

**PROCEDURE FOR ALUMINOTHERMIC
RAIL WELDING**

BOUTET PROCESS

QPCJ PROCESS

WITH

CJ CRUCIBLE (ONE SHOT)

**VERSION 1.10
AUGUST 2006**

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PREFACE

This notice concerns instructions for carrying out the Boutet QPCJ process, for 1 inch Welds, using premix packing sand, Oxygen/Propane preheat and the CJ crucible (one shot).

This manual does not replace the Railroads own welding and safety instructions.

1 - INTRODUCTION

The subject of this manual is the Boutet QPCJ thermite weld. This process uses prefabricated molds, welding charge, pre-mix packing sand and the CJ crucible.

- Preheating Oxy-propane

With this procedure, preheating is performed with a oxy-propane torch. It is necessary to use cylinders of propane and oxygen which are capable of providing the prescribed pressures (see 2.07). **The use of any other gas is not recommended.**

- Preheating Air-Propane

With this procedure, one can also preheat using Railtech's Air-Propane preheating system. It is necessary to have been trained by a Railtech certified instructor before using this system.

- CJ Crucible

The CJ crucible is ready to use out of the package. After the crucible has been used and removed from the molds it will decompose.

- Packaging of the Kit

Each welding kit for the present procedure contains:

- Two half molds, a bottom base briquette and a diverter plug.
- A welding charge packaged in a sealed plastic bag.
- A CJ crucible equipped with its self tapping thimble.

All of these items are packed in cardboard boxes.

- Recommendations

Molds and base briquettes should be handled with care at all times to prevent breakage as well as to be protected from moisture.

Thermite oxide charges must be stored in dry places at all times. No attempt should be made to use a thermite oxide charge that is or has been wet or is suspected of containing moisture.

All welding material shall be protected from any moisture at all times.

Always order the correct material to match the rail size and type of rail.

2 - PERFORMING THE WELDING OPERATION

2.01 - Before leaving for the site

Make sure you have everything needed for the work to be performed:

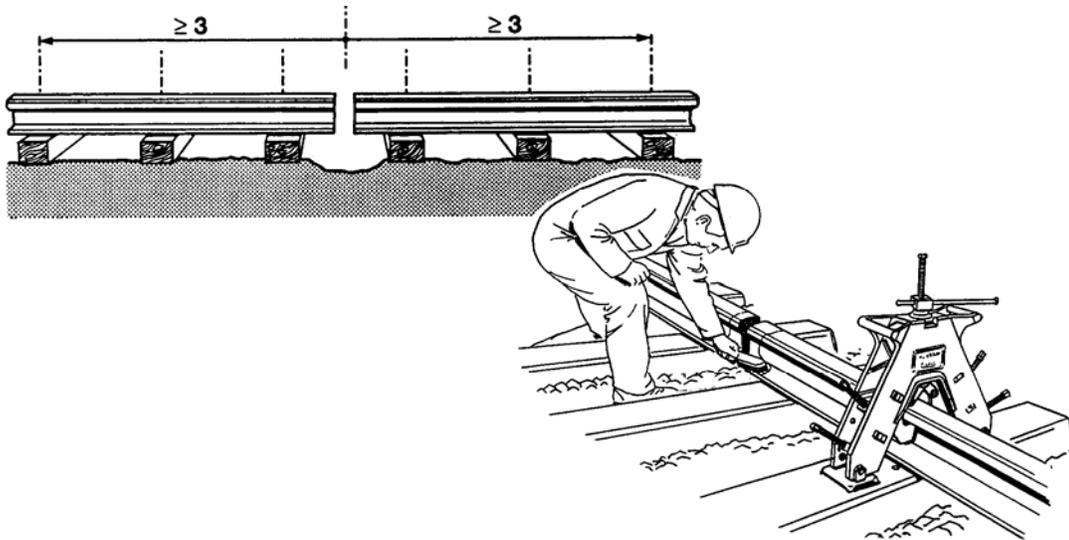
- Railroad approved safety items to perform work.
- The correct number of kits and the correct size kits for the work to be done. (see kit identification 2.04)
- Enough propane and oxygen, along with regulators, hose and torch.
- Complete set of hardware (base plate, jackets, mold clamp, slag basin, CJ fork and torch stand.
- Control Tools (tape measure, straight edge (36 inch or 1 meter), wedges, wire brush, taper gauge, striker, stop watch, paint stick, fire extinguisher, file, tempil stick or other temperature measuring device.
- Welding manual
- Preparation and finishing materials (saw, gas, oil, abrasive wheels, grinder, grinding wheels, etc.)
- Enough CJ crucibles to match the number of welding kits.
- Consumables (packing sand, dry sand, refractory paste, ignitors, etc.)

It is suggested that a check list of everything needed for the work to be done be established.

For best welding results, welding should be conducted in temperatures above 32 F - 0 C. Cold weather procedures should be followed, at temperatures 40 F and below. See 2.02

2.02 - Preparing the joint to be welded.

- Space ties, if necessary (4" min. from edge of rail to edge of tie).
- Remove tie plates if necessary.
- Remove spikes on 1 or 2 ties on each side of the joint (more in a curve, depending on its radius).
- Flame clean and wire brush the rail ends 4-6 inches back to remove rust, grease, paint, and mill scale. A poorly cleaned rail end causes porous areas.
- If welding in wind, rain, snow or temperatures below 40 F, apply a supplemental heat of 110 F to the rail ends, 3 feet each direction from the joint and retard cooling.
- Check rail ends for batter and surface bend (consult your railroads specifications). Grind Rail flow.
- Check for cracks in the rail ends and bolt holes.
- Remove bond wires and excess copper by grinding.
- The use of a rail puller is recommended below 40 F.



RAIL TEMPERATURE	WEATHER CONDITIONS	
	Clear	Wind, Rain, or Snow
Above 40F	<ul style="list-style-type: none"> • Air cool • A weld cooling cover is not required 	<ul style="list-style-type: none"> • Apply weld cooling cover* immediately after shearing • Leave cover in place until weld has cooled below 900F (Approximately 25 minutes)
Between 0F And 40F	<ul style="list-style-type: none"> • Prior to the application of the molds, preheat rail head and base to hand warm temperature (110F) for a distance of 3 feet on both sides of weld gap. • Complete weld and unmold normally. • Apply cooling cover* immediately after shearing. • Leave weld cover in place until weld has cooled below 900F (Approximately 25 minutes). 	
Below 0F	<ul style="list-style-type: none"> • NO THERMITE WELDING PERMITTED 	

* Welding Blanket or Cooling Cover

2.03 - Adjusting the joint

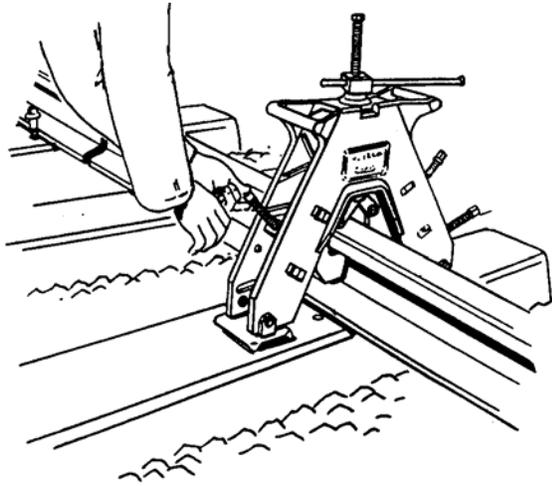
Four parameters to be considered in adjusting the joint to be welded: the gap, the horizontal alignment, the vertical alignment, and the twisting.

