding rebuild the flange bearing portion, if the wear depth does not exceed 1 inch. At no time can the flange bearing area be raised more than its original height.

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109.4: Work-Hardening

While manganese steel in track-work undergoes work-hardening:

1. Do not weld minor low spots.
2. Avoid all welding repairs unless the track component is deeply cracked or has broken or missing parts.

3. Confine other repairs to grinding only.
4. As the steel loses its ductility and becomes hardened, critical areas of flangeways will show metal flow. Do the following:

    a. Check clearances using frog gauges when appropriate
    b. Correct any deviation as follows:
    c. Grind off excess metal to restore the proper dimensions and contours.
    d. While grinding, make sure no excess heat builds up in the metal.

Note: To grind properly, allow the grinding wheel to cut without applying excessive pressure, which can produce heat buildup. If surface moisture is present, heat manganese casting before welding repair begins, to dry the casting.

Note: This temperature must not exceed 100° F

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109.5: Mark and Remove Defective Material

Mark worn areas or defective metal to be removed using a straightedge and soap stone. Use Carbon Arc Cutting (CAC) to remove work-hardened and defective metal.

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109.5.1: Power Source Setup (CAC)

Power source equipment must be set at Direct Current Electrode Positive / Constant Current. Use a Carbon Arc Cutting torch with a minimum 400 amp rating.
Angle and travel speed determines depth of cut.
When Carbon Arc Cutting, electrode stick-out should not be more than 6 inches.

1. If stick-out exceeds 6 inches, air pressure is insufficient to remove the molten metal.

2. Ensure air stream is directed toward the end of and under the electrode. (See Figure 109B)

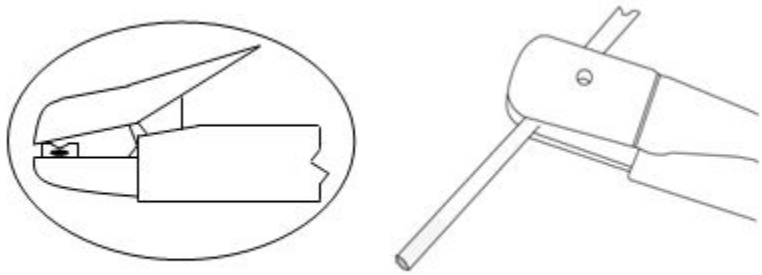

Figure 109B *Carbon Arc Cutting Torch*

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109.5.2: Ground Clamp Placement

Before CAC or electric arc welding, grind area clean where ground clamp will make contact with metal. Apply ground clamp to the carbon steel binder rail near the heel of the frog. (See Figure 109C)

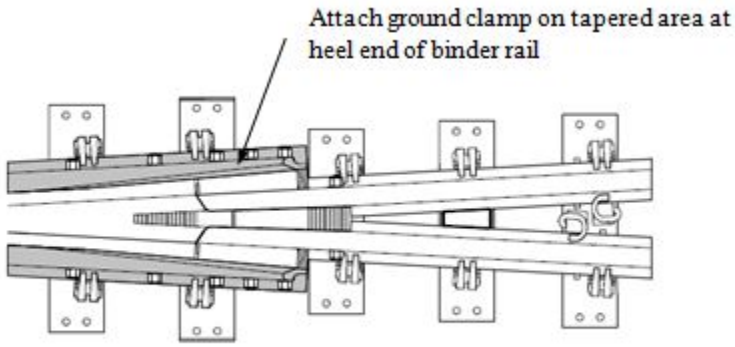

Figure 109C *Ground Clamp Location*

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109.5.3: Remove Work Hardened Material

Use CAC to remove work-hardened material.

- Remove 1/4 inch of metal to get below work-hardened zone.
- Do not allow the temperature of the manganese casting to exceed 500º F, which will result in embrittlement and thermal cracking.
- After CAC, grind area to a clean level surface.

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109.5.4: Horizontal Cracks

Use CAC to remove horizontal cracks.

- Remove all horizontal cracks and taper area at ends to accommodate grinding wheels.
- To properly remove defective metal, remove metal at each end of the crack and work back toward damaged metal and crack. Cutting from both ends of a horizontal crack may allow for the removal of a single piece of metal. (See Figure 109D)

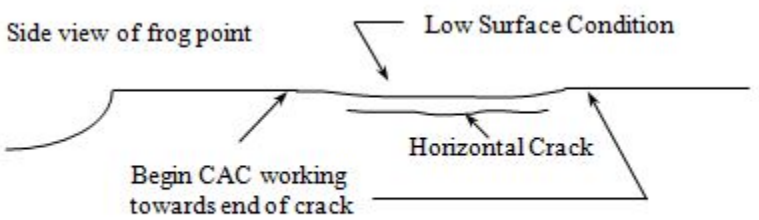

Figure 109D *Repair Area (side of point view)*

- After removing metal piece, use CAC or grinding to remove at least 1/4 inch of work-hardened surface metal.
- Grind area to a clean level surface.

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109.5.5: Vertical Cracks

Use CAC to remove material at a vertical crack.

- Identify vertical crack.

- Remove entire vertical crack if possible, without burning through frog casting.
- For cracks in frog flangeway including longitudinal cracks in the bottom of the flangeway, do not exceed 1/2 inch depth in metal removal.
- On frog wing rails and frog point, remove metal in the shape of a 'U' groove type pattern. (See Figure 109E)
- Grind repair area to a clean surface.
- Use an approved stainless stick electrode designed to seal vertical cracks that cannot be fully removed.

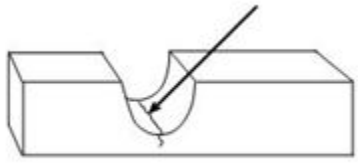

Figure 109E *"U" Groove Pattern*

- Use no more than three passes over crack.
  (See Figure 109F)

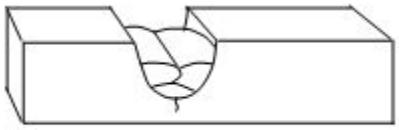

Figure 109F *Bead Passes*

- Complete the buildup using approved manganese welding product.
- Do not allow the temperature of the manganese casting to exceed 500º F, which will result in embrittlement and thermal cracking.

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109.6: Repairing Manganese Steel Frogs

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109.6.1: Approved Stick and Wire Electrodes

(Refer to Table 109A and Table 109B)

Table 109A Stainless Steel Type

Item Number	Approved Electrode	Welding Parameters
460-4060	Postalloy 1/8"	120 Amps
460-1043	Postalloy 5/32"	140 Amps

Table 109B Manganese Steel

Item Number	Approved Electrode	Welding Parameters
460-1042	Frogbuild 3/16"	180-200 Amp
460-1047	Frogbuild 7/32"	200-220 Amps
460-1100	FrogMang 3/16"	175-215 Amps
460-1101	FrogMang 1/4"	235-280 Amps
460-6915	Frogbuild 575 5/64" Wire	28 - 29 Volts/ 280 Amps
460-6905	Lincoln FrogMang 5/64" Wire	28 - 29 Volts/ 280 Amps
460-1036	Postalloy FrogTuff 5/64" Wire	28 - 29 Volts/ 280 Amps

Note: Manganese stick electrodes are a drag type electrode.
(Maintain contact with the component while welding)

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109.6.2: Manganese Buildup Procedures

When repairing manganese castings by welding, use the following instructions:

- Maintain a 10º to 30º trailing electrode angle from vertical axis while welding.
  - Drag the molten steel puddle, do not push it.
- Do not start and stop beads at the same place, which creates stress lines – overlap bead start and stops.
- Use proper amperage and travel speed to prevent overheating.

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109.6.3: Weld Bead Length and Width

To maintain proper weld bead characteristics and low heat input.

1. Bead length must not exceed 9 inches with stick electrodes.
2. Bead length must not exceed 12 inches with wire electrodes.
3. Bead width must not exceed 5/8 inch maximum.

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109.6.4: Skip and Alternating Methods

Skip Method: To help prevent frogs from overheating when repairing one portion of the frog, weld a bead of proper length, skip 6 inches, then weld another bead of proper length.

Alternating Method: When repairing more than one part of the frog, alternate from point to wings to avoid over-heating. To evenly support the weight of trains, build up frog point and wing rails together to maintain even height.

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109.6.5: Maintain Temperature

Manganese steel changes metallurgical properties at temperatures above 500° F. It becomes brittle and can fracture easily.

- When welding on manganese steel, keep temperature of the base metal below 500° F.
- Periodically check temperature 1/2 inch from deposited metal by using either the appropriate temp-stick or pyrometer.

Note: If using a non-contact pyrometer, always check at a distance not exceeding 8 inches.

If temperature of manganese casting approaches 500º F., stop all welding and cool steel with air flow.

- Air is the only approved method for cooling manganese steel.

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109.6.6: Welding Areas

Weld lowest areas first to create a level plane.
(See Figure 109G)

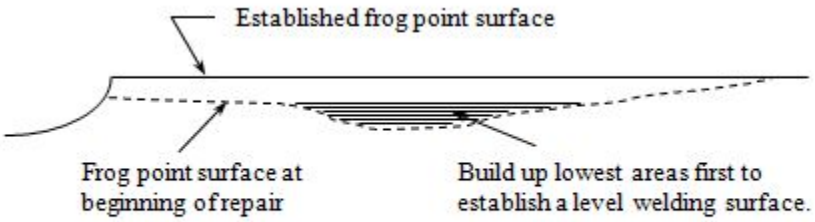

Figure 109G *Weld Area (side of point view)*

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109.6.7: Removing Slag and Relieving Stress

After applying each weld bead, remove slag and peen to remove stress.

1. Remove slag from the beginning of the weld bead to the end of weld bead.

- The beginning of the bead is cooler so the slag will be more easily removed.

1. Peen from the end of weld bead toward the beginning 2 to 3 times per inch of weld.

- Peen with the round part of a 2 lb. Ball-Peen Hammer before weld bead cools.
- This step places the weld bead in compression and relieves stress created by welding.

Order store stock item # 410-2286 for approved hammer.
Another means of stress relief is direction of weld travel. By alternating direction of travel, stresses are reduced to help maintain frog strength.

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109.6.8: Train or Equipment Interruption

If welding is interrupted by trains or other equipment movement, grind clean where wheels made contact with frog to remove contaminants.

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109.6.9: Finish Grinding

Industry standard radius on manganese frog casting is 5/8 inch.
After repairing manganese frogs, grind frog point and wings to specified contours.

- Gage side of point and wings must be ground to original uniform radius as indicated.

(See Figure 109H)
Order store stock item # 410-1980 for a radius gauges.

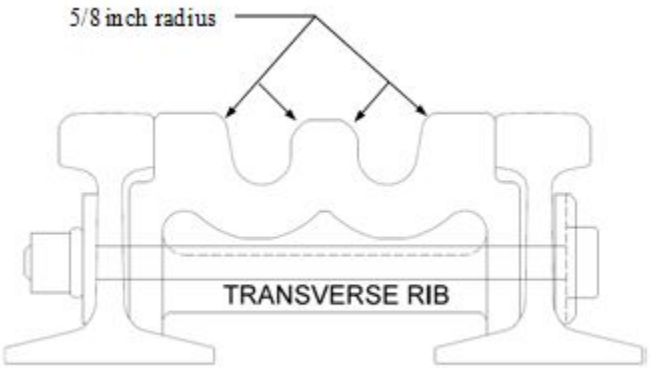
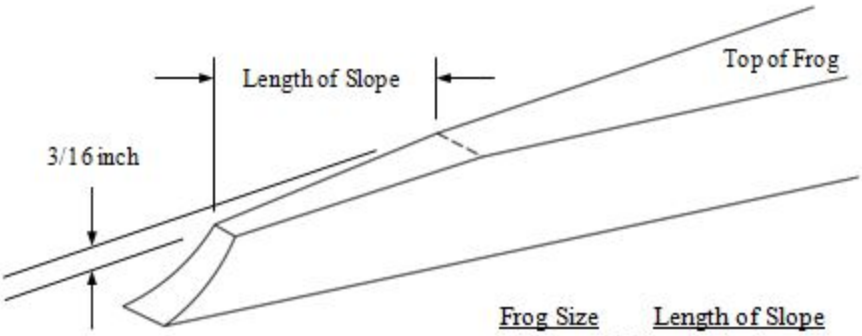


Figure 109H *Frog Radius*

- Grind the surface of frogs to the original contour without grinding onto parent steel
  Note: Grinding off of welded area onto parent steel creates secondary batter.

The tip of the frog point shall be 3/16 of an inch below the wings and slope upward, until the point is even with the wings and binder rails.
(See Figure 109I)



Frog Size	Length of Slope
#10 or smaller:	8 inches
#14	11 inches
#16	12 inches
#20	15 inches

Figure 109I *Frog Slope*

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109.6.10: Slotting

Using a hand grinder with a slotting stone no wider than 1/8 inch, grind all areas between the manganese insert and carbon binder rails to a depth of 3/16 inch and slightly bevel to remove sharp edges.

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109.6.11: Use of Frog Gauges

The flangeway gauge is used to measure the flangeway width and radius. (See Figure 109J)

The narrow side, or check side of the gauge is for determining flangeways that are too narrow for the wheel flange to pass through. This is the minimum clearance for all flangeway openings. If this portion of the gauge cannot be inserted into the flangeway as shown below, the flangeway must be ground to the original contour.
Order store stock item # 410-1990
The finish side of the gauge is the correct opening and must accept the gauge. The radius at the top must also correspond to the gauge as shown in the illustration on the right.

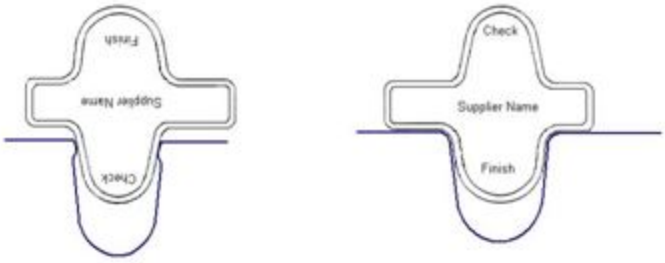

Figure 109J *Frog Gauge*

Do not over grind sides of flangeways.

- Over grinding reduces running surface area and affects guardrail measurements.

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109.6.12: Follow-up Grinding

It is critical to re-grind metal flow and restore radius to frogs. Depending on traffic patterns, follow-up grinding should be completed 7 to 10 days after new frog installations or repairs by welding, to prevent cracking and chipped areas.

If not completed in a timely manner, metal will flow to the point of failure requiring premature weld repairs.

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109.7: Repairs to Carbon Rail Steel Binder Rails

Do not weld carbon steel binder rails on main line frogs in Class 3 and above tracks. (See Figures 109K and 109L)

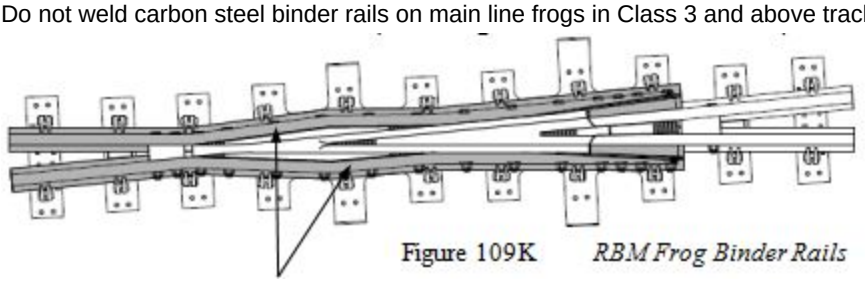

Figure 109K *RBM Frog Binder Rails*

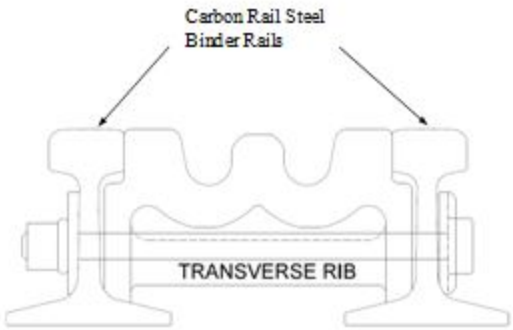

Figure 109L *RBM Frog Binder Rails*

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109.7.1: Mark and Remove Defective Metal

- Determine area to be welded using a 24 inch straightedge and mark with a soap stone.
- Remove defective metal by grinding only.
- Do not use carbon arc cutting or oxy-fuel cutting

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109.7.2: Preheat Carbon Rail Steel Binder Rail

Before welding, preheat carbon rail steel binder rail portion of manganese frogs to 700° F.

- Maintain this inter-pass temperature throughout the entire welding procedure.
- Do not allow carbon rail steel to cool to a temperature below 700° F during the welding process.

Note: Inter-pass temperature is the minimum temperature allowed while welding on carbon rail steel. This temperature will equal the preheat temperature.

If the welding repair is interrupted and carbon rail steel binder rail cools below minimum inter-pass temperature, re-heat to a minimum of 700° F before resuming welding repairs.

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109.7.3: Welding Carbon Rail Steel Binder Rail

Do not begin or end weld beads over a bolt hole.

- Beginning or ending weld beads over a bolt hole increases the chance of rail breaking due to stresses caused by welding and the wheel transition from binder rail to manganese wing rail.

Approved stick and wire electrodes for welding rail steels must be used with a weld bead width of 3/4 inch to 1 inch.

- Remove slag from each weld bead before relieving stress by peening. Do not use a needle scaler for this purpose.
- Strike weld bead 2 to 3 times per inch of weld using a 2 lb. Ball-Peen Hammer to relieve stress.

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109.7.4: Finish Grind Carbon Rail Steel Binder Rails

When welding is completed, grind binder rails to their existing contour.

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109.7.5: Postheating Carbon Rail Steel Binder Rails

- Postheating the carbon steel binder rails is prohibited.
- This will increase the risk of overheating the adjoining manganese steel casting causing it to become brittle and create thermal cracks.

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109.8: Manganese Insert Spring Rail Frogs

- Weld only manganese cast portion of frog and rail ends. (See Figure 109M)
- Follow manganese steel welding procedures as stated beginning at Rule 109.0.

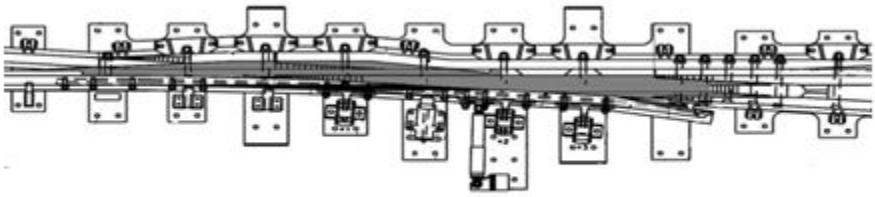

Figure 109M *Manganese Spring Rail Frog*

- It is recommended that a hydraulic jacking tool be used to open wing rail when welding or grinding is being done.
- Use of a wood block or wood wedge is recommended to hold wing rail open.
- Frog point will not be left at a height that will allow the outside edge of the wheel to make contact with the gage face of the spring rail.
- Straightedge and radius gauge must be used to verify correct grinding.
- Do not over grind flangeway area.
- Final grinding should allow proper fit of wing rail.
- Wing rail must be closed before trains are allowed to pass.
- Grind slope on point. (Refer to Table 109C)

Table 109C Frog Slope

Frog Type	Rail Section	Point Depth	Length of Slope
#14 Manganese Spring Insert	133#	3/16"	14 inch
#14 Manganese Spring Insert	136#	3/16"	14 inch

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109.9: RBM Heel Leg Extension Rail (Carbon Rail Steel)

Certain RBM frogs have a heel leg extension of a design that allows welding repairs. Specific frog design must be identified to determine electric arc welding allowance or prohibition. Heel leg extension rails are made of carbon rail steel. Make repairs according to Chapter 105.0 Rail End Repair.

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109.9.1: RBM Frog Heel Leg Identification

A standard RBM frog with a wide heel leg extension rail that bolts to the heel portion of the manganese insert can be repaired by electric arc welding if all requirements are met. Conformal frog or manganese insert spring rail frog with tapered heel leg extension rails that are machined to a narrow end are not allowed to be repaired by any welding process. The purpose of repair would generally be due to correct mismatch or chipping.
(See Figures 109N and 109O)

1. Standard RBM Wide Heel Leg Extension

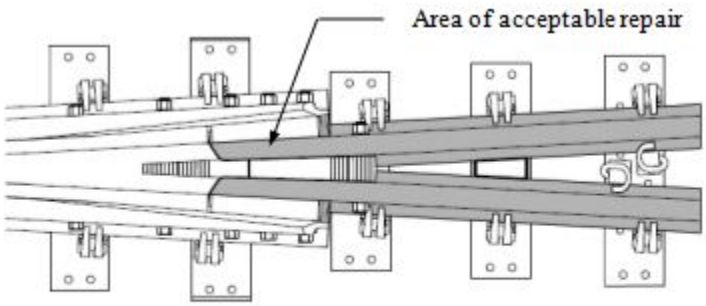

Figure 109N *Standard RBM Heel Leg Extension*

2. Conformal RBM / Manganese Insert Spring Rail with Narrow Heel Leg Extension

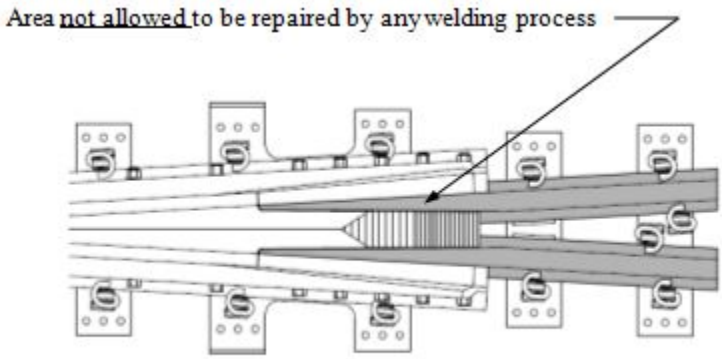

Figure 109O *Conformal RBM Heel Leg Extension*

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109.9.2: Instructions for Repair

Once determined that welding repairs can be made, the heel leg extension rail must be ultrasonically tested before the weld process begins to verify no defects exist including bolt hole cracks.

