MARTA Track Safety Standards

I hereby certify that on the date indicated below, I received a copy of the MARTA Track Safety Standards, issued by the Department of Track and Structures.

I recognize that it is my responsibility to be familiar with the contents of this document and to have these standards with me during all Track Inspections and Maintenance work.

Employee Name ____

Employees Signature ______________________________________

Date Received ____________________ **Badge #** ____________

This Page Left Intentionally Blank

General Purpose & Overview

Rail Standards

Rail Joint Standards

Third (3rd) Rail Standards

Exhibits

GENERAL PURPOSE AND OVERVIEW

Purpose

The purpose of this procedure is to provide MARTA's Track Walkers and Maintainers with a set of guidelines by which they can inspect, maintain and compare the track and its components in the field. This information is to be used when inspecting and maintaining MARTA's railroad and wayside to insure safety, integrity and ride quality of the tracks and its structures. The primary aim is to insure that all tracks meet the safety and maintenance standards for MARTA Track Safety Standards for Class 1 through 4 Track.

The requirements prescribed in these standards apply to specific track conditions that may exist in isolation. They may also be considered in a combination of track conditions, none of which individually amount to a deviation from the requirements in these standards but may require remedial action for provide safe train operations over that segment of track when taken in totality.

When conditions arise and the designated class of track cannot meet the Track Safety Standards for that class, the Track Walker must be able to make accurate and timely decisions as to the conditions of the track and at what speed or Class of Track, trains can safely operate. If speed restrictions are necessary, that will be determined by the class of track that the conditions and observations warrant or have predetermined train speeds as are stated within these safety standards.

If a segment of track does not meet all of the requirements for its intended class, it is reclassified to the next lowest class of track for which it does meet all of the requirements. If the track fails to meet minimum Class 1 standards then the track will be taken out of service.

These standards establish minimum required condition levels and also identify track conditions requiring restriction or suspension of train operations. It is intended that a Track Walker apply the required restriction or suspension immediately upon discovery of the substandard condition, and that the track be repaired to meet the appropriate condition level as soon as practical. A track restriction shall require the operational speed to be less than the posted speed.

Overview

Each mainline track will be subject to a walking inspection twice weekly, with at least one calendar day between inspections

Each mainline switch will be inspected monthly, as outlined in the **"Switch Inspection Standards".**

Each mainline track will be subject to a riding inspection by the Track Inspection and Support supervisory personnel on a monthly basis. Report will be submitted to the Manager of Track Inspection and Support.

All yard and secondary tracks will be subject to a walking inspection on a weekly basis.

All mainline tracks will be inspected at least semi-annually by an automated track geometry car and ultrasonic rail-testing car.

Data will be promptly reviewed and appropriate protective actions implemented until corrective actions can be taken. This data will also be used to prioritize track repairs.

Inspection Type and Frequency

Semi-weekly

Walking inspection of all mainline tracks and turnouts.

Inspection of rail lubricators.

Weekly

Riding inspection by trackwalkers of all mainline tracks. (Verbal report to T&S Management of any changes in ride quality).

Walking inspection of all yard tracks.

Monthly

Inspect all mainline switches as outlined in the Switch Inspection Guidelines. (See Section on Switches for details)

Tighten and replace as necessary, all gauge rods, rail clips and anchor bolts in interlockings, which can be accomplished without disrupting revenue service.

Inspect all Yard switches as outlined in the Switch Inspection Guidelines. (See Section on Switches for details)

Semi-annual

Test all mainline tracks with track geometry car.

Ultrasonically test all mainline tracks for internal rail defects.

Annual

Measure rail head wear on designated mainline curves.

Special Inspections

In the event of fire, flood, severe storm, seismic (earth quake) activities or other occurrence which might have damaged the track structure or components, a special inspection shall be made of the track involved as soon as possible after the occurrence and, if possible, before the operation of any train over that track.

Direction: This section is general in nature, because it is not practical to specify all the conditions that could trigger a special inspection or the specific manner and timing.

- This section is not meant to imply that train operations must necessarily stop until the special inspection is made.

However, all special inspections should be conducted for the primary purpose of determining whether the track structure is safe for the continued operation of trains. Inspectors are directed to review the significant impacts to transit operations in regard to fire, flood and severe storm.

When the Rail Service Control Center is notified of a possible track-damaging occurrence, a special inspection must be made. The Manager of Track & Structures will be responsible for making a determination on who will perform the special inspection as required.

Severity Estimators

Severity Estimators is a rating system designed to enable the Track Walker to effectively communicate track conditions and priority. This rating should be applied to each service request/defect entered into the CMMS.

Green

Track observations, conditions or defects that are reported for the purpose of monitoring. Such conditions do not affect system safety, ride quality or personal safety. This rating should be used to identify conditions that may eventually develop into a defect requiring corrective action.

Examples:

- Minor engine burns in the rail head
- Lubrication that is in acceptable condition (having a thin coating of grease on the gauge corner of the rail in the last curve preceding the lubricator)
- One (1) tunnel light out

Yellow

Such designation alerts to a track condition that may affect the ride comfort qualities of the track and that may degrade to a worse condition if left uncorrected. Track conditions or defects that require corrective action but do not affect system or personal safety will be loaded into the FA Suite data base. Every effort shall be made to correct these defects as soon as practicable.

These defects will be monitored, prioritized for repair and addressed as resources and schedules permit or condition requires.

Examples:

- Minor overflow or hairline crack in frog point
- Minor rail-end batter
- Track Geometry deviations as defined in MARTA's Track Safety Standards
- Missing Coverboard

Red

The Qualified Track Inspection Designee detecting such Condition (s) shall make every effort to correct the condition immediately, and must also evaluate whether to allow operations to continue under restricted conditions, supervision or to place the track out of service immediately. If operation is allowed to continue, the person (s) making the decision must not leave the scene until the condition is protected, they are relieved or until the defect is repaired.

When safe to do so, **"walking"** trains over such a condition is allowed. Each train shall be stopped short of the defect and a Qualified Person on the ground shall communicate the situation to the train operator. Movements shall be made at **"Restricted Speed with Extreme Caution";** that is, proceeding no faster than 5 to 15 mph dependent upon conditions.

- Be prepared to stop at least two car lengths short of a visible object on the track or within the train envelope.
- Watching rails and switches for the correct predetermined route.
- Looking for anything within the train envelope that is unsafe to pass.

Train protection includes slow orders, visually flagging trains over defective conditions or removing track from service.

Examples:

- Defective, damaged or broken rail or track component
- Cracked or broken frog point
- Broken Shoulder or Heelblock bolt
- Not meeting Track Geometry criteria (profile, line, gauge, etc.) as defined in the MARTA Track Safety Standards.

DOCUMENTATION

Track and Switch Inspection Reports

Service Requests/Defects shall be entered into the CMMS via the Mobile Focus or FA Suite applications.

An automatically updated track Inspection Report, will be carried by each Track Walker to prevent duplicate entries.

The updated inspection report and subsequent work order will be printed from the CMMS signed by the Track Walkers and maintained for managerial and outside review.

Reports will be reviewed by the Track Inspection Supervisory personnel and Track Inspection Planner for scheduling of work.

Items of significance or needing attention should be brought to the immediate attention of the Track Inspection supervisory Personnel.

Notification of Management Personnel

When conditions indicate that ASAP notifications, the following order should be observed:

(A) Rail Control Center (if train protection is required)
(B) Track Supervisory Personnel (Foreperson)
(C) General Foreman Track Inspection & Support or General Foreman Track Maintenance
(D) Manager of Track
(E) Director of Maintenance of Way

Rail Lubricator Inspection Report

Rail Lubricator PM work orders will be completed daily in the CMMS and filed with the Track Inspection Supervisory personnel for each rail lubricator that is inspected.

Marked Measurements

Marked Measurements will be entered into the CMMS via the test result function of FA Suite or Mobile Focus. The test type ID is "TS4-SW-MEASURE".

This inspection will include comments, gauge, crosslevel, flange-way, guard face and guard check readings. This report will be printed, signed by the inspectors, attached to the corresponding work order and filed with the Track Inspection Foreperson.

Track Maintenance Daily Summary Report

All work performed on mainline and secondary tracks will be reported on the Track Maintenance Daily Summary Report.

This report will be shared daily with the Track Walkers prior to the daily track inspection. All maintenance work will be recorded and tracked in FA Suite for reporting purposes.

Running Rail Defect & Replacement Report

A Running Rail Defect and Replacement Report must be completed and filed with the Track Inspection Supervisory personnel each time a rail defect is replaced. Any new report will be distributed to the Track Walker prior to initiating the daily inspection.

These reports will be kept for a period of no less than three (3) years.

Drawings, Manuals and Specifications

All pertinent drawings, ,manuals and specifications are available for review and consultation at the Track and Structures Maintenance Office. Track Charts are easily accessed through the Optram System.

TRACK WALKER REQUIREMENTS

Qualifications

Must have completed high school and received a diploma or GED equivalent.

Must have good English language oral and written skills.

Must have a minimum of three (3) years experience within MARTA's Track Maintenance and Structures Division or equivalent.

He/she must demonstrate their knowledge in a structured interview given by MARTA Supervisory Personnel. This interview shall consist of two (2) sections, a written and a hands-on/field evaluation. Candidates must achieve a score of at least an 80% average in order to be considered for a Track Walker position.

Be knowledgeable in MARTA's track standards and inspection procedures.

It is the responsibility of a qualified Track Walker to take the appropriate action, based on his/her inspection of the track. This is to include immediate correction of the problem if possible, reporting of the problem in the proper manner for verification and follow up, or immediate protective action (to include slow orders, visual supervision of train operation or taking the track out of service).

The Track Walker will be required to take a re-qualifying exam yearly on a schedule set by the Office of Track & Structures.

At this time he/she must display their knowledge in a written and/or field evaluation and achieve a score of at least 80%.

If the individual does not achieve a passing score of at least 80%, the Track Walker will be placed on 3 months' probation. During the probation, the Track Walker will be allowed to inspect track only with a qualified Track Walker.

The Track Walker may re-test any time during this probation period but must obtain their qualification before the end of the 3 month period which begins with the date of the first test.

If the individual does not achieve a passing score of at least 80% on the exam:

- The Training Instructor will contact the individuals management staff to provide details of examination results
- The employee will be instructed to perform self-study
- The management staff will consult with the Track Walker and schedule the first re-test
- The re-test scoring will be evaluated accordingly

If the individual fails the first re-test:

- The Training Instructor will contact the individuals management staff to provide details of examination results
- The employee will be instructed to perform self-study
- The supervisor will have ten (10) days to consult with the Track Walker and schedule a second re-test.
- The re-test scoring will be evaluated accordingly with the results sent to the individuals management.

If the individual fails the second re-test:

- Track & Structures management will notify the individual of their disqualification from current job position.
- If disqualified, the individual will have fourteen (14) days following notification to occupy another position within Track & Structures or the Authority, (other than Track Walker) as seniority and qualifications allow.

The employee will **not** be eligible to return to this craft or test for the position of Track Walker within 12 months from the disqualification date pursuant to paragraph 228 of the current labor agreement.

Qualified Person

A designated Qualified Person shall have at least:

- One year of Track Supervisory experience, or
- Been Qualified as a Track Walker, or
- Two years experience in Track Maintenance

The Qualified Person must be able to demonstrate that they:

- Know and understand the requirements of these Track Safety Standards:
- Can detect deviations from these standards
- Can prescribe appropriate remedial action to correct or safely compensate for the track deviations and defects found wayside in order to ensure the safe operation of all train movements.

Defective conditions or a combination of conditions may be found which are not directly addressed within these safety standards. In such cases, the Track Walker shall exercise their best judgment in applying the appropriate operating restrictions.

Track Walker Duties

The primary duties of the Track Walker are as follows:

Make a thorough inspection of the assigned territory at the designated time interval to insure that the track, and all pertinent structures and right of way are in a safe and operable condition. If any unsafe conditions are found, based on the information in this procedure, the Track Walker shall take steps at once to protect approaching trains.

The Track Walker shall notify the Rail Control Center and the Track Inspection Foreperson. It is the responsibility of a qualified Track Walker to take the appropriate action, based on their inspection of the track.

- This includes immediate correction of the problem, reporting of the problem in the proper manner for verification and follow-up, or immediate protective action which includes:

Slow Orders

1. Slow order. (according to preset speed restrictions or adjusted track speed to the class of track for which the track is rated.)
2. Visual supervision of the train operation (flagging) through the affected area.
3. Taking the track out of service.

The Track Walker is to keep themselves informed of work performed in their assigned territory by MARTA crews or contract personnel to insure no work is done that will interfere with safe passage of trains.

Give special attention to places where obstructions are likely to occur, examine slopes for the possibility of slides and falling rock.

Examine mainline track and components including but not limited to, turnout frogs, crossing frogs, joint bars and bolts, bonded, insulated and standard bonded joints, rail track surface, alignment and gauge, switch rods, tie and ballast conditions, rail lubricators, hi-rail accesses, rail anchors, direct fixation fasteners, direct fixation concrete and anchors, contact rail, fencing, vegetation conditions, structures, etc., looking for defects or breaks and other conditions that require corrective maintenance.

Any obstruction to the track must be reported immediately to the Rail Services Control Center and appropriate steps taken to protect approaching trains.

Note any potential areas which would allow for unauthorized persons or wildlife to enter the property. Any unauthorized personnel on the wayside should be reported immediately to the Rail Services Control Center.

Observe conditions of the contact rail (3rd rail), feeder and return cables, Train Control, Communication and all wayside equipment and report any conditions needing attention to the Track Inspection Supervisory personnel.

<u>Additional Duties</u>

- Update the CMMS Service Request/Defect Function during and after each inspection for review by the Inspection Foreperson.
- Escort contractors or other personnel whose work requires wayside access.
- Perform corrective maintenance of track when applicable. (This includes but is not limited to, tightening of gauge rods, rail clips, adjustment of 3rd rail anchors, removal of vegetation, etc.)
- Conduct special inspections of project work.
- Perform other miscellaneous duties as assigned.

Track Walkers Inspection Tools

All Track Walkers must have the following inspection tools with them while they are performing their daily inspections.

1) MARTA Track Safety Standards Book.

2) Frog Gauge

3) Tape Measure

4) Combo gauge when taking marked measurements or when required for your inspection.

5) One Person on the Inspection team must have the most recent (that days copy) hard copy of the inspection defect report.

6) Ink pin and Paint Marker

7) Special inspection tools as required (rail profile gauge, stringline, etc. when required)

Continuous Inspection
On the job observations shall be on going at all times when equipment is on the system working. Equipment operators and maintainers shall be encouraged to observe and to report any track related problems, defects or obstructions of the track.

Areas to be aware of are broken rails or other rail defects, faulty switch point closure, indications of wide gauge, poor alignment or surface defects. In addition observations of joint bars, loose bolts, rail pull-a-parts, evidence of possible track buckling, and blocked drains.

Any of the above could contribute to a train derailment and should be brought to the attention of Track Department Supervision.

Classes of Track: Operating Speed Limits.

1. The following maximum allowable operating speeds apply at all times on the MARTA Rail System.

Over track that meets all requirements prescribed within these standards	The allowable operating speed for transit trains within their class of track is
Class 1 Track	0 to 15 mph
Class 2 Track	16 to 30 mph
Class 3 Track	31 to 60 mph
Class 4 Track	61 to 80 mph

2. If a segment of track does not meet all of the requirements for its intended class, it is re-classified to the next lowest class of track for which it does meet all of the requirements of this part

Train operating speed is always determined by the track conditions. The poorer the track conditions the slower the operating speed. The better the track conditions the greater the operating speed. Once the track fails to meet any set class of track we must then determine what class of track the conditions will fall under.

The Track Safety Standards classifies track solely on the basis of authorized speeds for transit vehicles. Tolerances are specified in the Track Safety Standards for each class of track. A deviation beyond the limiting tolerances for Classes 1 through 4 requires repair, or reduction of speeds to the appropriate class.

The initial speed of any track is based on the design characteristics of that track.

RAIL STANDARDS

General Rail Inspection

MARTA's running rail is standard AREA 115RE section.

- See exhibit

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 Service Request / Defect Module of the CMMS utilizing the information found in the Sperry Rail Manual 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 reduce the operating speed to 10 M.P.H.

In addition, the Track Walker must flag all trains over 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.

The Preferred Rail Laying Temperature for all track outside of tunnels is 90°, within the canapy areas of rail stations 75° and within all tunnels 60°.

Ambient Temperature Versus Rail Temperature

All references to temperature should refer to rail temperature. In hot weather, the rail temperature is generally greater than the ambient (air) temperature. In cold weather, the rail temperature is essentially equal to the ambient temperature.

Inspection of Rail.

1. In addition to the track inspections required a continuous search for internal defects shall be made of all rail in Classes 4 track, Class 3 and Class 2 track over which transit trains operate, at least twice a year.

2. Inspection equipment shall be capable of detecting defects between joint bars, in the area enclosed by joint bars.

3. Each defective rail shall be marked with a highly visible marking on both sides of the web and base..

4. If the person assigned to operate the rail defect detection equipment being used determines that, due to rail surface conditions, a valid search for internal defects could not be made over a particular length of track, the test on that particular length of track cannot be considered as a search for internal defects under paragraph (a) of this section.

5. If a valid search for internal defects cannot be conducted for reasons , MARTA shall before the expiration of time -
   (a) Conduct a valid search for internal defects;
   (b) Reduce operating speed to a maximum of 25 miles per hour until such time as a valid search for internal defects can be made; or
   (c) Remove the rail from service.

Rail Types

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

<u>Control Cooled</u>. All rail is 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.

<u>Head-Hardened Rail.</u> This rail is control cooled rail with the rail head being heat treated to increase its strength and durability.

<u>Head-Hardened rail is used in:</u> <u>Turnouts, Curves and Station Platforms.</u>

<u>Rail Brands</u>

The rail web is branded at least every 16 feet, and the branding will consist of the following information:

- Weight per every 3 feet of rail: two- or three-digit number
- Section: two-letter code
- Type of process used for hydrogen elimination: two-letter code
- Manufacturer: spelled out, letter code, or symbol
- Year rolled: four-digit number
- Month rolled: lines or roman numerals

115	**RE**	**CC**	**Tennessee**	**1974**	**1111111**
Rail Weight	Section	Type of Steel	Manufacturer	Year Rolled	Month (July)

115 RE CC Name of Mill 1974 lllllll

- This means that the rail is of the <u>115-pound</u> 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

The web of each rail is "hot stamped" at least every 16 feet on the opposite side as the branding and should not be within 2-foot proximity of a rail end. The data will contain the following information:

- Heat Number
- Rail Position Letter
- Ingot or Strand/Bloom Number

Method of Hydrogen Elimination (Optional)

Ingots are numbered by letters that succeed each other starting with "A," designating their position in the cast. Strand/bloom numbers may be joined or separately coded at the manufacturer's preference.