This adjustment is especially important because it determines the dimensional quality of the welding and its lifespan.

If the weld is low, high or has vertical offset, the weld will cycle with each wheel loading, resulting in a short weld lifespan and a progressively deteriorating track geometry.

To adjust the joint, wedges may be used, or any other aligning equipment. *As a general rule, avoid all shocks which may damage the rail during the adjusting operations.*

To work more easily, safely, and quickly, use the frame aligners (See illustration below).



a) The welding gap

This is the space between the two rails to be welded. This gap is 1 inch +/- 1/16 inch.

This dimension shall be measured with a gauge or tape measure on both side of the rail, at the rail head and base, obtaining four measurements.

The limit values of the four measurements taken must fall within the tolerance span determined above (15/16 to 1- 1/16 inch).

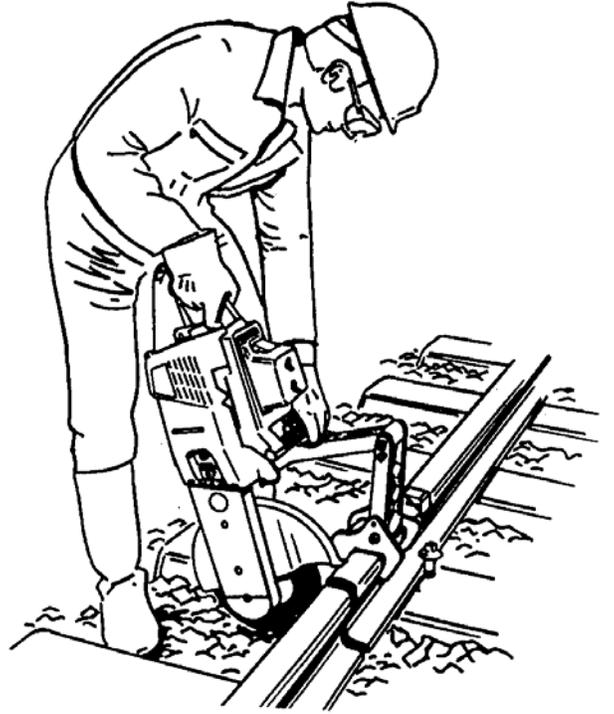
The **gap** must remain constant during the operation. If necessary, use rail pullers to maintain proper gap.

In order to obtain this value (1 inch +/- 1/16 inch), it may be necessary to cut the rails. In this case, use only a rail saw.

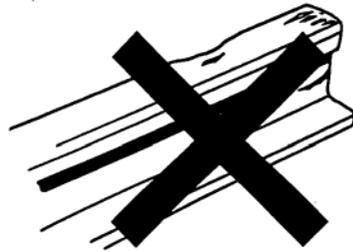
Use equipment in good condition, correctly attached to the rail, so as to obtain perpendicular cuts (if the cuts are not truly perpendicular, the correct tolerance may not be obtained).

It is not recommended to weld torch cut rails, for this may cause micro-cracks. If the ends have already been torch cut, always cut them again with a saw following the instructions of your company.

Caution !
Strictly follow the safety instructions (notice) concerning the use of your saw. If the notice is not available, consult your supervisor.



Damaged rail ends, (chips, nicks, batter, surface deformation, old torch cuts, etc.) must be re-cut if the damage is isolated within a small area. If the damage is not isolated (i.e if it extends over a significant length of rail), consult the person in charge of the site. Sometimes it may be necessary to cut a little off of each rail, to remove rail end batter and maintain proper bolthole distance.

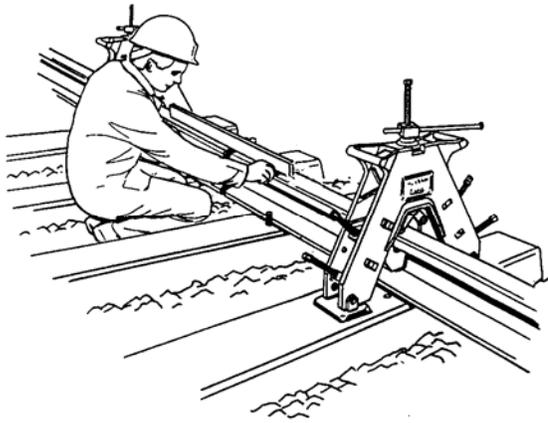


b) Vertical adjustment

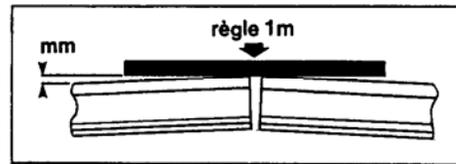
Prior to welding, the rail ends must be crowned, so when the weld cools, the weld will not be low.

The crown shall be measured as indicated in the sketch below.

Take measurements from the ends of a Railtech 36" straight edge. The amount of crown will be determined by the length of the straight edge.

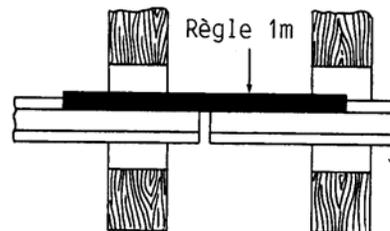
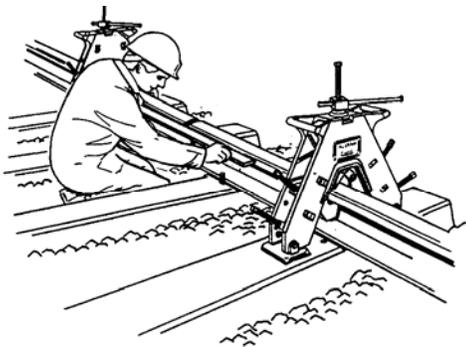