1. Mark the area of repair on top of the rail using a straightedge and soap stone. (See Figure 109P)

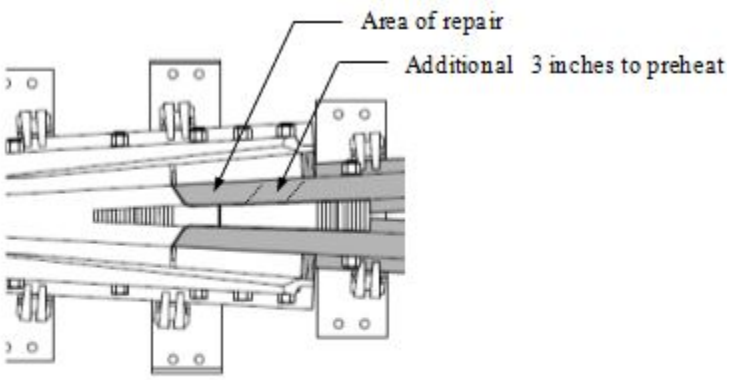

Figure 109P *Standard RBM Heel Leg Extension Area of repair and preheat*

2. If repairing a chipped rail end, grind area of repair to remove all defective material.
3. If building up rail end due to mismatch, remove all material showing indication of fatigue, spalling, shelling etc. to get below the damaged metal.
4. Use of an oxy-fuel torch or carbon arc cutting to remove surface or defective material is prohibited.
5. Use dye penetrant to ensure all cracks have been removed by grinding.
6. Have all necessary tools readily available and welding machine running and properly set.
7. Using an oxy-fuel torch, preheat the area of repair plus an additional 3 inches to a minimum of 700º F. The additional 3 inches is required to slow the cooling rate.

    - Direct the flame towards the outside and under the rail head and away from the manganese insert casting. Overheating the manganese casting will result in embrittlement and cause the casting to crack or chip.

    See Figure 109Q)

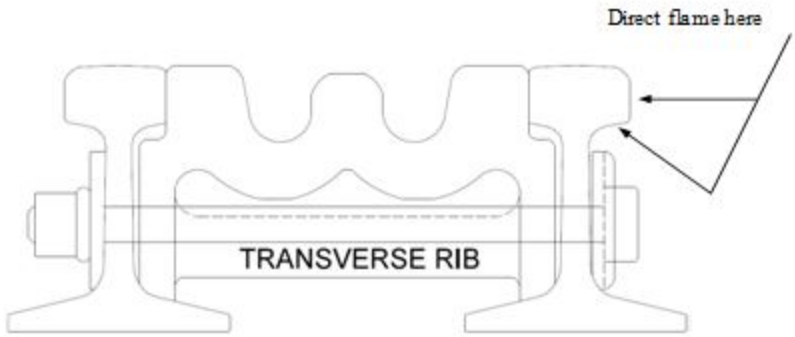

Figure 109Q *Areas of Preheat*

8. Upon removal of the preheating flame, immediately begin welding to prevent cooling of the metal.
9. If welding is interrupted and the weld area has cooled to below 700º F, welding must not resume until the weld area and additional 3 inches has been reheated to at least 700º F.
10. Use of a straightedge is required to determine weld height.
11. Upon completion of welding, begin the grinding process.

    - A surface type grinder to finish the running surface should be used as this will provide the best result. Use of an angle hand grinder with an abrasive grinding disk, will provide a satisfactory running surface if a true surface grinder is not available.
    - Only grind the area of repair and not onto the parent steel which will result in secondary batter and increase impact force.
    - Use the proper radius gauge when grinding to ensure required radius is achieved on gage corner of the rail head.

12. Postheating is prohibited due to the required high temperature that will damage the manganese insert casting.
13. Using a straightedge, check the transfer area between the carbon rail and manganese insert and blend in if necessary to ensure a smooth transition.

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110.0: THERMITE WELDS: RAILTECH-BOUTET

Chapter Introduction

Following proper welding and safety procedures is essential to the installation of a quality thermite weld and the continued safe operation of the Union Pacific Railroad.

- 110.1: Personal Protective Equipment (PPE)
- 110.2: Safety
- 110.3: General
- 110.3.1: Replacement Rail
- 110.4: Weather Restrictions
- 110.5: Identify Rail
- 110.5.1: Identify Rail Type (Alloy or Standard)
- 110.5.2: Determine Weld Location
- 110.5.3: Compromise Welds
- 110.6: Compromise/Transition Rail
- 110.7: Speed Restrictions - Alloy Rail
- 110.8: Eliminate Bolt Holes
- 110.9: Reference Marks
- 110.10: Remove Defects
- 110.11: Torch Cut Rail
- 110.12: Rail Puller
- 110.13: Clean Rail Ends
- 110.14: Rail End Gap - Standard (1-inch) and Wide Gap Weld (WGW)
- 110.15: Alignment System
- 110.16: Create Crown - Standard and Wide Gap Weld
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- 110.20: Preheating Procedures
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- 110.20.2: Start the Preheat Process (Refer to Table 110B)
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- 110.21: Crucible
- 110.22: Igniting and Pouring
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- 110.24: Remove Excess Mold
- 110.25: Rough Grinding
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- 110.28: Identify Weld
- 110.30: Clean Up
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- 110.32.7: Take Down Times
- 110.32.8: Protect Weld from Cooling
- 110.32.9: Grinding
- 110.32.10: Clean Up
- 110.32.11: Required Molds and Equipment

110.1: Personal Protective Equipment (PPE)

Task	**Required PPE**
Abrasive grinding and cutting rail	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must <u>not</u> be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel/ Fuel-gas use: • cutting rail • warming rail • removing grease and mill scale	Hard hat, hearing protection, dual eye protection as follows: 1. Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or 2. Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing.

• observing thermite preheat	See respiratory policy for respirator requirement.
Removing weld mold material and risers	Hard hat, hearing protection, type of eye protection as follows: 1. Wrap-around face shield with goggles or safety glasses, or 2. Mono-goggle XTR with safety glasses can be used as an alternative, work gloves, welding jacket or welding sleeves, approved safety-toe boots, and flame resistant clothing.
Packing Molds	Hard hat and gloves are required.

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110.2: Safety

The presence of moisture in the thermite portion or in the crucible can lead to the rapid buildup and uncontrolled release of steam when the thermite reaction occurs.

- This may cause ejection of the molten metal from the crucible. Therefore, the thermite portion, crucible, and molds must be dry and moisture must not be allowed to enter the system before or during the welding process.
- Moisture will also cause the weld to be defective.

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110.3: General

The instructions below must be followed when installing a thermite weld.
These instructions apply to installing Railtech thermite welds.
Only Railtech materials (molds, portions, pre-mix packing sand and crucibles) are to be used when installing Railtech welds.
Individual thermite welds are the responsibility of the welder who performs the preheating of the rail ends.
All thermite welds must have reference marks indicating the original amount of rail between marks.
Do not use a wet crucible, molds or thermite oxide charge to make a weld.

- If moisture enters the crucible, molds or charge, or is suspected of being present in one of them, discard the damaged item.
- Before discarding charges or igniters, contact the local Manager Environmental Field Operations for instructions on proper disposal.

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.
Recommended shelf life for weld kits is three years. All weld kits must be stored in a dry location, stacked no more than three kits high.
When using mold kits:

- Inspect crucibles for loose sand, cracks and loose thimbles.
- Molds that are broken with pieces missing should not be used.
- Use standard molds for rail end mismatch up to 1/8 inch.
- Use new to worn molds if rail ends are mismatched between 1/8 inch and 1/4 inch.

Compromise welds (different rail base widths) must not be installed in class 4 and above main tracks:

- On subdivisions where regularly scheduled passenger trains operate.
- On subdivisions in excess of 40 MGT.

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

- The maximum difference in curve worn rail head width should not exceed 1/8 inch on the gage side of the rail head. This measurement for curve wear should be taken at the top of the rail head.
- Excessive mismatch must be tapered with a grinder to provide a smooth transition.

Proper location of a thermite weld is the center of the crib.
Apply reinforcing weld-mate straps to thermite welds only under the following circumstances in any FRA class of track:

- Compromise thermite welds that are between rails of different sections (rail base widths).
- Thermite welds that involve alloy rail (one or both rails).

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110.3.1: Replacement Rail

All replacement rails must be UT tested or certified in accordance with the Engineering Track Maintenance Field Handbook.

Replacement rail used for maintenance welding must be at least 15 feet in length.

- Vertical height difference must not exceed 1/4 inch.

Use a compromise/transition rail on 6 inch base rail when rail end mismatch exceeds 1/4 inch on main track and sidings.

Torch cut rail ends must have at least 2 inches removed with a rail saw.
If a rail end is ground down to eliminate mismatch, ground portion must be cut out or replacement rail installed on main track prior to thermite welding. Rail ends must be square to get proper crown.

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110.4: Weather Restrictions

When severe temperatures and weather conditions are present, observe the following welding restrictions:

1. Do not make thermite welds on alloy rail when the rail temperature is below 32° F.
2. Do not make any other welds when the rail temperature falls below 5° F.
3. When rail temperature is at or below 40º F, or in windy conditions, thermite weld must be covered immediately after shearing with a cooling cap or welding blanket until the weld cools to below 700º F., to prevent weld from cooling too quickly.

4. During light rain, sleet, snow or mist;

    - Do not begin the welding process unless properly protected from wet weather.
    - If the thermite weld process is already in progress, protect the weld from excessive moisture or stop the welding operation.

    Take the following measures to prevent moisture from entering the mold, crucible or welding charge:

    - Use of a welding tent with a solid top is allowed to prevent moisture from entering the molds and crucible.
    - Use of an umbrella is allowed only if moisture can be entirely prevented from entering molds and crucible.
    - Ensure that rain, sleet, snow, or mist does not cool the rail placing the weld in tension as the rail contracts.
    - Use a rail puller, when conditions require, to prevent rail movement.
    - During takedown, all welding mold remnants and slag must be placed to eliminate all hazards including slip, trip and fall hazards.

5. Before applying molds, use a rail thermometer or pyrometer to check the rail temperature. If the rail temperature is below 35° F, warm the rails as follows:

    - Heat 30 inches to 36 inches from the end of each rail.
    - Raise the rail temperature to between 90° F and 110° F.
      (This is to add supplemental heat and remove surface condensation)

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110.5: Identify Rail

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110.5.1: Identify Rail Type (Alloy or Standard)

Rail type must be determined as different rail chemistries determine specific maintenance and welding requirements.

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110.5.2: Determine Weld Location

Do not make a weld on top of a tie and ensure there are two good ties immediately under each side of the weld for proper support. (See Figure 110A)

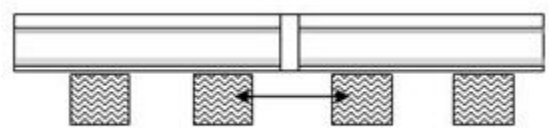

Figure 110A *Weld Placement*

Do not place a thermite weld closer than:

- 30 inches from an existing plant weld or in-track weld.

a. On subdivisions equal to or greater than 75 MGT, or as specified by the Chief Engineer, make thermite welds at least fifteen (15) feet from an existing rail joint or thermite weld.

For a list of subdivisions that must comply with the 15 foot rule, refer to TMP home page link named: '15' Weld Rule Subdivisions'.

Note: Special track work including Switches and Rail Crossings (Diamonds), make welds at least 30 inches from an existing rail joint or weld of any type.

Subdivisions with less than 75 MGT or not specified by the Chief Engineer, make thermite welds at least 30 inches from an existing rail joint or weld of any type.

Note: In order to prevent weld clusters or a multitude of thermite welds installed closely together, no more than four (4) thermite welds are allowed in a 39 foot section of rail.

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110.5.3: Compromise Welds

Identify "handed" joints and welds as follows:
Stand in between rails with back towards larger rail and face the smaller rail. The joint on the left side would be designated as the left-hand (LH) joint, and the joint on the right side would be designated as the right-hand (RH) joint. (Refer to Figure 110B)

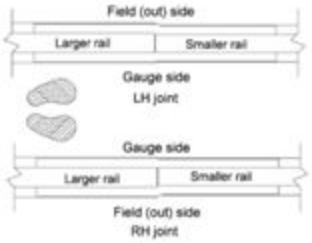

Figure 110B *Compromise Weld Identification*

Compromise weld kits are not interchangeable due to different base offsets on gauge and field sides.

- Gauge side base offset is 1/8 inch.
- Field side base offset is 3/8 inch.

Do not make a compromise weld between rails of different rail chemistry and different width bases; e.g., between 136 lb. alloy rail and 119 lb. standard carbon rail. (Refer to Figure 110C)

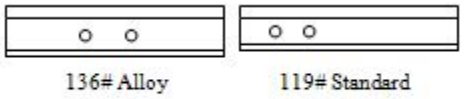

Figure 110C *Rail Chemistry*

If rails with different base widths and different chemistries must be joined:

1. Weld a standard carbon rail of the same weight and section as the alloy rail, to the alloy rail.
    - Length of rail cut-in must not be less than 15 feet.
2. Make the compromise weld between the rails of the same chemistry.
   (Refer to Figure 110D)

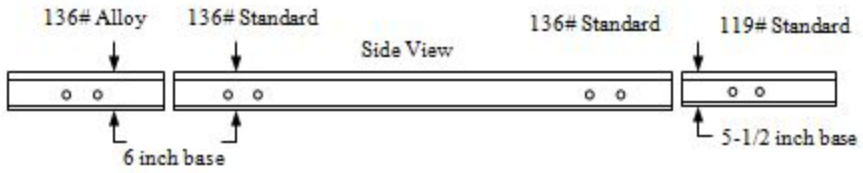

Figure 110D *Cut-in Rail*

Compromise welds on opposite rails should be made within the same crib.

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110.6: Compromise/Transition Rail

Use compromise/transition rails when required to reduce or eliminate the use of compromise thermite welds on main track and sidings.
(See Figure 110E)
Standards drawings are available online in the Engineering Department web page – Procedures and Standards.

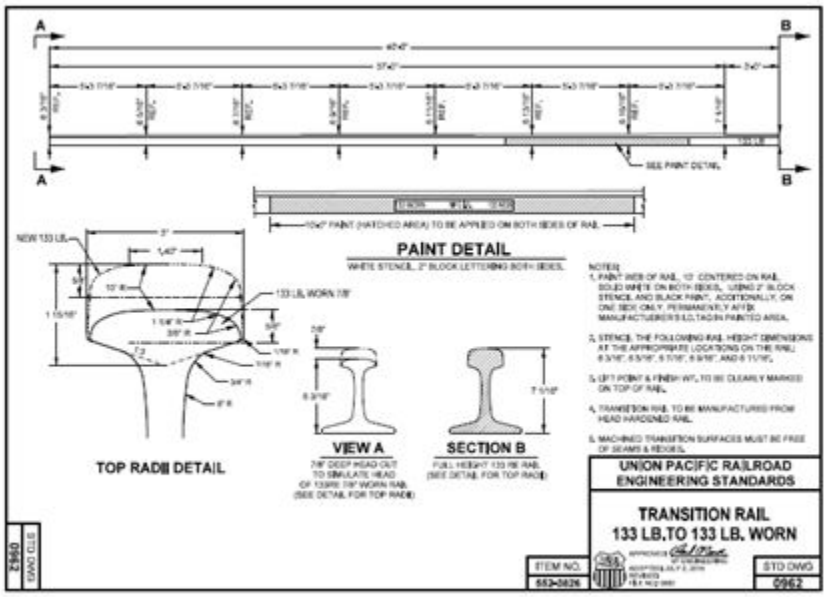

Figure 110E *133# to 133# Worn Transition Rail*

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110.7: Speed Restrictions - Alloy Rail

For all thermite welds involving alloy rail:

1. Restrict speed to a maximum of 30 mph for a minimum of 24 hours after installation.
2. Do not remove speed restriction until all thermite welds in Class 3 and above tracks are inspected and protected by weld-mate straps.

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110.8: Eliminate Bolt Holes

Eliminate bolt holes on thermite welds as follows:

1. On thermite welds that require weld-mate straps, eliminate:

    a. Bolt holes with centers closer than 8 inches from the rail ends being welded.
    b. Holes not needed to install the weld-mate strap.

2. On thermite welds that do not require the use of weld-mate straps, eliminate all holes with centers closer than 6 inches from the rail ends being welded.

    - This includes bond wire holes drilled by Signal Maintainers.

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110.9: Reference Marks

Apply reference marks before cutting rail or removing joint bars as outlined in the Engineering Track Maintenance Field Handbook Section 7.0 Track Buckling Prevention Guidelines.

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110.10: Remove Defects

Refer to Engineering Track Maintenance Field Handbook for rail defect remediation matrix. (Section 4.0 Rail and Joints)
Replacement rail is required when more than one defect of any kind is detected within the same 39-foot length of rail in the same test. (Except for bolt hole crack defects)
When rail detector cars find a defect in a weld, do the following:

1. In a plant or in-track weld, cut out the defect by removing a 1-1/2 inch section of rail, 3/4 inch each direction from center of weld. (See to Figure 110F)
2. In a thermite weld, cut out the defect by removing a 2-3/4 inch section of rail, at least 1-3/8 inches each direction from center of weld.(See Figure 110F)

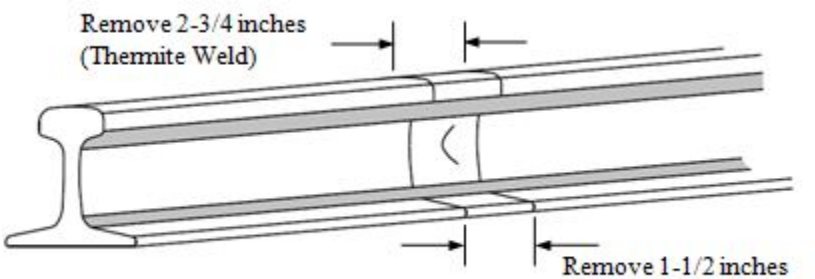

Figure 110F *Defect In Weld*

When defects previously marked by detector car personnel are repaired, the entire defect must be removed and each rail visually inspected before installing a thermite weld.

- If rail is not cut and marks are not visible, rail must be re-tested.
- If rail is not cut and marks are visible, cut on outside of marks.(See Figure 110G)

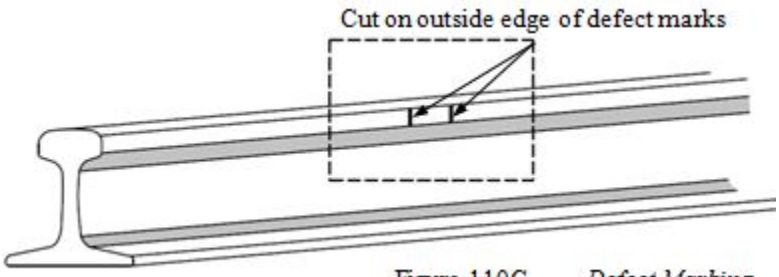

Figure 110G *Defect Marking*

- If rail was previously cut and no marks are visible, remove 1-3/8 inch from each rail end.(See Figure 110H)

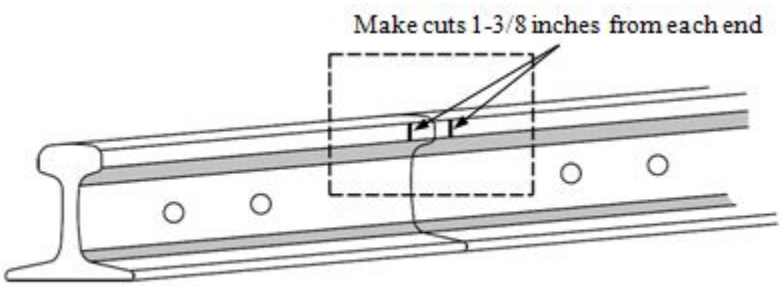

Figure 110H *Marking Additional Cuts*

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110.11: Torch Cut Rail

Anytime rail is cut using a torch, do the following.

1. Use a rail saw to trim the torch cut rail end square immediately after the torch cut is made to eliminate the growth of deep thermal heat cracks.
    - All indication of torch cut must be removed.
2. If a rail saw is not used to square the torch cut rail end within 15 minutes after the torch cut is made, an additional 2 inches of rail must be removed from rail end to get past the thermal crack growth.

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110.12: Rail Puller

Refer to Chapter 104.1.3 Hydraulic Rail Pullers for maintenance and use requirements.When using a Rail Puller while installing thermite welds, follow these procedures:

1. Surface the rail joint and tamp at least two ties each side of the joint before placing rail puller on the rail.
2. Remove sufficient amount of rail anchors to allow longitudinal movement of rail.
3. Alignment plates must be used to achieve crown and horizontal alignment prior to pulling rail.
4. Remove by grinding, any raised lettering or other protrusions on the rail where rail puller jaws will contact rail.

5. Remove dirt or grease from this area using a wire brush or torch if necessary.
6. Clean and inspect the rail puller jaws for conditions that could reduce gripping.
7. Operate the rail puller to obtain the correct gap.
8. Never remove additional rail anchors while rail puller is under pressure.
9. If the desired pull cannot be achieved, release the expander, remove additional anchors, and repeat the process.
10. Remove rail puller after weld has cooled to 700° F or less.

(Check the weld temperature on the top center of the weld using a 700° F temp-stick or a pyrometer. If the temp-stick does not melt or the pyrometer registers 700° F or less, remove the rail expander gradually)

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110.13: Clean Rail Ends

Clean rail ends removing dirt, rust or other material to ensure a sound weld.

Use an oxy-fuel torch to remove:

- Mill scale 3/4 inch from the each end of rail around the entire periphery.
- Grease 4 inches from each end of rail.

Use a wire brush to remove:

- Dirt, rust or other material 4 inches from the end of each rail.
  - Visually inspect rail ends for defects

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110.14: Rail End Gap - Standard (1-inch) and Wide Gap Weld (WGW)

The required gap must be achieved to within 1/16 inch before thermite welding. Improper gap width results in improper preheating or lack of sufficient weld material.

Rails must be cut square to within 1/16 inch perpendicular from the top to the bottom and from the gage side to the field side.

- Combined deviation between both rails will not exceed 1/8 inch.