CT	**287165**	**B**	**12**
Grade of Rail	Heat Number	Rail Position	Strand & Bloom Number

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 strand & bloom number.

Torch Cut Rail:

No rail having a torch cut end or torch cut bolt hole shall be used on the MARTA Rail System. Rail shall not be torch cut in any manner. This includes cropping the rail ends, burning bolt holes and trimming mismatched rail ends. Rails shall be cut using a mechanical or abrasive rail saw or other appropriate cutting tools.

Measuring Rail Temperature

Rail temperatures are measured on the side of the rail that is out of direct sunlight. Keep it on the web for 10 minutes. (if measured in direct sunlight the rail thermometer will heat up because of the sunlight, causing an inaccurately high reading).

Steel tends to contract or shrink as its temperature is lowered. If it is restrained, so that it cannot contract, a tensile force is built up within the steel.

As the temperature of the steel is increased, it will tend to expand. If some restraint does not permit it to expand, a compressive force develops within the steel.

In track with continuous welded rail, expansion and contraction cannot occur. This results in much larger tensile stresses in cold weather (causing rail to break) and compressive stresses in hot weather. (Causing the track to buckle.)

Do not remove thermometer from rail to read temperature. Read temperature as it sits on the web of the rail.

Defective Rails.

1. When MARTA's track to which this part applies learns, through inspection or otherwise that a rail in that track contains any of the defects listed in the following table, a Qualified Persons shall determine whether or not the track may continue in use. If it is determined that the track may not continue in use, operation over the defective rail is not permitted until—
   (a) The rail is replaced; or
   (b) The remedial action prescribed in the table is initiated.

See table on the following page for Remedial Action

Remedial Action Table

Type of Rail Defect	Remedial Action required for identified rail defects	Remedial Action	
		Replace Defective Part of Rail	Apply Joint Bars
Bolt Hole Crack - Less than 2 inches Greater than 2 inches	A E and F	Preferred Required	Allowed (2) Allowed (2)
Broken Base – Less than 6 inches Greater than 6 inches	D A or D and E	Preferred Required	Allowed Not Allowed (2)
Corrosion Rail Base – Greater than .25”	A	Required	Not Allowed (2)
Complete Break – Clean & Square	A or E	Preferred	Allowed (1)
Complete Break – Rough or Angled	A	Required	Not Allowed (2)
Pull-Apart (at rail joint or broken rail)	A or E	Preferred	Allowed
Crushed Head	D	Required	Not Allowed
Defective Weld	A or E and F	Required	Not Allowed (2)
Fissure – Compound - Less than 25% Size less than 70% (3) Size greater than 70% (3)	D B A	Allowed (1) Allowed (1) Required	 Allowed Allowed
Fracture – Engine Burn (3) Size less than 2 inches (3) Size greater than 2 inches (3)	E and F A or E and F	Allowed (1) Required	Allowed Allowed
Head / Web Separation Length Less than 4 inches Length greater than 4” or breaks out into the Rail Head	B A	Required Required	Not Allowed (2) Not Allowed
Piped Rail – Less than 4 inches Greater than 4 inches	B A	Required Required	N/A N/A
Running Surface Damage	D	Allowed	Not Allowed (2)
Split Head – Horizontal Less than 2 inches	E and F	Required	Not Allowed (2)
Split Head – Vertical Vertical Split - Gauge Side Vertical Split - Field Side	A A	Required Required	Not Allowed (2) Not Allowed (2)
Split Web – Less than 4 inches Greater than 4 inches	B A	Required Required	Not Allowed (2) Not Allowed

Notes:

(1) Not allowed if results in a length of rail less than 14 feet.
(2) May be allowed as an emergency measure until defect is re moved provided operations are restricted to Class 1 track and a Qualified Person is present.
(3) Defect estimated from internal rail flaw testing. If size is un known, assume greater than 70%.

A. If it is determined by a Qualified Person to continue train opera-
tions, the person making the decision must not leave the scene until the condition is protected, they are relieved or until the de- fect is repaired.

- When, in the judgment of a Qualified Person, that it is safe to do so, **"Walking"** trains over such a condition is allowed.
- Limit operating speed over defective rail to that as authorized by a Qualified person who shall have at least:
  - (i) One year of Track Supervisory experience, or
  - (ii) Been Qualified as a Track Walker, or
  - (iii) Two years experience in Track Maintenance
- Each train shall be stopped short of the defect and a Qualified Person on the ground shall communicate the situation to the train operator. Movements shall be made at **"Restricted Speed with Extreme Caution";** that is, proceeding no faster than 5 to 10 mph dependent upon conditions.
- The Qualified Person on the ground will constantly monitor the movement of each train over the defect and be prepared to stop the train at any time that it is determined to be unsafe to continue.

B. Limit operating speed over defective rail to that authorized by a
Qualified Person.

(i) The operating speed cannot exceed 30 m.p.h. or the maximum allowable speed for the class of track concerned, which ever is lower.

C. Apply joint bars bolted only through the 2 outermost holes to defect within 24 hours after it is determined to continue the track in use. In the case of Classes 3 through 4 track, limit operating speed over defective rail to 30 m.p.h. until joint bars are applied; then, limit speed to 50 m.p.h. or the maximum allowable speed for the class of track concerned, whichever is lower.

When a search for internal rail defects is conducted and defects are discovered in Classes 3 through 4 which require remedial action C, the operating speed shall be limited to 50 m.p.h., or the maximum allowable speed for the class of track concerned, whichever is lower, for a period not to exceed 24 hours.

If the defective rail has not been removed from the track or a permanent repair made within 4 days of the discovery, limit operating speed over the defective rail to 30 m.p.h. until joint bars are applied; thereafter, limit speed to 50 m.p.h. or the maximum allowable speed for the class of track concerned, which ever is lower.

D. Apply joint bars bolted only through the outermost Holes to defect within 24 hours after it is determined to continue the track in use. In the case of Classes 3 through 4 track, limit operating speed over the defective rail to 30 m.p.h. or less as authorized by a person designated who has at least one year of supervisory or track maintenance experience until joint bars are applied; then limit speed to 50 m.p.h. or the maximum allowable speed for the class of track concerned, which ever is lower

E. Apply joint bars to defect and bolt in accordance with MARTA
Rail Joint Standards

F. Limit operating speed over defective rail to 30 m.p.h. or the maximum allowable speed for the class of track concerned,

External Rail Defects

External defects are not always easily detectable unless they have resulted in an obvious break in the rail or a breakout of a piece of rail from the running surface or from the base of the rail.

Visual inspection is sometimes aided by a mirror to check under the head and base of the rail and discover the more obvious defects such as, vertical split heads and half-moon base breaks.

However, this type of inspection cannot detect those internal defects.

Some of the conditions are considered to be defects because under continued service they will lead to failure.

Corrugation

Corrugation, sometimes called washboard rail, is a series of waves or variations in top of the railhead which are more or less accentuated and irregular. The short wave or rail length of the corruption usually varies from 2 to 3 inches.

Intermediate wave corrugation or undulations at times could exceed 10 to 12 inches in length.

The very long wave corrugations have a wavelength greater than 24 inches and are common on very high speed operations.

Furthermore, this type of corrugation has a very shallow depth between peaks. Corrugations have the appearance of regular bright and dark streaks across the running surface of the rail.

Corrugation is caused by uneven rail wear. It is generally attributed to a repetitious wheel sliding action of some nature whether through heavy braking or lateral motion across the rail surface. It is not considered to be a serious defect but is usually removed from high speed track because of rough ride.

Crushed Head

Crushed head is a rail flaw caused by flattening or drooping of several inches of the railhead. It is usually accompanied by a crushing down of the metal but with no signs of cracking under the head.

The crushed head usually originates by a soft spot in the steel of the head, which gives way under heavy wheel loads.

The continual passage of the heavy wheel loads causes it to grow.

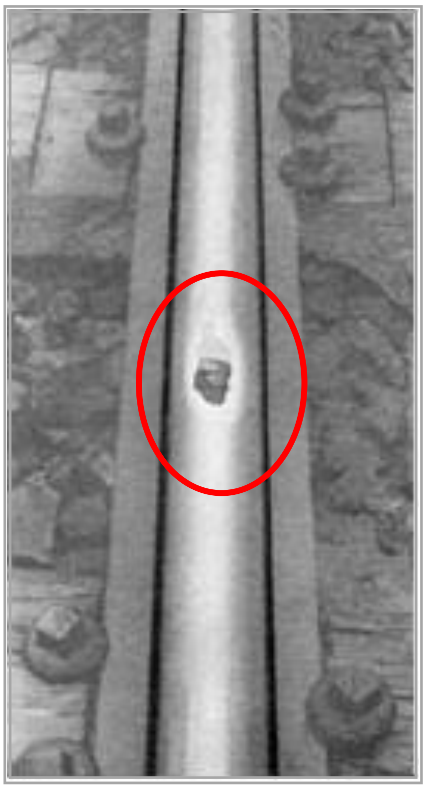
- Also higher train speeds and increasing depth of the flat spot accelerate growth. A flattening and widening of the head for several inches, with the entire head sagging. Small cracks in the depression on the running service.
- In advanced stages, crepe (wrinkled) surface or a bleeding crack at the fillet under the head.

The crushed head is not a serious defect, but it is generally removed from high speed track because it causes rough riding of rolling stock. Points of concentrated loading may develop defects.

Engine Burn or Burned Rail

Engine burn is a defect consisting of damage to the rail tread caused by the high friction of a slipping locomotive wheel. The locomotive driving wheel overheats and displaces wheel tread metal on the running surface.

The burn does not actually grow, however, the damaged area may gradually chip out and roughen under repeated traffic.



The engine burn is also known as wheel burn.

The presence of an engine burn in the track can also present other maintenance problems.

The irregularity on the running surface of the rail creates an impact stress each time a wheel passes over it. This can produce increased deterioration of the supporting ties.

Many small engine burns remain in the track for long periods of time because they are not large enough to create pounding of an appreciable amount.

Others have the irregularity minimized by grinding off upset metal which has been displaced or disturbed by some other action.

Do not confuse an engine burn with an electro burn. An electro burn occurs during the flash butt welding process and looks similar to an engine burn. When in doubt, check to see if the burn is near a weld.

Rail End Batter

This pounding effect on the receiving end of the rail in a rail joint causes the steel to become deformed or battered over a period of time.

As batter develops, this irregularity in the running surface of the rail causes the pounding to become even more severe. As the pounding of the wheels becomes more severe, the extent of the batter becomes worse. The process tends to become self destructive.

If rail traffic is predominately in one direction, (as is the practice here at MARTA) and the same rail end is almost always the receiving end, this will be evident in the way in which rail end batter develops.

- But eventually both rail ends will show signs of batter.

However, if the traffic is evenly distributed as to direction, as in a single track operation, a different pattern of rail end batter will develop. Both rail ends in a joint will develop batter.

Every wheel moving across the rail joint will be moving downward before it gets to the rail end gap because of the batter on the leaving end. This further increases the pounding effect that can be anticipated.

Rail end batter develops relatively slowly. There are various conditions that can contribute to this development in addition to the movement of wheels across the rail end gap.

At times under heavy traffic conditions, so called secondary batter will develop on the rail within the limits of the joint bars beyond the area that first showed signs of batter.

In **Insulated Joints,** after a period of time, the rail ends begin to batter down and a lip of steel forms on top of the end-post. This lip must be carefully removed with a grinder, hacksaw or file taking care not to damage the end-post. All resulting filing must be cleaned away so not to **short circuit** the insulated joint. The space between the rail ends must be maintained to the width of the end-post.

Head Check

A head check is a rail defect consisting of shallow surface or hair-

line cracks, which appear in the gauge corner of the rail-head. They appear at any angle with the width of the rail. Head checks generally run at a 45 degree angle to the axis of the rail: they usually occur on the high rail of curves. Concentrated wheel loading at the gauge corner of the railhead causes them. Detail fractures can originate from head checks.

Flaking (Spalling)

Flaking is a rail defect consisting of the gouging of metal on the

railhead; it is indicated by small chipping and cavities. It is a progressive horizontal separation on the running surface of the rail near the gauge corner, with scaling or chipping of small slivers. Flaking should not be confused with shelling, as the flaking takes place only on the running surface near the gauge corner of the rail and is not as deep as shelling.

It usually occurs on the high rail of curves.

- While flaking is not considered to be a serious defect, it sometimes develops into shelling.

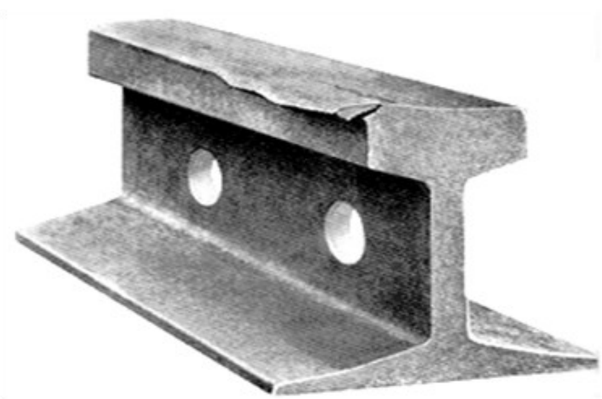
Flaking originates at the surface of the rail. It is prevalent on the high side of curves, switch points and locations where concentrated loading on the tread and gauge corner cold works the steel.

The growth depends on the loading. The separation progresses about 1/32 inch below the running surface toward the gauge side of the head, usually coming to the surface close to that point where the tread contour turns downward at the gauge side.

Very shallow depressions with irregular edges, occur on the running surface near the upper gauge corner. They generally will not occur more than one-fourth inch from the gauge corner of the rail. Horizontal cracks along the running surface near the upper gauge corner of the railhead resemble small slivers.

Flowed Rail

A flowed rail defect consists of the rolling out of the tread metal beyond the field corner, with no breaking down of the underside of the head. Flowed rail is not a serious defect. Flow is due to distortion of the rail metal under repeated loads. This gradual change of the head contour does not damage the metallic structure of the metal.



Flowed rail is a change in shape rather than a growth. It occurs, predominately in curved track, under repeated service. The extent of the chance is usually proportionate to the length of service of the rail. Rail in tangent track may also become flowed, although at a slower rate than in curved track.

Surface metal on the head flowed on the field side, giving a creased appearance on the running Surface near the field. A smooth protruding lip (which may extend the length of the rail) In advanced stage, flow becomes like a blade, jagged, or non-uniform, and may hang down or separate from the railhead.

Damaged Rail

Any rail broken or damaged by wrecks, broken, flat, or unbalanced wheels, slipping, or similar causes.

One result of external damage can be a sudden rupture of the rail in the transverse direction. It is similar to the ordinary break, except that the break can be attributed to some event that caused it.

Another type of damage may produce kinking of the rail.

Kinked rail is not considered to be serious from the standpoint of possible failure but continued use can create maintenance problems.

Another form of damage consists of nicks in the rail.

Nicks can cause the development of defects. The likelihood of this happening is dependent upon the depth, sharpness, and location of the nick.

Track workers carelessly using a spike maul while spiking, or striking the rail while adjusting expansion may cause some nicks.

Other nicks on the head of the rail are caused by broken wheels and these could be serious.

Shelling (Shelly Spots)

Shelling, sometimes called Shelly spots, is a rail defect consisting of shell like flakes of steel that have come off the railhead. It is a progressive horizontal separation that may crack out at any level on the gauge side, generally at the upper gauge corner.

It extends longitudinally, not as a true horizontal or vertical crack, but at an angle related to the amount of rail wear. Very shallow shells are called spalls. Also, in the case of a small shell there may be no surface evidence.

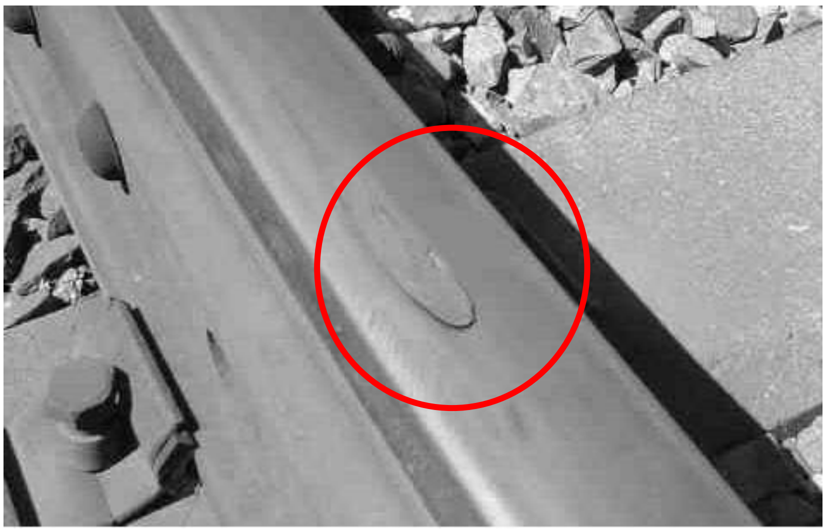
Shelling is prevalent at curves and where excessive pressure is exerted on the railhead. It is accelerated if streaks or small seams are present and provide stress concentration points. Uncapped shell often shows these characteristics of origin. The growth depends on the loading. The separation progresses in the path of least resistance. Shelling may turn down to form a transverse separation, in which case the defect would be classified as a detail fracture from shelling.

Dark spots are irregularly spaced on the gauge side of the running surface. Longitudinal separation occurs at one or several levels in the upper gauge corner, with discoloration from bleeding. If rail is turned, shelling will appear on the field side, with an irregular overhanging lip of metal. Appearance is then similar to flowed metal.

Shelling is potentially dangerous because it occurs most frequently in curve territory and transverse separation may develop at any stage of shelling or at any point along the shell.

Slivers

Slivers, sometimes called rail sliver, is a rail defect consisting of a thin tapered mass of metal that has separated from the surface of the head, web or base of a rail. Slivers occur from an imperfection during the rolling process, when a small pre-oxidized section of rail laps over instead of flowing and welding under pressure of' the rollers.



Slivers separate rather than grow, but may chip off, cause batter, or furnish a point of origin for a transverse or longitudinal separation.

They are not a serious defect.

1) Thin slivers (similar to wood slivers) are on the Surface of the railhead and parallel to the rail length.
2) Darkened slivers are shown (in advanced stage) giving an appearance much like the vertical split head but without any spreading or crushing of the railhead.
3) Slivers on the side of the railhead. Such slivers may be both shorter and thicker than slivers on the running surface. All slivers are generally less than 1/8, inch thick.

They form part of the rail contour, lying flat on a surface, but may be cracked loose from rail metal on three sides. If a sliver has been dislodged, only an indentation will remain on the rail surface.