Crown: .065 to .075 using a taper gauge



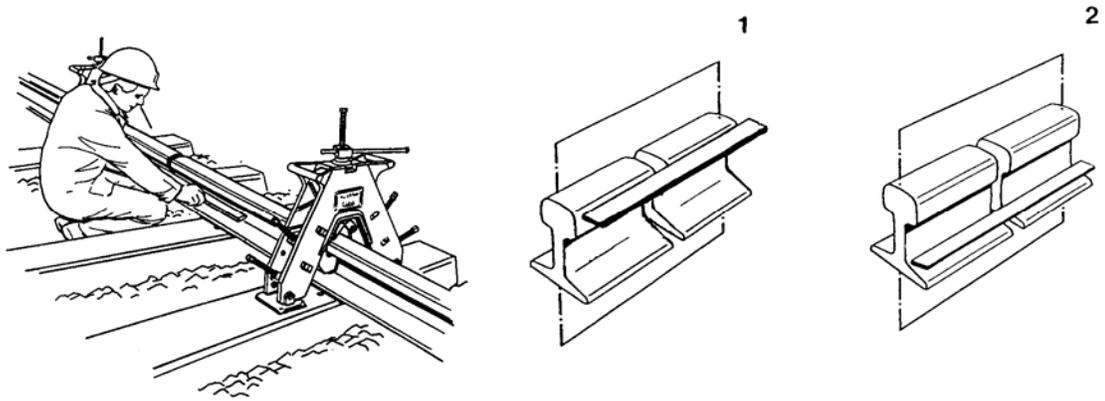
c) Horizontal alignment

Alignment shall be measured on the gauge side of the rail. No more than .010 offset on the gauge side with straight edge.

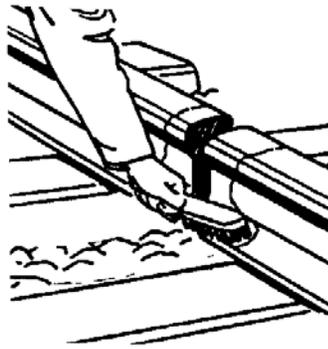


d) The twisting of the rails

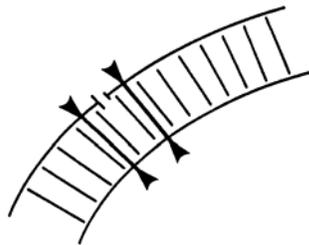
- Both rails must be checked for twist.
- Check inside surface on the gauge side of the railhead and the gauge rail base.
- They must be flush or true to the straight edge and / or web.
- Twist should be removed from rail in section D.



Note 1: The two ends to be welded must remain dry and clean after being cut.



Note 2: When welding in curves, it will be easier to remove horizontal kink with the use of gauge rods.



2.04 - Opening the kit

The Kits must be stored in a dry place where they shall not be damaged: do not stack more than 4 Kits high, and use a pallet to distribute the weight. When storing with pallets, do not stack more than two high.

The date is printed on the side of the packaging to enable you to rotate your stock.

- The Kit must be conserved in its original packaging, closed and without any distortion or traces of dampness.
- Identification of the process and type of rail and rail size on the Kit packaging.
- Make certain that the Kit corresponds to the rails to be welded.
- A label on the plastic bag of the welding charge indicates the date of batch and reference numbers of the charge. This label should be removed from the welding charge bag and placed on the recording sheet corresponding to the welding operation.

The reference number indicated on this label should be recorded. (See 2.17 <<Marking and possibility of tracing>>).

EXAMPLE :	132 QPCJ 25 QPCJ 8 AP 25 Y 25 JANV 05 VS001	Rail and process Welding charge and gap Date and batch
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2.05 Applying the Molds

The molds must be centered over the rail end gap, making sure equal amounts of rail are exposed in the mold cavity.

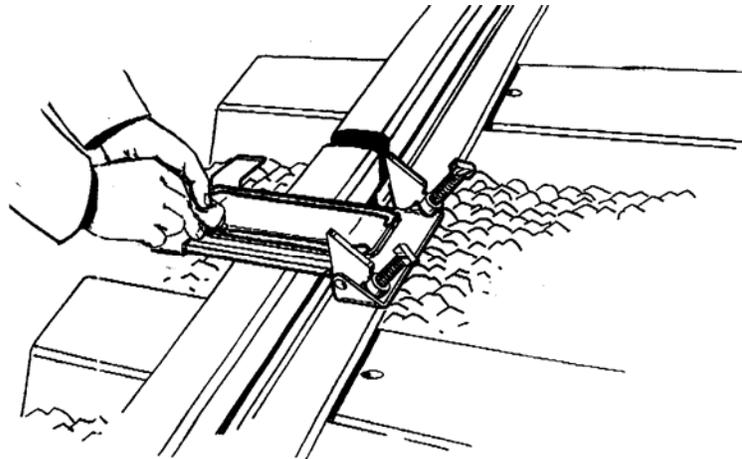
If you have a vertical mismatch of the rail exceeding 1/8 inch, then a new to used mold design must be used along with a 1/4 inch step base briquette.

Grind off any rail flow that will prevent the molds from fitting tight against the rail.

The molds should never be placed near a bolt hole. We suggest the edge of the bolt hole be at least 4" from the rail end. Instructions from your railroad welding manual may require a greater distance; refer to those rules.

To apply the molds, proceed as follows:

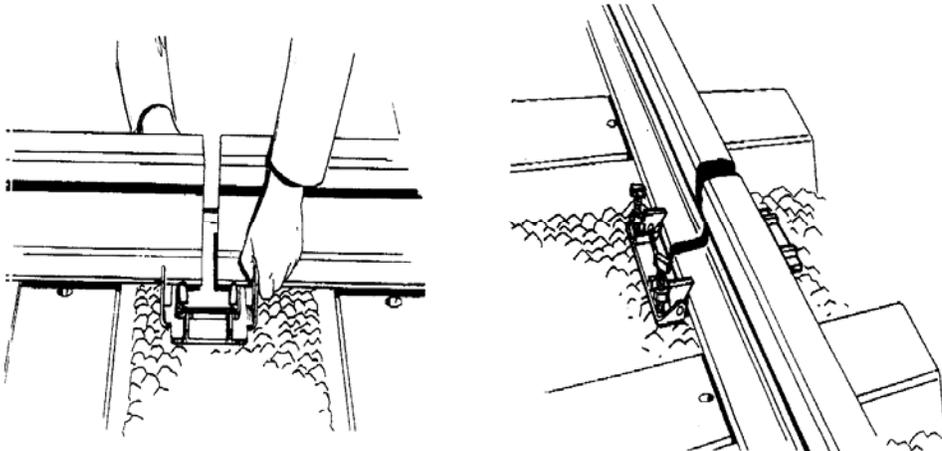
a) Place the base briquette in the base plate. Before applying paste to briquette, do a dry run test to assure proper fit and alignment on base of rail. In the recess on both sides of the briquette, apply a bead of refractory paste the diameter of a pencil. Be careful not to apply too much paste or it won't dry out during the preheat. Do not allow any paste in the middle depression of the base brick.