When thermite welding, create the proper gap as follows:
1. Create a 1 inch gap for a standard thermite weld.

2. Create a 2-3/4 inch gap for a wide gap weld.

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110.15: Alignment System

Use of rail alignment plates is required when installing thermite welds.

Exception: Alignment wedges may only be used where rail alignment plates fail to work properly such as switches.
Note: Steel wedges must be kept in safe condition and metal flow dressed to eliminate cracks and chipping. After dressing wedge, apply an approved protective covering.

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110.16: Create Crown - Standard and Wide Gap Weld

Use a 36-inch straightedge to ensure proper crown is established. Use of a taper gauge is required to setup the adjustable type straightedge and must always be used with a non-adjustable straightedge while crowning rail ends.

To create the proper crown using rail alignment plates, do the following:

1. On wood ties, move tie plates to accommodate rail alignment plates.
    - Adz ties for proper fit of alignment plates if necessary.
2. On concrete ties, remove pads, if necessary, to accommodate rail alignment plates.
3. Rail fasteners may need to be removed for 2 or 3 ties in each direction of the joint.
4. Insert rail alignment plates and adjust to achieve required crown.

With the proper crown, the ends of each rail just contact the underside of the straightedge. The proper crown for a standard weld is 0.065 inch to 0.075 inch and 0.090 inch to 0.095 inch for a wide gap weld.

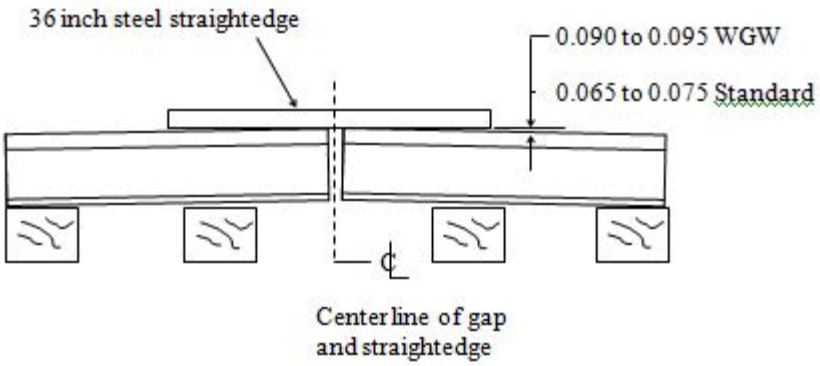

Figure 110I *Crowning Rail Ends*

(See Figure 110I)

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110.17: Rail Alignment (Straight and Compromise)

Rail twist is the mis-alignment of the rail head and base from the center axis and is not allowed.

When making a weld, use a 36-inch straightedge to check the alignment of rails. Ensure that the gage side of the rails are perfectly aligned at the base of the rail first, then the head of the rail, lastly getting the proper crown.

On rail joints where one rail is excessively curve worn, align rail on the field side of the head and base.

On compromise joints where rails are of different base widths:

1. Use alignment plates to achieve proper crown.
2. Align rails so that the base on the gage side has a 1/8 inch offset and that the base on the field side has a 3/8 inch offset.
3. Align rails so that the gage side of the head is perfectly aligned.

Compromise weld molds (handed weld molds) are designed with the offsets and are designated left-hand or right-hand. Compromise weld molds are not interchangeable and cannot be modified to fit other rail configurations.

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110.18: Molds, Base Plate and Packing

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110.18.1: Molds and Base Plate

Step 1: Place a mark on both sides of the rail base of each rail, 2-1/2 inches from the end of each rail. (See Figure 110J) This is where to check the rail end temperature during preheating with a 450ºF temp-stick only. Do not pack beyond these marks.

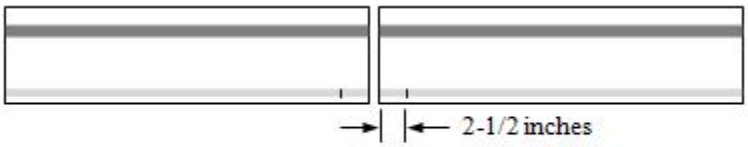

Figure 110J *Heat Measure Marks*

Step 2: Check the mold fit against the rail before applying the base plate. Filing or rubbing may be needed to ensure proper mold to rail fit before installing base plate. Over rubbing or filing may cause flashing due to gap.

Note: Do not file or rub Railtech-Boutet hybrid molds which will result in damage to fitting strips.

Step 3: Clean the base plate to allow the base brick to fit freely.
Step 4: Maintain the base plate in good condition so that it aligns properly at a right angle with the rail.
Step 5: If rail bases are mismatched over 1/8 inch, a 1/4 inch stepped base brick must be used.
Step 6: Apply paste to the edges of the base brick only.
Step 7: Avoid leaving excess paste, which could be carried into the weld with the molten metal.
Step 8: Ensure that the recess in the base brick is in the exact center of the rail gap and the base plate clamping screws are snug but not over-tightened.
Step 9: After installing the base plate, recheck the alignment and crown.
Step 10: Ensure that the molds are perfectly centered on the base plate and rail gap and ensure the molds fit up against the side of the rails and that no gaps are visible.
Step 11: Place the molds in the steel jackets, then set the molds onto the rail ends so that they fit with the tabs on the metal jackets properly placed onto the base plate.
Step 12: If any gap is large enough for pre-mixed packing sand to enter the mold cavity, fill the gap with paper to prevent the packing sand from

entering the cavity.
Step 13: Place the mold clamp over the molds and jackets.
Step 14: Tighten the mold clamp only enough to hold the molds firmly against the rail. Over tightening the mold clamp may crack the molds.
Step 15: Cover the top of the mold to prevent any foreign material from entering the mold cavity during packing.

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110.18.2: Packing

Pack the mold solid with pre-mix packing sand as follows:

1. Tightly seal all seams and joints with a minimum thickness of packing sand to ensure that all voids are filled.
2. Apply a second layer of packing sand by pressing firmly into place with your finger tips or palm.
   - Do not pound against the pre-mix packing sand, as this pounding may jar the rail and cause it to mis-align.
3. Ensure packing sand does not enter the mold cavity.
4. If packing sand does enter the mold cavity, disassemble the mold, remove the sand mixture and repack the mold.

Plan the packing stage so that the preheating cycle can begin immediately after the packing is complete. Once the packing is complete, do not
allow the finished mold to sit more than 10 minutes before preheating.

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110.19: Position Slag Basin

To allow the slag to flow out of the risers properly:

- On tangent track, position the slag basin on the inside of the rail (gauge side).
- On curves, position the slag basin on the low side of the rail.

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March 1, 2007

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110.20: Preheating Procedures

Before preheating, ensure you are familiar with and have been properly trained in the operation of that equipment. Approved torch stand must be used when preheating thermite welds. Torch must be level and torch height checked prior to preheating.

1. Use of a stopwatch is required when thermite welding for preheat, tap and take down times.

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110.20.1: Use of Oxy-Propane Equipment

Use a Victor HD310C torch body or equivalent with the Railtech flat head or Victor TWN-5 rectangular torch tip.

- Pressure settings may vary for each set of equipment and should be adjusted accordingly.
- Torch mounted in-line gauges must be used to verify pressure settings on every weld and will be placed between torch handle and flashback arrestors.
- Extreme pressure variances of 15 psi or more between cylinder regulator and in-line gauge indicates a restriction or problem, and must be corrected.
- Ensure there is sufficient oxygen and fuel-gas in cylinders to complete the preheating.

These pressure settings are required at the torch and are shown for both standard 1 inch and wide gap welds and assume the torch has 50 feet of 3/8 inch ID Grade "T" hose, check valves and flashback arrestors. (Refer to Table 110A)

Verify the oxygen and propane pressures at the torch and adjust if necessary.

The following pressure settings are required at the torch.
The torch must be in the molds and flame adjusted properly to achieve these settings.

Table 110A Torch PSI Requirement

	Standard 1 inch Weld	**Wide Gap Weld**
Propane	15 psi	15 psi
Oxygen	60 psi	60 psi

1. Do not use hose lengths greater than 100 feet.
2. Operate torch 1-1/2 inches above the top of the rail for standard 1 inch weld.
3. Operate torch 2-3/8 inches above the top of the rail for wide gap weld.
4. Ignite the oxy-propane torch and place onto rail mounted torch stand.
5. Adjust for full oxygen by opening the oxygen valve completely.

6. Open the propane valve until a crackle sound occurs, then slowly close the propane valve until the crackle sound disappears.

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110.20.2: Start the Preheat Process (Refer to Table 110B)

Preheat times are as follows: (Refer to Table 110B)

Table 110B Preheat Times

	Standard 1 inch Welds	**Wide Gap Welds**
5-1/2 inch rail base – 119# or smaller	5 to 5-1/2 minutes	6 minutes
6 inch rail base – larger than 119#	6 to 6-1/2 minutes	6 minutes
Do not exceed 8 minutes when preheating		

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110.20.3: Monitor Preheating Process

Wear the required PPE when monitoring the preheat process.

- Ensure the torch is centered and straight.
- The employee igniting and placing the torch must observe the entire preheating of the rail ends.
- Ensure the rail ends do not melt.
- Ensure the rail ends and molds heat evenly to prevent improper fusion and internal cracks that result from uneven cooling.
- Ensure that the web glows a bright red/orange with no signs of sweating or melting.
  - If rail ends appear to be getting too hot, cool the flame by increasing the propane at the torch handle.
- Ensure the rail head and base glow a dull red and have no black areas.
- After removing the torch, observe the true color of the rail ends. If they do not hold their color, replace the torch and continue preheating.

If rail end melting occurs: Stop, tear down molds, re-cut rail ends and start over.

Preheating is completed when the required preheat time has been achieved and the rail base is 450° F on all four sides. (At the marks measured 2-1/2 inches from the end of rails with a temp-stick only). Do not use a pyrometer to check rail base

temperature.

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110.20.4: Railtech Propane/Compressed Air Rail Preheater (Model 03800B)

To setup and operate the Propane/Compressed Air Rail Preheater, follow these instructions. (Refer to equipment manual for complete operating instructions and safety precautions)

1. Connect the stainless steel flex line from the regulator on the hydraulic propane unit to the propane cylinder. Make sure that all fittings are tight.
2. Connect the hydraulic hoses from the power source to the hydraulic propane unit.
3. Align the inox-heating nozzle so that the flat piece of the nozzle is no higher than the top of the inside of the mold where the diverter plug fits. The nozzle tip must be aligned straight up and down perpendicular to the rail.
4. Prior to starting the preheating unit, tilt the nozzle up slightly to help start the flame.
5. Ensure that there is no pressure on the diaphragm by turning the pressure adjusting screw counter-clockwise on the propane regulator.
6. Operate hydraulic system at 10 GPM @ 2000 psi.
7. Open the hydraulic control valve on the preheater to engage the blower unit.
8. Open the valve on the propane cylinder completely.
9. Open the air bypass valve located at the inox burner to adjust air pressure for ease of lighting.
10. Turn the pressure adjustment screw clock-wise on the propane regulator to supply 8 psi to 10 psi.
11. Open the propane valve on the inox heating nozzle and ignite flame by placing a friction lighter over a riser hole.
12. Allow the flame to warm the molds for approximately 10 seconds to 15 seconds, and then slowly straighten the nozzle in the molds so that the nozzle is straight up and down.

    - The flames should be in the rail area and in the risers. If the flames are in the risers only, again tilt the nozzle up, then slowly straighten.
    - It may be necessary to adjust the flame using the propane on-off valve located on the inox burner.

13. After adjusting nozzle to achieve desired flame, begin the preheat time. (Refer to Table 110C)

Table 110C Preheat Times

	Standard 1 inch Weld	**Wide Gap Weld**
5-1/2 inch rail base - 119# or smaller	5 to 6 minutes	6-1/2 minutes
6 inch rail base - larger than 119#	6 to 7 minutes	6-1/2 minutes
Do not exceed 8 minutes when preheating		

14. Preheating is completed when the required preheat time has been achieved and the rail base is 450° F on all four sides. (At the marks measured 2-1/2 inches from the end of rails with a temp-stick only). Do not use a pyrometer to check rail base temperature.

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110.21: Crucible

While preheating the molds and rail ends:

- Inspect crucible for loose sand and cracks.
- Do not use if cracks are present or has a loose thimble.
- Do not place crucible directly on any surface that may allow foreign material to stick to the bottom.
- Fill the crucible with the charge.
- Warm the diverter plug 30 seconds prior to removing the preheat torch by placing it on the top edge of the mold.

When preheat is complete, remove the torch and insert the diverter plug in the top of the mold, pushing the plug down firmly.

Do not pound the plug into place.

Note: The diverter plug allows the molten steel to flow into the mold properly, filling the mold evenly.
Place the crucible onto the molds and center over diverter plug, using the two large riser holes as a guide.

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110.22: Igniting and Pouring

To ignite the charge:

- When using a stick igniter, light the igniter by touching it on the inside of the riser hole.
- Place the stick igniter in the charge within the crucible to a depth of 1-inch and step back. (Do not over insert)
- Do not use an oxy-fuel torch to ignite the stick igniter or thermite weld charge.

Tap Time: The time it takes after igniting the charge for the molten steel to flow out of the crucible.

- Acceptable tap time is 15 seconds to 35 seconds.
- If tap time is less than 15 seconds or more than 35 seconds, the weld must be considered defective and removed from track.

Hot metal or slag coming in contact with moisture can cause an explosion. When the thermite weld is pouring, protect yourself and others from:

- Coming in contact with hot molten steel, as high as 5,000° F.
- Bright light from the thermite reaction-protect your eyes.

After igniting the charge:

- Stand back at least 15 feet while the molten steel pours into the mold.

If a leak develops in the mold, do not attempt to stop the leak.

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110.23: Minimum Take Down Times

Step 1. Remove crucible using a "CJ" fork and place at a safe dry location.
Step 2. Remove slag basin and place at a safe dry location.

- Wait twenty (20) minutes before emptying slag basin.

Step 3. Remove mold clamp and jackets.
Step 4. De-mold weld material.
Step 5. Shear weld. Ensure shear is adjusted properly, 1/8" above rail head. Before shearing, the weld must stop bubbling and started turning
grayish/black in color. Shear slowly.
Step 6. Bend down risers without breaking off to accommodate profile grinder.

When the slag stops pouring into the slag basin, start the minimum take down times as follows:

Table 110 D Minimum Take Down Times

	Standard 1 inch Weld	Wide Gap Weld
Remove Crucible	5 minutes	5 minutes
Remove Slag Basin	5 minutes	5 minutes
Remove Clamp and Jackets	5 minutes	10 minutes
De-mold	6 minutes	10-1/2 minutes
Shear	7 minutes	11-1/2 minutes
Remove Base Plate	20 minutes	20 minutes

Remove Alignment Tools and Empty Slag Pan	20 minutes	20 minutes
Remove Risers	25 minutes or 900° F	900° F
Remove Rail Puller	When weld is less than 700° F	When weld is less than 700° F

After removing slag pan, place it in a safe dry location where it can continue to cool.

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General Order

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110.24: Remove Excess Mold

Follow these safety requirements when removing mold material:

1. Wrap-around face shield with goggles or safety glasses must be worn when removing the mold and cleaning the weld, or
2. Mono-goggle XTR with safety glasses can be used as an alternative.
3. Protect yourself from hot metal fragments and sand.
4. Do not discard the hot slag where someone could step on it, or where it could start a grass fire.
5. Do not discard hot slag on wet soil, snow or throw into water.

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110.25: Rough Grinding

Rough grinding of the rail head portion of the thermite weld can be performed after shearing. Rough grinding of the running surface of the rail shall be performed with a surface grinder and is completed when the excess weld material is reduced to approximately 30 thousandths (0.030) of an inch.

When the surface of the weld is above 700° F, it is permitted to "blue" the weld.

Remove alignment plates and base plate in accordance with take down times.

Remove risers by lightly tapping downward toward ground.

Apply rail fasteners and ensure ties are tamped solid under the weld.

- Use a hydraulic tamper if available.

Train traffic or heavy work equipment (spikers, tampers, etc.) must not be allowed over a thermite weld until the weld has cooled below 700° F.

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110.26: Finish Grinding

Using an 8' x 1' straight stone grinder:

- Taper and remove sharp edges from the teardrop under rail head. (See Figure 110K)
- Grind the risers flush with weld collar.
- Do not grind into the collar.
- Do not grind into the parent metal.
- If inclusions are visible and cannot be removed by grinding, the weld must be removed.

Thermite welds must not have the weld collar ground as to reduce the amount of metal from the web area.
Removing metal from the weld collar to accommodate joint bars is prohibited

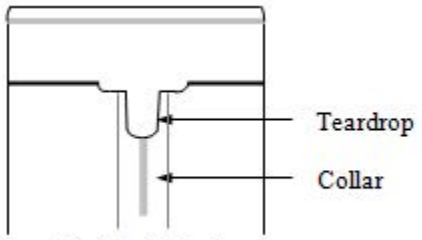

Figure 110K *Underside of Rail Head*

If vertical offset or gage face mismatch is apparent, grind the rail to achieve a gradual transition.

Final surface grinding will be performed after the weld has cooled to below 700° F. When doing the final grinding, use a straightedge and check as you go. Only grind where the straightedge indicates the need. When weld temperature is equal to or below 700° F, 'bluing' of the rail or weld surface is not permitted. A gentle or light effort shall be used.

The running surface of the weld shall be ground to exactly match the contour of existing rails. A radius is to be applied to the gage and field sides so no sharp edges remain.

Do not grind off the weld onto the lower or curve worn rail as this will create secondary batter and increase impact forces. Use the following formula to determine proper length of taper. (Refer to Table 110E)

Minimum Ramp Length (feet) = Off-set (thousandths of an inch)

0.008 inch

Table 110E Length of Taper

Offset	Taper Length
0.030 inch	4 inches
0.060 inch	8 inches
0.090 inch	12 inches
0.125 inch	16 inches

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110.27: Weld Tolerance Specifications

To improve overall track geometry and reduce Evaluation Car exceptions, the Thermite maximum weld tolerances below must be followed.
(Refer to Table 110F)
These are cold (ambient temperature), finish ground specifications.

Table 110F Weld Tolerance Specifications for Finished Thermite Welds

	Vertical Crown	Vertical Offset	Horizontal Offset	Horizontal Kink	Base (HOS) Horizontal Offset	Base (VOS) Vertical Offset
Thermite	0.040"	0.020"	0.040"	0.025"	0.060"	0.250" (a)

a. Maximum base vertical offset will not exceed 0.250 inch on same base width rails.

Combined Vertical Crown and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld.
Combined Horizontal Kink and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld as measured on the convex side of rail head.
After a thermite weld has been installed, use a straightedge to measure for crown, vertical offset, horizontal offset, horizontal kink, base horizontal offset, base vertical offset, and over grind. (See Figures 110L – 110R)

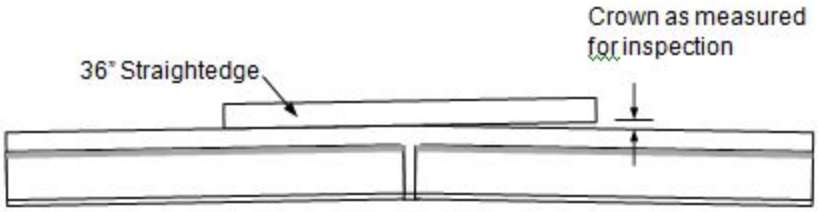

Figure 110L *Crown Inspection – Side View*

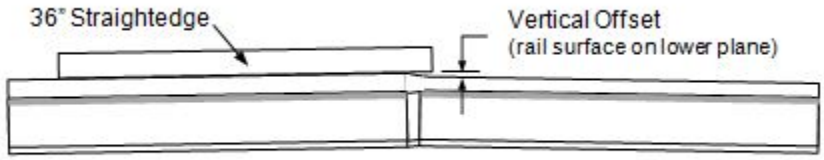

Figure 110M *Vertical Offset – Side View*

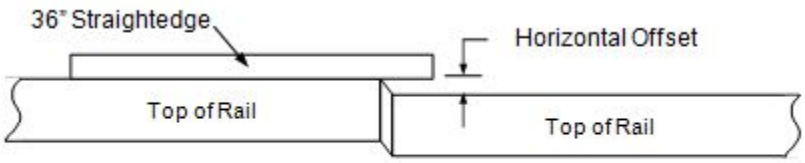

Figure 110N *Rail Head Horizontal Offset – Overhead View*

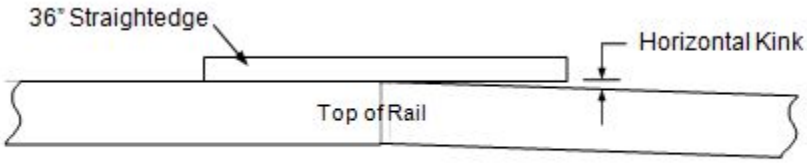

Figure 110O *Horizontal Kink – Overhead View*

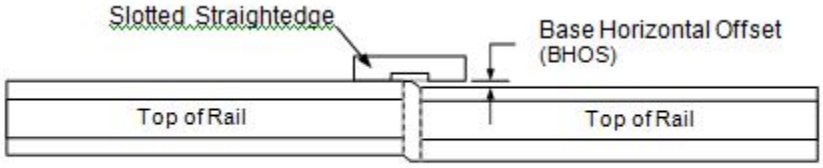

Figure 110P *Base Horizontal Offset – Overhead View*

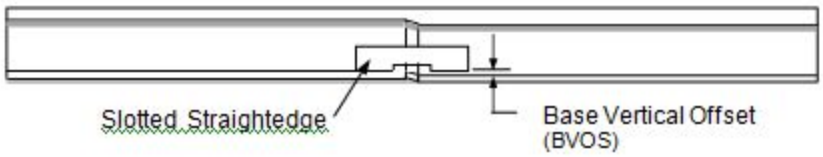

Figure 110Q *Base Vertical Offset – Side View*

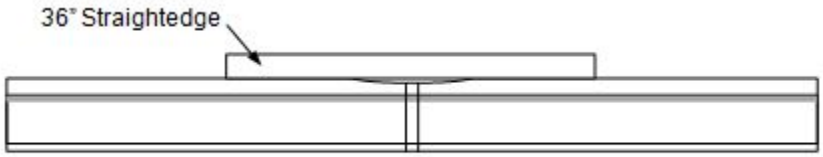

Figure 110R *Surface Over Grind*

Welds must not be over ground. Use the straightedge periodically to check progress.

