marta®

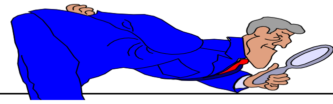
Technical Training

Track & Structures

Track Inspection Training

Rail

Section 5



RAIL

A. Rail, Shape and Size

Tee rail comes in many sizes and with some minor variations in shape.

Rail is usually identified according to its weight per yard and by the shape of its cross section.

Size

For example, 115 RE rail means that a piece of this rail **3-feet in length weighs 115-pounds** and that its shape is according to the design recommended by the **American Railway Engineering Association. (AREA)**

We here at MARTA have only one rail size, that is **115 pound RE rail**.

Rail Brands

All rails have certain markings on each side of the web that gives a good deal of information about the rail.

At times it may be necessary to do a good bit of scraping or cleaning with a wire brush to read these marks.

On one side, the characters will be branded with raised letters and figures.

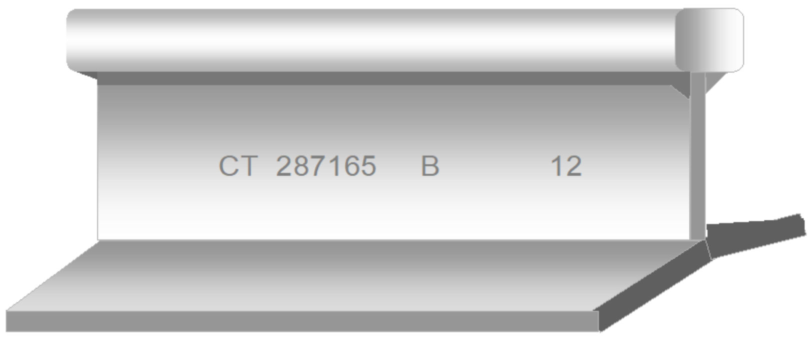
An example would be as follows:

- This means that the rail is of the **115-pound RE section**.
- CC stands for **Control Cooled**.
- The name of the mill at which the rail was manufactured will be identified. Such as Workington, Tennessee or Bethlehem Steel.
- The year and the month (seven vertical strokes indicating (July) in which the rail was manufactured is shown.

Rail, Stamped

On the other side the characters are indented.

Following is an example:



- CT means that the rail is heat- treated. (HT)
- The following numbers indicate the heat number from which the ingot is poured.
- The letter B indicates that it is the second rail from the top of the ingot.
- This is followed by the ingot number

Rail

MARTA's running rail is standard AREA 115RE section. This rail must be inspected daily in conjunction with the regular walking semi-weekly Track Inspection. Any and all rail defects must be noted in the Track Inspection Database utilizing the information found in the MARTA Track Safety Standards as a guide. All visible cracks, which extend beneath the surface of the rail, should be reported to Track and Structures supervisory personnel ASAP, and the operating speed reduced to 10 M.P.H. In addition, the Trackwalker must flag all trains through the defect area. Upon arrival, supervisory personnel must decide if the slow order should remain in effect, if normal operations should be restored, if joint bars should be applied to the defective area, if the track should be removed from service until the defective rail can be replaced, or any combination of the above.

Internal Rail Defects

In the case of visual inspection, internal defects are not readily visible unless they have resulted in a break in the rail or a breakout of a section of rail. Therefore, when this type of defect is found through routine visual track inspection, they are generally quite significant and may require immediate action. For more information on these defects, refer to the MARTA Track Safety Standards. All revenue tracks are ultrasonically inspected at least semi-annually to locate internal defects.

Rail Wear

Rail should be carefully inspected for gauge face wear. This is extremely important in curves and is almost always observed on the outer (high) rail. The following inspection standards apply. Annual rail wear inspections will be made by Track Supervisory Personnel. All locations with excessive rail wear should be reported and brought to the attention of Track Supervisory Personnel for verification.

Rail Types

All MARTA rail is AREA 115RE section, but there are different metallurgical types. Listed below are these types and their identifying marks. This information must be included on all Rail Defect and Replacement Report forms.

Control Cooled. - All rails are control cooled, but this is usually used to describe standard hardness and metallurgical content rail. On the MARTA system this rail is usually located on tangents and shallow curves. There are several mill markings, including, Tennessee; Algoma CC 1988; Workington; Wheeling Pittsburgh.

Head-Hardened Rail - This rail is control cooled rail with the rail head being heat treated to increase its strength. This rail is used in turnouts, curves, and station platforms. This rail cannot always be identified by markings, but some can be identified by the following: Illinois, US Steel, and CF&I Head Hardened which has metal tags attached to the rail web.

Chromium Alloy. This rail has a high chromium content to improve wear characteristics. This rail is found on the North Line between Arts Center and Brookhaven, and on the South Line between West End and East Point. This rail is stamped Workington 1 CR.

Chrome/Moly Alloy. This is another alloy rail formulation and is found in the CY154 (East Point to Airport & Brookhaven to Chamblee) area. This rail is stamped Wheeling Pittsburgh WWR.

Rail Lubrication

The rail must be inspected for proper lubrication in conjunction with the scheduled walking inspection. This is extremely important in curves. .

Rail Lubricators

Inspection of rail lubricators and lubricant is a very important part of the daily inspection process. Rail is the single most expensive part of the track, and proper rail lubrication helps us to extend the life of the rail.

- The goal is to have grease on the gauge corner of the rail, but not on the top of the head of the rail, as this will interfere with train braking.
- The Rail Lubrication Report must be completed daily.

Lubricators must be kept operational and adequately supplied with the proper lubricant. The grease at every lubricator within your daily inspection area should be stirred with the clean paddle stored in the tank.