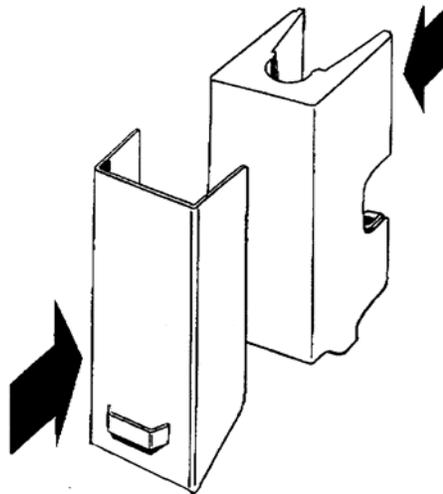
b) Apply the base plate to the base of the rail, making sure that equal amounts of rail are exposed in the depression of the base briquette. Place the thumb screws to

the field side of the rail, hand tighten, then give 1/4 turn with a wrench. The base briquette needs to be centered.

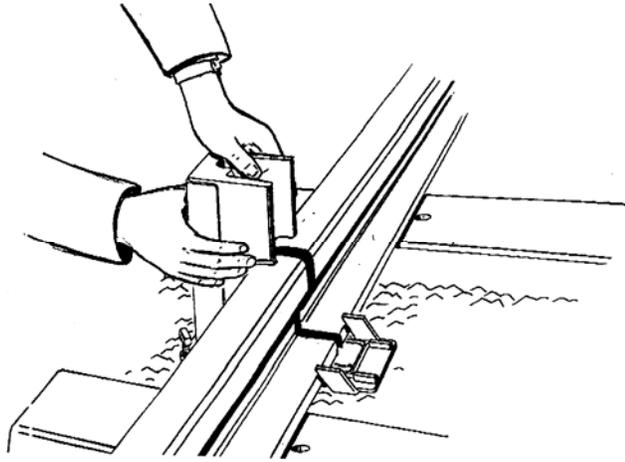
You must re-check the rail crown after installing base plate.



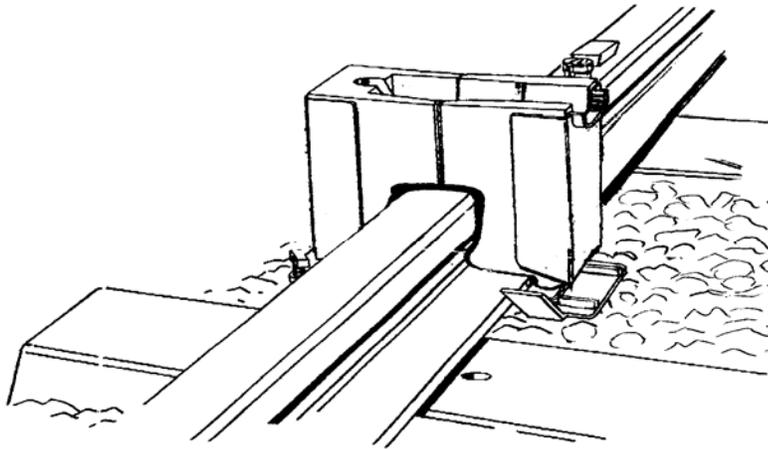
c) Place each mold jacket on respective half mold.



d) Place half mold (Center vertically in relation to the gap and the base brick). Maintain this half mold in place by hand. Pouring spout and mold clamp handle should be on the gauge side of the rail on tangent track or on the low side of a curve.

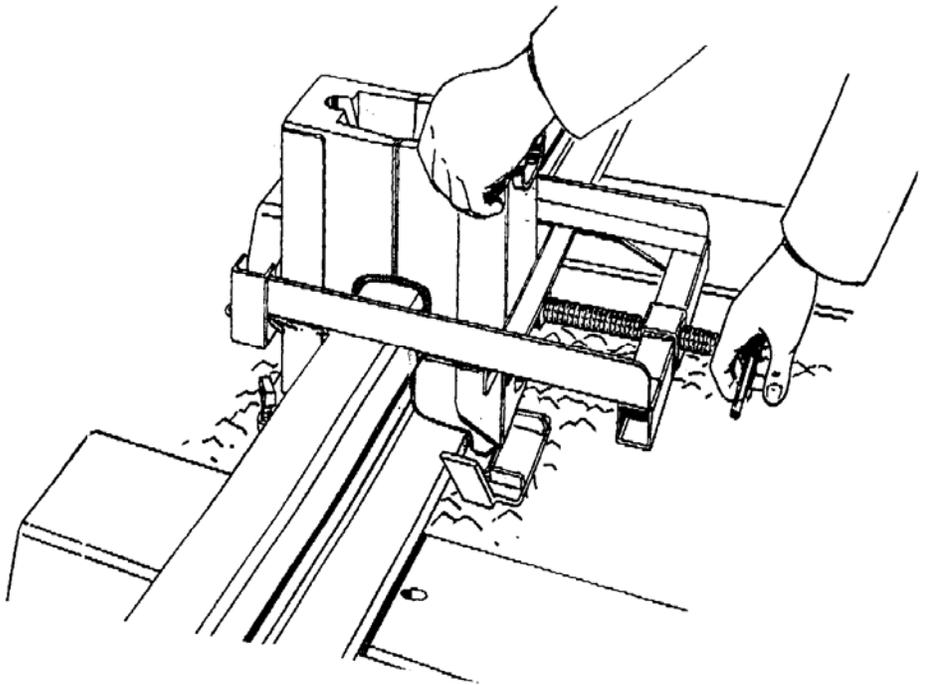


e) Place second half mold in place, pre-adjust it (Centering up and down). Two mold halves must be perfectly aligned.



f) Final adjustment and control is obtained by positioning the mold clamp. Be careful not to break the mold when tightening the mold clamp. After clamping, we recommend to cover the top of the molds with cardboard to prevent any material from falling into the molds.

CAUTION : OVERTIGHTENING OF BASE PLATE OR MOLD CLAMP SCREWS MAY CAUSE CRACKING OF THE MOLDS AND SUBSEQUENT LEAKING OF MOLTEN STEEL WHICH CAN CAUSE SERIOUS PERSONAL INJURY. IF MOLDS ARE DAMAGED, DO NOT USE.



2.06 - Packing of the Molds

The packing forms a seal between the rail and the molds. Poorly aligned rail or poor aligned molds increase chances of leakage due to a poor seal.

- 1) First if rail is worn or welding in a curve, make sure to fill the gap at the head of the rail with paper or cardboard before applying packing sand.
- 2) Evenly apply by hand the pre-mixed packing sand around the entire profile of the rail, starting at the base (under the base plate).
- 3) Fill in the heel of the molds (where the mold sits on the base briquette).

- 4) Then apply packing sand along the entire profile of the rail and wipe it as you were using a sealant. This is the most important step of the packing process as this will clog any gaps. Finish the packing process by adding additional packing sand along the profile of the rail and on the head of the rail.

Do not let packed molds sit idle longer than 10 minutes. After packing, place the slag basin on the mold clamp, under the pour spout of the pour jacket. Apply a small amount of premix sand on the lip of the pour spout. Place one inch of dry sand into the slag basin.