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110.28: Identify Weld

The engineering department requires the placement of metal weld tags on all welds. Use a generous amount of adhesive on the back of the tag and place on the field side of the rail. (See Figures 110S and 110T).

Thermite weld tags will be punched to indicate the following:

1. Employee ID (not gang number)
2. Month and year installed
3. Month and year weld kit manufactured
4. 1-inch gap or wide gap weld

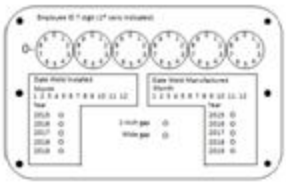

Figure 110S *Weld Tag*

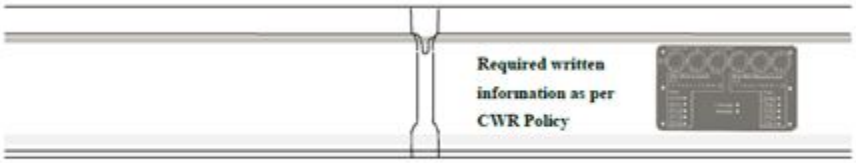

Figure 110T *Weld Tag Placement*

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110.30: Clean Up

The clean up can be performed before the final grinding. Clean up includes:

- Reapplying the rail fasteners.
- Reapplying the anchors.
- Filling cribs.
- Remove any weld material waste including slag, spent molds, risers and packaging from worksite and dispose of properly.
- Do not leave weld waste exposed at worksite.

Approved welding bucket can be used to remove debris from worksite. Store stock item # 460-7115.

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110.29: Thermite Weld Quality Audit

Managers and employees will use the written Thermite Weld Quality Audit form to assess the workmanship of the welding gang in the field. Weld audits will be submitted into the electronic Weld Quality Auditing System in the TMP.

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110.32: Thermite Head Wash Weld

Only designated track welding employees who have been trained and qualified are allowed to install thermite head wash welds.
All PPE must be worn as required for any thermite welding procedure.
When performing dye-penetrant testing, wear wrap-around face shield with goggles or safety glasses.

- Mono-goggle XTR with safety glasses can be used as an alternative.

Railtech-Boutet kits are available for 115# and 132#/136# rail.
On Railtech-Boutet welds, the rail head is removed by grinding except the lower 1/4 inch. Defect must not be in or below this 1/4 inch.
Head wash welds use wide gap weld hardware.

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110.32.1: Rail Preparation

1. Do not weld on non-alloy rail when the rail temperature is below 5° F.
    - Warm rail to remove any surface moisture around entire periphery of rail.
2. Use an oxy-fuel torch and wire brush to clean the rail of any dirt, oil, grease or other contaminants.
3. Using rail alignment tool, pre-crown the rail to 0.045 inch using a 36 inch straightedge and taper gauge before grinding the 2 inch slot.
4. Mark the rail for depth of grind on both sides of the rail head using the depth tool.
5. Remove by grinding, the entire defect within the rail head leaving 1/4 inch of the rail head.
    - The ground surface must be level and even on both sides of the rail head.
    - Use a file or hand grinder if necessary to remove any sharp edge after defect removal.
6. After grinding the 2 inch slot, adjust crown to 0.060 inch to 0.070 inch.

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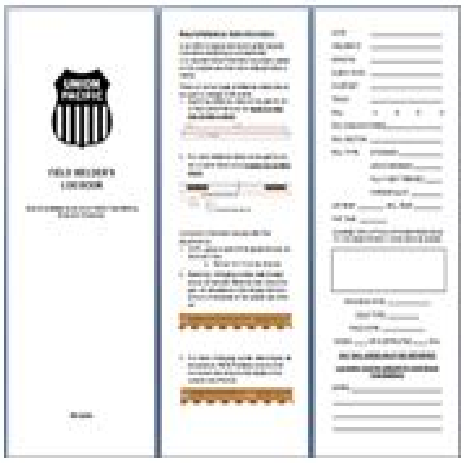
110.31: Welders Log Booklet

All thermite welds installed must be recorded in the welders log booklet with all required information including placing the weld charge sticker to the specified area on log page. If sticker cannot be placed into the booklet, sticker information must be written in.

All completed welders log booklets must be kept in a safe location and made available for review by any manager or their representative.

Welders Log Booklet item number PB-24095.



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110.32.2: Dye Penetrant Testing

Conduct Dye-Penetrant Test on DF type defects (Not required for SSC type defect)

1. Gloves must be worn during the entire process.
2. Brush the surface of the rail with a wire brush to remove contaminants.
3. Clean the surface of the rail free of dust and dirt with a piece of cloth.
4. Spray the cleaner on the surface to remove oil, grease, etc. and wipe with cloth.
5. Apply the dye penetrant (by spraying) adequately to cover the area to be tested. Allow 3 to 5 minutes for dye to penetrate into the cracks.
6. Wipe off the excess penetrant on the surface with a piece of cloth.
7. Again spray the surface with the cleaner to remove the remnants of the red dye if needed.

8. Spray the developer evenly on the surface to give a thin even layer. This layer absorbs the penetrant from the cracks and red spots or lines appear on the surface to give a visible indication of the flaws.
9. The crack if any will be indicated with the red dye absorbed by the white developer.

    - Remove white developer before proceeding.

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110.32.3: Torch Height

1. Pre-set oxy-fuel torch height to 4-1/8 inches.
2. Pre-set inox burner torch height to 3-3/8 inches.

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110.32.4: Molds and Clamp

1. Place molds and clamp.
    - Molds may need to be filed / rubbed to ensure a tight fit to rail.
    - Care must be taken to not over file or rub as this may cause flashing.
2. Cover top of molds before beginning packing to prevent contaminants from entering mold cavity.
3. Pack molds with packing mud (molds are similar to wide gap molds).
4. Place slag pan.

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110.32.5: Preheating (Oxy-fuel Torch)

1. Preheating using an oxy-fuel torch:

   (Refer to Table 110G and Table 110H)

Table 110G Pressure Settings

	Oxygen	Propane
115# / 119#	50 psi	15 psi
132# / 136#	50 psi	15 psi
133#		
141#		

Table 110H Preheat Time

	Preheat Time
115# / 119#	5 minutes
132# / 136#	5 minutes
133#	
141#	

2. In-line gauges are required as specified by UPRR track welding rules to provide accurate preheat when using an oxy-fuel torch.
3. When using an oxy-fuel torch, ignite torch before placing into molds, adjust flame and re- adjust pressure settings if needed.
4. Adjust (open) propane control valve on torch handle if needed to cool the flame.
5. Monitor preheat during entire process to ensure no melting of rail occurs.

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110.32.6: Preheating (Forced Air/Propane Torch)

1. Preheating using a forced air/propane torch:
   (Refer to Table 110I and Table 110J)

Table 110I Pressure Settings

	Air	Propane
115# / 119#	2 to 2-1/2 psi	8 to 12 psi
132# / 136#	2 to 2-1/2 psi	8 to 12 psi
133#		
141#		

Table 110J Preheat Time

	Preheat Time
115# / 119#	5 minutes
132# / 136#	5 minutes
133#	
141#	

2. Tilt torch head out of molds to ignite and allow to burn for approximately 20 seconds before leveling out torch.

After preheat is complete, remove torch and place crucible.
Using igniter, ignite charge and stand back at least 15 feet while ignition process and pouring of the weld takes place.
Do not attempt to stop any leak.

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110.32.7: Take Down Times

Follow minimum takedown times. (Refer to Table 110K)

Table 110K Minimum Takedown Times

	Take Down Times
Remove Crucible and Slag Pan	5 minutes
Remove Clamp and Mold Jackets	8 minutes
Remove Top of Mold (Demold)*	9-1/2 to 10 minutes
Shear (Slowly)**	10 - 10-1/4 minutes

* When demolding, proceed slowly and watch for leaks.
** Keep rail clamps loose when shearing.

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110.32.8: Protect Weld from Cooling

When rail temperature is at or below 40 F, or in high wind conditions, apply cooling cap immediately after shearing to reduce the cooling rate of the weld until the weld temperature is 700 F or less.

- Refer to Chapters 101.0 and 110.0 for weather condition requirements.

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110.32.9: Grinding

Rough grind weld until material is reduced to about 0.030 inch in height.
Do not finish grind (blend in) while weld temperature is above 700 F. as this will result in a low weld.
Do not grind onto the parent steel as this will result in "dipping and batter", unless apparent existing batter is present that requires tapering to smooth transition.

- This may be apparent on some SSC type defects.

Empty slag basin at 20 minutes after the pour is completed.

Remove crowning device at 30 minutes after the pour is completed.

- Time begins when last drop of slag flows into slag basin.

Finish grinding the weld to match the contour of the existing rail.
Any indication of "flashing" under the rail head must be removed by grinding.

- Flashing contributes to defect development.

All welds will be identified with the standard weld tag **and** green "test" tag for identification.
Ensure weld is accurately entered into the reporting system using the code (BH) for Boutet head weld.

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110.32.10: Clean Up

The clean up can be performed before the final grinding. Clean up includes:

- Reapplying the rail fasteners.
- Reapplying the anchors.
- Filling cribs.

- Remove any weld material waste including slag, spent molds, risers and packaging from worksite and dispose of properly.
    - Do not leave weld waste exposed at worksite.
- Approved welding bucket can be used to remove debris from worksite. Store stock item # 460-7115.

Record weld installation information into the welders log book.

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110.32.11: Required Molds and Equipment

Railtech-Boutet Head Wash Kits		
552-5370	115# Head Repair Kit	FIELD WELD KIT, 115# ONE SHOT, HEAD WASH REPAIR
552-5575	136# Head Repair Kit	132# to 136# FIELD WELD KIT, ONE SHOT, HEAD WASH REPAIR
In development	133# Head Repair Kit	FIELD WELD KIT, 133# ONE SHOT, HEAD WASH REPAIR
In development	141# Head Repair Kit	FIELD WELD KIT, 141# ONE SHOT, HEAD WASH REPAIR

Grinders and Abrasives (Either grinder with appropriate abrasive is available)		
420-1663	PortaCo Notch Grinder (use 411-1577 abrasive below)	GRINDER TO REMOVE 2" SLOT FOR THERMITE HEAD REPAIRS
411-1577	12 x 2 x 1 arbor Grinding Stone	USED FOR THERMITE HEAD REPAIR WELDS, GRIND RAIL HEAD
420-1662	Matweld Slot Grinder (use 411-1198 abrasive below)	GRINDER TO REMOVE 2" SLOT FOR THERMITE HEAD REPAIRS
411-1198	8 x 2 x 1 Grinding Stone	USED FOR THERMITE HEAD REPAIR WELDS, GRIND RAIL HEAD

Hardware		
552-5263	Railtech-Boutet Mold Jackets	FIELD WELD JACKET - WIDE GAP WELD

552-6200	Cooling Cap	COOLING RETARDER CAP

Dye Penetrant		
410-7895	Dye Penetrant Testing Cleaner	01-5750-79 MINEWELD, SPOT CHECK CLEANER
410-7903	Dye Penetrant Testing Penetrant	TWK-1003 MINEWELD, SPOT PENETRANT
410-7912	Dye Penetrant Testing Developer	TWK-1003 MINEWELD, SPOT CHECK DEVELOPER

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111.0: THERMITE WELDS: ORGO-THERMIT

Chapter Introduction

Following proper welding and safety procedures is essential to the installation of a quality thermite weld and the continued safe operation of the Union Pacific Railroad.

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- 111.2: Safety
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- 111.3.1: Replacement Rail
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- 111.5.1: Identify Rail Type (Alloy or Standard)
- 111.5.2: Determine Weld Location
- 111.5.3: Compromise Welds
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- 111.10: Remove Defects
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- 111.13: Clean Rail Ends
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- 111.15: Alignment System
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- 111.19.2: Start the Preheat Process
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- 111.24: Rough Grinding
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- 111.31.4: Torch Height
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- 111.31.6: Preheating (Oxy-fuel Torch)
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- 111.31.8: Protect Weld from Cooling
- 111.31.9: Grinding
- 111.31.10: Clean Up
- 111.31.11: Required Molds and Equipment

111.1: Personal Protective Equipment (PPE)

Task	**Required PPE**
Abrasive grinding and cutting rail	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.
Oxy-fuel Fuel-gas use: • cutting rail • warming rail • removing mill scale	Hard hat, hearing protection, dual eye protection as follows: 1. Wrap-around face shield with goggles or safety glasses. *(one has to be shade #5)*, or 2. Mono-goggle XTR shade #5 with safety glasses can be used as an alternative, leather welding gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing.

• observing preheat times	See respiratory policy for respirator requirement.
Removing weld mold material and risers	Hard hat, hearing protection, type of eye protection as follows: 1. Wrap-around face shield with goggles or safety glasses, or 2. Mono-goggle XTR with safety glasses can be used as an alternative, work gloves, welding jacket or welding sleeves, approved safety-toe boots and flame resistant clothing.
Packing Molds	Hard hat and gloves are required.

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111.2: Safety

The presence of moisture in the thermite portion or in the crucible can lead to the rapid buildup and uncontrolled release of steam when the thermite reaction occurs.

- This may cause ejection of the molten metal from the crucible. Therefore, the thermite portion, crucible, and molds must be dry and moisture must not be allowed to enter the system before or during the welding process.
- Moisture will also cause the weld to be defective.

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111.3: General

The instructions below must be followed when installing a thermite weld.
These instructions apply to installing Orgo-thermit thermite welds.
Only Orgo-thermit materials (molds, portions, pre-mix packing sand and crucibles) are to be used when installing Orgo-thermit welds.

Individual thermite welds are the responsibility of the welder who performs the preheating of the rail ends.

All thermite welds must have reference marks indicating the original amount of rail between marks.
Do not use a wet crucible, molds or thermite oxide charge to make a weld.

- If moisture enters the crucible, molds or charge, or is suspected of being present in one of them, discard the damaged item.

- Before discarding charges or igniters, contact the local Manager Environmental Field Operations for instructions on proper disposal.

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.
Recommended shelf life for weld kits is three years. All weld kits must be stored in a dry location, stacked no more than three kits high.
When using mold kits:

- Inspect crucibles for loose sand, cracks and loose thimbles.
- Molds that are broken with pieces missing should not be used.
- Use standard molds for rail end mismatch up to 1/8 inch.
- Use new to worn molds if rail ends are mismatched between 1/8 inch and 1/4 inch.

Compromise welds (different rail base widths) must not be installed in class 4 and above main tracks:

- On subdivisions where regularly scheduled passenger trains operate.
- On subdivisions in excess of 40 MGT.

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

- The maximum difference in curve worn rail head width should not exceed 1/8 inch on the gage side of the rail head. This measurement for curve wear should be taken at the top of the rail head.

Proper location of a thermite weld is the center of the crib.
Apply reinforcing weld-mate straps to thermite welds only under the following circumstances in any FRA class of track:

- Compromise thermite welds that are between rails of different sections (rail base widths).
- Thermite welds that involve alloy rail (one or both rails).

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111.3.1: Replacement Rail

All replacement rails must be UT tested or certified in compliance with the Engineering Track Maintenance Field Handbook.

Replacement rail used for maintenance welding must be at least 15 feet in length.

- Vertical height difference must not exceed 1/4 inch.

Use a compromise/transition rail on 6 inch base rail when rail end mismatch exceeds 1/4 inch on main track and sidings.

Torch cut rail ends must have at least 2 inches removed with a rail saw.
If a rail end is ground down to eliminate mismatch, ground portion must be cut out or replacement rail installed on main track prior to thermite welding. Rail ends must be square to get proper crown.

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111.4: Weather Restrictions

When severe temperatures and weather conditions are present, observe the following welding restrictions:

1. Do not make thermite welds on alloy rail when the rail temperature is below 32° F.
2. Do not make thermite welds on non-alloy rail when the rail temperature falls below 5° F.
3. When rail temperature is below 40º F, or in windy conditions, thermite weld must be covered immediately after shearing with a cooling cap or welding blanket until the weld cools to below 700º F., to prevent weld from cooling too quickly.
4. During light rain, sleet, snow or mist;

    - Do not begin the welding process unless properly protected from the wet weather.
    - If the thermite weld process is already in progress, protect the weld from excessive moisture or stop the welding operation.

    Take the following measures to prevent moisture from entering the mold, crucible or welding charge:

    - Use of a welding tent with a solid top is allowed to prevent moisture from entering the molds and crucible.
    - Use of an umbrella is allowed only if moisture can be entirely prevented from entering molds and crucible.
    - Ensure that rain, sleet, snow, or mist does not cool the rail placing the weld in tension as the rail contracts.
    - Use a rail puller, when conditions require, to prevent rail movement.
    - During takedown, all welding mold remnants and slag must be placed to eliminate all hazards including slip, trip and fall hazard.

5. Before applying molds, use a rail thermometer or pyrometer to check the rail temperature. If the rail temperature is below 35° F, warm the rails as follows:

    - Heat 30 inches to 36 inches from the end of each rail.
    - Raise the rail temperature to between 90° F and 110° F.
      (This is to add supplemental heat and remove surface condensation)

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111.5: Identify Rail

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111.5.1: Identify Rail Type (Alloy or Standard)

Rail type must be determined because different rail chemistries determine specific maintenance and welding requirements.

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111.5.2: Determine Weld Location

Do not make a weld on top of a tie and ensure there are two good ties immediately under each side of the weld for proper support. (See Figure 111A)

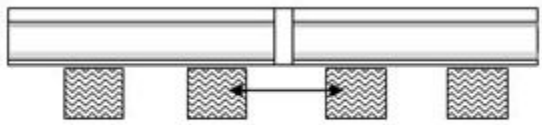

Figure 111A *Weld Placement*

Do not place a thermite weld closer than:

- 30 inches from an existing plant weld or in-track weld.
- On subdivisions equal to or greater than 75 MGT, or as specified by the Chief Engineer, make thermite welds at least fifteen (15) feet from an existing rail joint or thermite weld.

For a list of subdivisions that must comply with the 15 foot rule, refer to TMP home page link named: '15' Weld Rule Subdivisions'.

Note: Special track work including Switches and Rail Crossings (Diamonds), make welds at least 30 inches from an existing rail joint or weld of any type.

Subdivisions with less than 75 MGT or not specified by the Chief Engineer, make thermite welds at least 30 inches from an existing rail joint or weld of any type.

Note: In order to prevent weld clusters or a multitude of thermite welds installed closely together, no more than four (4) thermite welds are allowed in a 39 foot section of rail.

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111.5.3: Compromise Welds

Identify 'handed' joints and welds as follows:
Stand in between rails with back towards larger rail and face the smaller rail. The joint on the left side would be designated as the left-hand (LH) joint, and the joint on the right side would be designated as the right-hand (RH) joint. (See Figure 111B)

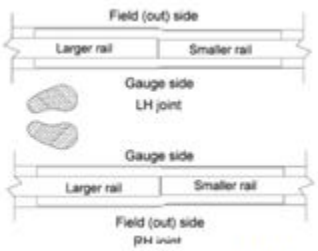

Figure 111B *Compromise Weld Identification*

Compromise weld kits are not interchangeable due to different base offsets on gage and field sides.

- Gage side base offset is 1/8 inch.
- Field side base offset is 3/8 inch.

Do not make a compromise weld between rails of different rail chemistry and different width bases; e.g. between 136 lb. alloy rail and 119 lb. standard carbon rail. (See Figure 111C)

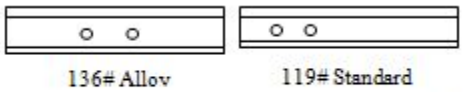

Figure 111C *Rail Chemistry*

If rails with different base widths and different chemistries must be joined:
1. Weld a standard carbon rail of the same weight and section as the alloy rail, to the alloy rail.

- Length of rail cut-in must not be less than 15 feet.
- Make the compromise weld between the rails of the same chemistry. (See Figure 111D)

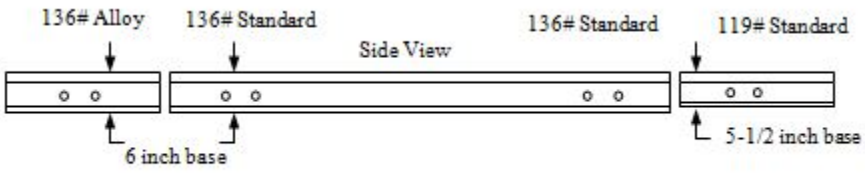

Figure 111D *Cut-in Rail*

Compromise welds on opposite rails should be made within the same crib.

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111.6: Compromise/Transition Rail

Use compromise/transition rails when required to reduce or eliminate the use of compromise thermite welds on main track and sidings.
(See Figure 111E)
Standards drawings are available online in the Engineering Department web page – Procedures and Standards.

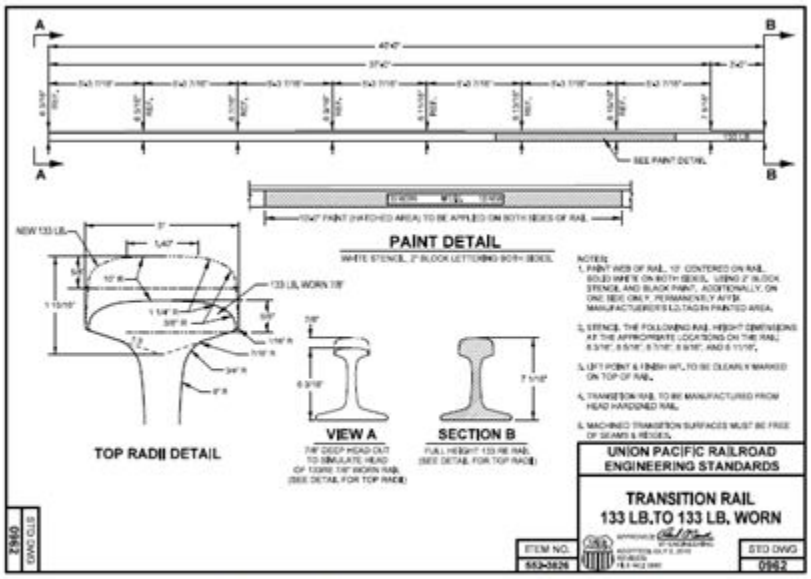

Figure 111E *133# to 133# Worn Transition Rail*

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111.7: Speed Restrictions - Alloy Rail

For all thermite welds involving alloy rail:

1. Restrict speed to a maximum of 30 mph for a minimum of 24 hours after installation.
2. Do not remove speed restriction until all thermite welds in Class 3 and above tracks are inspected and protected by weld-mate straps.