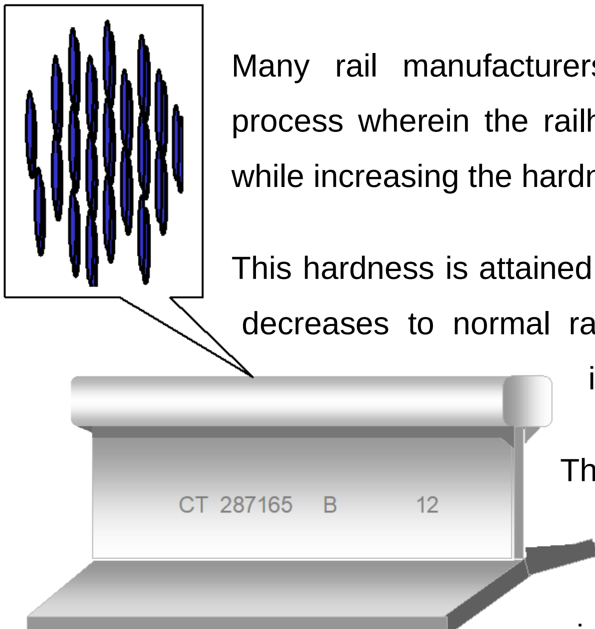
- This must be done daily.

The top of the railhead should be checked at a location 500 ft. from the lubricator in the direction of train traffic. The amount and location of the grease on the head of the rail should be a good indication as to how the grease is being carried.

The carry-curve for the lubricator also must be checked for the proper amount of lubricant. The carry-curve is the last curve the lubricator services before the next lubricator. The condition of the lubricant on each carry-curve should be noted and highlighted on the regular Track Inspection Report.

All repairs and modifications to the rail lubricators will be done on an as needed basis by trained and qualified rail lubrication personnel.

Brinell Head Hardening Process



Many rail manufacturers have developed a railhead hardening process wherein the railhead is hardened to fine pearlitic structure, while increasing the hardness up to 360 BHN.

This hardness is attained at the surface of the railhead and gradually decreases to normal rail hardness at approximately 40 mm (1.6 inches or 1-3/5 inches) below the rail top.

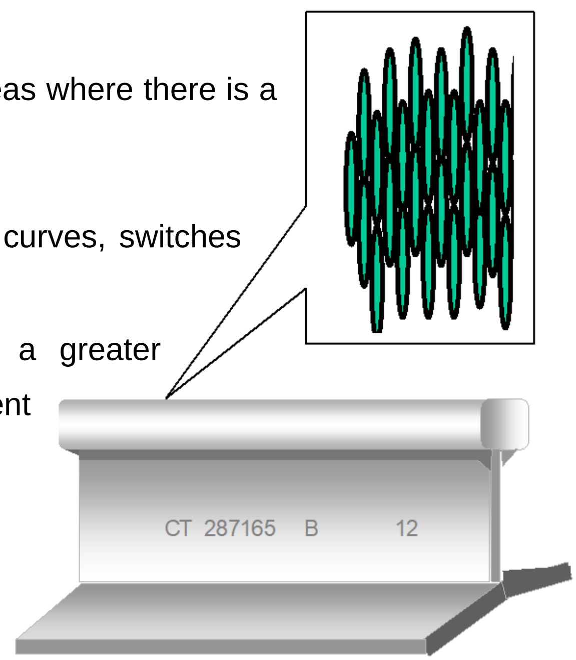
The process involves induction heating of the rails followed by sequential compressed air cooling. This results in increasing the service life of the rails.

A fine pearlitic structure of the railhead increases the wear resistance and prolongs the life of the rail.

- This type of rail is used in areas where there is a higher degree of rail wear.

Such areas at MARTA are in the body of curves, switches and turnouts, and also in station platforms.

- These areas are prone to a greater degree of wear than is tangent track.



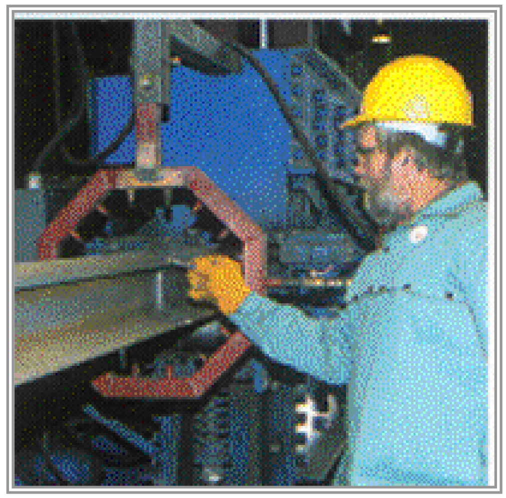
Surface Hardness

The Brinell hardness test shall be performed on a rail or a piece of rail at least 6 inches long cut from a rail of each heat of steel or heat-treatment lot.

A test report shall be furnished to the purchaser.

(1) The test shall be made on the side or top of the railhead after de-carbonized material has been removed to permit an accurate determination of hardness.

(2) The test shall otherwise be conducted in accordance with ASTM E 10. Standard Test Method for Brinell Hardness of Metallic Materials, using the latest version of that test.



If any hardness test result fails to meet the specifications, two additional checks shall be made on the same piece.

If both checks meet the specified hardness, the heat or heat treatment lot meets the hardness requirement.

If either of the additional checks fails, two further rails in the heat or lot shall be checked.

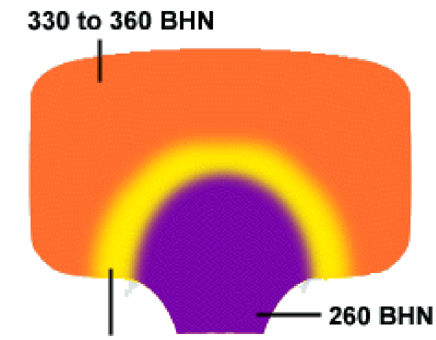
- Both of these checks must be satisfactory for the heat or lot to be accepted.
- If any one of these two checks fails, individual rails may be tested for acceptance.

If the results for heat-treated rails fails to meet the requirements the rails may be retreated at the option of the manufacturer, and such rails shall be re-tested in accordance with, the above stated procedure.