WARNING :

IF MOISTURE IN ANY FORM EXISTS UNDER THE JOINT, PLACE DRY SAND UNDER THE JOINT TO BE WELDED.

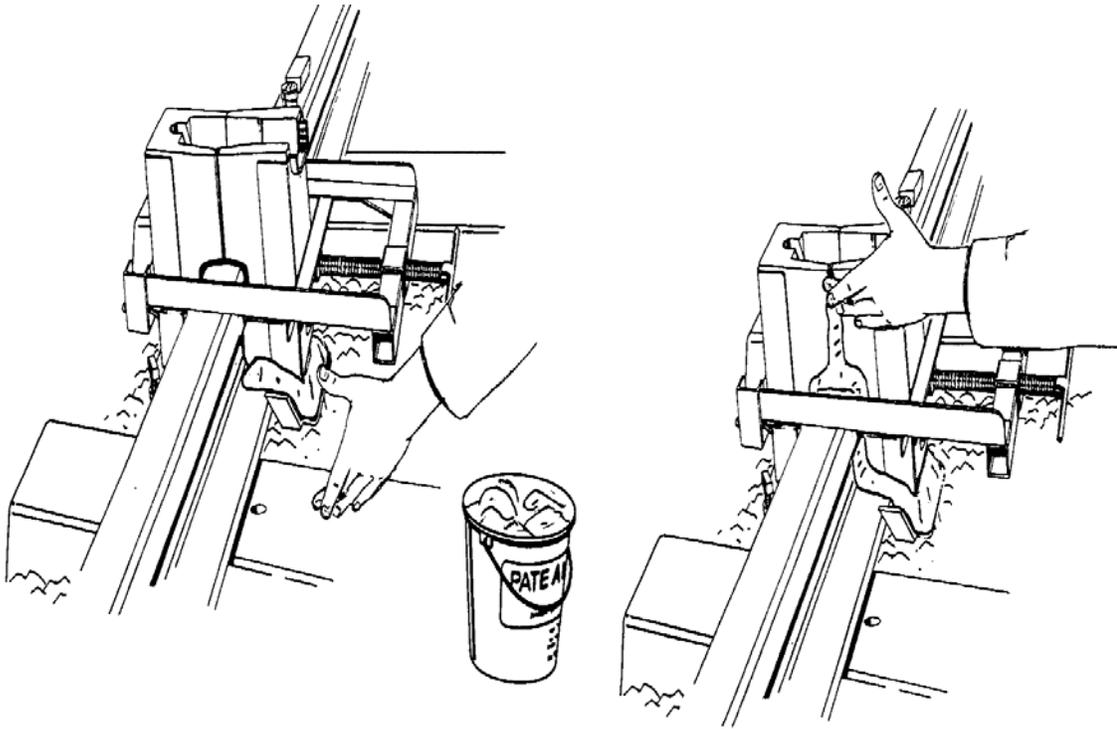
CAUTION :

CARELESS PACKING MAY CAUSE LEAKAGE OF MOLTEN STEEL AND COULD CAUSE PERSONAL INJURY.

FOR SAFETY REASONS :

MOLTEN STEEL AND HOT SLAG CAN CAUSE SERIOUS EXPLOSIONS

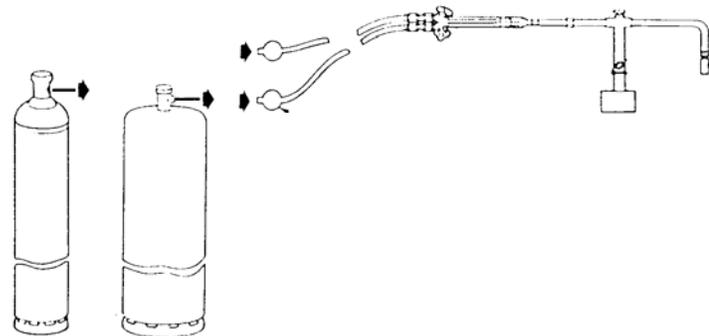
UPON COMING INTO CONTACT WITH SNOW, ICE, STANDING WATER AND FROZEN BALLAST OR SOIL. A CONTAINER FULL OF DRY SAND SHOULD BE PLACED ON THE BALLAST, DIRECTLY UNDERNEATH THE WELD BEING MADE SO THAT ANY LEAKAGE -- WHATEVER IT'S CAUSE -- WOULD FALL IN THE DRY SAND.



2.07 - Preheating

Preheating is an operation of major importance. Its function lies in the elimination of residual moisture from the molds and in a temperature increase of both rails and molds. If using a Railtech Hydraulic Preheater, call Railtech for instructions.

It is important to check Oxygen and Propane pressures before each pre heat.



Watch pressure in cold temperature conditions !

The torch is fed with propane and oxygen by 50 ft of 3/8 twin grade T hose with flash arrestors behind the torch body, with working pressures of:

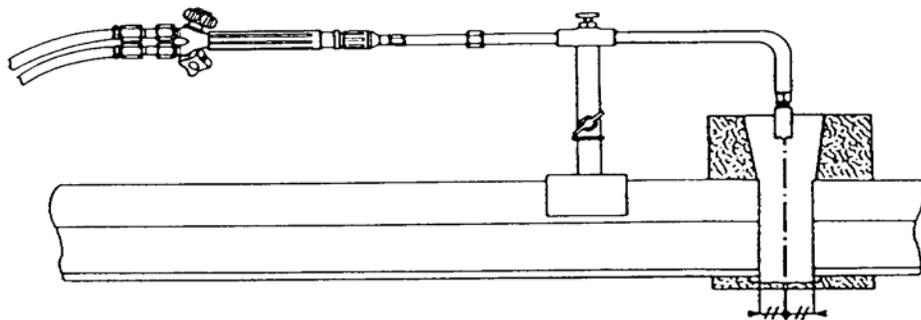
Victor -	15 psi propane 60-65 psi oxygen
Smith -	15 psi propane 60-65 psi oxygen
Airco	15 psi propane 60-65 psi oxygen

- **A Victor HD310C torch body is required (for Victor torch tip)**
- **Smith SW1B torch body is required (for Smith torch tip)**

The pressures should be measured at the regulator and at the torch. The use of inline gauges at the torch handle is recommended to achieve proper preheat temperatures. Also, make sure that the propane and oxygen cylinders are full enough to complete the operation.

In order to achieve proper preheating, proceed as follows:

- Using the stop on the torch stand, set the torch tip height 1 1/2" above the head of the rail. With the torch on the stand, pre-align the torch in the molds, remembering the importance of heating both rails evenly.



b) Remove the torch from the stand. Light the torch, adjustment of torch will vary depending on type of torch body used. Place torch in molds and adjust.