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111.8: Eliminate Bolt Holes

Eliminate bolt holes on thermite welds as follows:

1. On thermite welds that require weld-mate straps, eliminate:

    a. Bolt holes with centers closer than 8 inches from the rail ends being welded.
    b. Holes not needed to install the weld-mate strap.

2. On thermite welds that do not require the use of weld-mate straps, eliminate all holes with centers closer than 6 inches from the rail ends being welded.

    - *This includes bond wire holes drilled by Signal Maintainers.*

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111.9: Reference Marks

Apply reference marks before cutting rail or removing joint bars as outlined in the Engineering Track Maintenance Field Handbook Section 7.0 Track Buckling Prevention Guidelines.

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111.10: Remove Defects

Refer to Engineering Track Maintenance Field Handbook for rail defect remediation matrix. (Section 4.0 Rail and Joints)

Replacement rail is required when more than one defect of any kind is detected within the same 39-foot length of rail in the same test. (Except for bolt hole crack defects)

When rail detector cars find a defect in a weld, do the following:

1. In a plant weld, cut out the defect by removing a 1-1/2 inch section of rail, 3/4 inch each direction from center of weld. (See Figure 111F)
2. In a thermite weld, cut out the defect by removing a 2-3/4 inch section of rail, at least 1-3/8 inches each direction from center of weld.(See Figure 111F)

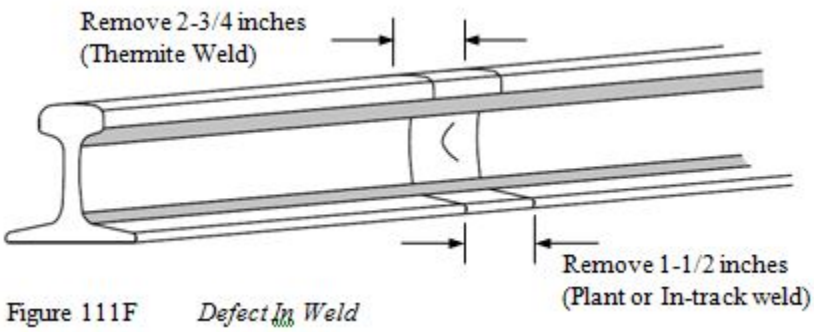

Figure 111F *Defect In Weld*

When defects previously marked by detector car personnel are repaired, the entire defect must be removed and each rail visually inspected before installing a thermite weld.

- If rail is not cut and marks are not visible, rail must be re-tested.
- If rail is not cut and marks are visible, cut on outside of marks.(See Figure 111G)

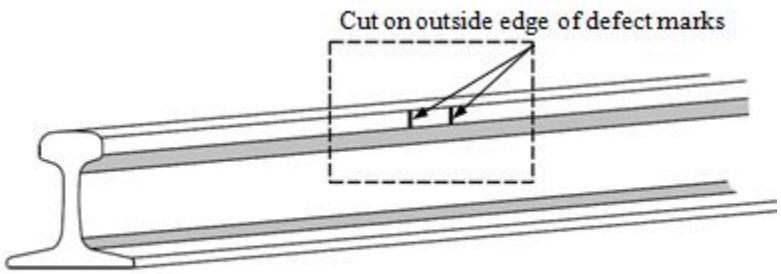

Figure 111G *Defect Marking*

- If rail was previously cut and no marks are visible, remove 1-3/8 inch from each end.(See Figure 111H)

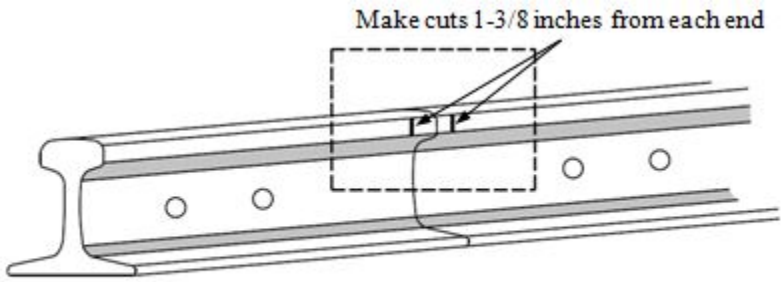

Figure 111H *Marking Additional Cuts*

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111.11: Torch Cut Rail

Anytime rail is cut using a torch, do the following:

1. Use a rail saw to trim the torch cut rail end square immediately after the torch cut is made to eliminate the growth of deep thermal heat cracks.
    - All indication of torch cut must be removed.
2. If a rail saw is not used to square the torch cut rail end within 15 minutes after the torch cut is made, an additional 2 inches of rail must be removed from the rail end to get past the thermal crack growth.

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111.12: Rail Puller

Refer to Chapter 104.1.3 Hydraulic Rail Pullers for operating instructions.

When using a Rail Puller while installing thermite welds, follow these procedures:

1. Surface the rail joint and tamp at least two ties each side of the joint before placing rail puller on the rail.
2. Remove sufficient amount of rail anchors to allow longitudinal movement of rail.
3. Alignment plates must be used to achieve crown and horizontal alignment prior to pulling rail.
4. Remove by grinding, any raised lettering or foreign object on the rail where rail puller jaws will contact rail.
5. Remove dirt or grease from this area using a wire brush or torch if necessary.
6. Clean and inspect the rail puller jaws for conditions that could reduce gripping.
7. Operate the rail puller to obtain the correct gap.
8. Never remove additional rail anchors while rail puller is under pressure.
9. If the desired pull cannot be achieved, release the expander, remove additional anchors, and repeat the process.
10. Remove rail puller after weld has cooled to 700° F or less.

    (Check the weld temperature on the top center of the weld using a 700° F temp-stick or a pyrometer.
    If the temp-stick does not melt or the pyrometer registers 700° F or less, remove the rail expander gradually)

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111.13: Clean Rail Ends

Clean rail ends removing dirt, rust or other material to ensure a sound weld.

Use an oxy-fuel torch to remove:

- Mill scale 3/4 inch from the each end of rail around the entire periphery.
- Grease 4 inches from each end of rail.

Use a wire brush to remove:

- Dirt, rust or other material 4 inches from the end of each rail.
    - Visually inspect rail ends for defects.

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111.14: Rail End Gap - Standard (1-inch) and Wide Gap Weld (WGW)

The required gap must be achieved to within 1/16 inch before thermite welding. Improper gap width results in improper preheating or lack of sufficient weld material.

Rails must be cut square to within 1/16 inch perpendicular from the top to the bottom and from the gage side to the field side.

- Combined deviation between both rails will not exceed 1/8 inch.

When thermite welding, create the proper gap as follows:

1. Create a 1 inch gap for a standard thermite weld.
2. Create a 2-3/4 inch gap for a wide gap weld.

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111.15: Alignment System

Use of rail alignment plates is required when installing thermite welds.

Exception: Alignment wedges must only be used where rail alignment plates fail to work properly such as switches.
Note: Steel wedges must be kept in safe condition and metal flow dressed to eliminate cracks and chipping. After dressing wedge, apply an approved protective covering.

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111.16: Create Crown - Standard and Wide Gap Weld

Use a 36 inch straightedge to ensure proper crown is established. Use of a taper gauge is required to setup the adjustable type straightedge and must always be used with a non-adjustable straightedge while crowning rail ends.

To create the proper crown using rail alignment plates, do the following:

1. On wood ties, move tie plates to accommodate rail alignment plates.
    - Adz ties for proper fit of alignment plates if necessary.

2. On concrete ties remove pads, if necessary, to accommodate rail alignment plates.
3. Rail fasteners may need to be removed 2 or 3 ties each side of joint.
4. Insert rail alignment plates and adjust to achieve required crown.

With a proper crown, the ends of each rail just contact the underside of the straightedge.

The proper crown for a standard weld is 0.065 inch to 0.075 inch and 0.090 inch to 0.095 inch for a wide gap weld. (See Figure 111I)

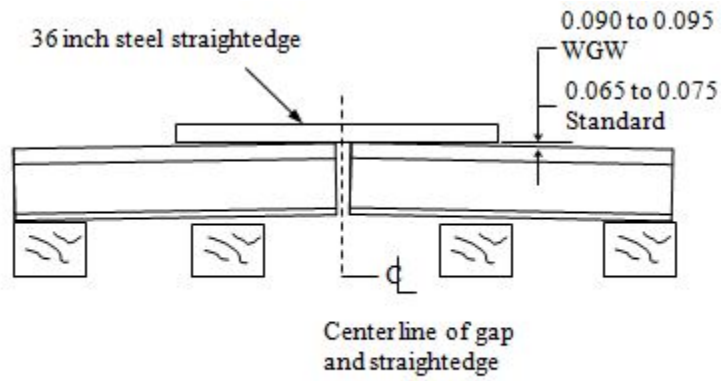

Figure 111I *Crowning Rail Ends*

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111.17: Rail Alignment (Straight and Compromise)

Rail twist is the mis-alignment of the rail head and base from the center axis and is not allowed.

When making a weld, use a 36-inch straightedge to check the alignment of rails. Ensure that the gage side of the rails are perfectly aligned at the base of the rail first, then the head of the rail, lastly getting the proper crown.

On rail joints where one rail is excessively curve worn, align rail on the field side of the head and base.

On compromise joints where rails are of different base widths:

1. Use alignment plates to achieve proper crown.
2. Align rails so that the base on the gage side has a 1/8 inch offset and that the base on the field side has a 3/8 inch offset.
3. Align rails so that the gage side of the head is perfectly aligned.

Compromise weld molds (handed weld molds) are designed with the offsets and are designated left-hand or right-hand. Compromise weld molds are not interchangeable and cannot be modified to fit other rail configurations.

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111.18: Molds, Base Plate and Packing

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111.18.1: Molds and Base Plate

Step 1: Place a mark on both sides of the rail base of each rail, 2-1/2 inches from the end of each rail. (See Figure 111J) This is where to check the rail end temperature during preheating with a 450ºF temp-stick only. Do not pack beyond these marks.

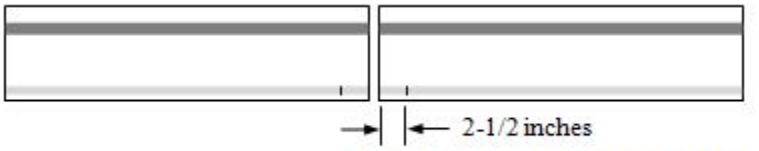

Figure 111J *Heat Measure Marks*

Step 2: Check the mold fit against the rail ensuring that no gap is present before clamping to rail. Filing or rubbing may be needed to ensure
proper mold to rail fit. Over rubbing or filing may cause flashing due to gap.

The following steps are for 3 piece welds only.
Step A: Clean the base plate to allow the base brick to fit freely.
Step B: Maintain the base plate in good condition so that it aligns properly at a right angle with the rail.
Step C: Ensure that the recess in the base brick is in the exact center of the rail gap and is evenly spaced on the sides of the base.
Step D: Ensure clamping screws are snug but not over-tightened and are positioned perpendicular to the rail to allow for ease of packing.
Step E: After installing the base plate, recheck the alignment and crown and re-adjust if necessary, taking precaution not to cause damage to the base brick.

Step 3: Place the setting gauge in the welding gap. (See Figure 111K)

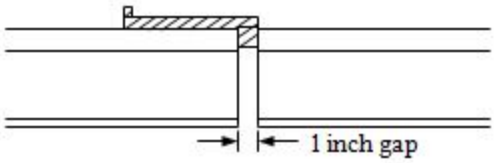

Figure 111K *Setting Gauge Placement*

Step 4: Attach universal clamp to rail flush with end of setting gauge and ensure clamp is in an absolute vertical position.
Step 5: Half of the mold is applied, centered on the gap and the swivel arm screw slightly tightened while lifting upwards on the mold shoe.
Step 6: Apply the other half in the same fashion while aligning at the base and the top.
Step 7: Swivel arm screws should not be over-tightened and should be left in the horizontal position to allow for slag pan placement.
Step 8: Tap the bottom of both mold shoes lightly to ensure tight fit-up.
Step 9: Check alignment of the mold halves on rail gap and ensure molds are flush on sides and bottom.
Step 10: Check diverting plug for fit if molds have been excessively filed.
Step 11: When welding in a curve, file the top of the diverting plug to ensure it sets level when installed, to provide uniform distribution of molten steel when pouring.
Step 12: If any gap is large enough for luting sand to enter the mold cavity, fill the gap with paper to prevent the luting sand from entering the cavity.
Step 13: Cover the top of the mold to prevent any foreign material from entering the mold cavity during packing.

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111.18.2: Luting

Use only Orgo-thermit luting sand with Orgo-thermit weld kits.
Pack the mold solid with luting sand as follows:
1. Tightly pack all seams starting from the base to the top as follows:

- Base lip (2 Piece Only)
- Bottom of rail base
- Top of rail base
- < >Rail head
- Side of mold above rail head
- Pouring lip
- Do not pound against the luting sand, as this will cause the rail to mis-align.
- Mold shoes should be firmly packed such that the luting flare is full.

2. Ensure packing sand does not enter the mold cavity.
3. If luting sand does enter the mold cavity, disassemble the mold, remove the sand mixture and repack the mold.
4. Position slag pans onto mold shoe lugs prior to beginning preheat.

    - Dry slag pans with preheating torch to ensure all moisture is removed.

Plan the packing stage so that the preheating cycle can begin immediately after packing is complete. Once the packing is complete, do not allow the finished mold to sit more than 10 minutes before preheating

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111.19: Preheating Procedures

Before preheating, ensure you are familiar with and have been properly trained in the operation of that equipment.

Use of a stopwatch is required when thermite welding for preheating, tap and take down times.

Prior to preheating, do the following:

- Torch must be level and torch height checked prior to preheating.
- Place burner saddle assembly on the universal clamp.
- Turn the saddle adjustment knobs to center the burner head in the gap.
- Align the burner head so it is vertically straight and not pointing toward the gage or field side of the railhead.
- After pre-aligning the burner, remove the burner saddle assembly from the universal clamp.

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111.19.1: Use of Oxy-Propane Equipment

Use a Hesa SKV-5 preheat burner and Hesa burner stem, Victor HD310C torch body or equivalent with the Railtech flat head or Victor TWN-5 rectangular torch tip.

- Pressure settings may vary for each set of equipment and should be adjusted accordingly.
- Torch mounted in-line gauges must be used and working properly to verify pressure settings on every weld and will be placed between torch handle and flashback arrestors.
- Extreme pressure variances of 15 psi or more between cylinder regulator and in-line gauge indicates a restriction or problem, and must be corrected.
- Ensure there is sufficient oxygen and fuel-gas in cylinders to complete the preheating.

These pressure settings are required at the torch and are shown for both standard 1 inch and wide gap welds and assume the torch has 50 feet of 3/8 inch ID Grade "T" hose, check valves and flashback arrestors. (Refer to Table 111A)
Verify the oxygen and propane pressures at the torch and adjust if necessary.
The following pressure settings are required at the torch. The torch must be in the molds and flame adjusted properly to achieve these settings.

Table 111A Torch PSI Requirement

	Standard 1 inch Weld	Wide Gap Weld
Propane	15 psi	15 psi
Oxygen	60 psi	60 psi

1. Do not use hose lengths greater than 100 feet.
2. Operate torch 1-3/8 inches above the top of the rail for standard 1 inch weld.
3. Operate torch 2-3/8 inches above the top of the rail for wide gap weld.
4. Ignite the oxy-propane torch and place onto rail mounted torch stand.
5. Adjust for full oxygen by opening the oxygen valve completely.
6. Open the propane valve until a crackle sound occurs, then slowly close the propane valve until the crackle sound disappears.

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111.19.2: Start the Preheat Process

Follow required preheat times. (Refer to Table 111B)

Table 111B Preheat Times

	Standard 1 inch Weld	Wide Gap Weld
5-1/2 inch rail base - 119# or smaller	5 to 5-1/2 minutes	5-1/2 minutes
6 inch rail base - larger than 119#	6 to 6-1/2 minutes	6-1/2 minutes
Do not exceed 8 minutes when preheating		

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111.19.3: Monitor Preheating Process

Wear the required PPE when monitoring the preheat process.

- Ensure the torch is centered and straight.
- The employee igniting and placing the torch must observe the entire preheating of the rail ends.
- Ensure the rail ends do not melt.
- Ensure the rail ends and molds heat evenly to prevent improper fusion and internal cracks that result from uneven cooling.
- Ensure that the web glows a bright red/orange with no signs of sweating or melting.

  - If rail ends appear to be getting too hot, cool the flame by increasing the propane flow at the torch handle.

- Ensure the rail head and base glow a dull red and have no black areas.
- After removing the torch, observe the true color of the rail ends. If they do not hold their color, replace the torch and continue preheating.

If rail end melting occurs: Stop, tear down molds, re-cut rail ends and start over.
Preheating is completed when the required preheat time has been achieved and the rail base is 450° F on all four sides. (At the marks measured 2-1/2 inches from the end of rails with a temp-stick only). Do not use a pyrometer to check rail base temperature.

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111.19.4: Railtech Propane/Compressed Air Rail Preheater (Model 03800B)

To setup and operate the Propane/Compressed Air Rail Preheater, follow these instructions. (Refer to equipment manual for complete operating instructions and safety precautions)

1. Connect the stainless steel flex line from the regulator on the hydraulic propane unit to the propane cylinder. Make sure that all fittings are tight.
2. Connect the hydraulic hoses from the power source to the hydraulic propane unit.
3. Align the inox-heating nozzle so that the flat piece of the nozzle is no higher than the top of the inside of the mold where the diverter plug fits. The nozzle tip must be aligned straight up and down perpendicular to the rail.
4. Prior to starting the preheating unit, tilt the nozzle up slightly to help start the flame.
5. Ensure that there is no pressure on the diaphragm by turning the pressure adjusting screw counter-clockwise on the propane regulator.
6. Operate hydraulic system at 10 GPM @ 2000 psi.
7. Open the hydraulic control valve on the preheater to engage the blower unit.

8. Open the valve on the propane cylinder completely.
9. Open the air bypass valve located at the inox burner to adjust air pressure for ease of lighting.
10. Turn the pressure adjustment screw clock-wise on the propane regulator to supply 8 psi to 10 psi.
11. Open the propane valve on the inox heating nozzle and ignite flame by placing a friction lighter over a riser hole.
12. Allow the flame to warm the molds for approximately 10 seconds to 15 seconds, and then slowly straighten the nozzle in the molds so that the nozzle is straight up and down.

    - The flames should be in the rail area and in the risers. If the flames are in the risers only, again tilt the nozzle up, then slowly straighten.
    - It may be necessary to adjust the flame using the propane on-off valve located on the inox burner.

13. After adjusting nozzle to achieve desired flame, begin the preheat time. (Refer to Table 111C)

Table 111C Preheat Times

	Standard 1 inch Weld	Wide Gap Weld
5-1/2 inch rail base - 119# or smaller	5 to 6 minutes	6-1/2 minutes
6 inch rail base - larger than 119#	6 to 7 minutes	6-1/2 minutes
Do not exceed 8 minutes when preheating		

Preheating is completed when the required preheat time has been achieved and the rail base is 450° F on all four sides. (At the marks measured 2-1/2 inches from the end of rails with a temp-stick only). Do not use a pyrometer to check rail base temperature.

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111.20: Crucible

While preheating the molds and rail ends:

- Inspect crucible for loose sand or cracks.
- Do not use if cracked.
- Do not place crucible directly on any surface that may allow foreign material to stick to the bottom.
- Fill the crucible with the charge.
- Warm the diverter plug 30 seconds prior to removing the preheat torch by placing it on the top edge of the mold or holding over the flame by use of fire tongs.

When preheat is complete, remove the torch and insert the diverter plug in the top of the mold, pushing the plug down firmly.

Do not pound the plug into place.

Note: The diverter plug allows the molten steel to flow into the mold properly, filling the mold evenly.
Place the crucible onto the molds and center over diverter plug, using the two large riser holes as a guide.

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111.21: Igniting and Pouring

To ignite the charge:

- When using a stick igniter, light the igniter by touching it on the inside of the riser hole.
- Place the stick igniter in the charge within the crucible to a depth of 1-inch and step back. (Do not over insert)
- Do not use an oxy-fuel torch to ignite the stick igniter or thermite weld charge.

Tap Time: The time it takes after igniting the charge for the molten steel to flow out of the crucible.

- Acceptable tap time is 15 seconds to 35 seconds.
- If tap time is less than 15 seconds or more than 35 seconds, the weld must be considered defective and removed from track.

Hot metal or slag coming in contact with moisture can cause an explosion. When the thermite weld is pouring, protect yourself and others from:

- Coming in contact with hot molten steel, as high as 5,000° F.
- Bright light from the thermite reaction-protect your eyes.

After igniting the charge:

- Stand back at least 15 feet while the molten steel pours into the mold.

If a leak develops in the mold, do not attempt to stop the leak.

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111.22: Minimum Take Down Times

Follow minimum takedown times. (Refer to Table 111D)
Step 1. Remove crucible with proper tool and place at a safe dry location.

Step 2. Remove slag pans and place at a safe dry location.

- Wait twenty (20) minutes before emptying slag pans.

Step 3. Remove universal clamp and shoes.

Step 4. De-mold weld material.

Step 5. Shear weld. Ensure shear is adjusted properly, 1/8" above rail head. Before shearing, the weld must stop bubbling and started turning
grayish/black in color. Shear slowly.

Step 6. Bend down risers without breaking off to accommodate profile grinder.