Internal Hardness of High-Strength Rail

The internal hardness of high-strength rail shall be determined on a transverse specimen cut from the head and at least 6 inches from the end of the rail.

- The specimen shall be ground so that the transverse surfaces are parallel.



The hardness tests shall be conducted with either of the following methods:

Brinell (ASTM E10) 1, Rockwell (ASTM E18)`, or Vickers (ASTM E92) 3.

The results shall be reported in the units of the method used. The results shall be reported in Brinell (using ASTM E1404 for conversion) when requested by the purchaser.

The testing frequency shall be one test per heat or 10.000 feet (256 sticks) of rail whichever is the smaller amount of rail.

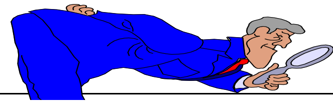
Tensile Properties

Rails shall be produced as specified by the purchaser within certain limits.

One longitudinal tension test specimen shall be 0.5-inch diameter and shall be tested per ASTM A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

For standard rail, the test frequency shall be one test for each heat for the first one hundred heats.

- One test for every fifth heat for the second hundred heats.
- One test for every tenth heat thereafter for heats furnished to the same customer.



For high strength rail, the testing frequency shall be one test per heat or 10,000 feet of rail, whichever is the smallest amount of rail.

If any test specimen fails because of a malfunction of the test equipment or a flaw in the specimen, it shall be discarded and another one taken.

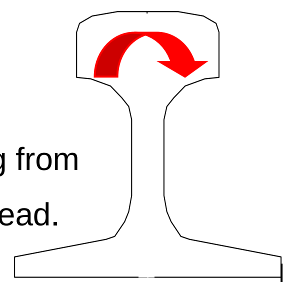
If the results for heat-treated high-strength rail fail to meet the requirements, the rails represented by the test may be reheat-treated and re-tested.

Section

The section of the rails shall conform to the design specified by the purchaser subject to the tolerances on dimensions prescribed by the purchaser.

Verification of tolerances shall be made with the gages or with other gages, as agreed by purchaser and manufacturer.

Rail Head Profile (1990)

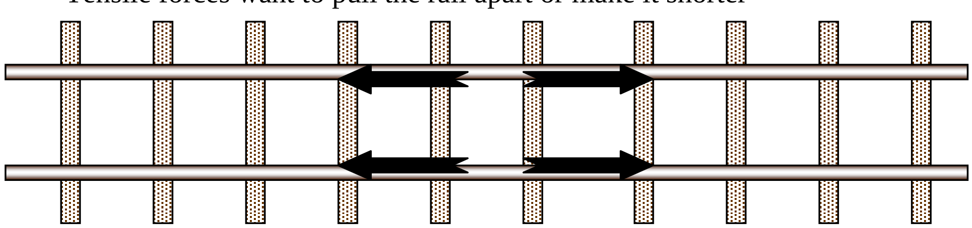


Transverse a cross- sectional geometry of the rail head extending from one bottom fillet radius to the other bottom fillet radius of the railhead.

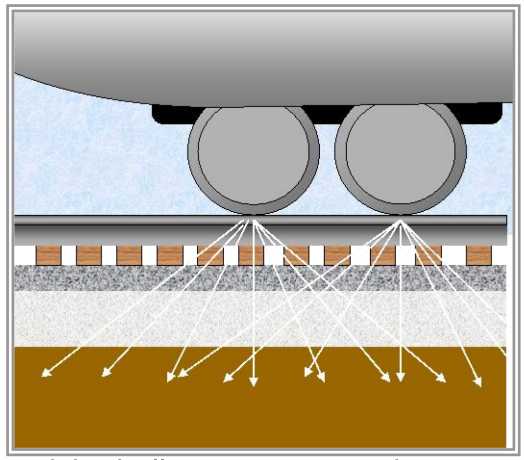
B. Load Transfer

The wheel loads have to be passed on from the rail to the other parts of the track structure.

Tensile forces want to pull the rail apart or make it shorter



The rail acts as a beam or girder in distributing the load.



Although the tie (which is directly under a wheel) receives more of the load than the adjacent ties, it does not receive the full load.

The greater the girder strength of a rail, the better it can distribute the load over a greater number of ties.

By controlling the maximum load, which a tie receives, the wear on the ties and the breakdown of the ballast support can be kept within reasonable limits.

This greater girder strength is one important advantage of the heavier rail sections.

Another advantage is that a wheel load sets up lower internal stresses in heavy rail than in light rail. This means that heavy rail is less likely to break under traffic.

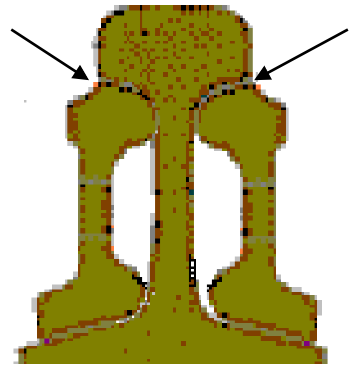
Just as the unit weight of rail has tended to become heavier over the years, so have rails tended to become longer.

Rail Joints

1. Ordinary Rail Joints

An ordinary rail joint consists of two joint bars plus the required number of bolts, nuts and springs washers.

- The two joint bars are considered to be a pair and usually have holes for six bolts. The joint bars may be either of the toeless type or may have a toe or base angle.

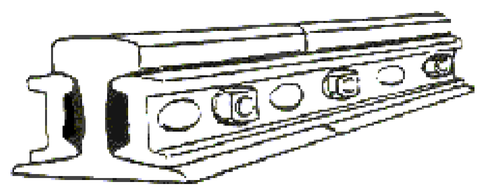


They may be of either the **head contact** or head-free type, depending upon the portion of the area under the railhead where the bars make contact with the rails.

Here at MARTA we use only the Head Contact type of joint bar.