Head / Web Separation

A progressive fracture, longitudinally separating the head from the web of the rail at the head fillet area. Acid action from some paving materials used at hi-rail accesses may start corrosion fatigue where the railhead joins the web.

Gravel at crossings, excessive speed on curves, or improper canting of the rail can cause unusual loading of the railhead.

In earlier stages wavy, wrinkled lines appear along the fillet under the head.

As the condition develops, small crack will appear along the fillet on either side, indicating growth through the web. It progresses longitudinally with slight irregular turns upward and downward.

In advanced stages. Bleeding cracks will extend downward characteristics of a head and web separation in track from the longitudinal separation through the web, and may extend through the base.

The growth usually occurs in gradual stages but can develop quite rapidly under extreme stress conditions often created by pumping or swinging joints.

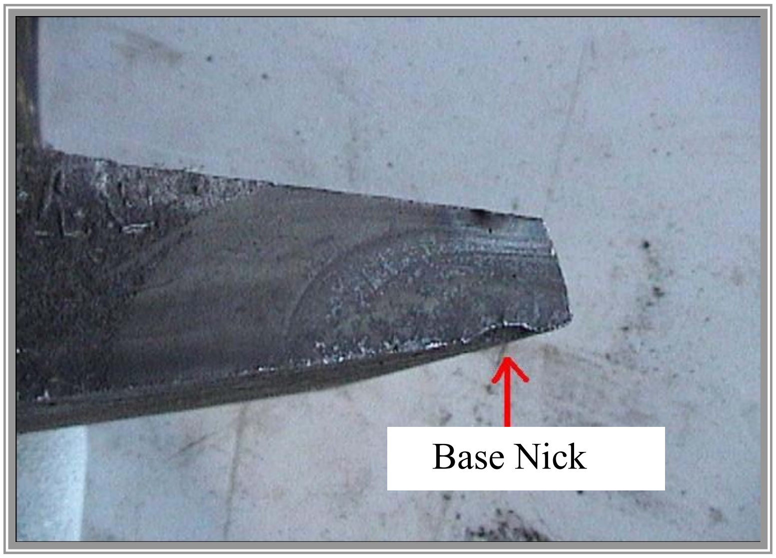
The growth is also rapid once the rail had been turned, as this moves the loading point to the opposite side of the head with the joint bars.

The head and web separations will appear as a hairline crack along the head fillet once the joint bars have been removed.

With the joint bars in place, visual detection is not possible until the defect has reached an extremely advanced stage of development.

Base Fracture

These defects, as a rule, originate on the outer edge of the base.



Base fractures are usually caused by a nick or blow on the edge of the base which results in an indentation or step.

Growth is relatively slow until the defect has progressed from the edge of the base into the rail approximately one-half inch. Base fractures seldom extend progressively farther than one-half inch into the rail before causing a complete break.

Base fractures are visible as hairline cracks for the extent of the progressive development into the rail.

The base fracture is a serious defect because:

1. Service failure is usually a complete break of the rail across head, web and base.
2. Failure frequently occurs before the defect can be discovered visually.

Broken Base

Any break in the base of the rail. A broken base defect is a progressive fracture in the base of the rail, with a vertical separation or split. The separation is substantially longitudinal, but usually turns out to the edge of the base. These separations arc often called half moon breaks.

Bearing on ties or tie plates or rail fasteners may cause the separation, or it may originate in a seam, segregation, or inclusion. The growth depends on the location of the break and the loading of

Flattened Rail

A short length of rail, not at a joint, which has flattened out across the width of the railhead to a depth of .38 inch or more below the rest of the rail. Flattened rail occurrences have no repetitive regularity and thus do not include corrugations, and have no apparent localized cause such as a weld or engine burn. Their individual length is relatively short, as compared to a condition such as head flow on the low rail of curves.

Ordinary Break

A partial or complete break in which there is no sign of a fissure, and in which none of the other defects described are found.

Corrosion

Corrosion is the decaying or corroding of the metal on the web or base of the rail which results in irregular pits or cavities.

Corrosion, as a rule, occurs in wet or damp areas such as tunnels or in hi-rail access and is essentially a rusting away of the metal.

Corrosion is usually a slow process which occurs over an extended period of time. However, this process is greatly accelerated by electrolytic action on transits where electricity is the primary means of propulsion.

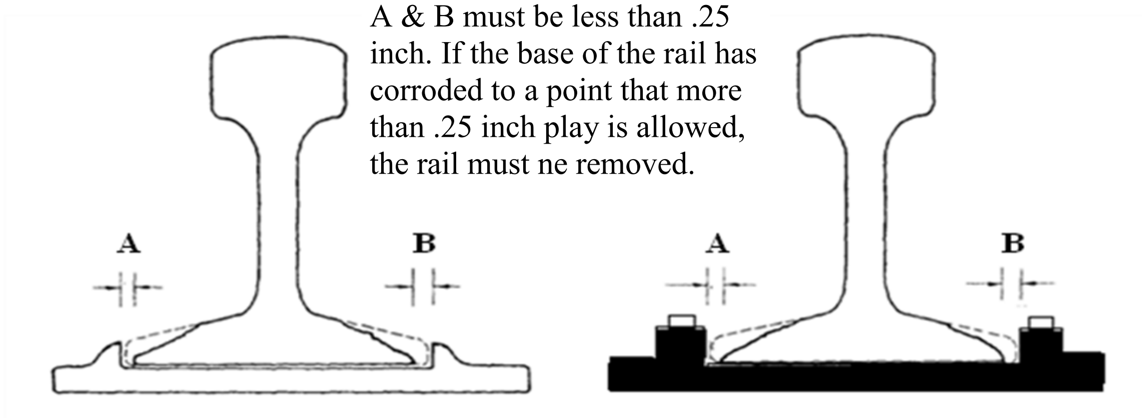
Corrosion can be recognized as pits or cavities on the upper base or web of the rail. Severest corrosion usually occurs underneath the base and is therefore not visible whenever the rail is in place in track, but can be seen by holding a mirror under the rail base and shinning a flashlight into the mirror to reflect up to the bottom of the base.

Faces of the break will have the appearance of a sudden rupture with no progressive transverse defect development such as highly polished growth rings.

- Pits or cavities often one-half inch deep will be evident at failure locations.

Corrosion is potentially dangerous because of the sudden and complete failure through the head, web and base usually occurs whenever the cross sectional area of the rail section is sufficiently weakened by the corrosive action.

Rail Base Corrosion. Rail shall be removed from track if the base is corroded more than 0.25 inch.



Shear Break

A shear break is a longitudinal separation of the rail head as the metal is torn off by mechanical forces.

It is typically associated with inherent conditions in material. A Shear break occurs when the rail is loaded off the center axis and is often associated with gauge problems, severely worn (vertical wear) rail, or off center loads caused by worn rail.

Growth of this defect is usually sudden.

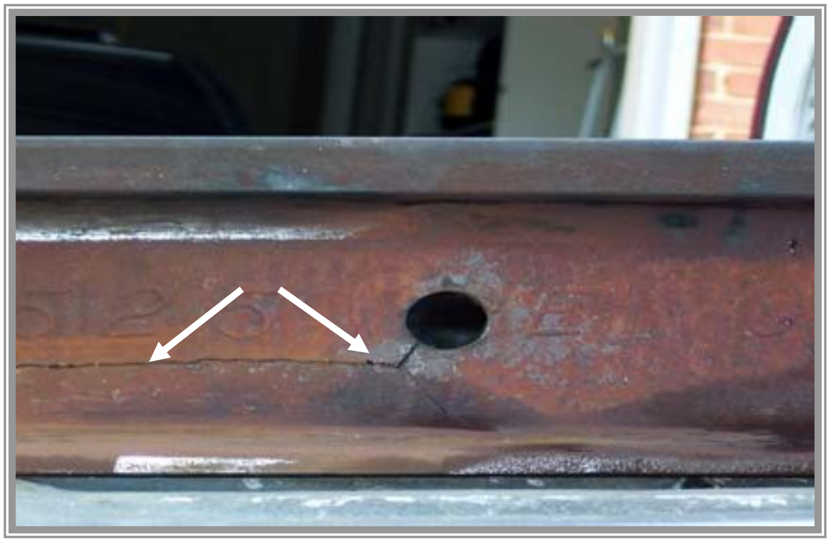
The warning sign for a shear break would be crepe or a stain in the head fillet area similar to that of a crushed head.

Appearance in the rail will be similar to that of a vertical split rail head.

Hazards can be the same as is described for a vertical split head.

Bolt Hole Crack

Is a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward toward the railhead or inclined downward toward the base. Fully developed bolt hole cracks may continue horizontally along the head/web or base/web fillet, or they may progress into and through the head or base to separate a piece of the rail end from the rail. Multiple cracks occurring in one rail end are considered to be a single defect.



However, bolt hole cracks occurring in adjacent rail ends within the same joint must be reported as separate defects.

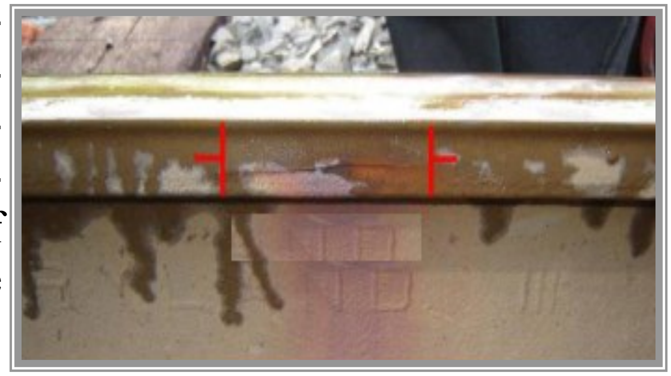
Bolt hole cracks frequently result in a piece of the railhead breaking off within the limits of the joint bars. Occasionally, the cracks may progress beyond the joint bars and cause a complete transverse separation.

A bolt hole defect originates at a bolt hole and usually progresses at an angle.

However, with current high axle loads and special rail steels bolt hole defects can be somewhat perpendicular out of the second and/ or third bolt holes. Bolt hole breaks are also developing on a somewhat horizontal plane particularly with respect to switch point heel joints, frog wing rails, railroad crossing rails, etc.

Horizontal Split Head

Is a horizontal progressive defect originating inside of the railhead, usually one quarter inch or more below the running surface and progressing horizontally in all directions, and generally accompanied by a flat spot on the running surface. The defect appears has a crack lengthwise of the rail when it reaches the side of the railhead.



Internal seams, segregation or inclusions within the railhead cause horizontal split heads. The splits develop longitudinally (lengthwise in the rail) in a horizontal plane. .

Evidence of horizontal split heads is usually visible before failure occurs. In the first stages, a flat spot or dip usually develops on the top of the rail-head. There may be a slight widening of the head.

Split Web

Is a lengthwise clack along the side of the web and extending into or through it. Split webs may be caused by a seam in the web or by external damage. At times, the cracks may bleed, making the defect more evident. If the rail is not replaced, the defect will grow, turning upward and down-ward until a complete break occurs. The growth is usually rapid after the crack extends through the web, and is accelerated by unusual or heavy loading.

The split web is a serious defect because:

- The rail is weakened for the distance of the separation.

Upon service failure, the rail may break into several pieces.

Detail Fracture From Welded Bond Wire Connection

(Traction Power & Signal wire connections)

The detail fracture from a welded bond wire connection is a progressive transverse defect that develops and expands from the point on the railhead where a head bond is attached by welding.

No sign of transverse defect is visible until the separation reached the rail surface and it cracks out.

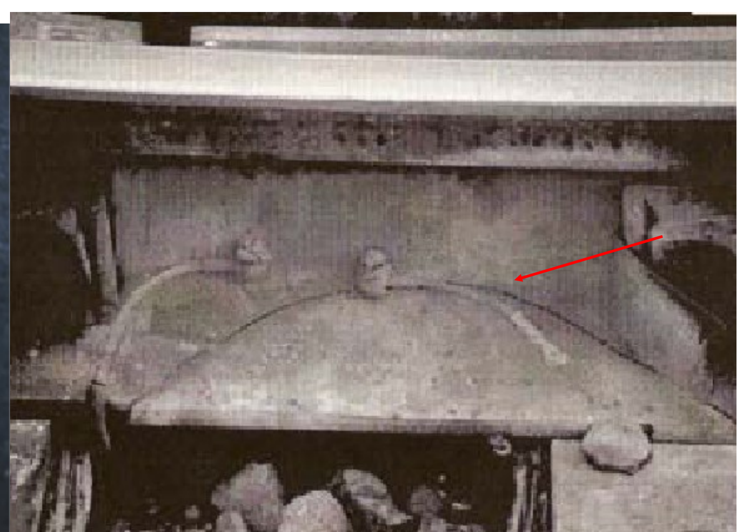
It is questionable whether the primary cause of detail fractures from welded bonds is due to thermal cracks being created by rapid or irregular cooling at or near the point where the bond is attached.

The defect can then be recognized by a hairline crack at right angles to the running surface near the point where a welded bond connection is or has been attached to the railhead.

The detail fracture from a welded bond connection is a dangerous defect because: Service failure results in a complete break through the head, web and base.

Growth is exceptionally rapid once the defect develops

Failure usually occurs before there is any external evidence that a defect is present .



Squats

The squat is a surface defect most commonly associated with high-speed rail and areas of high traction effort. It is characterized as a shallow depression more or less in the center of the rail head on tangent and mildly curved track.

- This depression is the result of subsurface cracking, reduced strength of the material and deposits of debris in that depression, giving it the appearance of a dark spot.

A cross section of the squat shows two cracks, a short leading crack (in the direction of travel) and a much longer trailing crack each propagating at approximately 30° from horizontal.

Because the stress intensity at the tip of the trailing crack is higher than on the leading crack for driving wheels, the trailing crack grows longer and more rapidly in areas of high traction effort.

From the trailing crack, many small branch cracks tend to initiate, one of which may turn downward into the head of the rail and initiate a transverse fracture. These cracks are especially problematic because, shielded by the long trailing crack.

- They are often not detected by conventional ultrasonic measurement systems.

Internal Rail Defects

Detail Fractures

A progressive fracture originating at or near the surface of the railhead. These fractures should not be confused with transverse fissures, or other defects, which have internal origins. Detail fractures may arise from Shelly Spots head checks, or flaking.

Normal Growth Detail Fracture Under Shell

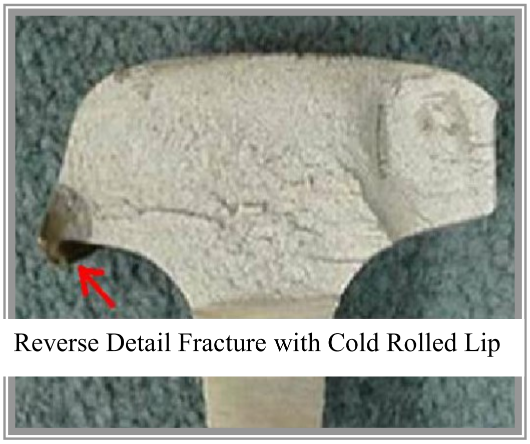
It is possible for a detail fracture to grow quite quickly. Failure often takes place before there is any visual evidence of the defect. Like the fissures, detail fractures lead to a complete transverse break across the entire rail.

The detail fracture from head check is a progressive fracture starting at the gauge corner of the railhead and spreading transversely through the head. It originates in the upper gauge corner of the rail, usually caused by the weight of concentrated loading which deforms the railhead.

The detail fracture from shelling, whether visible or internal, is a progressive fracture starting from a longitudinal separation close to the running surface of the railhead, then turning downward to form a transverse separation substantially at right angles to the running surface. It usually originates from a longitudinal seam or streak near the running surface on the gauge side (field side if the rail has been turned or transposed).

Reverse Detail Fracture

Is a progressive fracture starting at either bottom corner of the rail-head, spreading transversely through the head. The origin is a stress riser on the cold rolled lip on the bottom corner (gauge side or field side of transposed or turned rail) of the railhead and typically associated with severely worn rail and high axle loading.



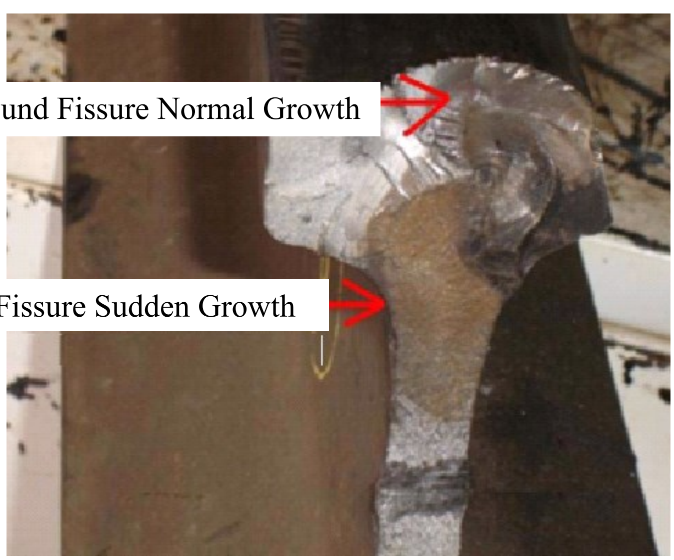
Reverse Detail Fracture with Cold Rolled Lip

The growth is normal to a size of ten percent and is often rapid or sudden prior to complete failure of the rail section. Reverse detail fracture is a dangerous defect because it can occur in several places in the same rail. It can fail completely below a 15 percent size.

Failure typically occurs at 80 percent of the speed at the time of a typical detail fracture. Service failure is a complete break of the rail across head, web and base.

Compound Fissure

A progressive fraction originating in a horizontal split head which turns up or down) in the head of the rail as a smooth, bright, or clerk surface progressing until substantially at a right angle to the length of the rail.



Compound fissures are dangerous for reasons similar to those that apply to the transverse fissure. They can occur at several locations in the same rail. In some cases, there is no visible defect until the rail actually breaks.

Engine Burn Fractures

Is a progressive fracture originating in spots where driving wheels have slipped on top of the railhead. In developing downward, they frequently resemble the compound or even transverse fissure with which they should not be confused or classified. Many surface defects on the railhead similar in appearance to the rail surface remain in track for long periods of time without developing internal defects. The existence of such a surface defect does not necessarily mean that the affected rail should be replaced.

Although failure sometimes takes place before the defect becomes visible, one or more cracks may be visible on the rail surface in the vicinity of an engine burn, prior to failure.

Appearance in Track - No sign of a transverse separation is visible until the defect reaches the rail surface (cracks out).

Piped Rail

Is a vertical split in a rail, usually in the web, due to failure of the shrinkage cavity in the ingot to unite in rolling.

Bulging of the web on either or both sides. Shallow cracks due to distortion may be found in the bulging surface. A slight sinking of the railhead is shown in the area above the pipe.