When the slag stops pouring into the slag pans, start the minimum take down times as follows:

Table 111D Minimum Take Down Times

	Standard 1 inch Weld	**Wide Gap Weld**
Remove Crucible	5 minutes	9 minutes
Remove Slag Pans	5 minutes	9 minutes
Remove Universal Clamp and Shoes	5 minutes	9 minutes
De-mold	6 minutes	10-1/2 minutes
Shear	7 minutes	11-1/2 minutes
Remove Base Plate * for 3 piece only	20 minutes	30 minutes
Remove Alignment Tools and Empty Slag Pans	20 minutes	30 minutes
Remove Risers	25 minutes or 900° F	900° F
Remove Rail Puller	When weld is less than 700° F	When weld is less than 700° F

After removing the slag pans, place them in a safe dry location where they can continue to cool.

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111.23: Remove Excess Mold

Follow these safety requirements when tearing down weld:

1. Wrap-around face shield with goggles or safety glasses must be worn when removing the mold and cleaning the weld, or
2. Mono-goggle XTR with safety glasses can be used as an alternative.
3. Protect yourself from hot metal fragments and sand.
4. Do not discard the hot slag where someone could step on it, or where it could start a grass fire.
5. Do not discard hot slag on wet soil, snow or throw into water.

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111.24: Rough Grinding

Rough grinding of the rail head portion of the thermite weld can be performed after shearing. Rough grinding of the running surface of the rail shall be performed with a surface grinder and is completed when the excess weld material is reduced to approximately 30 thousandths (0.030) of an inch.
When the surface of the weld is above 700° F, it is permitted to "blue" the weld.
Remove alignment plates and base plate in accordance with take down times.
Remove risers by lightly tapping downward toward ground.
Apply rail fasteners and ensure ties are tamped solid under the weld.

- Use a hydraulic tamper if available.

Train traffic or heavy work equipment (spikers, tampers, etc.) must not be allowed over a thermite weld until the weld has cooled below 700° F.

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111.25: Finish Grinding

Using an 8' x 1' straight stone grinder:

- Taper and remove sharp edges from the teardrop under rail head (See Figure 111L).
- Grind the risers flush with weld collar.
- Do not grind into the collar.
- Do not grind into the parent metal.
- If inclusions are visible and cannot be removed by grinding, the weld must be removed.

Thermite welds must not have the weld collar ground as to reduce the amount of metal from the web area.

Removing metal from the weld collar to accommodate joint bars is prohibited.

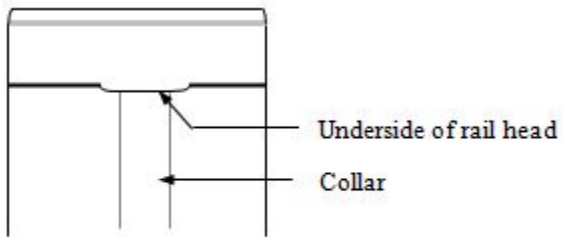

Figure 111L *Underside of Rail Head*

If vertical offset or gage face mismatch is apparent, grind the rail to achieve a gradual transition.
Final surface grinding will be performed after the weld has cooled to below 700° F. When doing the final grinding, use a straightedge and check as you go. Only grind where the straightedge indicates the need. When weld temperature is equal to or below 700° F, 'bluing' of the rail or weld surface is not permitted. A gentle or light effort shall be used.
The running surface of the weld shall be ground to exactly match the contour of existing rails. A radius is to be applied to the gage and field sides so no sharp edges remain.

Do not grind off the weld onto the lower or curve worn rail as this will create secondary batter and increase impact forces. Use the following formula to determine proper length of taper. (Refer to Table 111E)

Minimum Ramp Length (feet) = $\frac{\text{Off-set (thousandths of an inch)}}{0.008 \text{ inch}}$

Table 111E Length of Taper

Offset	Taper Length
0.030 inch	4 inches
0.060 inch	8 inches
0.090 inch	12 inches
0.125 inch	16 inches

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111.26: Weld Tolerance Specifications

To improve overall track geometry and reduce Evaluation Car exceptions, the Thermite maximum weld tolerances below must be followed.

(Refer to Table 111F)
These are cold (ambient temperature), finish ground specifications.

Table 111F Weld Tolerance Specifications for Finished Thermite Welds

	Vertical Crown	Vertical Offset	Horizontal Offset	Horizontal Kink	Base (HOS) Horizontal Offset	Base (VOS) Vertical Offset
Thermite	0.040"	0.020"	0.040"	0.025"	0.060"	0.250" (a)

(a) Maximum base vertical offset will not exceed 0.250 inch on same base width rail.

Combined Vertical Crown and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld.
Combined Horizontal Kink and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld.

After a thermite weld has been installed, use a straightedge to measure for crown, vertical offset, horizontal offset, horizontal kink, base horizontal offset, base vertical offset, and over grind. (See Figures 111M – 111S)

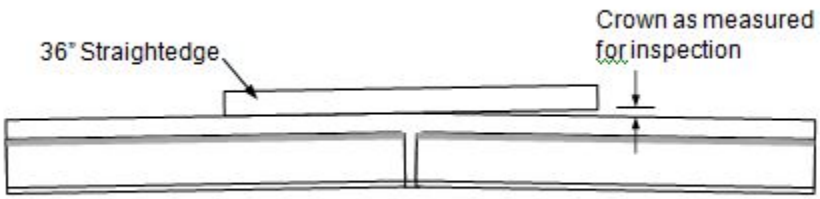

Figure 111M *Crown Inspection – Side View*

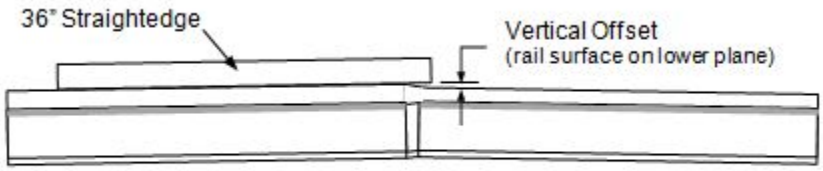

Figure 111N *Vertical Offset – Side View*

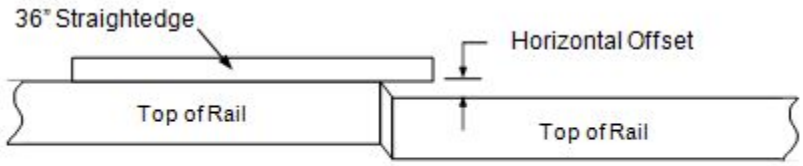

Figure 111O *Rail Head Horizontal Offset – Overhead View*

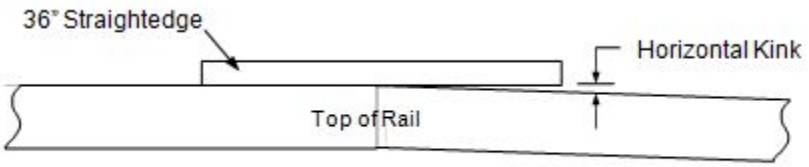

Figure 111P *Horizontal Kink – Overhead View*

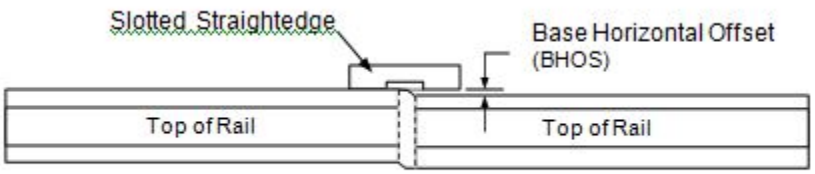

Figure 111Q *Base Horizontal Offset – Overhead View*

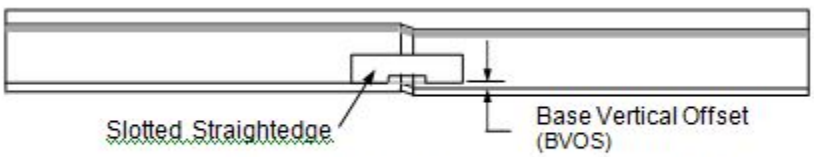

Figure 111R *Base Vertical Offset – Side View*

Figure 111S *Surface Over Grind*

Welds must not be over ground. Use the straightedge periodically to check progress.

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111.27: Identify Weld

The engineering department requires the placement of metal weld tags on all welds. Use a generous amount of adhesive on the back of the tag and place on the field side of the rail. (See Figures 111T and 111U)

Thermite weld tags will be punched to indicate the following:

1. Employee ID (not gang number)
2. Month and year installed
3. Month and year weld kit manufactured
4. 1-inch gap or wide gap weld

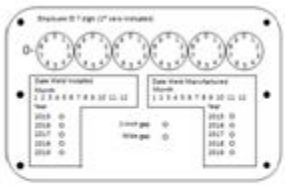

Figure 111T *Weld Tag*

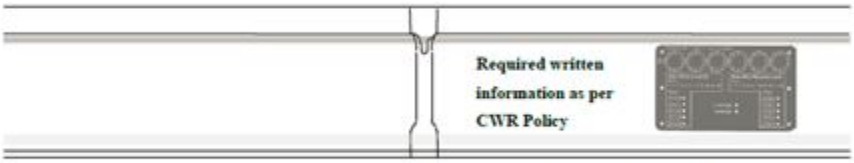

Figure 111U *Weld Tag Placement*

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111.28: Thermite Weld Quality Audit

Managers and employees will use the written Thermite Weld Quality Audit form to assess the workmanship of the welding gang in the field. Weld audits will be submitted into the electronic Weld Quality Auditing System in the TMP.

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111.29: Clean Up

The clean up can be performed before the final grinding. Clean up includes:

- Reapplying the rail fasteners.
- Reapplying the anchors.
- Filling cribs.
- Remove any weld material waste including slag, spent molds, risers and packaging from worksite and dispose of properly.
- Do not leave weld waste exposed at worksite.

Approved welding bucket can be used to remove debris from worksite. Store stock item # 460-7115.

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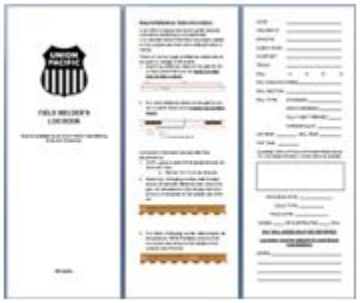
111.30: Welders Log Booklet

All thermite welds installed must be recorded in the welders log booklet with all required information including placing the weld charge sticker to the specified area on log page. If sticker cannot be placed into the booklet, sticker information must be written in.

All completed welders log booklets must be kept in a safe location and made available for review by any manager or their representative.
Welders Log Booklet item number PB-24095.



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111.31: Thermite Head Repair Weld

Only designated track welding employees who have been trained and qualified are allowed to install thermite head repair welds.
All PPE must be worn as required for any thermite welding procedure.
When performing dye-penetrant testing, wear wrap-around face shield with goggles or safety glasses.

- Mono-goggle XTR with safety glasses can be used as an alternative.

Orgo-thermit weld kits are available for 115#/119#, 132#, 133#, 136# and 141# rail.
On Orgo-thermit welds, entire rail head is removed by grinding.
Head repair welds use specific weld hardware.

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111.31.1: Rail Preparation

1. Do not weld on non-alloy rail when the rail temperature is below 5° F.

- Warm rail to remove any surface moisture around entire periphery of rail.

2. Remove by grinding, the entire defect within the rail head until the web of rail is exposed to a width of 1-inch only. (entire rail head is removed)

- Care must be taken not to over grind the notch.
- Use a file or hand grinder if necessary to remove any sharp edge after defect removal.
- Depth of cut will vary depending on amount of rail head loss.

3. Use an oxy-fuel torch and wire brush to clean the rail of any dirt, oil, grease or other contaminants.

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111.31.2: Dye Penetrant Testing

Conduct Dye-Penetrant Test on DF type defects (Not required for SSC type defect)

1. Gloves must be worn during the entire process.
2. Brush the surface of the rail with a wire brush to remove contaminants.
3. Clean the surface of the rail free of dust and dirt with a piece of cloth.
4. Spray the cleaner on the surface to remove oil, grease, etc. and wipe with cloth.
5. Apply the dye penetrant (by spraying) adequately to cover the area to be tested. Allow 3 to 5 minutes for dye to penetrate into the cracks.
6. Wipe off the excess penetrant on the surface with a piece of cloth.
7. Again spray the surface with the cleaner to remove the remnants of the red dye if needed.
8. Spray the developer evenly on the surface to give a thin even layer. This layer absorbs the penetrant from the cracks and red spots or lines appear on the surface to give a visible indication of the flaws.
9. The crack if any will be indicated with the red dye absorbed by the white developer.

    - Remove white developer before proceeding.

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111.31.3: Crowning Rail

Rail must be crowned using a 36 inch straightedge with taper gauge and alignment tools.

- Crowning will be 0.050 inch to 0.060 inch.

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111.31.4: Torch Height

- Pre-set preheat burner height to 3 inches as measured from top of rail.

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111.31.5: Molds and Clamp

1. Set mold clamping device and apply molds.

    - Molds may need to be filed / rubbed to ensure a tight fit to rail, especially the area directly under the rail head.
    - Care must be taken to not over file or rub as this may cause flashing.

2. Place pouring plug inside mold to check fit (remove plug).
3. Cover top of molds before beginning packing to prevent contaminants from entering mold cavity.
4. Pack molds working from the bottom up.
5. Place slag pans on each side.

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111.31.6: Preheating (Oxy-fuel Torch)

1. Preheating using an oxy-fuel torch:
2. Both time and temperature requirement must be met to complete preheat stage.
   (Refer to Table 111G and Table 111H)

Table 111G Pressure Settings

	Oxygen	Propane
115#/119#	60 psi	15 psi
132#/136#	60 psi	15 psi
133#	60 psi	15 psi
141#	60 psi	15 psi

Table 111H Preheat Time and Temperature

	Time	Temperature
115#/119#	2-1/2 minutes	250 F
132#/136#	2-1/2 minutes	250 F
133#	2-1/2 minutes	250 F
141#	2-1/2 minutes	250 F

3. In-line gauges are required as specified by UPRR track welding rules to provide accurate preheat when using an oxy-fuel torch.
4. When using an oxy-fuel torch, ignite torch before placing into molds, adjust flame and re- adjust pressure settings if needed.
5. Adjust (open) propane control valve on torch handle if needed to cool the flame.
6. Monitor preheat during entire process to ensure no melting of rail occurs.
7. Warm diverter plug during the last 30 seconds of preheat by using the tongs.

After preheat is complete, remove torch and place crucible.
Using igniter, ignite charge and stand back at least 15 feet while ignition process and pouring of the weld takes place.
Do not attempt to stop any leak.

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111.31.7: Take Down Times

Follow minimum takedown times. (Refer to Table 111I)

Table 111I Minimum Takedown Times

	Take Down Times
Remove Crucible and Slag Pans	3 minutes
Remove Mold Shoes and Clamping Device	4 minutes
Remove Top of Mold (Demold)*	5 minutes
Shear (Slowly)**	5 minutes

* When demolding, proceed slowly and watch for leaks.
** Keep rail clamps loose when shearing.

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111.31.8: Protect Weld from Cooling

When rail temperature is at or below 40 F, or in high wind conditions, apply cooling cap immediately after shearing to reduce the cooling rate of the weld until the weld temperature is 700 F or less.
Refer to Chapters 101.0 and 111.0 for weather condition requirements.

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111.31.9: Grinding

Rough grind weld until material is reduced to about 0.030 inch in height.
Do not finish grind (blend in) while weld temperature is above 700 F. as this will result in a low weld.
Do not grind onto the parent steel as this will result in "dipping and batter", unless the need to taper rail due to apparent existing batter is present that requires tapering to smooth transition.

- This may be apparent on some SSC type defects.

Empty slag pans and remove crowning device at 20 minutes after the pour is completed.

- Time begins when last drop of slag flows into slag basin.

Finish grinding the weld to match the contour of the existing rail.
Any indication of "flashing" under the rail head must be removed by grinding.

- Flashing contributes to defect development.

All welds will be identified with the standard weld tag **and** green "test" tag for identification.
Ensure weld is accurately entered into the reporting system using the code (OH) for Orgo-thermit head weld

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111.31.10: Clean Up

The clean up can be performed before the final grinding. Clean up includes:

- Reapplying the rail fasteners.
- Reapplying the anchors.
- Filling cribs.
- Remove any weld material waste including slag, spent molds, risers and packaging from worksite and dispose of properly.
    - Do not leave weld waste exposed at worksite.
- Approved welding bucket can be used to remove debris from worksite. Store stock item # 460-7115.

Record weld installation information into the welders log book.

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111.31.11: Required Molds and Equipment

Orgo-thermit Head Repair Kits		
552-6595	115# Head Repair Kit	FIELD WELD KIT, 115#/119# DHR, SINGLE USE, HEAD REPAIR
552-6598	132# Head Repair Kit	FIELD WELD KIT, 132# DHR, SINGLE USE, HEAD REPAIR
552-6601	133# Head Repair Kit	FIELD WELD KIT, 133# DHR, SINGLE USE, HEAD REPAIR
552-6605	136# Head Repair Kit	FIELD WELD KIT, 136# DHR, SINGLE USE, HEAD REPAIR
552-6621	141# Head Repair Kit	FIELD WELD KIT, 141# DHR, SINGLE USE, HEAD REPAIR

Temp-Stick		
410-7418	250 F Temp-stick	STICK, TEMP, MSW90250MS, 250F TEMPERATURE DETECTION STICK., TO BE USED WITH ORGO THERM HEAD, WELDS

Grinders and Abrasives (Either grinder with appropriate abrasive is available)		
420-1663	PortaCo Notch Grinder (use 411-1577 abrasive below)	GRINDER TO REMOVE 2" SLOT FOR THERMITE HEAD REPAIRS
411-1577	12 x 2 x 1 arbor Grinding Stone	USED FOR THERMITE HEAD REPAIR WELDS, REMOVE RAIL HEAD
420-1662	Matweld Slot Grinder (use 411-1198 abrasive below)	GRINDER TO REMOVE 2" SLOT FOR THERMITE HEAD REPAIRS
411-1198	8 x 2 x 1 Grinding Stone	USED FOR THERMITE HEAD REPAIR WELDS, REMOVE RAIL HEAD

Hardware		
552-6770	Orgo-thermit Mold Shoes	55-30-115 FIELD WELD HEAD REPAIR, MOLD SHOES
552-6200	Cooling Cap	COOLING RETARDER CAP

Dye Penetrant		
410-7895	Dye Penetrant Testing Cleaner	01-5750-79 MINEWELD, SPOT CHECK CLEANER
410-7903	Dye Penetrant Testing Penetrant	TWK-1003 MINEWELD, SPOT PENETRANT
410-7912	Dye Penetrant Testing Developer	TWK-1003 MINEWELD, SPOT CHECK DEVELOPER

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112.0: ELECTRIC FLASH-BUTT WELDING

Chapter Introduction

The following instructions must be adhered to when making all Electric Flash Butt (EFB) welds utilizing Mobile In-Track Welder (ITW) equipment.

- 112.1: Types of Welds
- 112.2: Welding Equipment Operators
- 112.3: Reference Marks
- 112.4: Welding Near Fixed Structures
- 112.5: Weather Guidelines
- 112.6: Rail Requirements
- 112.7: Weld Location
- 112.8: Preparation
- 112.9: Flash Butt Welding Procedures
- 112.10: Torch Cut Rail Ends
- 112.11: Traffic Restrictions
- 112.12.1: Rail Head
- 112.12: Finish Grinding
- 112.12.2: Rail Web, Fillets and Base
- 112.13: Measuring Weld Cooling Rate
- 112.14: Weld Rejection/Acceptance
- 112.15: Weld Quality Standards
- 112.16: Identify Welds

112.1: Types of Welds

EFB welds will be either of the following types:

- Head Weld – Weld is made with one or both rails not secured longitudinally.
- Closure Weld – Weld is made on longitudinally secured rails using a rail puller (Super Jack) to pull rails together during weld flashing and upset while holding the rail in place during cooling.

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112.2: Welding Equipment Operators

Union Pacific employees operating the controls of electric flash butt welding equipment must do so under the direct supervision of a qualified employee.

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112.3: Reference Marks

Reference marks must be placed on the rail prior to cutting rail and must be applied in accordance with the Engineering Track Maintenance Field Handbook (ETMFH) - Section 7.9.2 Placing Reference Marks.
The types of reference marks that are used to manage the CWR events are:

- Spanning reference marks are used for service failures, pull-aparts, detector car defects, track panels less than or equal to 80', rail change out less than or equal to 80'. Refer to Section 7.9.3 Placing Spanning Reference Marks.
- Pull back reference marks are used for rail change out greater than 80' or less than or equal to 360'and track panels greater than 80' or less than or equal to 360'. Refer to Section 7.9.4 Placing Pull Back Reference Marks.
- Match marks are used when rail change out is greater than 360'. Refer to Section 4.5.1.A Monitor Rail Movement.

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112.4: Welding Near Fixed Structures

To minimize longitudinal stresses on track components, do not make closure welds within 150 feet of any rail crossing (diamond) or turnout. All rail restraints must be applied between closure weld and frog. Apply solid box pattern rail anchors as per ETMFH specification in turnouts. Closure welds must not change UPRR switch point to stock rail specifications.

Do not raise the rail neutral temperature above the subdivision rail laying temperature.

Care must be taken when working near detectors, insulated joints or other signal appliances.

When welding in or near a tunnel with a curve, do not over stretch the rail. Over stretching can disturb track alignment and decrease tunnel clearances.

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112.5: Weather Guidelines

Union Pacific welding manager or welding supervisor will determine if conditions are safe for operation.
Welding is prohibited if the first 30 inches of rail measured from each rail end cannot be kept dry.

- Precautions must be taken to shield the weld from excessive moisture.
- Welding is permitted when the web of the rail can be heated, dried and kept dry until the weld is completed.

1. Ensure that all welding machine fluids, including welding head and Super-Jack, are at operating temperature before starting welding process.
2. If raining or snowing, a welding blanket must be placed over the weld immediately after shearing to prevent moisture from contacting the weld; or during high wind conditions until the weld temperature is below 700° F.