The bolts, which are used to secure the joint, are known, as **track bolts**. These bolts usually have an oval or elliptical neck under the bolt head.

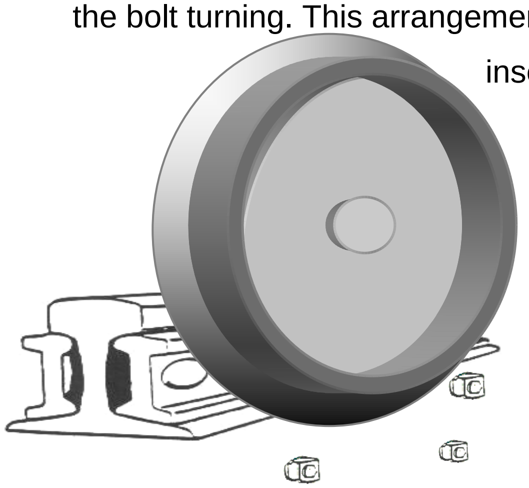
- The joint bars usually have alternate holes, which are oval in shape; the intermediate holes are round.



When the bars are matched up to form a joint, one on the gauge side and one on the field side of the rail, an oval hole is always opposite a round hole.

By inserting each bolt from the side with an oval hole, the oval bolt neck fits into the oval hole in the joint bar.

As long as the bolt is fully inserted, the nut can be tightened or loosened without the bolt turning. This arrangement requires that alternate bolts within a joint be inserted from opposite sides of the rail.



This pattern has potential advantage should a derailed wheel pass by the joint. Such a wheel is more likely to strike the nut, which protrudes considerably, than the rounded bolt head (which protrudes very little).

Under such conditions, it is unlikely that more than half the bolts in a joint will be broken or severely damaged.

This can be an appreciable advantage in restoring the track to service quickly, if such derailed equipment traveled several miles before being detected.

In addition to the ordinary rail joint, there are joints for special purposes.

2. Insulated Joints

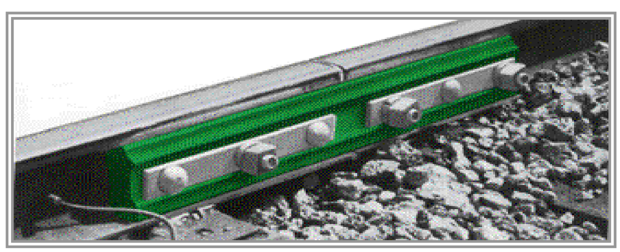
Insulated joint is electrically insulating one rail from the next.

These are used to isolate an A.T.C. signal circuits or circuits controlling automatic crossing protection for the railroads.

Insulated joints of more recent design have been developed to better meet the demands placed on the joint by continuous welded rail.

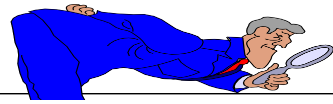
These joints employ adhesives on the surfaces where the joint bars and rail are in contact.

The adhesives transfer much of the stress that occurs in welded rail due to temperature changes.



- Otherwise, these stresses would have to be carried by the track bolts.
- There are several designs of these adhesive type, or glued joints that have gained widespread use.

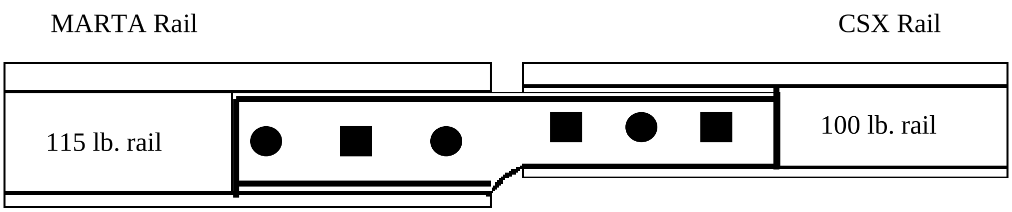
One feature common to all of them is that they are designed so that the maximum practical area can be utilized for applying the glue material between the joint bars and the rails.



Compromise Joints

Another type of rail joint is the **compromise joint** (used to match heads of adjacent rails of different sections or sizes). These joints are also called **Step Joints**. Stepping from one rail size to another.

We at MARTA have only one pair of compromise joints, and they are where the MARTA track ties in with the CSX Railroad behind the M.O.W. shop.



Rail Joint Maintenance

Bolts must be tightened annually when the rail gaps are closed.

- Tightened to the prescribed torque.

Before tightening bolts:

a. Remove the two center bolts, one at a time, and inspect for straightness.

b. If either center bolt is bent, remove the remaining bolts and inspect, do this one bolt at a time.

c. All bent bolts must be replaced.

Replace bolts and washers that are broken or missing.

- Bolts threads should be lubricated annually.

It is permissible to dismantle and remove joint bars without using a hydraulic rail expander, if rail temperatures are within the Bolted Rail Working Zone.

This is a working zone where rail temperatures are within the rail neutral zone. At this temperature rail will neither expand or contract. Allowing for the rail joint to be dismantled without the rail moving.

If joint bars must be removed when the temperature is below the Bolted Rail Working Zone, an expander or heat source should be used to close the gap that will develop when the joint bolts are removed.

Before the bolts are removed, the rail anchors or rail clips, for at least 200 feet on either side of the joint must be checked and adjusted, if necessary.

- This involves checking all the anchors to make sure that they are tight to the sides of the ties.
- Or to check the Pandrol clips to see if they are properly installed and that any loose or broken clips are replaced.

1. If the rail joints do not close at a rail temperature 40°F above the Preferred Rail Laying Temperature (PRLT), the matter should be brought to the Foreperson or Managers attention. Where they will arrange to take any necessary action.

One method to relieve the problem would be to loosen the bolts and slacken the anchors or remove the clips, leaving every fifth clip in place to hold the rail for 200 ft. in each direction.

If the rail gaps close, the anchors must be re-positioned, clips reinstalled and the bolts tightened to the proper torque.