Transverse Fissure

Is a progressive crosswise fracture starting from a crystalline center or nucleus inside the head from which it spreads outward

as a smooth, bright, or dark, round or oval surface substantially at a right angle to the length of the rail. The distinguishing features of a transverse fissure from other types of fractures verse fissure or defects are the crystalline center or nucleus and the nearly smooth surface of the development which surrounds it.

Mill Defects

Mill defects are deformations, cavities, seams. or foreign material found in the head, web or base of a rail. They occur when the ingot is poured. Slag, gas, or foreign material may be included.

Metal that splashes on the side of an ingot mold may cool and oxidize to some extent before busing with the liquid metal.

Although the defect does not actually grow, it may furnish the point of origin for a transverse or longitudinal separation.

Further development depends on the type of mill defect, its location in the rail, and loading of the rail.

Vertical Split Head

Is a vertical split through or near the middle of the head and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head. Internal segregation, seams or inclusions within the railhead also cause vertical split heads. They usually develop rapidly and lengths up to 10 feet are not unusual.

An experienced inspector can frequently detect a vertical split head in the rail.

At times, widening of the railhead or sagging of one side of the railhead may be noted. When these signs appear, the existence of a vertical split may be further verified by looking under the railhead at the fillets between the head and web. A rust or dark streak or a bleeding crack is further evidence of the presence of such a defect.

(a) A dark streak on the running surface.
(b) Widening of the head for the length of the split. The side of the head to which the split is offset may show signs of sagging or dropping.
(c) The dropping of the head causes a rust streak to appear on the fillet under the head.
(d) In advanced stages, a bleeding crack wills be apparent at the fillet.

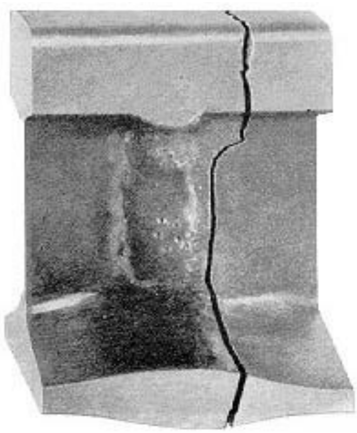
Vertical split heads usually grow to considerable size before such signs are visible. The length of these defects increases the likelihood of severe disintegration of the rail when a piece breaks out of the railhead.

A vertical split head is a dangerous defect because: It is usually not visible on the surface until it has grown to a length of several feet.

If the split is on the gauge side of the rail and breaks off in service, car wheels will tend to climb to the top of the rail or drop between the rails causing a derailment. Upon service failure the rail may break into several pieces

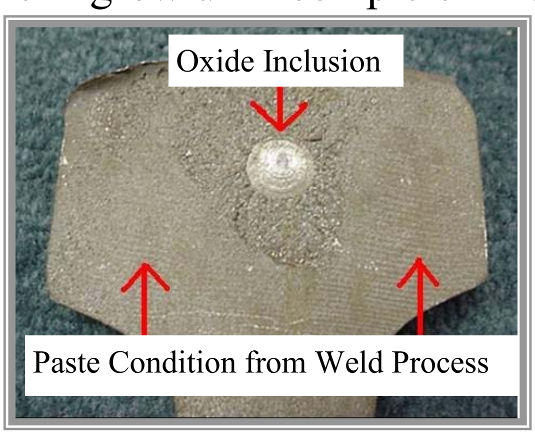
Defective Weld

Is a field or plant (shop) weld containing any discontinuities or



pockets, exceeding 5 percent of the rail head area individually or 10 percent in the aggregate, originated in or near the transverse plane, due to incomplete penetration of the weld metal between the rail ends, lack of fusion between weld and rail end metal, entrainment of slag or sand, under-bead or other shrinkage cracking, or fatigue cracking. Web defects may originate in the rail head, web, or base, and in some cases, cracks may progress from the defect into either or both adjoining rail end.

A defective weld is most frequently a transverse defect, but sometimes, it is a longitudinal or split web type of defect, which can grow until complete failure occurs.



Foreign matter on the faces of the rail ends can cause it at the time of welding, by incomplete fusion during welding or by cracks caused by the heating of the rail during the welding process.

The defect may be in the head, web, or base of the rail.

Rail Stresses

Bending Stress

Bending of the rail that occurs from vertical wheel loading and lateral wheel loading. Vertical wheel loading normally results from loading between the tie supports, and causes tensile longitudinal stresses in the rail base area and head/web fillet area.

Lateral Wheel Loading

Applies tensile longitudinal stresses in the rail web area and head/web area of the rail field side.

Thermal Stress

These stresses occur in continuous welded rails due to thermal expansion and contractions that occur as the actual rail temperature increases above or reduces below the rail neutral temperature. When the rail temperature is above neutral temperature, compressive longitudinal stresses are established. When the rail temperature is below neutral temperature, tensile longitudinal stresses are established. These stresses can drastically influence rail flaw development.

Residual Stress

These stresses are a result of the manufacturing process, particularly from roller straightening and head hardening. They can also result from the welding of rails because of the different expansion and contraction of the steel that occurs during the weld process. Residual stresses can be found in any location within the rail section and can exhibit high tensile stresses that can result in rail failure.

Plastic flow

Plastic flow or mechanical deformation of the rail head can occur on high or low rail, and is normally associated in curves that carry higher axle load operations. Plastic flow is a result of wheel/rail contact stress that is exceeding the material strength of the rail steel.

CWR Inspection

Changes in temperature can greatly affect the integrity of CWR. Typically, significant increases in rail temperature can cause buckling-prone conditions, and significant de-creases in rail temperature can cause pull-apart prone conditions. We cannot quantify the specific temperatures that would cause a buckling-prone condition or a pull-apart prone condition.

MARTA Track Inspection shall—

- Specify the appropriate remedial actions to be taken when buckling prone conditions are found.

When buckled track is suspected slow order track to 25 MPH and monitor every train over the affected area. Notify Rail Service Control Center and Track & Structure Management ASAP.

When buckled track has occurred and the deviation in alignment still falls within Class 1 Track Safety Standards or higher for a 62' chord measurement slow order the affected area to 10 MPH, monitor every train over the affected area. Notify Rail Service Control Center and Track & Structure Management ASAP.

If the buckled track fails to meet even Class 1 Track Safety Standards for alignment using the 31' or 62' chord measurements, take the track out of service and notify Rail Service Control Center and Track & Structure Management ASAP.

Begin setting up an Out of Service Track Restriction following the appropriate Wayside Access Procedures.

Track buckles are usually caused by a combination of four factors:

1) High compressive forces
2) Lowered rail neutral temperature
3) Weakened track conditions
4) Vehicle forces

Particular attention should be given to periods of temperature fluctuations. In the event daily cycles of extreme temperature fluctuations occur, consideration shall be given to repeated inspections.

We cannot quantify the specific temperatures that would cause a buckling-prone condition or a pull-apart prone condition.

Physical track inspections are to be performed to detect pull-a-parts in cold weather or buckled track in hot weather. At a minimum, these procedures shall address inspecting track to identify -

1) Locations where tight or buckling rail conditions are likely to occur;
2) Locations where pull-a-parts are likely to occur;
3) Locations where track work, such as replacing ties, lining & surfacing track etc. have recently been performed.

For the inspection of CWR, the following areas are to be addressed:

Rail

- Canting or tipping of the rail
- Rail crowing the shoulder of the fastening system
- Rail lifting or riding up in the fastening system
- Scrape marks on the rail indicating longitudinal rail movement
- Uneven wear patterns on the rail gauge face or running surface
- Excessive longitudinal rail movement at switch points & stock rails causing misaligned switch points

Rail Joints

- Pull A-parts
- Track bolts that are bent, broken or worn
- Heavily worn fishing surfaces of the rail joint
- Frozen joints (rail end gaps at rail joints that are open when the rail is hot & closed when rail is cold)

Rail Fasteners

- Tearing, lifting or separating of the Direct Fixation fasteners
- Missing rail clips or rail anchors
- Rail anchors that are away from the edge of the tie
- Resilient fasteners that are loose, missing or broken along one side of the rail
- Skewed gauge rods

Crossties

- Skewed ties
- Hanging ties, particularly at approaches to bridges or aerial structures
- Clusters of defective ties or pads
- Skewed gauge rods

Ballast

- Churned (recently disturbed) ballast or displaced ballast
- Gaps in the ballast at the ends or sides of ties
- Bunched up or piled ballast at the ends or sides of ties
- Insufficient ballast shoulders

Track Geometry

- Misalignment, kinks, buckles or flat spots in the track
- Changes in alignment with temperature changes
- Irregular gauge
- Pumping track

Other Areas of Concern

- Track that has recently been worked (lined, surfaced, ties replaced)
- Past derailments, buckled track or flat alignment spot locations
- Steep grades (up hill or down hill)
- Locations subject to heavy acceleration or braking (platforms, speed changes, interlockings)

Curves may shift inward during cold weather even though no work was done. This occurs because the rail temperature is lower than the rail neutral temperature, placing the rail in tension as in a pull-a-part. This condition can be identified by ties pulling inward, leaving a gap in the ballast on the high side of the curve or a flat spot in the alignment in that curve.

Pay close attention in cold weather to announcements by RSCC or YTS of a track circuit being down. This may indicate a broken rail or a pull-a-part in that area. Investigate immediately.

Longitudinal Rail Stresses from Trains In addition to the longitudinal stresses induced by changes in rail temperature, trains can generate huge longitudinal forces. When trains accelerate or brake the momentum of the train is translated into longitudinal forces in the rail. These forces can be very high. For rail transit systems the affects of these forces can be compounded since trains stops and starts occur nearly at the same locations, in the same directions with every train. Locations such as stations, speed changes and interlockings are particularly impacted. Automatic Train Control systems (ATC) further exasperate these effects, since it will automatically brake and accelerate all trains at exactly the same locations, every time: whereas with manually controlled trains each train operator will brake/accelerate trains in different locations and rates.

Longitudinal Rail Restraint This section discusses the large forces that can be generated in CWR. When CWR is in the track these forces are offset with four restraints: pad or rail seat friction, joint bar restraint, fastening system and ballast.

At properly maintained rail joints the longitudinal restrain of the rail is approximately equal to the clamping force of each bolt. A properly torque bolt provides about 25,000 pounds of restraining force. For a rail joint with 4 bolts installed, this equates to 100,000 pounds of restraining force: (150,000 pounds for 6-hole joint bars) The key point is a "properly maintained" rail joint. Loose rail joints do not provide as much restrain as is possible with tight rail bolts.

The fastening system provides the primary resistance to longitudinal rail forces and movement. The Pandrol rail anchor / fastening system can provide significant longitudinal restraint, if properly maintained. Loose or missing Pandrol clips can greatly reduce restraining capacity.

With many resilient fasteners the rail alignment and longitudinal restrain are combined. The longitudinal restrain capacity of a well maintained fastening system is approximately 5,000 pounds per tie or fastener.

Rail should be maintained at proper thermal adjustment, regardless of the type of track construction. Sudden failure of the fastening system can occur if the rail is not properly adjusted.

The high forces will also be transferred to the structure, causing permanent damage. Sun-kinks and pull-a-parts can also occur on these track, the results are usually take more resources to repair, with symptoms such as loss of gauge and failed DF fasteners.

On ballasted track the longitudinal forces from the thermal rail expansion and contraction are transmitted from the rail fastening system to the ties. The ties then transmit these loads to the ballast. At times this can cause the rail can lift the ties out of the road bed.

Well maintained ballast with well maintain fastening system provide approximately 1,300 pounds per anchored tie. This can be significantly reduced if there is insufficient ballast, the ballast is not well compacted, ballast that has poor interlocking properties is used, or if the track is not firmly tamped.

- With fouled or dirty ballast water can make a very slippery surface for the ties to sit in allowing them to move laterally.

Neutral Rail Temperature

Neutral rail temperature is the rail temperature at which the rail is not in compression. Initially, it is the rail temperature which the rail was laid. At MARTA that temperature is 90° outside of tunnels, 60° inside of the tunnels and 75° under the rail stations canopy.

Measuring the Stress Free Rail Temperature (SFT)

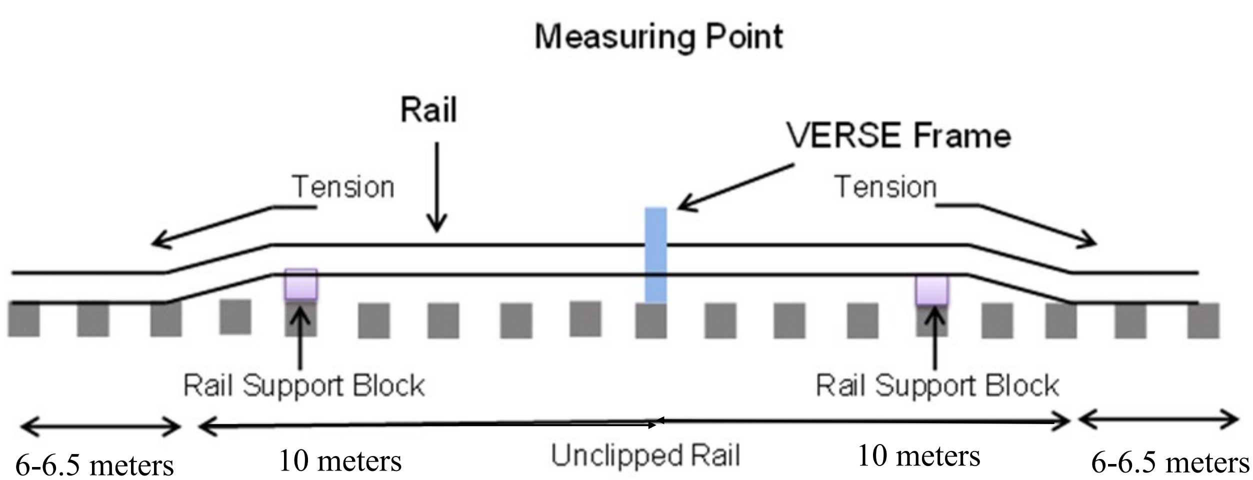
VERSE (Vertical Rail Stiffness Equipment) is a system for measuring the stress free temperature (SFT) of continuous welded rails (CWR). The system is based on the principle that the vertical force required to lift a rail varies with the axial force contained within the rail due to stressing.

The VERSE equipment consists of a portable loading frame, which is positioned over the rail to be measured. An upward vertical force is applied to the rail via the system hydraulics. Transducers are used to measure the applied force with respect to the vertical displacement of the rail.

This data is stored in a small hand held computer, which, along with a signal conditioning system, powers the transducers, captures their output signals and calculates the SFT to the nearest whole °F. VERSE SFT results are based on calculating the axial force in the rail from the measured load and displacement data.

The VERSE system is supplied with a Radix FW900 hand-held computer. Each of the data files recorded from the VERSE measurements are held in the Data directory. The files are recorded in numerical order and will remain on the Radix until they are deleted.

This equipment will be used on an as needed bases.



Thermite Welds

An initial inspection to the Thermite Weld shall be conducted. If an ultrasonic inspection cannot be performed immediately after the weld is made, a 25 mph slow order will be placed for 24 hours after which the weld will be visually inspected by a qualified person prior to lifting the slow order.

Weld Straps

At MARTA we apply standard Weld Straps to thermite type field welds. These straps do not provide the same support as do joint bar. They would provide only limited support if a weld were to break under a train movement or thermal stresses. Weld Straps do not comply with the provisions in the section on Rail Joints and are not to be used as standard joint bars.

Rail Base Corrosion

CONDITION	GREEN	YELLOW	RED
Corrosion - Rail Base	1/8 inch or less	3/16 inch to 1/4 inch	Greater than 1/4 inch [a],[b]

[a] Perform a visual inspect after each train passes over defective rail.

[b] Replace rail

Rail Wear (Gauge Face and Vertical Head 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 Personnel. All locations with excessive rail wear should be reported and brought to the attention of Track Supervisory Personnel for verification. The table below shows the MARTA Standards.

Size of Rail	Condition Setting	Gauge Face Wear in Inches	Vertical head Wear in Inches	Gauge Face Angle in Degrees
115-RE	GREEN	0” to .44”	0” to .06”	0.0° to 20°
115-RE	YELLOW	.50” to .56”	.13 “ to .25”	20° to 26°
115-RE	RED	.63’ & over	.31” & over	>26°

Expansion Rail Joint

Whenever inspecting sliding joints, several areas of joint evaluation must be performed. The sliding joint must be inspected for any loose bolts, loose hold-down devices (spikes, screws, elastic fasteners, etc. Check the sliding rail to ensure it has been properly lubricated and is indeed moving.

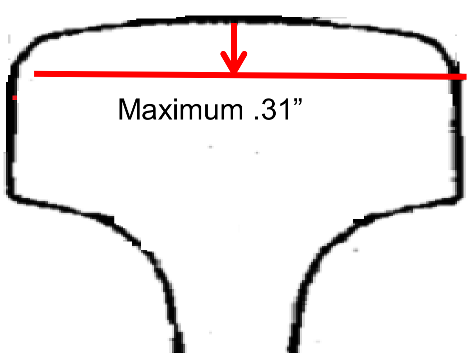
Measuring Rail Wear

Rail gauge face wear and head vertical wear shall be measured at the gauge line as defined herein. Vertical wear shall be measured along the centerline of the rail head. Mark in the rail where each measurement is taken. Take measurements as directed by the Foreperson or every 10 feet in a curve. That would be every 4 ties or pads.

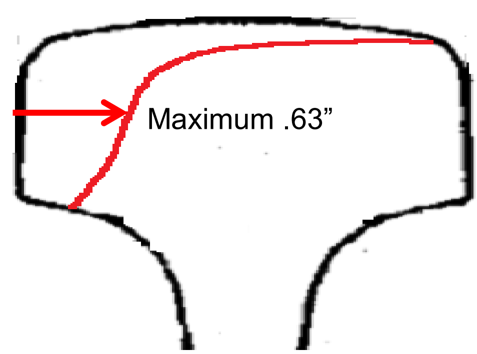
This inspection should be performed by a qualified Track Walker, using the appropriate measurement tool (Rail wear gauge for 115 RE rail). At a minimum, this inspection should include inspection of rail wear, rail surface condition, and rail end condition.

Integrated rail inspection measurements should be performed every 12 months on main tracks and as required in the Rail Yards.

In the case of rail wear, all locations that exceed any of the criterions defined should be recorded.



Vertical Wear



Gauge Face Wear

Rail Wear Measurement Tool (See Exhibit)

Rail wear measurements will be taken using the Rail Wear Gauge. This gauge is designed to be carried by an inspector, and manually applied to the rail, to take both railhead and side wear measurements.

The Rail Wear Gauge is used by inserting the gauge against the web of the rail, with the curved inside portions of the handle fitting into and against the bottom fillet and the rail web. The measuring gauge is then pushed tight to the rail at two locations, to measure the head wear and the gauge face wear.