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112.6: Rail Requirements

Replacement rail used for maintenance welding in an in-track operation must meet the following guidelines:

- Minimum length of 15 feet.
- Vertical height difference from existing rail must not exceed 1/4 inch.
- Torch cut ends must re-cut with a rail saw.
  (See 112.10 below)
- Thermite welds must be removed when practical.
- Must be UT tested, certified and meet the installation requirements per Section 4 of the Engineering Track Maintenance Field Handbook.
- Do not EFB weld alloy rail.

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112.7: Weld Location

When making welds in track, do not make a weld on top of a tie. If welds are made out-of-track and it is unknown where the weld will lie once rail is installed, excess weld material must be ground from the bottom of, and both sides of the rail base flush with the parent steel to properly fit in the tie plate or seat. Ensure there are two good ties immediately under each side of the weld for proper support.

(See Figure 112A)

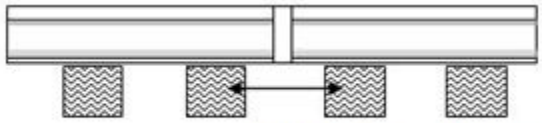

Figure 112A *Weld Location*

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112.8: Preparation

Welding torch cut rail ends is prohibited.
Before flash butt welding, do the following:

1. Remove mill scale, rust, grease etc., where the welding electrodes will contact the rail web.
    - Area to be cleaned must be ground to bright metal.
2. Remove by grinding, all raised lettering and other protrusions where the electrodes or jack wedges will contact the rail.
3. Clean rail ends of all foreign material.
4. All bolt holes should be eliminated when possible:
    - Completed welds must not be closer than 6 inches from the center of any hole including bolt holes and rail bond holes.
    - All bolt holes must be deburred, beveled and inspected for defects when left in the track.
5. Prepare weld location:
    - Weld location must be between ties that will provide adequate clearance for shear as required including removing ballast.
    - Track must be properly aligned and surfaced prior to welding.
    - Adz wood ties if necessary to provide proper clearance for weld head.
    - Anchors and fasteners must be removed to allow movement when aligning rail.
    - All fasteners and plates removed must be kept clear of the welding head during the welding operation.
    - On closure welds, remove a minimum of 300 feet of anchors or fasteners for standard consumption welds and a minimum of 200 feet for low consumption welds.
    - If fixed track structures are encountered, remove additional anchors in the opposite direction
    - Welds made out of track must have the bottom and sides of the rail base ground flush with parent metal.
    - Do not weld battered rail ends or surface bent rails.

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112.9: Flash Butt Welding Procedures

Rail must be aligned vertically to provide finished welds that are within the vertical crown and vertical off-set dimensions at ambient temperature. (Refer to Table112B)

- If vertical rail height between rail ends is less than 1/8 inch, align the rail heads even and provide the off-set in the base.
- If vertical rail height between rail ends is 1/8 inch to 1/4 inch, spilt the difference between the base and rail head. (Do not offset the base more than 1/8 inch)
- If vertical rail height between rail ends is more than 1/4 inch, a better matching rail or compromise/transition rail must be installed.

Any rail end cut with a rail saw shall be cut square to within 1/8 inch both vertically and horizontally.

- Rail ends being welded that have a combined deviation of more than 1/4 inch will be rejected and must be re-cut.
    - As checked with the two rails touching.
- If rail ends are not cut square top to bottom or side to side, the EFB equipment operator must not manually burn rails more than 1/4 inch before starting the weld process. Any remaining excessive rail must be cut off with a rail saw.

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112.10: Torch Cut Rail Ends

All rail ends prepared for electric flash butt welding shall be cut square with a rail saw. Welding torch cut rail ends is prohibited.
Rail ends cut with an oxy-fuel torch will be trimmed back no less than 1/4 inch if done within 15 minutes of the initial torch cut.

- If rail ends cannot be re-cut with a rail saw within 15 minutes of the torch cut, a minimum of 2 inches must be removed to get beyond the thermal heat cracks.

If a completed weld must be re-welded and is torch cut due to rail in compression, trim back each rail end no less than 1/4 inch. Trimming must be completed within 30 minutes of the torch cut.

- If the re-weld torch cut rail ends cannot be re-cut (trimmed) with a rail saw within 30 minutes, then a minimum of 2 inches from each rail end must be removed to get beyond the thermal heat cracks.

Note: If rail is not in compression it may be possible to simply cut the rail with a rail saw.

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112.11: Traffic Restrictions

Train traffic or heavy work equipment (spikers, tampers, etc.) must not be allowed over an EFB weld until: (ITW equipment exempt)

- The running surface and gage face are rough ground to within thirty thousandths (0.030) of an inch.
- The weld has cooled below 700° F.
- All wedges, jacks and blocks are removed.
- Ties in each side of the weld have been tamped.

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112.12.1: Rail Head

1. Grind the gage and field side of the rail to match the existing rail profile. (Remove overflow)
2. The running surface of the weld shall be ground to exactly match the contour of existing rails. A radius is to be applied to the gage and field corners so no sharp edges remain.
3. Do not over-grind welds. Do not remove parent material.
4. When tapering rail due to vertical or gage face mismatch, do not grind off the weld onto the parent metal. Use the following formula to determine proper length of taper. (Refer to Table 112A)

Minimum Ramp Length (feet) = Off-set (thousandths of an inch) / 0.008 inch

Table 112A Length of Taper

Mismatch Offset	Taper Length
0.030 inch	4 inches
0.060 inch	8 inches
0.090 inch	12 inches
0.125 inch	16 inches

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112.12: Finish Grinding

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112.12.2: Rail Web, Fillets and Base

When grinding rail web, fillets and base:

1. Grind all welds smooth to within 1/16 inch of the original contour of the web and fillets. Do not grind into the parent metal.
2. Grind the top of the base to within 1/16 inch of the original contour.
3. Grind the sides of the base smooth.
4. Visually inspect all welds for defects including where the current carrying electrodes make contact with the rail web.
5. When shearing the upset, inspect the area on the web of every weld for gouges or smear. Reject any weld that has gouged into the parent material. All smears must be ground from welds.

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112.13: Measuring Weld Cooling Rate

Weld temperature must be below 700° F before releasing welding head, super-jack or lowering crowning cylinders. Use a pyrometer in the radius between the web and head of the weld.

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112.14: Weld Rejection/Acceptance

If welding system indicates the weld is out-of-spec or an interruption occurs during the welding cycle, weld must be considered defective, removed and rail re-welded.

If an out-of-spec weld or bad weld is identified and marked by the welding system as shown on the weld certificate or chart, weld must be removed and rail re-welded.

If no chart is available for weld, it must be removed and rail re-welded.

Weld charts and certificates must be reviewed by Union Pacific supervisory personnel and verified as a good weld before signing daily weld production form, for each weld produced and left in track.

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112.15: Weld Quality Standards

Finished welds must meet the following requirements.

- These are cold (ambient temperature), finish ground specifications. (Refer to Table 112B)

Table 112B Maximum Tolerance of Finished Ground Weld

	Vertical Crown	Vertical Offset	Horizontal Offset	Horizontal Kink (1)	Base (HOS) Horizontal Offset	Base (VOS) Vertical Offset
Class 1-5	0.060"	0.020"	0.040"	0.025"	0.060"	0.125" *
Class 6	0.030"	0.020"	0.030"	0.025"	0.060"	0.125" *

(1) Measure on the convex side with straightedge centered on weld

* If rail height difference is greater than 0.125 inch, offset top of rail and grind. Any offset on the top of rail must be tapered to provide a smooth transition. (See Figures 112B – 112H)

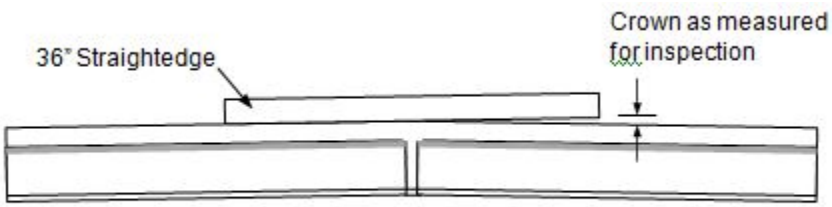

Figure 112B *Crown Inspection – Side View*

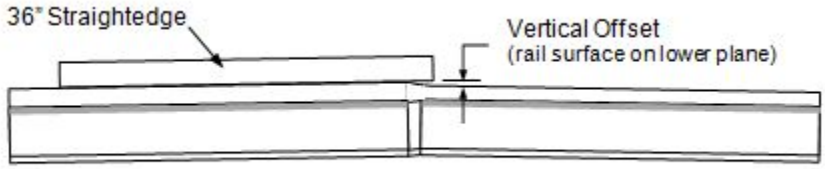

Figure 112C *Rail Head Vertical Offset – Side View*

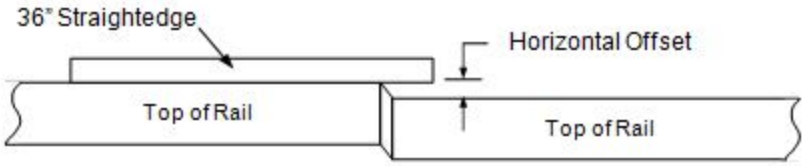

Figure 112D *Rail Head Horizontal Offset – Overhead View*

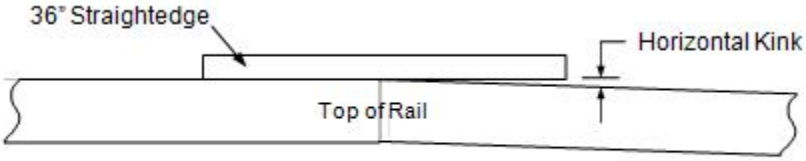

Figure 112E *Horizontal Kink – Overhead View*

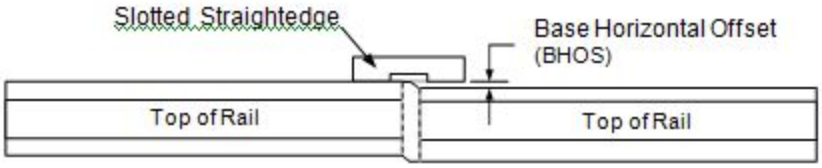

Figure 112F *Base Horizontal Offset – Overhead View*

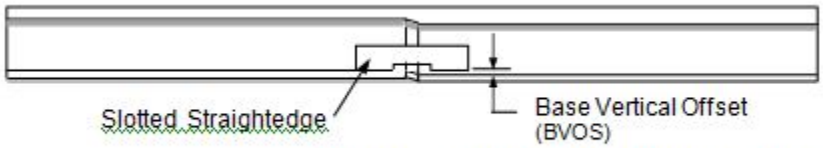

Figure 112G *Base Vertical Offset – Side View*

Figure 112H *Surface Over Grind*

Welds must not be over ground. Use the straightedge periodically to check progress.

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112.16: Identify Welds

Rail temperature and amount of rail removed must be recorded on the field side of rail web with a white metal marker.

The engineering department requires the placement of metal weld tags on all welds. Item number for in-track weld tags is 412-7661. (See Figure 112J)
Placement of the weld identification tag will be on the field side of the rail web near the weld, as shown in the illustration below and applied with a silicon adhesive. (See Figure 112I)

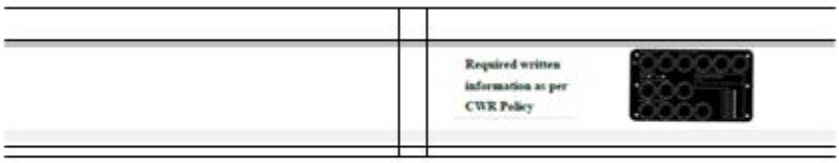

Figure 112I *Weld Tag Placement*

Use a generous amount of adhesive on the back of the weld tag to ensure adequate adhesion.

Before installing a metal weld id tag, use the metal punch to indicate the following:

- Welding employee ID number
- ITW machine number
- ITW weld number (consecutive number starting the first of each year)
- Month and year weld installed

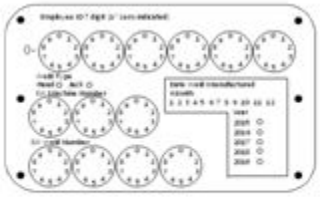

Figure 112J *Weld Tag*

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113.0: SWITCH MAINTENANCE GRINDING

Chapter Introduction

These instructions apply to turnout maintenance grinding. The purpose of switch maintenance grinding is to increase the longevity of the component by removing metal flow and restoring radius preventing chipping and cracking.

When performing any of these tasks, use frog and radius gauges to check and control the amount of grinding.

The RPM rating of abrasive wheel/stone must meet or exceed the RPM rating of the power equipment that is being used.

- 113.1: Personal Protective Equipment (PPE)
- 113.2: Grinding Turnout and Crossing Frogs (Diamonds)
- 113.2.1: Remove Flowed Metal
- 113.2.2: Grind Slots
- 113.2.3: Grind Running Rail
- 113.3: Grinding Stock Rails and Switch Points
- 113.3.1: Remove Flowed Metal
- 113.3.2: Grind Switch Points
- 113.4: Grinding and Slotting Rail Ends
- 113.4.1: Use Proper Abrasive Wheels
- 113.4.2: Slot Rail Ends

113.1: Personal Protective Equipment (PPE)

Task	Required PPE
Abrasive Grinding	Hard hat, hearing protection, type of eye protection as follows: 1. Welding hood with clear lens or in grind mode with safety glasses, or 2. Wrap-around face shield with goggles or safety glasses *(#5 shade must not be worn)*, work gloves, welding jacket or welding sleeves, leather leggings, approved safety-toe boots and flame resistant clothing. See respiratory policy for respirator requirement.

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113.2: Grinding Turnout and Crossing Frogs (Diamonds)

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113.2.1: Remove Flowed Metal

1. Remove all flowed metal from the gage side corner of the frog.
2. Apply steady pressure to effectively remove metal without gouging the parent steel.
3. Grind the gage side corner to a 5/8 inch radius.

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113.2.2: Grind Slots

Abrasive wheels used in slotting must not be more than 1/8 inch thick. Appropriate blotters must be used between the abrasive wheel and metal flange.
A. Carbon Rail Frogs
On carbon rail frogs, slot to a depth of at least 3/16-inch and slightly bevel the top:

- Slot between the short point and the adjacent rail.
- Slot between the filler block at the heel of the frog and the adjacent rail.

B. Manganese Insert Frogs

On manganese insert frogs, slot to a depth of at least 3/16-inch and slightly bevel the top:

- Slot between the insert and the binder rails.
- Slot between the narrow portion of the manganese insert and the carbon steel heel leg extension rails at the heel of the frog.

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113.2.3: Grind Running Rail

Remove metal flow from running rails in the area adjacent to guardrails.

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113.3: Grinding Stock Rails and Switch Points

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113.3.1: Remove Flowed Metal

Remove all flowed metal from the gage and field sides of the stock rail as follows:

1. On gage side, remove metal flow 4 inches ahead of the switch point and grind back to where the switch point ends contact with the stock rail.
2. Ensure no sharp projections remain after grinding.
3. Ensure the flowed metal on stock rail is tapered back from the switch point at a minimum of 4 inches to eliminate a sharp corner.
4. Grind the gage and field sides of the stock rail to a 5/16-inch to 9/16-inch radius.
5. When grinding Samson stock rails, it is important not to change the dimension of the gage face. Only apply enough pressure to remove metal flow without gouging the parent steel or changing the angle of the gage face.

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113.3.2: Grind Switch Points

Grind switch points as follows:

1. Ensure tip of the point is 5/8 inch to 3/4 inch lower than the stock rail. Refer to standard drawings for specific dimensions of various size switch points.
   a. Ensure the top of the point tapers back so the first 8 inches of the point will not carry any load.
   b. Remove metal flow on the gage side of the switch point and restore to a 5/16-inch to 9/16-inch radius.
2. Remove metal flow on the back of switch point to obtain a close fit between switch point and stock rail.
3. The back of the switch point must be slightly beveled at the top, except the first 10 inches from the end of the point.
4. Slot the rail ends at the heel of the switch point.

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113.4: Grinding and Slotting Rail Ends

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113.4.1: Use Proper Abrasive Wheels

Abrasive wheels used in slotting rail ends must not be more than 1/8 inch thick. Rubber or paper blotters must be used between the abrasive wheel and metal flange.

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113.4.2: Slot Rail Ends

After surface grinding, slot rail ends to the required dimensions using proper equipment.

- The slot should match the contour of the rail end.
- Avoid cutting into or nicking the joint bars.

The following procedures apply to slotting rail ends:

Open Joints:

- Square the rail end by removing any metal flow by grinding.
- Slot the rail end to 1/4 inch to 5/16 inch deep.
- Bevel the rail end to 1/16 inch to 3/32 inch back.

Closed Joint:

- Center the slotting wheel between the rail ends of closed joints to remove an equal amount of metal from each rail.
- Slot the rail end to 1/4 inch to 5/16 inch deep.
- Slot to a width of 3/16 inch.

Insulated Joints:

- Remove only flowed metal from rail ends and ensure no sharp edges remain.
- Avoid cutting the end post as much as possible.
- Do not slot any deeper than necessary to remove flowed metal.

Slot Outside Rail of Curves:

On the outside rail of curves, continue slotting over and around the gauge side to include the area usually engaged by the wheel flange.

- Avoid nicking or grinding the joint bar.

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114.0: DEFINITIONS

- 114.0: Definitions

114.0: Definitions

ACETONE:
A flammable, volatile liquid used in acetylene cylinders to dissolve and stabilize acetylene under high pressure.

ACETYLENE:
A highly combustible gas composed of carbon and hydrogen. Used as a fuel gas in the oxyacetylene welding process.

AIR-ARC CUTTING:
An arc cutting process in which metals to be cut are melted by the heat of the carbon arc.

ALLOY:
A mixture with metallic properties composed of two or more elements, of which at least one is a metal.

ALTERNATING CURRENT:
An electric current that reverses its direction at regularly recurring intervals.

ANNEALING:
A comprehensive term used to describe the heating and cooling cycle of steel in the solid state. The term annealing usually implies relatively slow cooling. In annealing, the temperature of the operation, the rate of heating and cooling, and the time the metal is held at heat depend upon the composition, shape, and size of the steel product being treated, and the purpose of the treatment. The more important purposes for which steel is annealed are as follows: to remove stresses; to induce softness; to alter ductility, toughness, electric, magnetic, or other physical and mechanical properties; to change the crystalline structure; to remove gases; and to produce a definite microstructure.

ARC BLOW:
The deflection of an electric arc from its normal path because of magnetic forces.

ARC CUTTING:
A group of cutting processes in which the cutting of metals is accomplished by melting with the heat of an arc between the electrode and the base metal. See CARBON-ARC CUTTING, METAL-ARC CUTTING, ARC-OXYGEN CUTTING, AND AIR-ARC CUTTING.

ARC LENGTH:
The distance between the tip of the electrode and the weld puddle.

ARC VOLTAGE:
The voltage across the welding arc.

ARC WELDING:
A group of welding processes in which fusion is obtained by heating with an electric arc or arcs, with or without the use of filler metal.

AS WELDED:
The condition of weld metal, welded joints, and weldments after welding and prior to any subsequent thermal, mechanical, or chemical treatments.

BACK FIRE:
The momentary burning back of a flame into the tip, followed by a snap or pop, then immediate reappearance or burning out of the flame.

BASE METAL:
The metal to be welded or cut. In alloys, it is the metal present in the largest proportion.

CARBON-ARC CUTTING:
A process of cutting metals with the heat of an arc between a carbon electrode and the work.

CARBONIZING FLAME:
An oxyacetylene flame in which there is an excess of acetylene. Also called excess acetylene or reducing flame.

CRACK:
A fracture type discontinuity characterized by a sharp tip and high ratio of length and width to opening displacement.

CRATER:
A depression at the termination of an arc weld.

CUTTING TIP:
A gas torch tip especially adapted for cutting.

CUTTING TORCH:
A device used in gas cutting for controlling the gases used for preheating and the oxygen used for cutting the metal.

CYLINDER:
A portable cylindrical container used for the storage of a compressed gas.

DEFECT:
A discontinuity or discontinuities which, by nature or accumulated effect (for example, total crack length), render a part or product unable to meet the minimum applicable acceptance standards or specifications. This term designates rejectability.

DEPOSITED METAL:
Filler metal that has been added during a welding operation.

DEPOSITION EFFICIENCY:
The ratio of the weight of deposited metal to the net weight of electrodes consumed, exclusive of stubs.

DEPTH OF FUSION:
The distance from the original surface of the base metal to that point at which fusion ceases in a welding operation.

DIRECT CURRENT ELECTRODE NEGATIVE (DCEN):
The arrangement of direct current arc welding leads in which the work is the positive pole and the electrode is the negative pole of the welding arc.

DIRECT CURRENT ELECTRODE POSITIVE (DCEP):
The arrangement of direct current arc welding leads in which the work is the negative pole and the electrode is the positive pole of the welding arc.

DISCONTINUITY:
An interruption of the typical structure of a weldment, such as lack of homogeneity in the mechanical, metallurgical, or physical characteristics of the material or weldment. A discontinuity is not necessarily a defect.

DUCTILITY:
The property of a metal which allows it to be permanently deformed, in tension, before final rupture. Ductility is commonly evaluated by tensile testing in which the amount of elongation and the reduction of area of the broken specimen, as compared to the original test specimen, are measured and calculated.

DUTY CYCLE:
The percentage of time during an arbitrary test period, usually 10 minutes, during which a power supply can be operated at its rated output without overloading.

EFFECTIVE LENGTH OF WELD:

The length of weld throughout which the correctly proportioned cross section exits.

ELECTRODE:

a. Metal-Arc. Filler metal in the form of a wire or rod, whether bare or covered, through which current is conducted between the electrode holder and the arc.
b. Carbon-Arc. A carbon or graphite rod through which current is conducted between the electrode holder and the arc.

ELECTRODE HOLDER:
A device used for mechanically holding the electrode and conducting current to it.

FACE OF WELD:
The exposed surface of a weld, made by an arc or gas welding process, on the side from which welding was done.

FILLER METAL:
Metal to be added in making a weld.

FILTER GLASS:
A colored glass used in goggles, helmets, and shields to exclude harmful light rays.

FLAME HARDENING:
A method for hardening a steel surface by heating with a gas flame followed by a rapid quench.