- If the gaps do not close, de-stressing the rail is called for.

Rail joints other than Bonded Insulated Joints are not recommended in concrete tie territory, except as a temporary measure when repairing breaks or buckles.

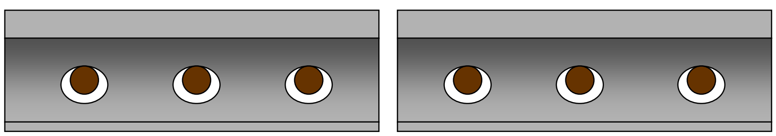
The pounding caused by a rail joint on concrete ties can cause premature deterioration of the tie. Joints must be replaced by field welds as soon as possible.

Rail Joint Gap

With the exception of the adhesive-type joints, rail joint assemblies are usually expected to permit a small amount of movement between the rail and the joint bars.

a) This provides for the expansion and contraction of rail in which stresses are to be relieved as the temperature changes.

b) Bolt holes in the rail are usually oversized in relation to the diameter of the track bolts in order to permit such movement.



c) Some railroads require that a lubricant be applied during rail-laying operations to the areas, where the rails and joint bars come in contact.
   - This reduces the frictional resistance to such movement in a joint with tight bolts.

When laying jointed rail, there is usually a small opening left between rail ends, unless the temperature is very warm when the rail is being laid. The proper way to do this will be discussed later.

It should be remembered that much of the rail traffic, which passes over a rail joint, does so while there is a small opening between the rail ends.

- Rail joints are normally designed to carry loads that the rail can carry.
- They generally do quite well if all parts are in good condition and well maintained.

Nevertheless, it is in the joint area that maintenance work is most frequently required.

The use of continuous welded rail (CWR) is due to the high cost of maintaining rail joints and the fact that joints are weak spots in the track structure.

Sliding Rail Joint

The sliding joint is designed to take care of the expansion and contraction problems associated with Continuously Welded Rail.

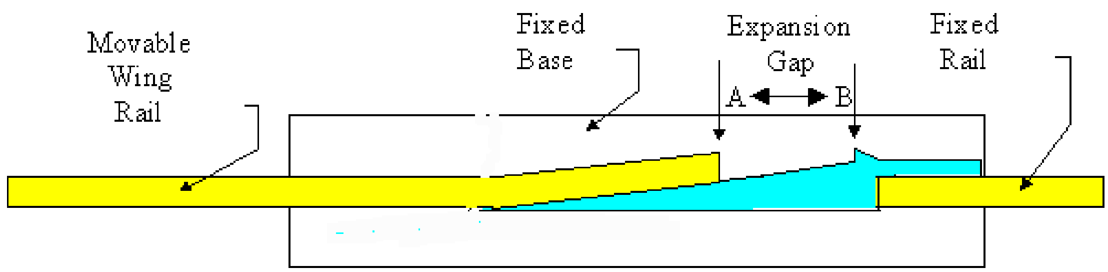
Expansion and contraction within the unit is permitted by simply allowing the wing rail to move back and forth.

The base (approximately 2400 pounds) provides a solid foundation for the sliding wing rail.

Maintenance Requirements:

- Ensure the wing rail is free to move (remove foreign matter from within the slide area)
- Check and tighten all braces and bolts, especially on open deck bridges
- Ensure the lag bolts have not broken off, if so, replace and tighten
- Check and maintain appropriate expansion gap in accordance with the following expansion gap table.

This type of rail joint can be found on the **YA track.** The YA track is located between the Airport Station and the South Yard. This type of joint relieves the stresses that are placed on the rail and the aerial structure.



SLIDING JOINT

Expansion Gap Table

Rail Temp ºF	Distance from A to B in Inches											
0	**16½**	**16¾**	**17⅛**	**17½**	**17⅞**	**18¼**	**18⅝**	**19**	**19⅜**	**19 ¾**	**20⅛**	**20⅜**
10	**16⅛**	**16⅜**	**16¾**	**17**	**17¼**	**17½**	**17⅞**	**18⅛**	**18⅜**	**18⅝**	**19**	**19⅛**
20	**15¾**	**16**	**16¼**	**16⅜**	**16⅝**	**16¾**	**17**	**17¼**	**17⅜**	**17⅝**	**17⅞**	**18**
30	**15½**	**15⅝**	**15¾**	**15⅞**	**16**	**16**	**16 ¼**	**16⅜**	**16 ½**	**16⅝**	**16 ¾**	**16 ¾**
40	**15⅛**	**15¼**	**15¼**	**15¼**	**15⅜**	**15⅜**	**15⅜**	**15 ½**	**15 ½**	**15 ½**	**15⅝**	**15⅝**
50	**14⅞**	**14¾**	**14¾**	**14¾**	**14⅝**	**14⅝**	**14 ½**	**14 ½**	**14 ½**	**14 ½**	**14 ½**	**14⅜**
60	**14½**	**14⅜**	**14⅛**	**14⅛**	**14**	**13⅞**	**13 ¾**	**13⅝**	**13 ½**	**13⅜**	**13⅜**	**13 ¼**
70	**14¼**	**14**	**13⅝**	**13⅜**	**13⅜**	**13¼**	**13**	**12 ¾**	**12⅝**	**12⅜**	**12⅛**	**12**
80	**13⅞**	**13⅝**	**13**	**13**	**12¾**	**12½**	**12⅛**	**11⅞**	**11⅝**	**11⅜**	**11**	**10⅞**
90	**13½**	**13¼**	**12½**	**12½**	**12⅛**	**11¾**	**11⅜**	**11**	**10⅝**	**10 ¼**	**9⅞**	**9⅝**
100	**13¼**	**12¾**	**11⅞**	**11⅞**	**11½**	**11**	**10⅝**	**10⅛**	**9¾**	**9¼**	**8¾**	**8½**
	Length of Unanchored CWR in Feet											
	400	**500**	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**

Rail Joint Deterioration

There are a number of reasons why a rail joint deteriorates.