All measurements for rail wear should be recorded so that wear rates can be documented.

Rail End and Weld Batter

Any excessively battered rail ends or welds should be noted and recorded. Batter must be measured with a 36" straight edge and taper gauge. All measurements should be recorded.

Class of Track	Operating Speed	Tread Batter	Weld Batter
Class 1	15 mph or less	.50 inches [a]	.38 inches [b]
Class 2	16 to 30 mph	.25 inches	.25 inches
Class 3	31 to 60 mph	.19 inches	.19 inches
Class 4	61 to 80 mph	.13 inches	.13 inches

[a] Repair by welding and grinding or replace the rail
[b] Supervise operations over defective weld until rail is replaced.

Rail Joint Standards

Inspect all rail joints for loose or missing bolts. **At least two (2) sound, tight bolts must be in each rail of each joint.** If there is at least one, but less than two good bolts in either rail, then a **25 M.P.H. slow order** must be placed in effect and Track and Structures Supervisory Personnel notified immediately. If there is not at least one good bolt in either rail, the track must be removed from service immediately. Insulated joints should be inspected and cleaned if necessary.

Also advise of any overflow of the rail ends at a insulated joint, as this could short out a train control circuit. If found report ASAP.

Rail End Mismatch (See Exhibit)

Any mismatch at the rail joint may not be more than….

Class of Track	Tread of the rail ends	Action	Gauge side of the rail head	Action
Class 1	.25 inch	15 mph	.25 inch	15 mph
Class 2	.25 inch	25 mph	.19 inch	Notify ASAP
Class 3	.19 inch	Notify ASAP	.19 inch	Notify ASAP
Class 4	.13 inch	Note & Record	.13 inch	Note & Record

Direction. Use a straightedge to determine the mismatch by holding the straightedge longitudinally along the railhead (tread) or along the gauge side (.63 inch down from the running surface) of the rail. Measure the distance directly between the straightedge and the rail.

One example of mismatch occurs when a section of a rail is placed in the track where the existing railhead is gauge and/or tread worn.

Mismatch can also occur when the joint bars are loose. Tighten joint bolts if loose. However, if unable to tighten and the loose bars do not result in mismatch exceeding the thresholds under this section, report the defect as loose joint bars and repair A.S.A.P.

A mismatch may result in high impact forces especially at higher speeds. If a mismatch in excess of the allowable results in significant rail end damage, re-classifying of track should be considered. Particular attention should be given to the mismatch on the gauge side of a rail. A thin flange, skewed truck, or combination of both may cause a wheel to climb, particularly on the outer rail of a curve.

<u>Rail Joint Gap</u>: Any gap over .38" should be noted. <u>Any gap over .63" notify ASAP. (Especially in cold weather)</u>. Look for any signs of bent or broken bolts within the rail joint.

<u>Rail Joint and Weld Stagger:</u> Bolted joints, bonded joints, field welds, and shop welds must meet the minimum distances listed in the table below. **If they fail to meet minimum distances, add to inspection report and notify Track Supervisory Personnel ASAP.**

Same Rail Measurements

	Bolted Joint	Bonded Joint	Field Weld	Shop Weld
Bolted Joint	14' 0"	14' 0"	14' 0"	14' 0"
Bonded Joint	14' 0"	14' 0"	14' 0"	36"
Field Weld	14' 0"	14' 0"	14' 0"	14' 0"
Shop Weld	36"	36"	14' 0"	N/A

Opposite Rail Measurements

	Bolted Joint	Bonded Joint	Field Weld	Shop Weld
Bolted Joint	10' 0"	14' 0"	10' 0"	AMAP*
Bonded Joint	AMAP*	AMAP*	10' 0"	AMAP*
Field Weld	10' 0"	10' 0"	10' 0"	AMAP*
Shop Weld	AMAP*	AMAP*	AMAP*	AMAP*

***As Much As Possible**

<u>Rail Joints.</u>

1. If a joint bar is cracked or broken between the middle two bolt holes or because of wear allows excessive vertical movement of either rail when all bolts are tight, it shall be replaced.
2. In continuous welded rail track, each rail shall be bolted with at least two bolts at each rail of a rail joint

3. Each joint bar shall be held in position by track or huck bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations. (joint bars should be lubricated when the joint is made)
4. No rail shall have a rail or bolt hole which is torch cut.
5. No joint bar shall be reconfigured by torch cutting in any Class of track.

Here are conditions of actual or potential joint failure. These conditions include, at a minimum, the following items:

(i) Loose, bent, or missing rail joint bolts;

(ii) Rail end batter or mismatch that contributes to instability of the joint; and

(iii) Evidence of excessive longitudinal rail movement in or near the joint, including, but not limited to, wide rail end gap, defective joint bolts, disturbed ballast, surface deviations, gap between tie plates or pad and the rail, or displaced rail anchors within the Yard tracks.

Rail Joint - Pull A-Part

Definition: When two sections of rail separate (pull a-part) at a point where they are joined. Rail shrinks in extremely cold weather. When the shrinkage pressure gets too severe, rail will Pull - A-Part at its weakest point, breaking the bolts at a rail joint or at any rail defect.

Action: If it is determined by a Qualified Person to continue train operations, the person making the decision must not leave the scene until the condition is protected, they are relieved or until the Pull-A-Part is repaired.

When, in the judgment of a Qualified Person, that it is safe to do so, **"walking"** trains over such a condition is allowed.

Each train shall be stopped short of the Pull-A-Part and a Qualified Person on the ground shall communicate the situation to the train operator.

Movements shall be made at **“Restricted Speed with Extreme Caution”;** that is, proceeding no faster than 5 to 10 mph dependent upon conditions. The Qualified Person on the ground will constantly monitor the movement of each train over the Pull-A-Part and be prepared to stop the train at any time that it is determined to be unsafe to continue.

Joint Bars on Defective Rails

Where appropriate, when applying joint bars to rail defects the following actions shall be taken:

1. Bolts shall be applied to the defective rail through the two outermost holes.
2. The minimum number of bolt that would be used for a rail joint at that same location as prescribed herein shall be used.
3. Care shall be taken not to drill bolt holes through the rail through the location of the defect.
4. At welds, if joint bars are used to protect rail defects, precautions shall be taken to ensure that the joint bars properly fit the rail. Either special rail joint bars specifically designed for that rail section and for use at weld locations or grinding the weld up set metal shall be used.

- Field modified, torch cut weld straps protective bars shall not be used and,

5. If a rail defect is found in the wing or heel rails of a frog, the existence of two sound, tight frog bolts on both sides of the defect may be considered the same as joint bars.

- See Remedial Action table for limits and restrictions.

Cracked or Broken Joint Bars

If a joint bar is cracked or broken between the middle two bolt holes or because of wear allows excessive vertical movement of either rail when all bolts are tight, the rail joint bars shall be replaced. Operations over that rail joint location shall not exceed 15 mph until repairs are made. Each movement over the rail joint must be monitored by a Qualified Person.

Operations shall not be permitted over any location where both rail joint bars are broken between the two middle bolt holes except under the flagging instructions of a Qualified Person. The Qualified Person will inspect the rail joint after each passing train to determine if train operations over that rail joint can continue. Operating speed over the rail joint must not exceed 10 mph.

Rail Joint Bolts

Maintenance standards require each joint to be huck bolted or track bolted with at least two bolts in each rail tightened so that the lock washers are completely compressed.

(1) All bolts shall be of proper size and tightly in place.

(2) Bolts shall be installed with AREMA spring washers. Nuts shall be installed against the spring washer. At least one full bolt thread shall extend past the outside of the nut.

(3)Bolts shall be installed so the nuts will run alternately on the inside and outside of the rail.

(4)Whenever bolts and joint bars are removed, the rail in the joint area and the contact surfaces of the joint bar shall be cleaned (wire brushed) and lubrication applied to the joint bar and the bolt threads. New joint bars and bolts shall be lubricated before installation.

(5)Safety standards require a restriction if all bolts are loose or if there is only one bolt through a rail. No operations are permitted over locations where all bolts in one rail are missing or ineffective.

Loose and Missing Bolts

(1) Maintenance standards require loose bolts to be tightened approximately 400 foot-pounds) during the next maintenance activity. Bolts that cannot be tightened shall be replaced.

(2) Maintenance standards require that missing bolts be replaced.

Inspection and Care of Manganese Expansion Joints (YA track)

The Manganese Joint should be closely inspected with regard to the metal flow that normally takes place under traffic. Manganese work hardens by plastic flow of the metal while graining structure under rolling wheel loads and impacts, therefore, regular inspections should be made to determine the amount of flow that is taking place in the top surfaces of the manganese.

- This flow or deformation results in a ridge forming on the gauge line side of the Manganese expansion joint.

This flow or deformation of the manganese expansion joint will be slowed as the hardness of the top surface increases by cold rolling under traffic.

The formation of this overflow, to some extent, closes or narrows the flange -ways opening. Should this overflow be allowed to form to its maximum, it is often the cause of failure. The overflow becomes exceedingly hard and chipping will often result due to action of or contact with the wheel flanges

When the overflow starts to form on the running line, it should be removed by grinding. This grinding will have to be performed a number of times, or until the top surface of the joints has reached the maximum hardness, and flowing has been slowed or stopped.

The grinding shall be confined to the top edges, where overflow has formed. No grinding should be done on the top surface, other than that necessary to correct a mismatch condition. A radius of .63" should be ground on the running line. No sharp edges should be left, as these become very hard and brittle when subjected to wheel loads.

- Thus, they become very susceptible to cracking, or chipping.

When cracks of any nature are first noted, a thorough inspection should be made as to the maintenance conditions that exist. Improper maintenance may not be the cause of a crack, but can have some bearing on future development. Any flexing of manganese joint, due to improper line, gauge, and surface or loose bolts can result in cracks developing at a faster rate.

The sliding joint must be inspected for any loose bolts, loose hold-down devices (anchors, screws, elastic fasteners, etc. Check the sliding rail to ensure it has been properly lubricated and is indeed moving.

Track Surface (Profile) Condition Descriptions

Track Surface (in inches) Condition Description	Class of Track				
	Chord Length	15 mph or less	16 to 30 mph	31 to 60 mph	61 to 80 mph
Deviation from uniform profile on either rail at the mid-ordinate of a…	31 ft.	1.00”	.75”	.50”	.38”
Deviation from uniform profile on either rail at the mid-ordinate of a…	62 ft.	2.25”	2.25”	1.75”	1.25”
Deviation from zero X-level at any point on tangent or reverse X-level elevation on curves may not be more than…		3”	2”	1.75”	1.25”
The difference in X-level between any two points less than 62 feet apart may not be more than….		2”	1.75”	1.50”	1.25”
Deviation from constant X-level…		3.00”	2.00”	1.75”	1.25”
Deviation from desired elevation on the spiral may not be more than…		2.00”	1.75”	1.50”	1.00”
Variation in X-level in a spiral between any two points may not be more than…	31 ft.	2.00”	1.75”	1.25”	1.00”
Variation in X-level in a spiral between any two points may not be more than…	62 ft.	3.00”	2.25”	2.00”	1.75”

Note: Either a 31’ or 62’ chord length or distance may be designated to be used. However the same chord length shall be exclusively used when applying this table.

Standards for Track Geometry

Crosslevel

Crosslevel is the difference in height between the two rails of the track at points directly opposite each other.

Design crosslevel on tangent **(straight)** track and in all turnouts and platforms is zero (0) inches.

In curves the outer rail is higher than the inner rail. This difference in height is known as "**superelevation**".

- Can range up to six (6) inches in curved track.
- See exhibit.

The superelevation is indicated in the curve table of the System Track Charts or on metal tags, which are affixed to the ties or direct fixation concrete throughout the spiral.

- The tags cease once full elevation is achieved.
- Increases or decreases in elevation are in increments of .25".
- See exhibit.

Crosslevel is checked with a track level when there is evidence of excessive deviation from normal.

Crosslevel defects can be readily identified by riding a train through the area and will be felt as a gentle **"rolling"** or **"swaying"** motion.

Once the amount of deviation is measured, refer to the MARTA Track Safety Standards for Track Surface (Profile) for appropriate action.

Consistent crosslevel is crosslevel that doesn't change or vary by much. It's crosslevel that stays close to a constant measurement.

Profile (Track Surface)

Surface or profile describes the horizontal smoothness of the track. Deviations from the desired condition can be observed by sighting the length of the rail with one's eye parallel to the top of the rail.

Track Surface describes the evenness or uniformity of the track in short distances measured along the tread of the rails.

The most common Surface deviation is a Dip (low spot) in the track**.** See exhibit on how to measure Dips & Humps.

Some minor deviation is normal. If the deviation appears abnormal **(more than 1 inch)** the area should be checked using a **31' or 62' chord** and accepted stringline methods in conjunction with a standard crosslevel. **"Flat"** track (tangent track) should read zero inches.

Suspect areas can usually be confirmed by riding a train over the area and noting the ride quality. Refer to these MARTA Track Safety Standards for appropriate action once the amount of the deviation is determined.

Elevation in Curves

Not all curves have elevation. Refer to the System Track Charts for necessary information on any particular curve or in the section in the back of this book for limited information pertaining to curves. (Curves equal to or less than 2° or Curves greater than 2°.

Trains traveling around a curve are subjected to an outward horizontal centrifugal force that acts conceptually through a car's center of gravity away from the center of the curve and tends to overturn the cars by directing the train weight toward the outside rail. Elevation helps to counter those forces.

For modern rail cars with a high center of gravity (90 to 98 inches) low speed curve negotiations under excessive levels of superelevation place the vehicle in an increase state of overbalance.

This condition creates the possibility of wheel unloading and subsequent wheel-climb when warp conditions are encountered within the curve.

- In other words, the wheel looses contact with the rail.

To counteract the centrifugal force, the outer rail is raised over the lower rail, or super-elevated. In effect, the combined effect of centrifugal force and weight produces a resultant force that is intentionally moved toward the center of the track.

- A balanced condition implies the vertical forces on each rail are equal.

In practice, transits generally do not operate trains at balanced speed: that is, train speeds are set to move the resultant force toward the outer rail, resulting in an unbalance typically less than three or four inches. MARTA trains have a four inch underbalanced.

- Unbalance or cant deficiency is the amount of elevation that would have to be added to the existing elevation to achieve a balanced condition.

For Classes 1- 4 limit the amount of unbalance to four (4) inches. (Such as our rail cars) Safe curving speeds are dependent on the engineering characteristics of the specific equipment involved, as well as the track conditions.

- Equipment factors such as the height of center of gravity, suspension characteristics, reaction to wind and other factors are considered.

SUPERELEVATION

a. Definition

Superelevation is the intended increase in elevation of the outer rail above the inner or low rail in a curve.

b. Reverse Superelevation

Safety standards require a restriction if the outside rail of a curve is lower than the inside rail by more than 0.5 inch. Maintenance standards require the outside rail of a curve to be at the same elevation or above the inside rail.

c. Maximum Superelevation

The outside rail of a curve may not be more than 6 inches higher than the inside rail.

d. Uniform Superelevation

If a curve is superelevated, the superelevation shall be uniform throughout the body of the curve.

Super-Elevation - Runoff

Super-elevation runoff shall be at a uniform rate, within the limits of track surface deviation prescribed in the MARTA Track Safety Standards. Super-elevation runoff shall extend the full length of the spirals **(TS to SC or CS to ST).** Because the super-elevation is runoff within the spirals, the minimum super-elevation in the curve shall be used to calculate the maximum operating speed.

Direction. Track surface is the evenness or uniformity of track in short distances measured along the tread (top) of the rails.

Under load, the track structure gradually deteriorates due to dynamic and mechanical wear effects of passing trains. Improper drainage, unstable roadbed, inadequate tamping, and deferred maintenance can create surface irregularities.

Superelevation runoff shall be at a uniform rate and shall extend at least the full length of the spiral. If no spiral is present, the superelevation runoff shall be accomplished on the tangent track. Safety standards require a restriction if the superelevation runoff exceeds 1.50 inches in any 31 feet of rail.

Track surface irregularities can lead to serious consequences if ignored.

- Premature deterioration of the roadbed, ballast, ties, rail and fastening system. Even train derailments can occur.

A Superelevation Runoff is the difference in elevation between tangent track and the body of the curve or between the body of the curve and tangent track..

Allowable deviations in track surface include runoff at the beginning and end of a raise, deviation from uniform profile, deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves, and the difference in crosslevel between any two points less than 62 feet apart, are specified in the track surface table. In addition, the table includes footnotes that address three special circumstances.

Run-off from Track Surfacing

The first parameter in the table in this section refers to the runoff (ramp) in any 31 foot segment at the end of a raise where the track is elevated as a result of automatic or manual surfacing or bridge work.

As in the more general profile parameter, damage to car components, undesirable brake applications or derailments may occur; especially when the vehicle experiences a lateral force such as a buff force. Look for the drawing that illustrates how to measure the runoff on newly raised track. See chart below for minimum Runoff for the height of the Surface raise.

Surface Raise	Minimum Length of Runoff	Runoff Length in Ties
.25” to 1.50”	31 foot runoff	13 ties*
1.75” to 3.00”	62 foot runoff	23 ties*
3.25” to 4.50”	93 foot runoff	38 ties*
4.75” to 6.00”	124 foot runoff	50 ties*

*Number of ties are rounded to the nearest whole number

Elevation of Curved Track; (run-off)

1. If a curve is elevated, the full elevation must be provided throughout the curve, unless physical conditions do not permit.
   - If elevation occurs in a curve, the actual minimum elevation must be used in computing the maximum allowable operating speed for that curve.

2. Elevation must be at a uniform rate. Within the limits of track surface deviation (Track Surface) and it must extend at least the full length of the spirals.
   - If physical conditions do not permit a spiral long enough to accommodate the minimum length of runoff, part of the run-off may be on tangent track.

Items to consider with respect to runoff include the following:
If elevation begins within the body of the curve rather than at the point of curve-spiral, the least average elevation that exists in the body of the curve will govern the allowable operating maximum speed throughout the full curve.