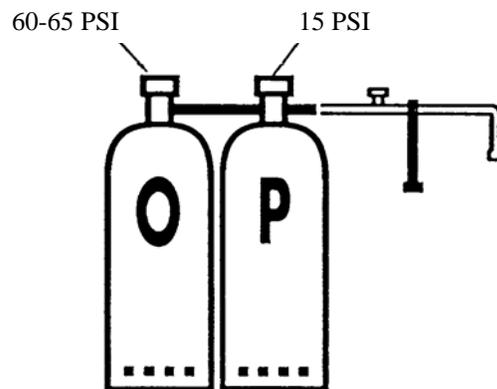
- Victor, uses full oxygen, adjusting propane until flame is just below crackle sound. If needed, open propane slightly to prevent rail end melting.

- Smith, uses full oxygen, adjusting propane until flame is just below crackle sound. If needed, open propane slightly to prevent rail end melting.

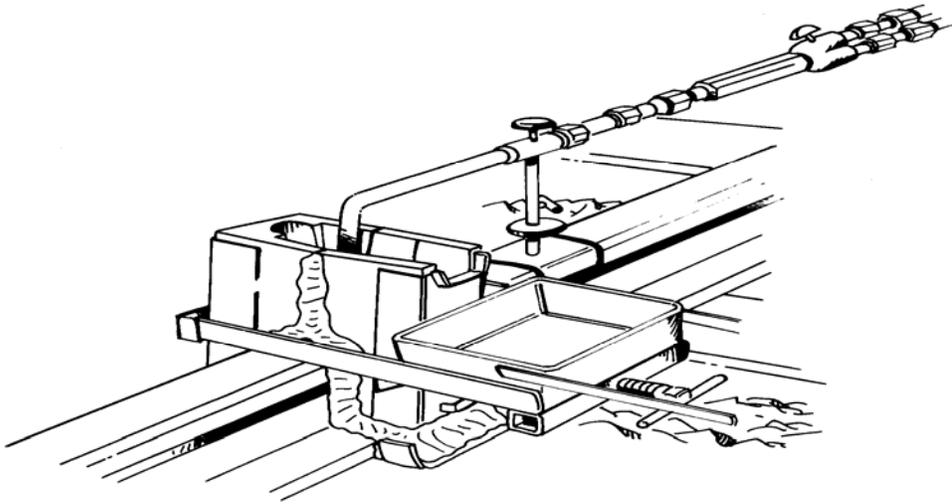
- Harris and Airco, use full propane, adjusting oxygen until flame is just below crackle sound. If needed, close oxygen slightly to prevent rail end melting.

Victor or Smith - If torch is performing hot, decrease oxygen 5 psi. If torch is performing cold, increase oxygen 5 psi.

Harris/Airco If torch is performing hot, decrease propane 1 psi. If torch is performing cold, increase propane 1 psi.



NOTE: Do not use hose lengths greater than 100 ft. Do not use quick disconnects. Also make sure to check equipment before making the next weld.



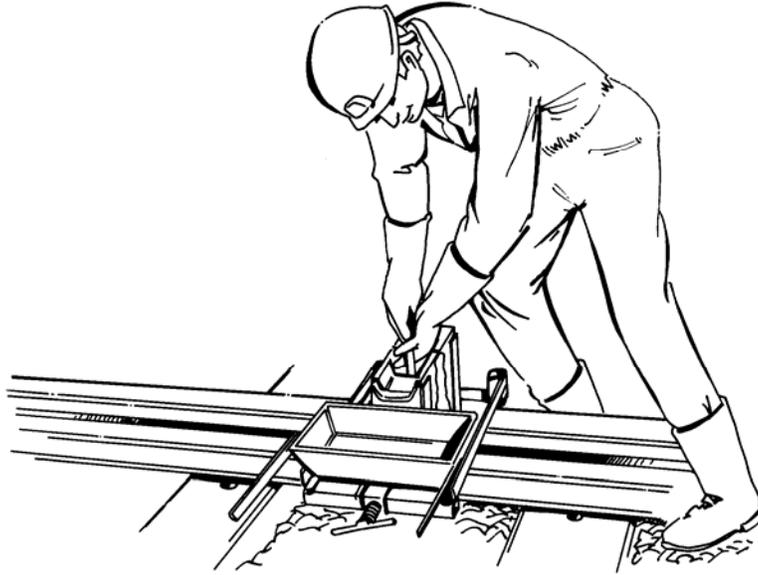
IMPORTANT:

d) Preheat time starts after you adjust the flame and fine tune the torch alignment. A stopwatch must be used. Preheat 6 min. on rail sizes 122 lbs or above. Preheat 5 min. on rail sizes below 122 lbs. While preheating, the helper can prepare the CJ crucible. (see 2.08). Use a 450F temperstick 2 ½ inches from the rail ends to test proper preheat. **The entire preheat must be observed by the welder making sure no rail melting occurs.**

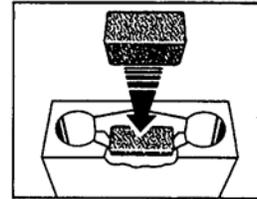
2.07.1 - Placing Diverter Plug

When the preheat is complete, remove the torch from the molds, making sure not to damage the inside walls of the molds. Place the warmed diverter plug into the molds and gently snug, do not tap.

Warning: Do not waste time between completion of the preheat and starting the reaction.



Insert with moderate pressure, do not tap.



2.08 - CJ Crucible

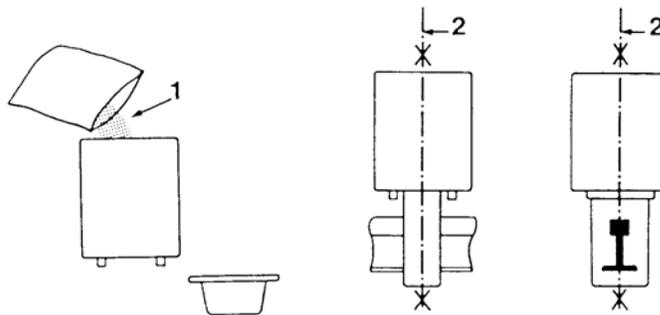
The CJ crucible is made from a refractory compound formed by means of a resin. The thermic factor being notably better than with a conventional crucible, it is mandatory to use the welding charge that corresponds to the new thermic balance (as provided in the CJ kit).

Consequently, use only the welding charge which is provided in the kit. Never mix two components from two different kits (That is to say, never pick up molds from one kit, the welding charge from another, etc...)

NEVER USE A WELDING CHARGE THAT HAS LOST MATERIAL OR HAS A HOLE IN THE BAG. DO NOT ADD ANYTHING. NEVER MIX TWO WELDING CHARGES.

During preheating:

- Inspect the crucible for cracks
- Clean out any loose sand from the interior
- Open and pour the charge into the crucible
- Place the crucible on cardboard near the working area and get an ignitor ready.
- Place the CJ fork near the work area.
- Place one inch of dry sand into the slag basin.