If only one of these conditions is present, in time, some of the others will appear.

- If left uncorrected, the deterioration of the joint occurs at an ever-increasing rate.

1. The gap between the rail ends, even though small causes an appreciable amount of pounding or impact because of the heavy loads being carried.
    - In time, this impact can cause batter to appear on the head of the rail end located on the receiving rail end.

2. On tracks with a substantial amount of traffic in both directions, such as a single-track operation, this battered condition may be equally severe on both of the rail ends in a joint.
3. The vibrations caused by loads moving over a joint can also cause bolts to lose tension. If this condition is not promptly corrected, excessive movement takes place in the areas where the joint bars and rails make contact.
    - If not corrected, this will cause wear on these surfaces so that the bars become incapable of providing full support, even if the bolts are re-tightened. This wear will effect both the rail and the joint bars creating a gap between the two surfaces.
4. Any of these conditions can cause excessively high impact forces that may result in a breakdown of the joint in additional ways. (Cracked joint bars, bent or broken bolts, the detraction of the crosstie or even the breakdown of the ballast under that joint.)

Continuous Welded Rail

The Federal Railway Administration has mandated the need for Continuous Welded Rail procedures. In addition, all railroads that have CWR on their property must have a training program in place to teach all employees responsible for the installation, inspection and maintenance of CWR.

Continuous Welded Rail (CWR);

Each track constructed of Continuous Welded Rail (CWR) shall have in effect and comply with written procedures which address the installation, adjustment, maintenance and inspection of CWR.

Each plan for compliance with the following --

(a) Procedures for the installation and adjustment of CWR which include --

 (1) Designation of a desired rail installation temperature range for the geographic area in which the CWR is located; and

 (2) De-stressing procedures/methods which address proper attainment of the desired rail installation temperature range when adjusting CWR.

(b) Rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and crosstie movement to the extent practical, and specifically addressing CWR rail anchoring or fastening patterns on bridges, bridge approaches, and at other locations where possible longitudinal rail and crosstie movement associated with normally expected train-induced forces, is restricted.

(c) Procedures which specifically address maintaining a desired rail installation temperature range during repairs and adjustments. Rail repair practices must take into consideration temperature so that --

(1) When rail is removed, the length installed shall be determined by taking into consideration the existing rail temperature and the desired rail installation temperature range; and

(2) Under no circumstances should rail be added when the temperature is below (a)(1), without provisions for later adjustment

(d) Procedures which address the monitoring of CWR in curved track for inward shifts as a result of disturbed track.

(e) Procedures which control train speed on CWR track when

(1) Maintenance work, track rehabilitation, track construction, or any other event occurs which disturbs the roadbed or ballast section and reduces the lateral and/or longitudinal resistance of the track; and

(2) In formulating this above, the track owner must --

(i) Determine track stabilization procedures (speed restrictions, ballast consolidation, etc.); and

(ii) Take into consideration the type of crossties used.

(f) Procedures, which prescribe when track inspections are to be performed to detect buckling prone conditions in CWR track. At a minimum, these procedures shall address inspections to identify --

(1) Locations where tight or kinky rail conditions are likely to occur;

(2) Locations where track work of the nature described in (e)(1) have recently been performed; and

(3) In formulating the procedures under this paragraph, the track owner shall -

(i) Specify the timing of the inspection; and

(ii) Specify the appropriate remedial actions to be taken when buckling prone conditions are found.

(g) The track owner shall have in effect a comprehensive training program for the application of these written CWR procedures, with provisions for periodic re-training, for those individuals designated under 213.7 as qualified to supervise the installation, adjustment, and maintenance of CWR track and to perform inspections of CWR track.

(h) The track owner shall prescribe record-keeping requirements necessary to provide an adequate history of track constructed with CWR. At a minimum, these records must include:

(1) Rail temperature, location and date of CWR installations. This record shall be retained for at least one year; and

(2) A record of any CWR installation or maintenance work that does not conform with the written procedures. Such record must include the location of the rail and be maintained until the CWR is brought into conformance with such procedures.

(i) As used in this section --

(1) **Adjusting/De-stressing** means the procedure by which a rail's temperature is re-adjusted to the desired value. It typically consists of cutting the rail and removing rail-anchoring devices, which provides for the necessary expansion and contraction, and then re-assembling the track.

(2) **Buckling Incident** means the formation of a lateral miss-alignment (sic) sufficient in magnitude to constitute a deviation from the Class 1 requirements specified in 213.55 of this part. These normally occur when rail temperatures are relatively high and are caused by high longitudinal compressive forces.

(3) **Continuous Welded Rail (CWR)** means rail that has been welded together into lengths exceeding 400 feet.

(4) **Desired Rail Installation Temperature Range** means the rail temperature range, within a specific geographical area, at which forces in CWR should not cause a track buckle in extreme heat, or a pull-apart during extreme cold weather. **MARTA P.R.L.T. is in tunnels 60° outside tunnels 80°**

(5) **Disturbed Track** means the disturbance of the roadbed or ballast section, as a result of track maintenance or any other event, which reduces the lateral and/or longitudinal resistance of the track.

(6) **Mechanical Stabilization** means a type of procedure used to restore track resistance to disturbed track following certain maintenance operations. This procedure may incorporate dynamic track stabilizers or ballast consolidators, which are units of work equipment that are used as a substitute for the stabilization action provided by the passage of tonnage trains.

(7) **Rail Anchors** means those devices, which are attached to the rail, and bear against the side of the crosstie to control longitudinal rail movement. Certain types of rail fasteners (Pandrol clips) also act as rail anchors and control longitudinal rail movement by exerting a downward clamping force on the upper surface of the rail base.

(8) **Rail Temperature** means the temperature of the rail, measured with a rail thermometer.

(9) **Tight/Kinky Rail** means CWR, which exhibits minute alignment irregularities, which indicate that the rail is in a considerable amount of compression.