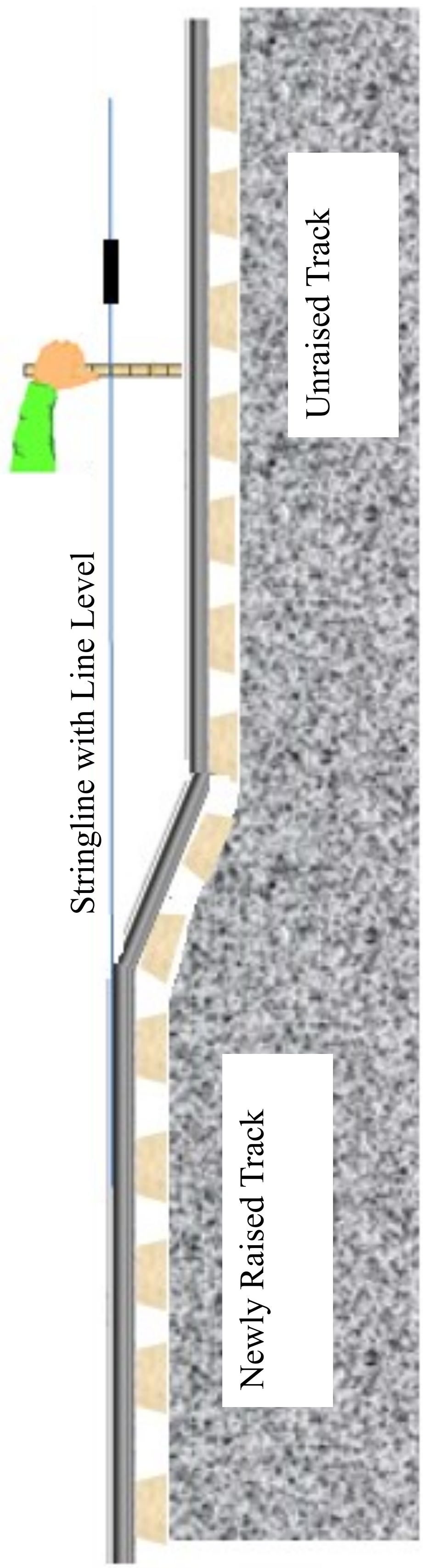
Elevation at the end of curves, or between segments of compound curves, must be at a uniform rate within the limits of track surface deviations prescribed in the table under Track Surface.

Particular attention must be given to the prescribed limits for difference in crosslevel between any two points less than 31 or 62 feet apart on spirals.

If physical conditions do not permit a spiral long enough to accommodate the minimum length of runoff, the runoff may be carried into the tangent in these circumstances, the surface table parameters under Track Surface will govern.

The actual minimum elevation and actual degree of curvature is determined by MARTA's Engineering Department.

Runoff is measured by taking a 31 foot or longer chord, stretching it out level (using a line level) from the top surface of the running rail and measure from the end of the string down to the top of the rail where the raised track returns to un-raised track.



Parameters for Warp

Maximum Allowable Operating Speed	62 ft. Length Warp in Spirals	31 ft. Length Warp in Spirals	62 ft. Length Warp in Curves & Tangents	31 ft. Length Warp in Curves & Tangents
15	3.00”	2.00”	3.00”	1.50”
20	2.75”	1.88”	2.75”	1.38”
25	2.50”	1.88”	2.50”	1.25”
30	2.25”	1.75”	2.25”	1.13”
35	2.19”	1.69”	2.19”	1.13”
40	2.13”	1.63”	2.13”	1.13”
45	2.13”	1.50”	2.13”	1.13”
50	2.13”	1.38”	2.13”	1.00”
55	2.00”	1.38”	2.00”	1.00”
60	2.00”	1.25”	2.00”	1.00”
65	2.00”	1.25”	2.00”	1.00”
70	1.88”	1.13”	1.75”	1.00”

All measurement greater than the maximum allowed in any chosen column requires that the Track will be **TAKEN OUT OF SERICE**.

Warp

The difference in crosslevel readings between any two points less than 62 feet apart (one rail or both rails) is commonly referred to as the 'Warp". Warp can consist of dips or humps in the track and will need to be measured with a crosslevel. Or warp can be measured between any two points 31 feet.

Direction Track surface is the evenness or uniformity of track in short distances measured along the tread of the rails.

Under load, the track structure gradually deteriorates due to dynamic and mechanical wear effects of passing trains. Improper drainage, unstable roadbed, inadequate tamping, and deferred maintenance can create surface irregularities. Track surface irregularities can lead to serious consequences if ignored.

Allowable deviations in track surface include runoff at the end of a raise, deviation from uniform profile, deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves, and the difference in crosslevel between any two points less than 62 feet apart, is specified in the track surface table.

The first parameter in this section refers to the runoff (ramp) in any 31 foot segment at the end of a raise where the track is elevated as a result of automatic or manual surfacing. Conditions created by track degradation (e.g., settlement or frost heaves) are to be addressed using the uniform profile parameter, under this section.

Trains encountering a ramp (up or down) will experience a vertical pitch or bounce if the change in elevation occurs in too short a distance.

The second parameter, profile, relates to the elevation of either rail along the track. When trains encounter short dips or humps in the track it can result in vertical separation of couplers, broken springs, bolsters, truck frames or tossing passengers in the train.

Dips can result from mud spots, rail joints or develop at the ends of fixed structures (e.g., bridges, hi-rail accesses, and transitions & aerial structures). Profile is determined by placing the mid -point of a 62-foot chord at the point of maximum measurement, irrespective of vertical curves. Profile may also be a track '**hump"** cause by a frost heave or other occurrence such as poor maintenance. The drawing in the exhibits illustrates the measurement of profile conditions.

Measuring Track.

When unloaded track is measured to determine compliance with requirements of this part, the amount of rail movement, if any, that occurs while the track is loaded (under train load) must be added to the measurement of the unloaded (static) track making it a dynamic measurement.

Examples: Measuring a hump in the track you have the string being held 3 inches above the top of the rail. You stretch the 62 foot stringline chord with the mid-point of the chord above the apex of the hump. Measure from the mid-point down to the top surface of the rail, subtract that number from the 3 inches for the total height of the hump. If the measurement was 1.25 inches you subtract that from 3 inches for a hump height of 1.75 inches. Check that against Surface Standards to see if it is within an allowable Surface deviation for the class of track.

For a dip stretch the stringline across the top of the railhead midpoint of the string at the deepest part of the dip and measure from the string to the railhead for the depth of the dip.

The third parameter refers to the deviation from zero cross-level at a point or reverse crosslevel in a curve. Crosslevel, utilizing a multi-gauge, is measured by subtracting the difference in height between the top surface (tread) of one rail to the tread of the opposite rail.

On tangent track both rails by design should be the same height, a term known as zero crosslevel.

On the spiral or body of a curve, the outer rail may not be lower than inner rail (reverse elevation) beyond the limits provided in the surface table.

- Also consider what implications, if any, V-max may impose at a curve body where reverse elevation is encountered.

This parameter provides maximum change in crosslevel between two points within specific distances along the track.

The warp parameter is, perhaps, the most critical of the surface parameters. Excessive warp contributes to wheel climb derailments. See drawings to illustrates warp measurements.

The threshold values for warp represent minimum safety standards and encompass the full range of rolling stock in present day operating fleets.

Inspectors should be aware that some rolling stock, because of certain design and/or demonstrated performance characteristics, may be subject to additional operating restrictions and/or more restrictive warp thresholds as determined by individual railroads.

The limits for warp, apply anywhere along the track, (curves, spirals, and tangent segments).

When measuring track surface parameters remember the location of the transition points between tangent, spiral, and curve body are determined by actual physical layout and are not assumed to be synonymous with railroad markers, tags, curve charts, or similar information. Therefore, be governed accordingly when applying the footnote or any other track geometry parameter.

This note is included to address the condition where a vehicle is operating on a curve with a large amount of elevation and then encounters a warp condition. Since the vehicle is typically in an unbalanced condition, the warp may induce wheel climb. Slow speed curve negotiation is a particular concern since the wheels on the outside rail of the curve will tend to unload due to the overbalanced condition of the vehicle. Where this condition is found, the appropriate corrective action would be reduction to Class 1 speed.

Twist

Although not included in the FRA Track Safety Standards, twist has been defined as the difference in cross level measurements at the trucks at two ends of a rail car. As the rail car go ever warped track the car will twist slightly. This twisting of the rail car will bind the trucks preventing them from turning as they follow the track.

Where twist is excessive, frictional curving forces cause the trucks to bind and prevent them from rotating under the car to follow spirals and curves. Measurements for twist on curves are covered by the definition and limits for warp in tangents, spirals and curves.

For this track deviation, we take any two cross level reading that are 62’ apart and find the difference between them. When taking these measurements, use the same grade rail for each measurement and mark the readings as either positive or negative in respect to the grade rail.

Measuring Warp on Tangents Track

For this defect type, we must find the maximum difference between any two cross level measurements located within 62' of each other.

That means that when you take a cross level reading at a rough spot, you must check cross level measurements for 62' (62' equals 25 ties or pads) to each side of that initial spot to determine the maximum difference between any two cross level readings within 62' of each other. Remember to use the same grade rail and mark readings as either positive or negative in relation to the grade rail. In the drawing, measurements A is the midpoint in a 62' chord with the largest deviation and C & B are the deviations within 62' on each side.

Measuring Warp within a Curve, find the largest deviation and mark it as point A. Then go 62 feet on each side of the deviation to find any other less severe deviations, they will be marked as points B and C.

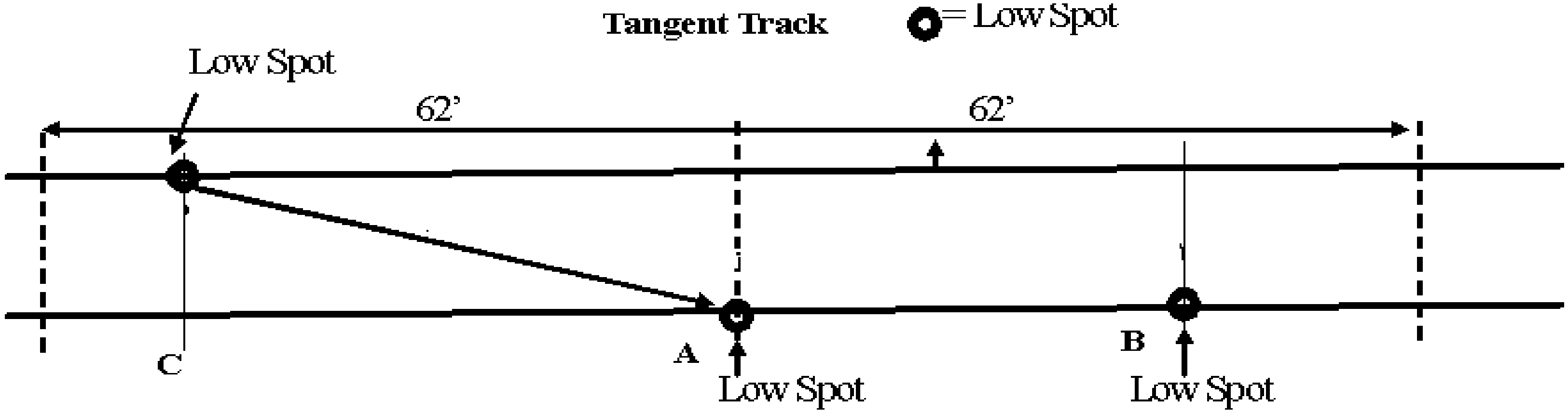
Take crosslevel readings in each side of the deviations to find what the elevation in that area should be. Elevation should be constant throughout the body of the curve. Deviations on the low rail will be larger than the average elevation reading. If at point "A" the elevation (crosslevel) reading should be 5.00" but reads 6.81" you subtract 5.00" from 6.81" for a deviation of 1.81". If point "B" reads 5.25" but should read 5.00" you subtract 5.00" from 5.25" to equal a deviation of .25". For point "C" elevation reading should be 5.00" but reads 4.31". Subtract 4.31" from 5.00" for a deviation of .69".

Now subtract B from A, A - B = 1.56" (same rail measurements you subtract B from A) 1.81 (A) - .25 (B) = 1.56"

Add A + C = a deviation of " (opposite rail low spots are added together). 1.81 (A) + .69 (C) = 2.50"

Now check in the Warp chart to see where the largest deviation (2.50") falls in the speed chart for Warp in a spiral. Chart will determine operating speed according to the largest deviation.

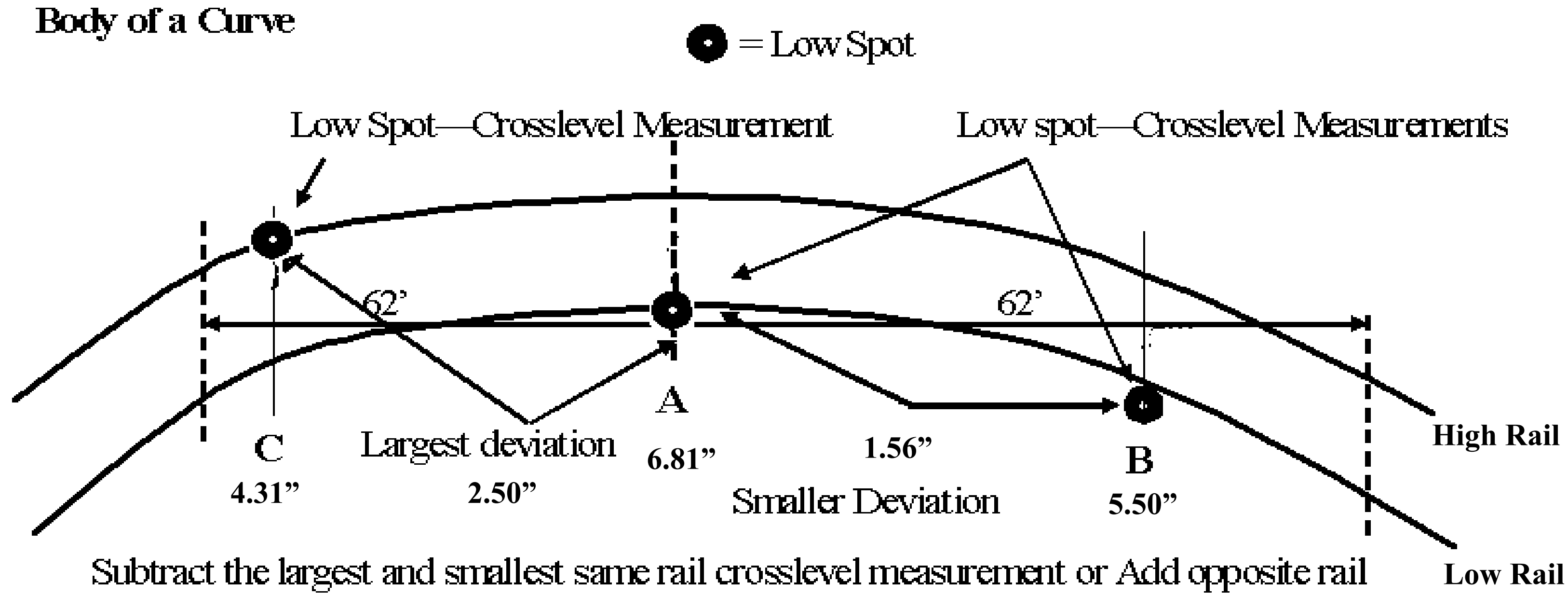
Tangent Track



Add largest two opposite crosslevel readings within 62feet

Subtract same rail measurements. Find the largest deviation between the two then look up that measurement in the Warp Table

Body of a Curve



Subtract the largest and smallest same rail crosslevel measurement or Add opposite rail crosslevel measurements within 62 feet.

Find the largest deviation between the two then look up that measurement in the Warp Table

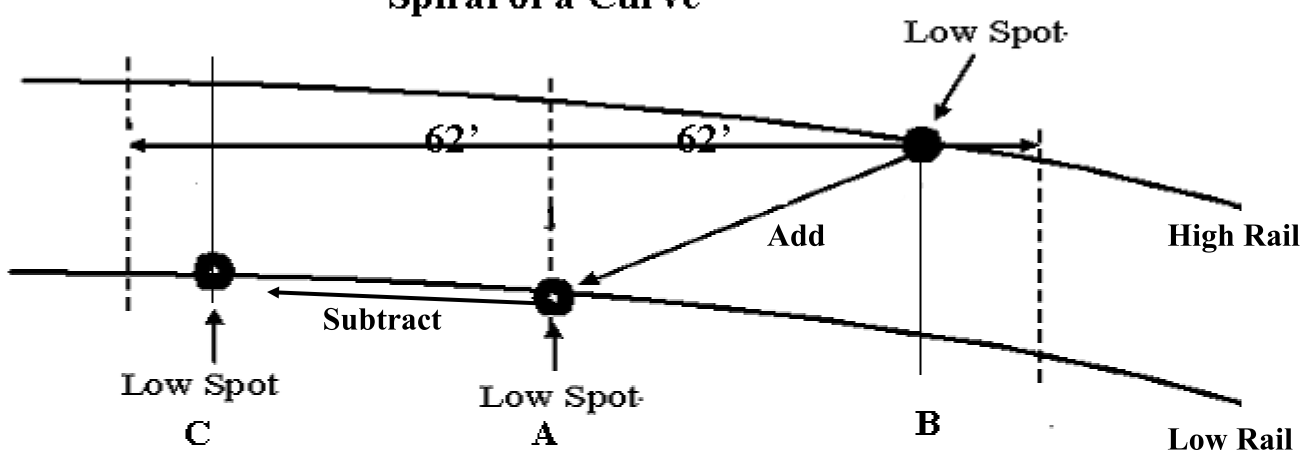
Warp within a Spiral, find the largest deviation and mark it as point A. Then go 62 feet on each side of the deviation to find any other less severe deviations, they will be marked as points B and C.

Take crosslevel readings in each side of the deviations to find what the elevation in that area should be. Deviations on the low rail will be larger than the average elevation reading. If at point "**A**" the elevation (crosslevel) reading should be 3.50" but reads 4.75" you subtract 3.50" from 4.75" for a deviation of 1.25".The deviations on the high rail will be smaller than the average. So if point "B" reads 2.50" and should read 3.75" because the curve continues to increase its spiral you subtract 2.50" from 3.75" to equal 1.25". For point "C" elevation reading should be 3.00" but reads 3.50". Subtract 3.00" from 3.50" for a deviation of .50".

Add A + B = a deviation of 2.50" (opposite rail low spots are added together). 1.25 (A) + 1.25 (B) = 2.50"

Now subtract C from A, 1.25 (A) -.50 (C) = .75" (same rail measurements you subtract C from A) Now check in the Warp chart to see where the largest deviation (2.50") falls in the speed chart for **Warp in a Spiral**. Chart will determine operating speed according to the largest deviation. No change in operating speed is necessary. Operating speeds are good for up to 25 mph. No matter what the warp chart states for operating speed it can never be greater than what the track is rated for.

Spiral of a Curve



Maximum Allowable Deviation from Design Alignment

	Tangent Track	Curved Track	
Class of Track	The deviation of the mid-offset from a 62 foot chord[1] may not be more than…	The deviation of the mid-offset from a 31 foot chord[2] may not be more than…	The deviation of the mid-offset from a 62 foot chord[2] may not be more than…
Class 1 track	3 inches	2.25 inches	3 inches
Class 2 track	2 inches	1.50 inches	2 inches
Class 3 track	1.50 inches	1 inches	1.50 inches
Class 4 track	1.25 inches	.75 inches	1.25 inches

Either rail may be used as the line rail, however, the same rail shall be used for the full length of the tangential segment of track

[1] The ends of the line shall be at a point on the gauge side of the line rail, five-eighths of an inch below the top of the rail head. .