2.09 - Pouring

As soon as preheating is over and the diverter plug is in place:

- The crucible is placed on top of the molds. To center the crucible, reference off the two large outside riser holes, equal amounts of each hole should be visible.

- Light the ignitor by touching it inside the large outside riser hole. Push the ignitor into the middle of the charge, one inch deep. Gently put on the crucible cover.

-While the reaction and the pouring of the aluminothermic material into the molds are taking place, all personnel must stand clear.

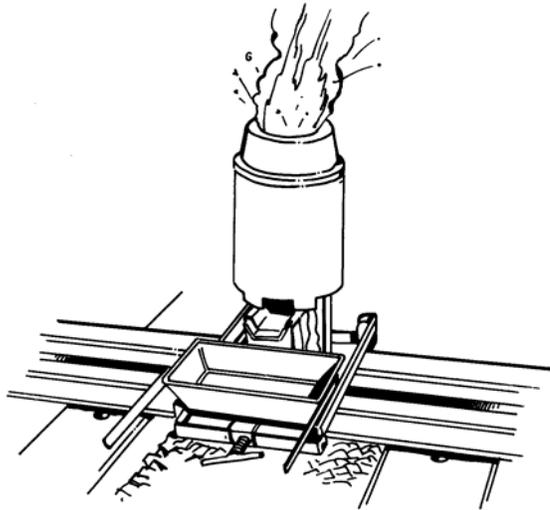
-When the molds are full, the slag will flow into the slag basin.

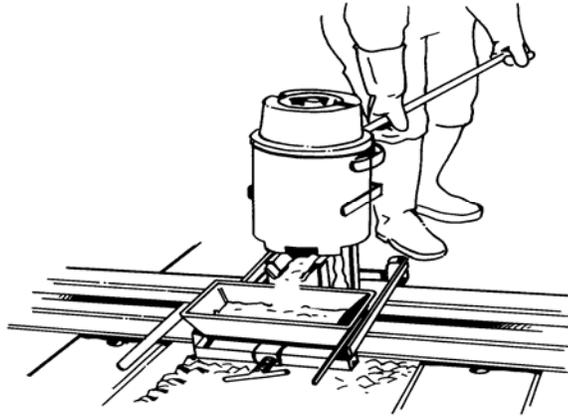
- After the flow of the molten material to the slag basin has stopped, start take down time.

- Sprinkle dry sand on top of the molds and on top of the slag in the slag basin.

-The CJ Crucible is designed with a bypass feature. In the event that the molten material is not discharged from the crucible within the normal tapping time, the bypass is designed to pour into the large riser hole at approximately 1 minute and 30 seconds after ignition.

-All personnel shall stand clear of the welding area until certain all molten material is contained or solidified.





2.10 - Removing the slag basin

Remove the slag basin no sooner than 5 minutes after the pour is complete.

Choose a dry location before removing the slag basin. Using gloves, pick the slag basin up level, carry it level, set it down level in your dry location. Do not flip it over. Never place the slag basin or its contents on wet or frozen ground, ice, or in water. Never throw a slag basin or its contents. If no dry location exists, place slag basin on a metal plate.

WARNING :

**HOT METAL OR SLAG COMING IN CONTACT WITH MOISTURE
CAN CAUSE AN EXPLOSION.**

2.10.1 - Removing the CJ Crucible

Five (5) minutes after the flow of molten material to the slag basin has stopped, the CJ Crucible may be gently removed from the weld using the CJ Crucible Fork.

Choose a dry location to place the crucible before removing it.

When removing the crucible with the CJ Crucible Fork, the crucible shall be lifted straight up and leveled, pausing momentarily, to ensure that all of the weld material has drained from the crucible into the molds.

2.10.2 – Demolding

Six (6) minutes after pour is complete, set the demolder over the weld and break it from side to side in order to remove excess mold and sand material.

2.11 - Shearing

The use of a hydraulic shear is recommended. This method insures a better alignment of the weld. Blade height should be adjusted no closer that 1/16” above running surface.

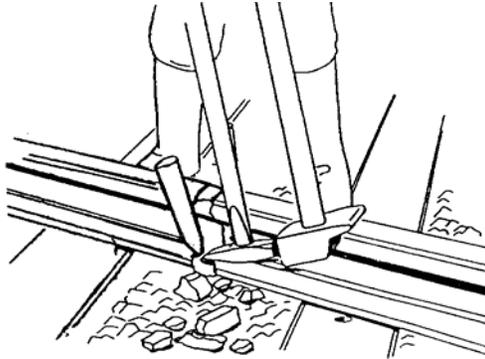
Shear through the weld, making sure not to tear the top gate.

If air temperatures are below 40 F or rain, snow or wind exists, cover the weld with a cooling retarding cap immediately after shearing. Remove cover after the weld has cooled below 700 F.

2.12 - Removing the risers

Base risers may be bent out slightly such that rough grinding can take place on the top surface, field and gauge faces of the weld. The angle between the base riser and the rail head should not exceed 60°. Care must be exercised when bending the risers so as not to create a hot tear in the top of the base.

Crowning wedges, alignment plates and base plate can be removed a minimum of 20 minutes after the weld pour has been completed.



2.13 - Rough grinding

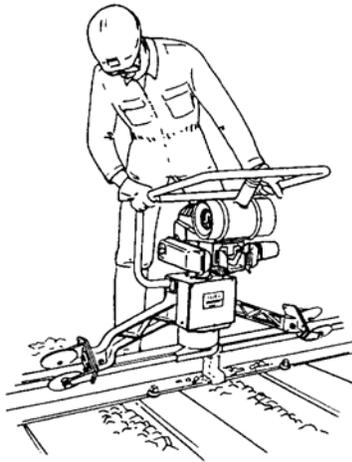
Rough grinding of the rail head portion of the thermite weld can be performed after shearing or hot cutting is completed.

Rough grinding of the running surface of the rail shall be performed with an approved surface grinding wheel. Rough grinding is completed when the excess weld material is reduced to approximately thirty (0.030) thousandths of an inch.

When the surface of the weld is above 700°F, it is permitted to “blue” the weld. When the surface of the weld is equal to or less than 700°F “bluing” of the rail is not permitted.

Grinding of the parent rail steel on either side of the weld is prohibited on the running surface during the rough grinding operation.

Grinding the required taper on the gauge and field faces is permitted during rough grinding on weld that contain a horizontal offset or mismatch.



2.14 - Rail Pullers and Traffic

Putting the weld into service.

If using a hydraulic rail puller, release puller after weld temperature has fallen below 700°F. Remove wedges or alignment tools no sooner than 15 minutes from end of pour.

Allow traffic over weld, only after the weld has cooled below 700°F and the rough grind has been performed. Weld temperature reading is taken at the top and center of the weld.