(10) **Train-induced Forces** means the vertical, longitudinal, and lateral dynamic forces, which are generated during, train movement and which can contribute to the buckling potential.

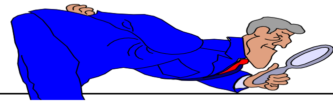
(11) **Track Lateral Resistance** means the resistance provided to the rail/crosstie structure against lateral displacement.

(12) **Track Longitudinal Resistance** means the resistance provided by the rail anchors/rail fasteners and the ballast section to the rail/crosstie structure against longitudinal displacement.

Re-tightening Track Bolts

Track bolts frequently become loose after rail traffic has operated over the newly laid rail for awhile.

- This may become noticeable after a few days or a few weeks, depending on the density of traffic.



This is first noticeable by a loss of tension in the lock washers. If the bolts are not re-tightened the nuts will work off the bolts, and the entire joint may become disassembled.

In most cases, one re-tightening of the bolts will be sufficient, as the joint bars will have become fully seated by the traffic prior to the re-tightening.

- Future tightening of the bolts may then only be needed at the relatively long intervals found in normal maintenance.

Lining

Lining should be carried out at temperatures within the Working Zone. Working Zone is a temperature range of 10° + or - from the P.R.L.T. of 60° in the tunnels and 80° outside tunnles.

Major realignment of a curve toward the inside or the outside may require de-stressing.

- Calculations for Change in Force Free Temperature for a given throw:

Example: A 1000-foot, 4º curve was thrown in an average of 2 inches during a lining operation. What is the change in Force Free Temperature?

Use the formula:

$$\Delta L = 6.3*T\ (L/100)\ (360/D) \approx TLD/5730$$

Where: ΔL = change in length of the curve (inches)

L = length of curve in feet

T = the amount of throw in inches

D = degree of curve

$$\Delta L = 6.3(2)\ (1000/100)/(360/4)$$

$$= 1.4 \text{ inches}$$

Then: $\Delta T = \Delta L/(L*\alpha)$

Where: ΔT = change in Force Free Temperature

α = Coefficient of thermal expansion of rail

$\Delta T = 1.4(1000*12*0.0000067) = 17.4^o$ F

The change in Force Free Temperature would be a decrease of 17.4º F. Since this is out of the PRLTR, the curve would require de-stressing.

If the ends of the ties were dug out or voids created they must be filled as soon as the lining is completed.

Look for these Rail Indicators,

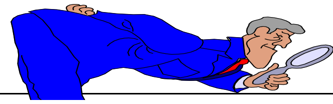
Canting on tie plates especially where small plates are used.

Crowding the shoulder of the tie plates on curves riding up or out of the tie plates.

Scrape marks on the base of the rail caused by the spike or fastener contacting the running rail.

Uneven wear on the rail surface, or welds.

Longitudinal movement of switch point to the stock rail indicated by the point of switch at the gauge plate. Kinky or snaky rail. Any sign of longitudinal movement of rail. (Note movement of fastener)



Indicators in Rail Joint Areas

Look for the following:

(a) Pull-a-parts.

(b) Heavily worn fishing surfaces on joint bars.

(c) Joints remain closed at low or moderate temperatures (rail in compression).

(d) Sliding joints out of adjustment.

(e) Track bolts that are, bent, worn or broken.

(f) Joints not closed at 40º F above the PRLT. (Indicates the rail is in tension).

Indicators at the Rail Fastenings

Rail Anchors that are:

(a) Missing (indicates the rail is not being restrained).

(b) Away from tie or plate.

(c) Tight on one side and loose on the other side of the tie (indicates the rail is running).

(d) Lifted spikes

(e) Loose and shifted Pandrol Clips

(f) Pandrol clips loose or missing on one side.

(g) Skewed gauge rods.

Indicators at the Crosstie Area

Skewing of the ties. Moving and bunching from longitudinal movement.

Indicators in Track Geometry

Check for the following

(a) Misalignment (kinks).

(b) Changes in alignment (misalignment) during the day.

(c) Lateral or vertical movement when temperature is more than 20° F above the PRLT.

(d) Buckles.

(e) Irregular gauge.

Ballast Section

Look for:

(a) Churned ballast.

(b) Displaced ballast, (gaps at end of ties, (often on the inside of curves), low crib ballast).

Method Description:

Continuous welded rail must be maintained so that it is at or near a state of zero thermal stress at a temperature of not more than 10° F above, nor more than 10° F below, the **Preferred Rail Laying Temperature (PRLT).**

- This range of temperature is known as the preferred rail laying temperature range (PRLTR).
- **The PRLT at MARTA is 60° inside tunnels and 80° F outside of tunnels.**

However, continuous welded rail may undergo movement or disturbances, so that it is force free at some temperature outside the preferred rail laying temperature range, as a result of such activities as:

- Track surfacing
- Tie renewals

- Ballast cleaning
- Track lining
- Curve rail renewal
- Spot rail replacements (plugs)
- Transposing.

Even if the track is not worked on, the rail can change its force free temperature as a result of:

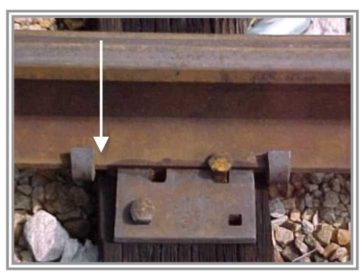
- Rail breaks
- Rail replacement
- Emergency brake applications
- Worn or defective anchors or Pandrol clips
- Poor quality or insufficient ballast
- Soft sub-grade.

On hills, rail is generally seen to move slowly downhill, which can result in an excessively low force free temperature (compression) at the bottom and an excessively high force free temperature (tension) at the top.

Continuous welded rail that shows signs of not being force free within the preferred rail laying temperature range should be distressed as if its actual rail laying temperature were unknown, whether on wood or on concrete ties.