[2] The ends of the chord shall be at a point on the gauge side of the outer rail, five-eighths of an inch below the top of the rail

Alignment

The term Alignment refers to the horizontal position of the track expressed as Tangent (including turnouts and stations), Spirals and Curves.

To observe the alignment condition the Track Walker should stand directly over the top of the rail and sight the rail length. Minor deviation is considered normal, especially in the turnout or curve areas.

If the visual inspection indicates an abnormal deviation the area should be stringlined using a **31 foot chord** in curves and a **62 foot chord** on tangent track and switches to verify the defect.

If using a 62 foot stringline chord the mid-ordinate (middle) point (stringline station) is at 31 feet. (Tangent Track or Switches) If using a 31 foot stringline chord the mid-ordinate (middle) point (stringline station) is at 15.50 feet. (Spirals and Curves)

All stringline measurements are taken in sixteenths of an inch.

Alignment is usually observed as kinks in both rails on Ballasted Track or on one or both rail on Direct Fixation Track. Be careful not to confuse gauge defects **(Wide or tight gauge)** which usually appear in only one rail on Direct Fixation track with kinked or buckled track. Alignment deviation in tangent track is easy to observe, but it is extremely difficult to see deviations in curves. If there is any question about alignment in a curve it is best to stringline the curve.

Defective alignment can be readily observed when riding a train through the area, and will be felt as a jerking side-to-side motion.

Ballasted track to direct fixation track, transitions areas, are known to be particularly prone to surface and alignment defects.

Changes in rail temperature are also known to contribute to the potential for alignment deviations.

Increased focus should be exercised, especially during periods of extremely hot ambient temperatures.

Static Alignment Reading. Measuring track not under load. When unloaded track is measured to determine compliance with requirements of this part, the amount of lateral rail movement, if any, that occurs while the track is loaded is not added to the measurements of the unloaded track.

Dynamic Alignment Reading. When unloaded track is measured to determine compliance with requirements of this part, the amount of lateral rail movement, if any, that occurs while the track is loaded must be added to the measurements of the unloaded track.

Horizontal alignment (line)

Horizontal alignment standards for curved and tangent track are based on the mid-ordinate (mid-chord offset) of a fixed chord length.

- 62 foot for Tangent Track and Switches (mid-ordinate at 31 feet)
- 31 foot for all Curves (mid-ordinate at 15.50 feet)

Measurements will be taken at points on the gauge side of the railhead .63 inch below the crown of the rail. On tangent track the rail that the train operator is seated over, for the normal flow of traffic, will be considered the line rail.

On curves, the outside or high rail shall be used. The deviation from uniformity of the mid-offset from a 31-ft.chord shall conform to that shown on the table for alignment.

Stations and Switches and Turnouts

All station platforms, switches and turnouts are on tangent track. All standards that apply to tangent track for surface and alignment apply to all platforms, switches and turnouts. Only exception is switch 13 in the H. E. Holmes turnback.

Buckled Track

A track buckle is a large lateral misalignment of track. CWR track is susceptible to buckling. Curved and tangent track can both buckle, but most buckles occur on curves. The most sever buckling will occur on tangent track.

Typical Buckles

Track buckles are usually caused by a combination of four factors:

- High compressive forces
- Lowered rail neutral temperature
- Weakened track conditions
- Vehicle forces

When buckled track is suspected slow order track to 25 MPH and monitor every train over the affected area. Notify Rail Service Control Center and Track & Structure Management ASAP.

When buckled track has occurred and the deviation in alignment still falls within Class 1 Track Safety Standards, using a 62' chord measurement, slow order the affected area to 10 MPH, monitor every train over the affected area. Notify Rail Service Control Center and Track & Structure Management.

If the buckled track fails to meet even Class 1 Track Safety Standards for alignment using the 62' chord measurement, take the track out of service and notify Rail Service Control Center and Track & Structure Management.

Begin setting up an Out of Service Track Restriction following the appropriate Wayside Access Procedures.

Lowered Rail Neutral Temperature

Tests have demonstrated that rail neutral temperature changes over time. It varies somewhat with the seasons and often decreases with rail replacement and track maintenance.

The magnitude of compressive forces depends on the difference between rail temperature and neutral temperature. These forces will be higher if the neutral temperature has fallen. Buckling becomes more likely.

Care must be taken to maintain correct neutral temperature. Track which becomes misaligned due to heat indicates that compressive forces were high, probably due to lowered neutral temperature.

- Rails must be cut to relieve the forces. Track must be adjusted to restore correct neutral temperature.

Weakened Track Conditions

Lateral and longitudinal track resistances are indications of how well the ballast, ties and fasteners keep rail in its correct alignment. Resistance is lowered if ballast is missing from under ties, in the crib or on the shoulder. Or pads are missing clips or pad bolts.

A full and well compacted ballast section is important, and special attention is required in curves. Ballast in the cribs and on the high side of a curve resists buckling. The low side is important to prevent inward movement in cold weather which could lead to a buckle when temperatures rise in early Spring.

Resistance is also lowered when ballast is disturbed. Surfacing, lining track and replacing ties will disturb the ballast. The lateral resistance of disturbed track could be as low as 40% of undisturbed track.

Vehicle Loads

A buckle usually begins as a small alignment deviation. Each train expands that deviation. That is why most buckling derailments occur deeper in a train rather than under the led car. Vehicles contribute to buckling by exerting lateral wheel forces in a curve.

Lateral forces can also occur in tangent track from rail car movement caused by line or surface deviations or by truck hunting. The track must be able to absorb this energy.

Heavy, dynamic or independent braking and emergency brake applications can trigger a buckle. Also areas where train speeds change, increase or decrease, can cause problems. It is important to inspect track after a train passes in hot weather, especially if the track has been recently disturbed.

TRACK INSPECTION - ALIGNMENT

You should anticipate where track may buckle. Make additional inspections on days when the ambient temperature increase significantly over previous days temperatures. Track not properly maintained during cold weather may buckle on the first warm Spring day.

Special attention must be given to track in areas such as:

- In a curve.
- In a dip.
- At the bottom of a grade.
- On bridge or aerial structure approaches.
- Recently disturbed or worked track.
- Track worked during the past winter and rail not adjusted and ballast not restored.
- Where rails have been replaced due to detected defects and not properly adjusted.
- Where rail has or is running.

Indications that track is about to buckle:

- New line deviations.
- Wavy or snaky rail alignment.
- Rail rotating or lifting out of tie or pad seat.
- Intermittent loose ties or pad fasteners.

- Rail running.
- Insufficient or missing rail clips.
- Insufficient ballast in cribs and at shoulders.
- Gaps in ballast at ends of ties, especially on the low side of a curve.
- A previous buckle track that has not properly repaired.
- Ballast disturbed around tie.

Although buckled track is more likely to occur in Curves, the most sever buckling will occur on Tangent track.

MEASUREMENT

Track may buckle if it is disturbed at high rail temperatures and trains are operated at normal speeds. The weakened track structure may not be able to absorb normal train forces.

Rail temperature is measured on the shady side of the web of the rail. The thermometer must remain on rail for at least 5 minutes and must be away from any form of artificial cold or heat and out of direct sunlight.

In hot weather, disturbed track must be protected as it needs time and traffic to stabilize after the ballast section has been restored.

Curves may shift inward during cold weather even though no work was done. This occurs because the rail temperature is lower than the rail neutral temperature, placing the rail in tension as in a pull-apart.

This condition can be identified by ties pulling inward, leaving a gap in the ballast on the high side of the curve.

If such a condition is found, report it to the Track & Structures Supervisor ASAP so remedial action can be taken.

Track Gauge

Class of Track	Standard Track Gauge	Minimum Track Gauge	Maximum Track Gauge
Class 1 track	56.50”	56.00”	57.75”
Class 2 track	56.50”	56.00”	57.75”
Class 3 track	56.50”	56.06”	57.50”
Class 4 track	56.50”	56.13”	57.25”

Gauge is the distance between the two rails of track at points directly opposite each other and measured .63 inches below the top of the rail head. Gauge measurements should be made and recorded in suspect areas.

Unusual rail wear can be an indication of tight gauge or misaligned track. Unusual rail wheel tread pattern on top of the rail can indicate wide or tight gauge. Rub marks on the field side of ties or concrete second pour made by pads or plates is an indication that there is lateral movement of the pads, plates and rail.

Evidence of fastener movement is another sign of potential gauge deviation. It is very important to understand that there are two types of gauge readings.

The normal gauge reading is a **“static”,** or unloaded reading. The second case is a **“dynamic”** reading, or a loaded reading.

If there is evidence of fastener movement in the suspect area, the amount of movement must be measured and added to the static reading and the total recorded as the **Dynamic Reading**. **Always check both rails for tie failure or pad movement.**

The dynamic reading is the actual condition that the train wheel encounters. Once the amount of the gauge deviation is determined refer to the MARTA Track Safety Standards for Gauge for the appropriate action.

Rail Fastening Systems.

Track shall be fastened by a system of components which effectively maintains gauge within the limits prescribed in Gauge. Each component of each such system shall be evaluated to determine whether gauge is effectively being maintained.

Any track with gauge measurements greater than 57.75 inches, regardless of location, will immediately be taken out of service until proper remedial action is taken. Notify Rail Control or Yard Tower Supervisor and Track & Structures Supervisory personnel ASAP.

Measuring Static and Dynamic Track Gauge.

Static Gauge Reading. Measuring track not under load. When unloaded track is measured to determine compliance with requirements of this part, the amount of lateral rail movement, if any, that occurs while the track is loaded will not be added to the measurements of the unloaded track.

Dynamic Gauge Reading. When unloaded track is measured to determine compliance with requirements of this part, the amount of rail movement, if any, that occurs while the track is loaded must be added to the measurements of the unloaded track.

Direction. In addition to the static (unloaded) gauge measurements taken, the amount of lateral detectable dynamic (loaded) movement that occurs under train movement must be included. This includes the amount of lateral rail movement occurring between rail base and tie pad, rail seat, and tie plate.

Each deflection under the running rails must be measured properly considered when computing the collective deviations under load. It is very important that consideration be given to both rails when measuring these deflections.

Lateral deflections may be found at locations such as rail joints and turnout locations with poor wooden crossties and direct fixation pads or at bridge abutments and over culverts where the sub grade has settled.

Gauge Rods

a. Use. Gauge rods are used to help maintain proper track gauge
but are not a substitute for good track maintenance and good tie or pad conditions. Gauge rods are sometimes used at the following locations:
(1) On sharp curves where there is difficulty holding the gauge.
(2) In turnouts just ahead of the switch points and on the curved closure rails.

b. Spacing. Where gauge rods are used in sharp curves, two to four rods should be installed for each rail length. Rods should be installed at evenly spaced intervals along the rail length.

c. Application. Gauge rods should be installed at right angles to
the rail with the jaws firmly gripping the base of the rail.

d. Inspect the gauge rods for cracks, loose or missing bolts or missing or damaged insulation. Insulation missing on a gauge rod will drop a track circuit causing a disruption in service.

e. Maintenance.
(1) Gauge rods shall be kept tight while maintaining the proper track gauge.
(2) Bent or broken gauge rods shall be replaced where the track conditions warrant their continued use.
(3) Inspect insulation on gauge rod.

Standards for Concrete Ties

Concrete crossties are manufactured in two basic designs:

1. Mono-block Concrete Crosstie

- A mono-block crosstie is similar in dimension to a timber or wood crosstie and contains pre-stress metal strands embedded into the concrete.

2. Two-Block Crossties

- Two-block crossties are designed with two sections of concrete connected by exposed metal rods.
- If the concrete cracks and spalls, or if the reinforcing bar is otherwise allowed to come out of contact with the concrete, then the reinforcing bar is no longer in tension, and the once pre-stressed concrete can no longer withstand tensile loads, and it will fail very rapidly in service, such as in a concrete tie.

Crosstie failure is exhibited in three distinct ways:

1. Stress induced (breaks, cracks)
2. Mechanical (abrasion)
3. Chemical (decomposition).

Breaks, cracking, mechanical abrasion, or chemical reaction in small or large degrees compromise the crosstie's ability to maintain the rails in proper gauge, alignment, and track surface.

Check the crosstie to see if it's broken through or deteriorated to the extent that pre-stressing material is visible.

Deteriorated such that the crosstie's fastening or anchoring system is unable to maintain longitudinal rail restraint, or maintain rail hold down, or maintain gauge due to insufficient fastener toe load.

Concrete ties should be inspected for the following:

Surface spalls, chips or broken out areas which expose the reinforcing wire or rods.

Cracked or otherwise impaired to the extent that it will not hold rail fastenings or rail fastening inserts. Special attention should be given to the insert area as cracks tends to start at one corner of the inserts and spread, leading ultimate tie failure.

Of special concern are ties which support contact rail anchor Assemblies and third rail anchors. High stress can develop at these locations due to contact rail expansion and contraction. Ties which support contact rail insulators also are more highly stressed and should be inspected closely.

Concrete ties are also highly susceptible to damage from malfunctioning or dragging equipment. Inspect very closely when work has been recently done in the area.

Concrete ties also fail due to poor manufacturing quality control. For example, poor concrete will result in the tie crumbling. This problem will be seen as an area which develops many **"shatter"** or small cracks. All loose or missing rail fastenings should be reported.

Categories for Concrete Crossties Failure

Worn/broken or missing insulators: Movement of the rail in the rail seat both laterally as well as longitudinally can cause the insulators (especially on the field side) to be abraded or crushed over time. The portion of the insulator between the shoulder casting and the rail base can be worn away allowing the rail base to contact the shoulder casting. This results in loss of electrical insulation as well as wide gauge.

Worn or loose shoulder castings: If the insulator is not replaced once the post has been worn away, the rail base continues to cut into the shoulder casting resulting in loss of shoulder strength, and wider gauge, and could result in shoulder failure.

Bottom abrasion: Concrete ties will, over time become abraded by rubbing action against the underlying ballast. This will result in a loss of depth and bearing area under the tie that could cause the tie to fail.

Worn or missing pads: Vertical loads, as well as longitudinal rail movement can abrade or crush the tie pad or even move the pad off the rail seat. If this happens and the rail is allowed to contact the concrete rail seat, rail seat abrasion or aggregate fracture can occur resulting in rail seat failure.

Frozen and broken-in-place hold-down clips: Dragging equipment, a derailed wheel or over driving the clip can result in a broken clip.

Rail seat abrasion: The actual cause of rail seat abrasion is not fully understood, but one theory is that silts or fines, mixed with water, find their way under the tie pad.

Broken shoulder castings: Dragging equipment, a derailed wheel or mishandling of the tie can result in the shoulder casting being struck. The casting can be broken off from the insert or the stem may become loosened inside the tie

Broken ties: Dragging equipment, a derailed wheel, or a falling equipment can smash a concrete tie. In addition, severe skewing of a tie can result in the tie splitting end to end through the shoulder inserts. Concrete ties that become center bound, putting the tie into reverse flexure will also break the tie in the center.

Concrete Tie Failure - General Information

Concrete crossties counted to satisfy the requirements set forth for the minimum number of crossties per 39' section of track, shall not be--

(1) Broken through or deteriorated to the extent that pre-stressing material is visible;

(2) Deteriorated or broken off in the vicinity of the shoulder or insert so that the fastener assembly can either pull out or move laterally more than .38 inch relative to the crosstie;

(3) Deteriorated such that the base of either rail can move laterally more than .38 inch relative to the crosstie on curves of 2 degrees or greater; or can move laterally more than .50 inch relative to the crosstie on tangent track or curves of less than 2 degrees;

(4) Deteriorated or abraded at any point under the rail seat to a depth of .50 inch or more;

(5) Deteriorated such that the crosstie's fastening or anchoring system, including rail anchors is unable to maintain longitudinal rail restraint, or maintain rail hold down, or maintain gage due to insufficient fastener toe-load.

Breaks or cracks are divided into three general conditions:

1. Longitudinal
2. Center
3. Rail seat

Longitudinal cracks are horizontal through the crosstie and extend parallel to its length.

- They are initiated by high impacts on one or both sides of the rail bearing inserts.

Crosstie center cracks (centerbound tie) are vertical cracks extending transversely or across the crosstie.

- These cracks are unusual and are the result of high negative bending movement (centerbound), originating at the crosstie top and extend to the bottom.

Breaks or cracks are divided into three general conditions: longitudinal cracks, center cracks, and rail seat cracks.

Crosstie center cracks are vertical cracks extending transversely (across) the crosstie. These cracks are unusual and are the result of high negative bending movement (usually center bound), originating at the crosstie top and extend to the bottom. Generally, the condition is progressive, and adjacent crossties may be affected.

Crossties transversely broken between the rail seats and showing signs of further deterioration (loss of tension in pre-stressing material—upper and lower levels of exposure to metal strands) constitute failure. This means that there cannot be a complete separation of the concrete material making up the crosstie.

Rail seat cracks are vertical cracks that are not easily visible. They usually extend from the bottom of the crosstie on one or both sides of the crosstie and are often hard to detect. It is possible for a crosstie to be broken through, but, due to the location of the break, the pre-stressing material may not be visible.

Crosstie strength, generally, does not fail unless the crack extends through the top layer of the pre-stressing material. Once the crack extends beyond the top layer, there is usually a loss of pre-stressing material and concrete bond strength.

It is possible for a crosstie to be broken through, but, due to the location of the break, the pre-stressing material may not be visible.

Crosstie strength, generally, does not fail unless the crack extends through the top layer of the pre-stress strands.

- Once the crack extends beyond the top layer, there is usually a loss of strand and concrete bond strength.

Significant cracking or discernible deterioration exposure of the reinforcing strands to water and oxygen produces loss of the pre-stress force through corrosion, concrete deterioration, and poor bonding.

Loss of the pre-stress force renders the crosstie susceptible to structural failure and as a consequence, stability failure relating to track geometry non-compliance.

Skewed Ties

A skewed tie is a tie that is not perpendicular to the rails by more than the tie width. Slightly skewed or individual skewed ties are not a serious problem. A section of track with skewed ties indicates a problem area (possible tight gauge) that should be investigated to ascertain the reason for the ties being shewed. (may be lack of ballast in the cribs)

Tie Spacing Mainline Track: Tie spacing for mainline track is 30 inches from center of tie to center of tie. For every 39 foot section of track there are 16 ties.

Ballasted Deck Bridges and Transitions. Here the tie spacing will be 24 inches center to center. There are 20 ties per rail length.

Tie Spacing in Switches will vary according to specifications.

Yard Tie Spacing is 36 inches center to center or 13 ties per rail length

Minimum number of non-compliant crossties.