FLAME SOFTENING:
A method for softening steel by heating with a gas flame followed by slow cooling.

FLASHBACK:
The burning of gases within the torch or beyond the torch in the hose, usually with a shrill, hissing sound.

FLAT POSITION:
The position in which welding is performed from the upper side of the joint and the face of the weld is approximately horizontal.

FLUX:
A cleaning agent used to dissolve oxides, release trapped gases and slag, and to cleanse metals for welding, soldering, and brazing.

FUSION:
A thorough and complete mixing between the two edges of the base metal to be joined or between the base metal and the filler metal added during welding.

FUSION ZONE (FILLER PENETRATION):
The area of base metal melted as determined on the cross section of a weld.

GAS POCKET:
A weld cavity caused by the trapping of gases released by the metal when cooling.

GAS WELDING:
A process in which the welding heat is obtained from a gas flame.

GOGGLES:
A device with colored lenses, which protect the eyes from harmful radiation during welding and cutting operations.

GROUND CONNECTION:
The connection of the work lead to the work.

HARD FACING:
A particular form of surfacing in which a coating or cladding is applied to a surface for the main purpose of reducing wear or loss of material by abrasion, impact, erosion, galling, and cavitations.

HARD SURFACING:
The application of a hard, wear-resistant alloy to the surface of a softer metal.

HARDENING:

a. The heating and quenching of certain iron-base alloys from a temperature above the critical temperature range for the purpose of producing a hardness superior to that obtained when the alloy is not quenched. This term is usually restricted to the formation of Martensite.
b. Any process of increasing the hardness of metal by suitable treatment, usually involving heating and cooling.

HEAT AFFECTED ZONE:
That portion of the base metal whose structure or properties have been changed by the heat of welding or cutting.

HEAT TIME:
The duration of each current impulse in pulse welding.

HEAT TREATMENT:
An operation or combination of operations involving the heating and cooling of a metal or an alloy in the solid state for the purpose of obtaining certain desirable conditions or properties. Heating and cooling for the sole purpose of mechanical working are excluded from the meaning of the definition.

HELMET:
A device used in arc welding to protect the face and neck. It is equipped with a filter glass and is designed to be worn on the head.

HOT SHORT:
A condition which occurs when a metal is heated to that point, prior to melting, where all strength is lost but the shape is still maintained.

INERT GAS:
A gas which does not normally combine chemically with the base metal or filler metal.

INTERPASS TEMPERATURE:
In a multi-pass weld, the lowest temperature of the deposited weld meal before the next pass is started.

KERF:
The space from which metal has been removed by a cutting process.

LAYER:
A stratum of weld metal, consisting of one or more weld beads.

MANIFOLD:
A multiple header for connecting several cylinders to one or more torch supply lines.

MARTENSITE:
Martensite is a microconstituent or structure in quenched steel characterized by an acicular or needle-like pattern on the surface of polish. It has the maximum hardness of any of the structures resulting from the decomposition products of austenite.

MELTING POINT:
The temperature at which a metal begins to liquefy.

MELTING RANGE:
The temperature range between solid and liquid.

METAL-ARC WELDING:
An arc welding process in which a metal electrode is held so that the heat of the arc fuses both the electrode and the work to form a weld.

MIXING CHAMBER:
That part of a welding or cutting torch in which the gases are mixed for combustion.

NEUTRAL FLAME:
A gas flame in which the oxygen and acetylene volumes are balanced and both gases are completely burned.

NONFERROUS:
Metals which contain no iron. Aluminum, brass, bronze, copper, lead, nickel, and titanium are nonferrous.

NORMALIZING:
Heating iron-base alloys to approximately 100 °F (38 °C) above the critical temperature range followed by cooling to below that range in still air at ordinary temperature.

OPEN CIRCUIT VOLTAGE:
The voltage between the terminals of the welding source when no current is flowing in the welding circuit.

OVERLAP:
The protrusion of weld metal beyond the bond at the toe of the weld.

OXIDIZING FLAME:
An oxyacetylene flame in which there is an excess of oxygen. The unburned excess tends to oxidize the weld metal.

OXYACETYLENE CUTTING:
An oxygen cutting process in which the necessary cutting temperature is maintained by flames obtained from the combustion of acetylene with oxygen.

OXYACETYLENE WELDING:
A welding process in which the required temperature is attained by flames obtained from the combustion of acetylene with oxygen.

OXY-PROPANE CUTTING:
An oxygen cutting process in which the necessary cutting temperature is maintained by flames obtained from the combustion of propane with oxygen.

PASS:
The weld metal deposited in one general progression along the axis of the weld.

PEENING:
The mechanical working of metals by means of hammer blows. Peening tends to stretch the surface of the cold metal, thereby relieving contraction stresses.

POROSITY:
The presence of gas pockets or inclusions in welding.

POSITIONS OF WELDING:
All welding is accomplished in one of four positions: flat, horizontal, overhead, and vertical. The limiting angles of the various positions depend somewhat as to whether the weld is a fillet or groove weld.

POSTHEATING:
The application of heat to an assembly after a welding, brazing, soldering, thermal spraying, or cutting operation.

PREHEATING:
The application of heat to a base metal prior to a welding or cutting operation.

QUENCHING:
The sudden cooling of heated metal with oil, water, or compressed air.

REGULATOR:
A device used to reduce cylinder pressure to a suitable torch working pressure.

REVERSE POLARITY:
The arrangement of direct current arc welding leads in which the work is the negative pole and the electrode is the positive pole of the welding arc.

ROCKWELL HARDNESS TEST:
In this test a machine measures hardness by determining the depth of penetration into the specimen under certain arbitrary fixed conditions of test. The penetrator may be either a steel ball or a diamond spherocone.

ROOT CRACK:
A crack in the weld or base metal which occurs at the root of a weld.

ROOT FACE:
The portion of the prepared edge of a member to be joined by a groove weld which is not beveled or grooved.

SHIELDED WELDING:
An arc welding process in which protection from the atmosphere is obtained through use of a flux, decomposition of the electrode covering, or an inert gas.

SLAG INCLUSION:
Non-metallic solid material entrapped in the weld metal or between the weld metal and the base metal.

SPALL:
Small chips or fragments which are sometimes given off by electrodes during the welding operation. This problem is especially common with heavy-coated electrodes.

SPATTER:
The metal particles expelled during arc and gas welding which do not form a part of the weld.

STRAIGHT POLARITY:
The arrangement of direct current arc welding leads in which the work is the positive pole and the electrode is the negative pole of the welding arc.

STRESS RELIEVING:
A process of reducing internal residual stresses in a metal object by heating to a suitable temperature and holding for a proper time at that temperature. This treatment may he applied to relieve stresses induced by casting, quenching, normalizing, machining, cold working, or welding.

STRING BEAD WELDING:
A method of metal arc welding on pieces 3/4 in. (19 mm) thick or heavier in which the weld metal is deposited in layers composed of strings of beads applied directly to the face of the bevel.

TEMPORARY RAIL END BUILDUP:
Welding beads applied on the lower rail to protect the taller rail when rail ends are mismatched. Rail ends must be properly prepared and preheated before welding, then postheated when completed.

THERMAL CONDUCTIVITY:
The rate at which temperature travels through metal.

THERMITE CRUCIBLE
The vessel in which the thermit reaction takes place.

THERMITE MIXTURE:
A mixture of metal oxide and finely divided aluminum with the addition of alloying metals as required.

THERMITE MOLD:
A mold formed around the parts to be welded to receive the molten metal.

THERMITE REACTION:
The chemical reaction between metal oxide and aluminum, which produces, superheated molten metal and aluminum oxide slag.

THERMITE WELDING:
A group of welding processes in which fusion is produced by heating with superheated liquid metal and slag resulting from a

chemical reaction between a metal oxide and aluminum, with or without the application of pressure. Filler metal, when used, is obtained from the liquid metal.

UNDERCUT:
A groove melted into the base metal adjacent to the toe or root of a weld and left unfilled by weld metal.

UNDERCUTTING:
An undesirable crater at the edge of the weld caused by poor weaving technique or excessive welding speed.

UPSET:
A localized increase in volume in the region of a weld, resulting from the application of pressure.

UPSET WELDING:
A resistance welding process in which fusion is produced simultaneously over the entire area of abutting surfaces, or progressively along a joint, by the heat obtained from resistance to the flow of electric current through the area of contact of those surfaces. Pressure is applied before heating is started and is maintained throughout the heating period.

UPSETTING FORCE:
The force exerted at the welding surfaces in flash or upset welding.

WEAVE BEAD:
A type of weld bead made with transverse oscillation.

WEAVING:
A technique of depositing weld metal in which the electrode is oscillated. It is usually accomplished by a semicircular motion of the arc to the right and left of the direction of welding. Weaving serves to increase the width of the deposit, decreases overlap, and assists in slag formation.

WELD:
A localized fusion of metals produced by heating to suitable temperatures. Pressure and/or filler metal may or may not be used. The filler material has a melting point approximately the same or below that of the base metals, but always above 800 °F (427 °C).

WELD BEAD:
A weld deposit resulting from a pass.

WELD GAUGE:
A device designed for checking the shape and size of welds.

WELD METAL:
That portion of a weld that has been melted during welding.

WELD SYMBOL:
A picture used to indicate the desired type of weld.

WELDABILITY:
The capacity of a material to form a strong bond of adherence under pressure or when solidifying from a liquid.

WELDER CERTIFICATION:
Certification in writing that a welder has produced welds meeting prescribed standards.

WELDER PERFORMANCE QUALIFICATION:
The demonstration of a welder's ability to produce welds meeting prescribed standards.

WELDING LEADS:

a. Electrode lead. The electrical conductor between the source of the arc current and the electrode holder.
b. Work lead. The electrical conductor between the source of the arc welding current and the workpiece.

WELDING PRESSURE:
The pressure exerted during the welding operation on the parts being welded.

WELDING ROD:
Filler metal in wire or rod form, used in gas welding and brazing processes and in those arc welding processes in which the electrode does not provide the filler metal.

WELDING TECHNIQUE:
The details of a manual, machine, or semiautomatic welding operation which, within the limitations of the prescribed joint welding procedure, are controlled by the welder or welding operator.

WELDING TIP:
The tip of a gas torch especially adapted to welding.

WELDING TORCH:
A device used in gas welding and torch brazing for mixing and controlling the flow of gases.

WELDING TRANSFORMER:
A device for providing current of the desired voltage.

WELDMENT:
An assembly whose component parts are formed by welding.

WORK LEAD:
The electric conductor (cable) between the source of arc welding current and the workpiece.

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May 2, 2016

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- APPENDIX B: ELECTRIC WELDING INSPECTION RECORD
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APPENDIX A: MILLER POWER SOURCE SETUP

Miller Power Source Setup

Amperage Settings for Miller Bobcat 225

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
50-100	50	55	60	65	70	75	80	85	90	95	100
70-150	70	78	86	94	102	110	118	126	134	142	150
85-225	85	99	113	127	141	155	169	183	197	211	225

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller Bobcat 225b

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
50-120	50	57	64	71	78	85	92	99	106	113	120
70-150	70	78	86	94	102	110	118	126	134	142	150
85-225	85	99	113	127	141	155	169	183	197	211	225

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller Bobcat 250

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
25-80	25	30.5	36	41.5	47	52.5	58	63.5	69	74.5	80
35-115	35	43	51	59	67	75	83	91	99	107	115
75-250	75	92.5	110	127.5	145	162.5	180	197.5	215	232.5	250

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller Trailblazer 250G

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
25-80	25	30.5	36	41.5	47	52.5	58	63.5	69	74.5	80
35-115	35	43	51	59	67	75	83	91	99	107	115
75-250	75	92.5	110	127.5	145	162.5	180	197.5	215	232.5	250

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller AirPac 400

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
85-210	85	97.5	110	122.5	135	147.5	160	172.5	185	197.5	210
110-270	110	126	142	158	174	190	206	222	238	254	270
190-400	190	211	232	253	274	295	316	337	358	379	400

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller AirPac 500

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
90-190	90	100	110	120	130	140	150	160	170	180	190
140-330	140	159	178	197	216	235	254	273	292	311	330
200-500	200	230	260	290	320	350	380	410	440	470	500

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller AirPac 750 Generating Power CC/CV – DC Only
(525 Amp 100% Duty Cycle / 550 Amp 60% Duty Cycle / 600 Amp 40% Duty Cycle)

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
85-250	85	101.5	118	134.5	151	167.5	184	200.5	217	233.5	250
125-400	125	152.5	180	207.5	235	262.5	290	317.5	345	372.5	400
185-525	185	219	253	287	321	355	389	423	457	491	525

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

Miller Power Source Setup

Amperage Settings for Miller Bib Blue 400

Estimated welding current at 0% to 100%

Use meter on power source for actual amperage output

This table is for CC welding only using the SMAW process (Stick Electrode)

Amp Range	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
90-225	90	103.5	117	130.5	144	157.5	171	184.5	198	211.5	225
120-280	120	136	152	168	184	200	216	232	248	264	280
200-400	200	220	240	260	280	300	320	340	360	380	400

UPRR Approved Stick Electrodes

Carbon Steel	**Size**	**Weld Parameters**	**Manganese Steel**	**Size**	**Weld Parameters**
PostAlloy RailTuff	3/16"	170-225 Amps	PostAlloy Stainless	1/8"	120 Amps
McKay M-932	1/4"	290-310 Amps	PostAlloy Stainless	5/32"	140 Amps
Railbuild 540	3/16"	170-225 Amps	Frogbuild	3/16"	180-200 Amps
Railbuild 540	1/4"	210-230 Amps	Frogbuild	7/32"	200-220 Amps
			FrogMang	3/16"	175-215 Amps
			FrogMang	1/4"	235-280 Amps

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APPENDIX B: ELECTRIC WELDING INSPECTION RECORD

Electric Welding Equipment Inspection

Required Monthly: Inspect for loose connections, condition of cables, connections, ground clamps, electrode holders, wire feeder and gun, leaking fluid from welding machine and overall machine performance.

Save & send full sheet to track welding manager/supervisor

Date (mm/dd/yyyy)	Gang # (#0000)	Defect (yes/no)	Employee Signature	Comments: Defect/Corrective Action Taken	Mgr's Initials
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APPENDIX C: OXY-FUEL INSPECTION RECORD

Oxy-fuel Equipment Inspection

Required: * Prior to initial use each day or shift * When combination torches have been converted or altered * When torch equipment has been dropped or is suspected of being damaged * When a flashback has occurred * When new torch equipment is installed

Save & send full sheet to track welding manager/supervisor

Date (mm/dd/yyyy)	Gang # (#0000)	Defect (yes/no)	Employee Signature	Comments: Defect/Corrective Action Taken	Mgr's Initials
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APPENDIX D: CONVERSION CHART

CONVERSION CHART: FRACTION/DECIMAL/MILLIMETER

fraction	decimal	mm		fraction	decimal	mm		fraction	decimal	mm
1/64	0.0156	0.3969		1 1/64	1.0156	25.7969		2 1/64	2.0156	51.1969
1/32	0.0313	0.7938		1 1/32	1.0313	26.1938		2 1/32	2.0313	51.5938
3/64	0.0469	1.1906		1 3/64	1.0469	26.5906		2 3/64	2.0469	51.9906
1/16	0.0625	1.5875		1 1/16	1.0625	26.9875		2 1/16	2.0625	52.3875
5/64	0.0781	1.9844		1 5/64	1.0781	27.3844		2 5/64	2.0781	52.7844
3/32	0.0938	2.3813		1 3/32	1.0938	27.7813		2 3/32	2.0938	53.1813
7/64	0.1094	2.7781		1 7/64	1.1094	28.1781		2 7/64	2.1094	53.5781
1/8	**0.125**	**3.175**		**1 1/8**	**1.125**	**28.575**		**2 1/8**	**2.125**	**53.975**
9/64	0.1406	3.5719		1 9/64	1.1406	28.9719		2 9/64	2.1406	54.3719
5/32	0.1563	3.9688		1 5/32	1.1563	29.3688		2 5/32	2.1563	54.7688
11/64	0.1719	4.3656		1 11/64	1.1719	29.7656		2 11/64	2.1719	55.1656
3/16	0.1875	4.7625		1 3/16	1.1875	30.1625		2 3/16	2.1875	55.5625
13/64	0.2031	5.1594		1 13/64	1.2031	30.5594		2 13/64	2.2031	55.9594
7/32	0.2188	5.5563		1 7/32	1.2188	30.9563		2 7/32	2.2188	56.3563
15/64	0.2344	5.9531		1 15/64	1.2344	31.3531		2 15/64	2.2344	56.7531
1/4	**0.25**	**6.35**		**1 1/4**	**1.25**	**31.75**		**2 1/4**	**2.25**	**57.15**
17/64	0.2656	6.7469		1 17/64	1.2656	32.1469		2 17/64	2.2656	57.5469
9/32	0.2813	7.1438		1 9/32	1.2813	32.5438		2 9/32	2.2813	57.9438
19/64	0.2969	7.5406		1 19/64	1.2969	32.9406		2 19/64	2.2969	58.3406
5/16	0.3125	7.9375		1 5/16	1.3125	33.3375		2 5/16	2.3125	58.7375
21/64	0.3281	8.3344		1 21/64	1.3281	33.7344		2 21/64	2.3281	59.1344
11/32	0.3438	8.7313		1 11/32	1.3438	34.1313		2 11/32	2.3438	59.5313
23/64	0.3594	9.1281		1 23/64	1.3594	34.5281		2 23/64	2.3594	59.9281
3/8	**0.375**	**9.525**		**1 3/8**	**1.375**	**34.925**		**2 3/8**	**2.375**	**60.325**
25/64	0.3906	9.9219		1 25/64	1.3906	35.3219		2 25/64	2.3906	60.7219
13/32	0.4063	10.3188		1 13/32	1.4063	35.7188		2 13/32	2.4063	61.1188
27/64	0.4219	10.7156		1 27/64	1.4219	36.1156		2 27/64	2.4219	61.5156
7/16	0.4375	11.1125		1 7/16	1.4375	36.5125		2 7/16	2.4375	61.9125
29/64	0.4531	11.5094		1 29/64	1.4531	36.9094		2 29/64	2.4531	62.3094
15/32	0.4688	11.9063		1 15/32	1.4688	37.3063		2 15/32	2.4688	62.7063
31/64	0.4844	12.3031		1 31/64	1.4844	37.7031		2 31/64	2.4844	63.1031
1/2	**0.5**	**12.7**		**1 1/2**	**1.5**	**38.1**		**2 1/2**	**2.5**	**63.5**
33/64	0.5156	13.0969		1 33/64	1.5156	38.4969		2 33/64	2.5156	63.8969
17/32	0.5313	13.4938		1 17/32	1.5313	38.8938		2 17/32	2.5313	64.2938
35/64	0.5469	13.8906		1 35/64	1.5469	39.2906		2 35/64	2.5469	64.6906
9/16	0.5625	14.2875		1 9/16	1.5625	39.6875		2 9/16	2.5625	65.0875
37/64	0.5781	14.6844		1 37/64	1.5781	40.0844		2 37/64	2.5781	65.4844
19/32	0.5938	15.0813		1 19/32	1.5938	40.4813		2 19/32	2.5938	65.8813
39/64	0.6094	15.4781		1 39/64	1.6094	40.8781		2 39/64	2.6094	66.2781
5/8	**0.625**	**15.875**		**1 5/8**	**1.625**	**41.275**		**2 5/8**	**2.625**	**66.675**
41/64	0.6406	16.2719		1 41/64	1.6406	41.6719		2 41/64	2.6406	67.0719
21/32	0.6563	16.6688		1 21/32	1.6563	42.0688		2 21/32	2.6563	67.4688

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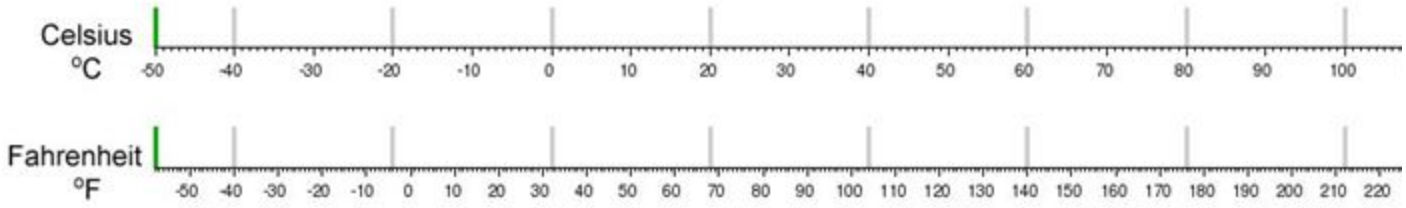
APPENDIX E: CONVERSION CHART: TEMPERATURES

Formula for conversion from Celsius to Fahrenheit:
°F = ((9/5) x °C) + 32

Formula for conversion from Fahrenheit to Celsius:
°C = (5/9) x (°F-32)



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APPENDIX F: WELD QUALITY AUDIT FORM

WELD QUALITY AUDIT

BUILDING AMERICA

Subdivision	Milepost & Track	Rail L or R	UT Certified Rail	Ref. Marks	Weld Tag Placed	Weld Install Date	Emp. ID or ITW Truck	ITW Weld ID #	Vertical Crown	Vertical Off Set	Horizontal Off-Set	Horizontal Kink	Base H.O.S.	Base V.O.S.	Bolt Holes Deburred	Weld Coll Ground
Comments:																
Comments:																

Acceptable Tolerance					
0.040" FW 0.060" ITW	0.020" (1)	0.040"	0.025"	0.060"	0.250" FW (2) 0.125" ITW (3)

FW = Thermite Field Weld
ITW = In-Track Weld (Flash Butt)

Record Exceptions

(1)	Any vertical offset after welding must be tapered by grinding.
(2)	Maximum base vertical offset will not exceed 0.250 inch on same base wifth rails
(3)	If rail height difference is greater than 0.125 inch, offset top of rail head and grind. Any offset on the top o
	rail must be tapered to provide a smooth transition.
Note:	(Maximum allowable rail end mismatch is 0.250" on same base width)
	(Transition rail to be used on rail end mismatch greater than 0.250" on same base width)
	(Over grinding of weld is not allowed)

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