2.15 - Finishing the weld

The best results will be obtained when the final grind is performed when the weld is completely cooled. This is not always possible, so take advantage of this knowledge and plan your work so the final grind is the last procedure before leaving the work site. When doing the final grinding, use a straight edge and check as you go. Only grind where the straight edge shows you to “Bluing” of the rail or weld surface shall not be permitted at any location on or near the thermite weld. A gentle or light effort shall be used.

The running surface of the weld shall be ground flush with the parent rail head surface.

The running surface of the weld shall be ground to exactly match the contour of the existing rail(s). A radius is to be applied to the gauge and field edges such that no sharp edges remain.

2.16 - Clean-up

The clean up can be performed before the final grind procedure. The work site shall be left secured and free of debris. Clean up includes:

- Nip, spike and tamp off ties at least 2 each side of welded joint
- Reapply anchors
- Fill crib under weld
- Loading up the truck
- Bury or transport back, cardboard, mold remains and various waste.



2.17 - Marking and possibility of Tracing

To insure tracing at a later date, it's important that the weld be marked properly and that a record sheet be filled out on every weld.

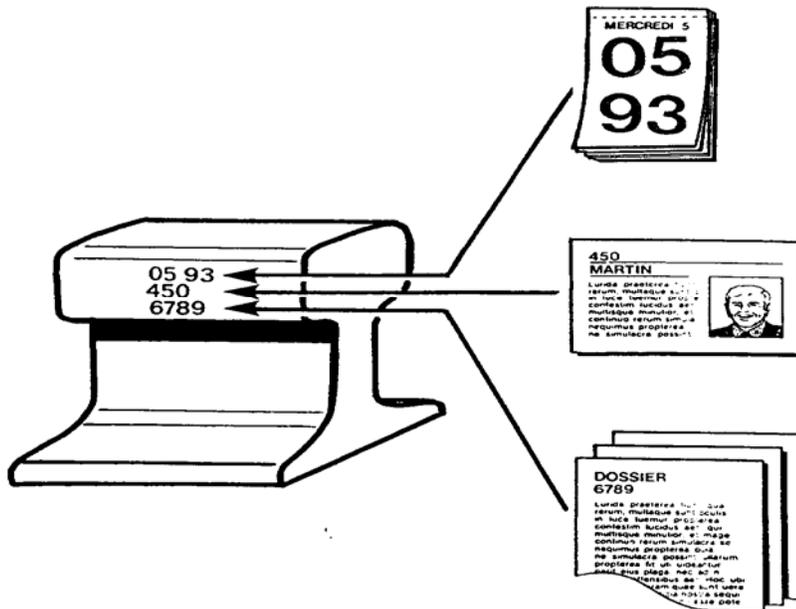
Marking procedures are according to current railroad instructions.

Marking the weld can be done with a paint stick on the web or with a metal punch stamp set on the field side of the ball.

Marking the weld includes:

- The date the weld was made.
- The welder agreement number and/or the welders name.
- The number of welds made that year.
- The rail temperature.
- The gang number.

The same information along with the weld location can be filled out on a record sheet. It is important that such records contain the peel off label from the corresponding charge bag.



3 - WORK QUALITY CONTROL

Quality is achieved when welder has fulfilled all precautionary measures required at each step of the work, from work site preparation to work site clean up. To obtain this quality and give guidance, a work self-check form can be used.

The set up of a training and certifying cycle for welders is highly recommended.

Nevertheless, the welder must check his end product and should the case occur, declare the weld as not up to quality requirements.

He will make this decision:

- When he sees that the welding he has just carried out bears a surface defect (lack of metal, cracks, inclusions, damage to parent rails, etc),

- If, while performing work, an occurrence or handling mistake (too soon or too late unmolding, leakage, incorrect gap, rail end melting, rail movement due to sudden temperature change, early traffic, over grinding, etc...) should lead him to see the end product as one of a doubtful quality.

- If the weld falls beyond geometrical requirements and can not be presented for acceptance.

He must then immediately notify the supervisor and give details about the nature of occurrence or defect that can justify his making such decision.

3.01 - Visual inspection

Visual inspection procedures are established by the user Railroad. Refer to current instructions.

Should these instructions be lacking, one may choose the following:

The weld must not show a large displacement of molds (such as, molds out of line, offset, or not fitting properly). On the rail head, the area which has been ground must not show any damage (shear blade marks, accidental grinder marks, metal leakage, hammer dents, etc...) Also it is important to check the weld and make sure it is not low.

The cast area shall not show these foundry surface defects such as:

- porosity
- shrinkage crack,
- sand or corundum inclusion,
- boss deformation,
- etc.

If such requirements cannot be met, the weld shall not be accepted.

3.02 - Geometry control

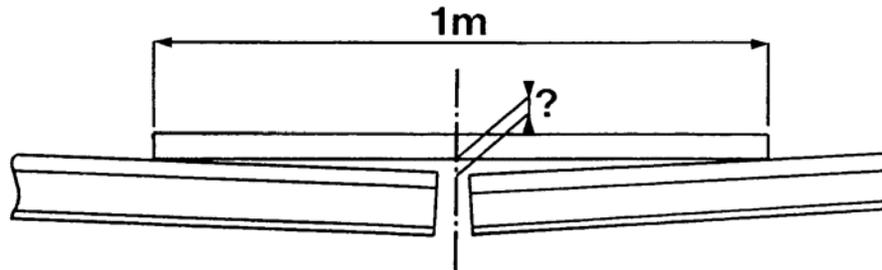
Geometry control procedures are established by the user Railroad. Refer to current instructions.

Should these instructions be lacking, one may choose the following:

The various measures proposed thereafter can be carried out with the help of a bevelled straight edge of about 1 meter long, placed on the weld.

a) Checking for possible cavities

3 Feet



The presence of a cavity is not recommended, but in case it should, do not exceed a .006" depth.

c) Checking Horizontal Alignment

With the straight edge placed on the rail head gauge side, 2/3 below the running surface, alignment should not exceed:

- In figure 1, that no gap is greater than y.
- In figure 2, that the gap at the end of the straight edge is not greater than Z.

Y and Z are values given by the railroad, and should be compatible with normal stress expected on welded rail, as well as compatible with welders qualifications.

If these values are exceeded, the weld shall be refused.

Figure 1

The length of the grinding area must also be checked.

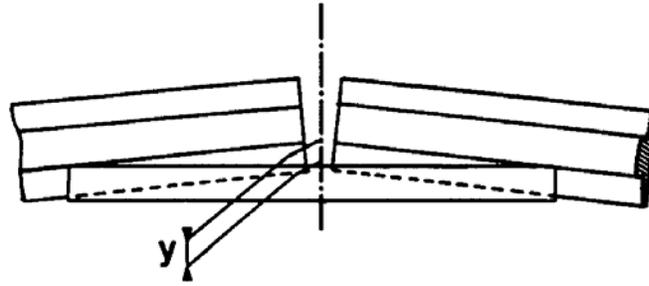


Figure 2