➢ **LOOK FOR THE FOLLOWING:**

(a) Extremely **kinky (snaky) rail** that is riding up or out of the pads or is crowding the shoulder castings on the curves.



(b) Pandrol clips or rail anchors not tight to the tie and marks on the base of the rail where the rail is moving through the spikes or Pandrol clips.

(c) Ties moving and bunching in the ballast from longitudinal movement. Indications of ties moving in or out of a curve, with ballast gaps at the end of the ties.

(d) Clusters of high spikes, broken clips and poor ties.

(e) Hanging ties on bridge or aerial structure approaches.

(f) Weak ballast shoulders and centers especially at approaches to bridges, road crossings, turnouts, interlockings, sliding joints, and any other fixed locations.

(g) New installations of culverts, turnouts or a hi-rail access.

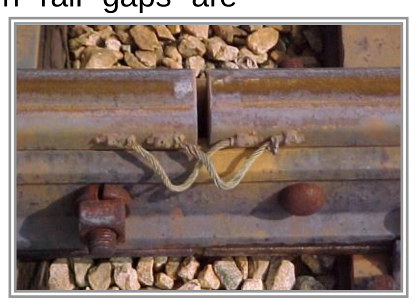
(h) Areas where renewal programs or surfacing has disturbed the track structure. In such areas ensure the slow order extends beyond the disturbed track to prevent brake application on the disturbed track.

(i) Site of a recent derailment, washout, or slide.

- Areas of known heavy brake application such as steep grades, permanent slow orders, approaches to interlockings, passing tracks and passenger stations.

(k) Locations of soft sub-grade such as swamps, bogs, or marsh where the rail moves excessively under traffic causing ties to skew and bunch up.

(1) Areas of buffer rails or any joints adjoining continuous welded rail. Bolts must be inspected for straightness when rail gaps are closed.



(m) Rail gaps that are not closed when the rail temperature is significantly above the preferred rail laying temperature.

(n) Shimming areas (if there are any) must be inspected closely for high spikes and spike killed ties. Anchors must be removed from shimmed track.

(o) Particular attention should be paid to curves in CWR territory. When small tie plates are used, watch for rail canting to the field side.

(p) Particular attention must be paid to welds in curves. Poor alignment of welds will result in heavy, unusual rail wear. Additional excessive forces will be placed on the high rail, causing inside spikes to lift, and track to go out of line.

(q) When surfacing and lining, watch out for lining the curve in or down towards the low rail. Doing so shortens the curve and if steel is not removed it lowers the force free temperature. Surfacing and lining of this nature in cold weather is potentially dangerous as it will be a location for a track buckle in hot weather.

(r) Particular attention should be paid to compromise joints and to locations where rail repairs were performed during winter to replace service failed or defective rails.

(s) In areas of joint elimination caution should be exercised so as not to add steel in the welding process.

(t) In areas of severe corrugation in curves, attention should be paid to rail creepage.

De-stressing of rail may be done by such means as:

(a) Atmospheric temperature

(b) Rail heaters

(c) Hydraulic rail pullers

De-stressing CWR with preferred rail-laying temperature unknown in wood and concrete tie territory

The following information is required:

(a) The preferred rail laying temperature

(b) The length of CWR to be de-stressed

(c) The maximum expected rail temperature for the day

De-stressing should be planned and completed when the rail temperature is at or below the PRLT.

The following **preparatory work** must be performed:

(a) Measure the length of rail to be de-stressed, determine and mark locations where rail is to be cut.

(b) Make match marks on the field side, on the base of the rail and on the tie pads of unanchored ties on both sides of the point where the adjustment is to be made.

(c) Properly adjust and install any sprung or missing Pandrol clips if necessary for all ties for at least 200 feet on each side of where the rail is to be cut.

(d) In wood tie territory, distribute risers, and in concrete tie territory distribute cording clips (if used), tie pads, insulators and risers.

Some important notes to be remembered while undertaking your de-stressing operation are:

The rail must be cut (or joint dismantled if in buffer rail territory) and placed in a position that will permit the rail ends to bypass each other.

The rail must be raised from the tie seat or tie pads and placed on risers. If power vibrators are used, it is not necessary to place the rail on risers.

On wood ties, rail anchors must be removed and spikes raised approximately one inch to allow placement of risers between the base of rail and tie plates.

Risers placed every four to six ties will ensure base of rail is free from tie pads or plates.

In concrete tie areas, all rail clips and clip insulators must be removed and cording clips should be installed on curves approximately every 15 ties.

The rail now in the raised position on risers, or fully power vibrated, is force free at the present rail temperature as it is totally unrestricted.

The base of the rail and tie plate or base of rail and clip shoulders must be match marked with a marking pencil throughout the length of rail to be de-stressed. The position of the rail after being made force free will dictate what action is necessary.

Knowing the length of rail being de-stressed, the PRLT and the present rail temperature, the calculations can now be made as to the adjustment requirement.

E. CWR Movement

The CWR Movement Chart is used to determine the amount of expansion or contraction that should be expected in a length of rail with a certain temperature change.

- This is used to determine the amount of expansion required in order to distress a certain length of rail.

The left vertical column is the length of rail being distressed from 100 to 1500 feet. The bottom row is the temperature difference (the difference between the existing rail temperature and the Preferred Rail Laying Temperature (PRLT).

As an example:

If we were going to distress 1000 feet of rail, the rail temperature is 45^{o}F and the PRLT for your territory is 80^{o} F. The temperature difference is $80^{o}-45^{o}=35^{o}$.

- Find the 1000 foot row on the left column
- Follow the row along to the column above the 35^{o} -temperature difference reading.
- Where the row and column intersect the reading is 2-7/8”.
- This is the amount of rail expansion needed in order to properly distress the rail to 80^{o}F.
- If the rail is to be welded by Thermit welding, an additional 1-inch must be cut off the 1000 foot rail before heating or expanding to make room for the weld.