Each 39 foot segment of track shall have the minimum number of crossties to hold gauge, line & surface within the prescribed standards for the class of track as indicated in the chart below.

Class of Track	Tangent track & Curves ≤ 2 degrees	Turnouts & Curved track greater than 2 degrees
Class 1 Track	5	6
Class 2 Track	8	9
Class 3 Track	8	10
Class 4 Track	12	14

All Concrete ties should be graded using the following criteria:

.

Grade 1: Faint, tight, unconnected surface cracks and minor spalls (small chips or flakes) on ends, near the inserts, third rail anchor and on the top surface of the tie.

- **Note:** Grade 1 ties are not to be entered into the defect database.

Grade 2: Multiple, clearly visible surface longitudinal cracks on the ends and top surface, may include small, traverse cracks at or near the Pandrol clip inserts and third rail inserts.

- Small hairline cracks becoming interconnected on the surface of the tie.

Grade 3: Spalls (small chips or flakes) and/or Cracks, .06 inches or greater, becoming interconnected and starting to open to a maximum width of .19 inches.

- "Mapping" (alligator skin or interconnecting cracks) on the top surface and on the field ends of the tie.

Grade 4: Interconnected cracks throughout the tie opening up to a maximum of .25 inches. Ends of tie broken but Pandrol clip holders still solid. Interior cable strands pulled into the tie body approximately .50 inches.

- Tie still has the ability to hold gauge, line and surface to within MARTA standards.

Grade 5: Complete loss of pre-stress cable bond. Pandrol clip inserts loose. Rail moves outward under load.

- Severe damage to the tie causing the tie to lose its ability to hold gauge, line or surface within MARTA standards.

Direct Fixation Fasteners

Inspect daily. Defective fasteners are to be noted in the inspection report database. The fastener is considered defective and should be reported as such, when:

- The pad is corroded, deteriorated or broken so that the fastener or anchor bolts no longer provide lateral or vertical support.
- Excessive lateral and or vertical movement is evident.
- Any fastener component is bent, cracked, or broken.
- The rail hold down is defective or missing so that gauge cannot be maintained

All anchor bolts and rail clips must be inspected. Note any loose or missing bolts and clips.

Pad Spacing Mainline Track: Each 39 ft. section of track must have a minimum number of acceptable fasteners on tangent track and on curves.

- There are 16 fasteners for each 39 foot section of track with pad spacing of 30 inches.

Tie Spacing in Switches will vary according to specifications.

Minimum number of non-compliant rail fasteners.

Each 39 foot segment of track shall have the minimum number of pads to hold gauge, line & surface within the prescribed standards for the class

Class of Track	Tangent track & Curves ≤ 2 degrees	Turnouts & Curved track greater than 2 degrees
Class 1 Track	5	6
Class 2 Track	8	9
Class 3 Track	8	10
Class 4 Track	12	14

Track shall be fastened by a system of components that effectively maintains gauge, line and surface within the limits prescribed. Each component of each such system shall be evaluated to determine whether gauge, line and surface are effectively being maintained.

The failure of certain critical components within a particular system could adversely affect the ability of the individual fastener to provide adequate gauge or line restraint.

When a Track Walker identifies a gauge or geometry condition where the fastener system has degraded and the location in question meets the factors described, the Track Walker must examine each component of the fastener system. If a fastener condition causes the gauge, line or surface to exceed the limits the Track Walker shall document and report the condition as a gauge, line or surface defect and describe the nature of the fastener condition. If the deviation in gauge, line or surface exceeds the prescribed limits for its class of track then the Track Walker must lower operating speed to the next lowest class that meets the existing conditions,

This also requires the Track Walker to exercise judgment in evaluating the condition of fasteners. The following factors should be considered in the evaluation:

- Gauge or line deviations close to or exceeding the prescribed limits.
- Evidence of recent significant damage to rail fasteners to the extent that gauge widening or line deviation is probable.
- Evidence of recent maintenance work improperly performed resulting in lack of sufficient fasteners to prevent gauge widening or line deviations under expected traffic.
- Conditions of curvature and grades.
- Clips loose indicating loss of pressure on the rail base.
- Longitudinal rail movement.
- Metal flaking or grease streaks in the center of the low rail in a curve caused by the outer rim of wheel (or false flange) placing excessive pressure on the head of the rail, a condition generally created by gauge-widening.

Direct Fixation Fastener Defects

a) The rail clip is broken or missing

b) One or Two anchor bolts are missing, broken or so loose as to be rendered ineffective on one pad

c) One or two anchor bolt inserts are stripped or otherwise unusable on one pad

d) The pad is corroded, deteriorated or broken such that the rail fasteners or anchor bolts no longer provide lateral, vertical or longitudinal support

e) The concrete supporting the fastener is deteriorated or impaired to such an extent that it does not provide proper support

Inspect the second pour for severe cracks and crumbling. All inserts and anchor bolts must be securely bonded to the concrete (2nd pour). Any areas of concrete failure should be noted on the Track Inspection Report.

If two (2) or more consecutive pads are judged to have failed, (unable to hold any one of the following, gauge, alignment or surface within prescribed MARTA standards) Track and Structures supervisory personnel should be notified ASAP. Each 39 ft. section of track must have a minimum number of acceptable pads on tangent track and on curves to hold gauge, line and surface within MARTA parameters.

See chart on page 103 for the number of pads necessary for the class of track the train is operating over. Once the correct number of ties or pads has been determined, go to the specific area (gauge, line, surface) to determine if the deviation is within the class of track operating speed for that section of track.

Rail Fastener Requirements

1) Rail fasteners (crosstie, direct fixation and other rail fasteners) shall be made of a material to which rail can be securely fastened. Fasteners must be capable of holding rails to their proper gauge and alignment, preventing excessive horizontal and vertical movement and transmitting wheel loads to the supporting structure.
2) Each segment of track shall have a sufficient number of rail fasteners that in combination provide effective support that will maintain gauge, surface and alignment as prescribed herein.
3) The minimum number of non-defective rail fasteners (along a single rail) for any 39-ft. length of rail shall be as prescribed in The section for fasteners.
4) The number of consecutive ineffective rail fasteners shall not be more than that prescribed in the section for DF fasteners as stated in the chart.

Torque Requirements for Direct Fixation Fasteners

Use the chart below for the proper torque values for the indicated rail fastener.

Torque Requirements		
Pad Style	**Pad Bolt**	**Clip Bolt**
Hixon or Switch Pads	225 ft./lbs.	200 ft./lbs.
F-10	300 ft./lbs.	
F-20	300 ft./lbs.	
F-30	300 ft./lbs.	

General Track Safety Standards for Ties or Fasteners

1. Crossties or pads shall be made of a material to which rail can be securely fastened.

2. Each 39 foot segment of track shall have

(a) A sufficient number of crossties or pads which in combination provide effective support that will

(i) Hold gauge within the limits prescribed by MARTA

(ii) Maintain surface within the limits prescribed by MARTA

(iii) Maintain alignment within the limits prescribed by MARTA

(b) The minimum number and type of crossties or pads specified in this section effectively distributed to support the entire segment; and

(c) At least one crosstie or pad of the type specified in paragraphs 3of this section that is located at a rail joint location as specified in paragraph (4) of this section.

3. Each 39 foot segment of Class 1 through Class 4 track shall have;

The minimum number of crossties or pads as specified in the sections on Crossties or Direct Fixation Fasteners that are not:

(a) Broken through;

(b) Split or otherwise impaired to the extent the crossties will allow the ballast to work through, or will not hold spikes or rail fasteners;

(c) So deteriorated that the tie plate, pad or base of rail can move laterally .50 inch relative to the crossties or pads;

(d) Cut by the tie plate or pad through more than 40 percent of a

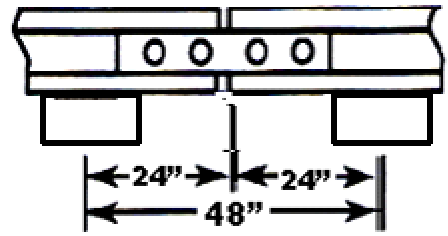
crossties thickness.

4. For track constructed without crossties, such as slab track, connected directly to aerial structures the track structure shall meet the requirements of paragraphs 2 (a) (i) (ii) & (iii) of this section.

5. Class 1 and Class 2 track shall have one crosstie whose centerline is within 24 inches of each rail joint location, and Classes 3 through 4 track shall have one crosstie whose centerline is within 18 inches of each rail joint location or, two crossties whose centerlines are within 24 inches either side of each rail joint location. The relative position of these ties is described in the following diagrams;

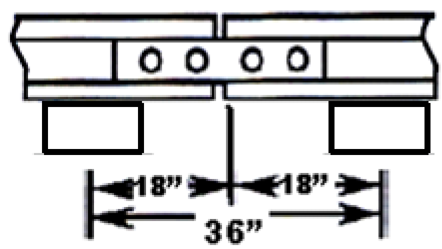
6. For track constructed without crossties, such as slab track, track connected directly to bridge structural components and track over servicing pits, the track structure shall meet the requirements of paragraphs (2) (a) (i), (ii), and (iii) of this section.

Class 1 and 2

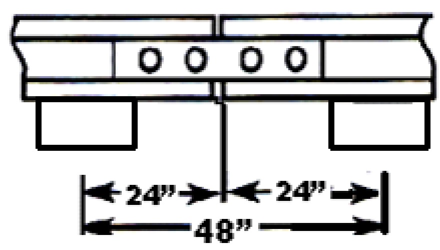


Each rail joint in Class 1 and 2 track shall be supported by at least one (1) crosstie or pad as specified in paragraph (C) of this section whose centerline is within 48" as shown above.

Class 3 through 4



Each rail joint in Class 3 and 4 track shall be supported by at least one (1) crosstie or pad as specified in paragraph (C) of this section whose centerline is within 36" as shown above, or:



Two (2) crossties or pads on each side of the rail joint whose centerlines are within 24" of the rail joint location as shown above.

Maximum Number of Consecutive Failed Ties or Rail Fasteners per 39 foot

Class of Track	Operating Speed	Tangent & Curves with Radii at or over 2000 feet	Curves with Radii between 1000 & 2000 feet	Curves with Radii of Less than 1000 feet
1	15 mph or Less	5	4	3
2	16 to 30 mph	5	4	3
3	31 to 60 mph	4	3	2
4	61 to 80 mph	3	2	1

As stated within these Track Safety Standards, there must be a definitive number of crossties or fasteners per 39 foot section of track that are holding gauge, line or surface within the MARTA Track Safety Standards which are set for the class of track that the train is operating over.

Direction: The number of consecutive failed ties or pads allowed per rail length is determined by the radius of each curve. All mainline curve radii have been placed in one of three categories in the back of this book. If a problem of consecutive failed crossties or fasteners occurs, refer to the Curve Radii Chart in the back of this book then refer to this chart for any corrective action.

Find the Curve Number by looking in the charts for Degree of Curve using the location of the defect, such as NR-527.54, go to the chart to find if the curve is ≤ 2° or in a curve that is greater than 2°. Write down the curve number then look in the chart for Curve Radii. Then check the chart on this page.

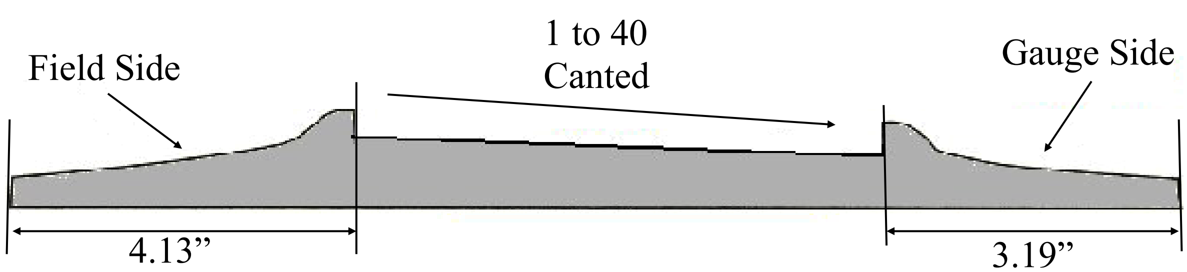
Shims

If track geometry is out of compliance with the requirements set forth within these standards or shims are required to support the direct fixation fastener then pad shims may be used.

Shims must be installed directly between the direct fixation fastener and the second pour or between the pad and crosstie. The shims must be of the proper design for the type of fastener or pad being used. The shims must be placed beneath the pad in the correct configuration. Shims should be tight not loose or working their way out from under the fastener.

Plates

1 Tie plates used shall be double shoulder on all track and turnouts. Do not mix together tie plates having different slopes in the same stretch of track. Do not place tie plates under the rail backwards.
2 The bottom of the rail and tie plates shall be cleaned before the rail is laid.
3 Plate shoulder shall bear against the outside base of the rail, centered on the tie with a flat, uniform bearing on the tie, and so that the rail cant is inward.
4 No portion of the shoulder of the tie plate shall be under the base of the rail.



Spikes

Spikes, where specified, will be used to secure rail and tie plates to cross ties, switch plates with a 6 inch by 5/8 inch cut track spike with reinforced throat of AREMA design. In special track work (turnouts), where specified by design, lock spikes shall be used at tight holding locations such as plates with braces. Spikes shall be driven with heads pointed toward the rail. An exception to this would be on ties located at glued insulated joints.

ROADWAY

a. Inspection. The roadway shall be inspected for the following defects:

(1) Ballast/subgrade pumping.
(2) Erosion of embankments and cut slopes.
(3) Embankment sliding or slippage.
(4) Potential slope stability problems.
(5) Settlement at approaches to bridges.
(6) Washouts under and/or adjacent to the track. If any of these defects are present, remedial action is required within a time frame necessary to prevent damage to the track structure.

b. Hazardous Conditions

Any condition presenting a hazard to the safe movement of trains shall be corrected before the first movement of a train over that location.

Standards for Ballast

Will be inspected daily. Observe for the following:

Clean, well compacted ballast (# 4) must be located in the cribs to the top of the crosstie but no closer than 1 inch of the bottom of the rail.

A **12” shoulder** must be maintained on the high side of the curve. At least a **6” shoulder** must be maintained at other locations. (Low side of a curve & both shoulders on tangent track)

Ballast must not be touching the bottom of the rail. **One inch (1”) minimum** must be maintained between the base of the rail and the top of the ballast.

When a track has been disturbed for maintenance, it must be examined carefully for stability. The ends of the ties should be carefully observed for any indications of lateral track movement.

In **extremely hot weather (100 degrees F or greater**), advise management personnel ASAP of any locations at which there is less than a standard ballast section.

Note and record the locations of extremely **“white”** ballast around the edges and ends of ties. This is an indication of **“pumping”** or poorly tamped track and should be scheduled for maintenance.

Ballast missing or gaps occurring at the end of the ties could be an indication if lateral track movement. This may occur prior to track buckling in hot weather or prior to the developing flat spots in a curve in cold weather. Report to T&S Supervisory personnel ASAP.

Certain track maintenance procedures result in disturbance of the ballast which can reduce its capacity to restrain the track from unwanted lateral movement.

The passage of train traffic over the track or the use of ballast stabilizers can restore this capacity by consolidating the ballast.

Ballast

The general standard for ballast states the duties which ballast must perform. Although the description is brief, it covers the requirements of ballast quite well. A crosstie base, side and ballast shoulder resistance contribute to the overall lateral resistance of the track. In general, each contributes (base 50%, side 20-30% & shoulder 20-30%) to this resistance but the ratios can very dependent upon ballast conditions. Lateral resistance also varies in location depending on the ballast shoulder geometry (slope), crosstie size and type and the state of ballast consolidation (compaction).

Unless it is otherwise structurally supported, all track must be supported by material which will:

(1) Transmit and distribute the load of the track and railroad rolling equipment to the sub-grade;
(2) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by trains and thermal stress exerted by the rails.
(3) Provide adequate drainage for the track.
(4) Maintain proper track crosslevel, surface, and alignment.

Wayside Components

Slopes and Drainage Ditches Check slopes for possibility of slides and falling rock. Observe and note any slope erosion. Ditches, catch basins, culverts must be clear of obstructions. It is the responsibility of the Track Walker to clear obstructions if possible.

All drains and catch-basins must be checked on each trip through the inspection area. Any obstructions should be noted and cleared.

Note that catch basins frequently clog after heavy rains. Please note and report any **"standing water."**

Direction: One of the most essential elements of track maintenance is a comprehensive drainage system. Drainage facilities (bridges, or culverts) should be given careful detailed consideration during inspections.

- Openings under the track are used to channel and divert water from one side of the roadbed to the other.

Each drainage structure shall be maintained and the Track Walkers should note conditions that would affect the integrity of the structure, such as culvert pull apart or separations, sink-hole, crushing or uneven settlement due to failure of or lack of head walls, too steep a gradient, sink-hole and insufficient support.

Drainage openings must also be inspected and notice given where debris has accumulated to such an extent that expected water flow cannot be accommodated.

Culverts designed with submerged inlets are common. Where questions are raised concerning the adequacy of drainage structures, the T&S Management should be consulted.

Track Walkers must take note of the conditions of:

- Right-of-way ditches, culverts and bridge inlets;
- Water carrying structures or passageways;
- Outlets or tail ditches;
- Scouring of embankments, piling or piers in channels or at abutments; and filling in of passageways from silting, sand wash or debris.
- Drains and water channels within tunnels and on aerial structures.

Track Walkers must notify the T&S Management of any drainage condition deemed hazardous, or potentially hazardous, to the safety of train operations or to track personnel.

High Water in the Track

Class of Track	Operating Speed	High Water Condition
Class 1 track	15 mph or less	Within the head of either running rail*
Class 2 track	16 to 30 mph	At the base of the head of either running rail
Class 3 track	31 to 60 mph	Within the web of either running rail
Class 4 track	61 to 80 mph	Touching the base of either running rail

*Only Supervised Operation is Permitted Where Water is Above the Running Surface of Either Rail.

(Refer to SOP # RT.4.2.22 - Flood on the Right-of-Way)

Signal Shunt System at Hi-Rail Accesses

A weekly check of the hi-rail signal shunt system will take place during the walking inspection. Findings will be documented on the work order.

Bumper Post

May be displaced if struck with sufficient force. This may be detected on ballasted track by movement of the ties, joints pulled apart ahead of Bumper Post, broken rails, severed connected bolts or scrape marks on the rail.

The height of the centerline of the pad of the bumper above the top of the running rail should be checked and maintained to the dimensions as shown in the drawing in the exhibits.

The torque values for the trailing shoes are found in the specifications.

North Springs : Rawie Friction Buffer – 111 foot-pounds torque

Proctor Creek : H.J. SKELTON Type 10EB Friction Element – 100 foot-pounds torque

Doraville : GWE Type 12/4 – 1 – 100 foot-pounds torque

Indian Creek : H. J. SKELTON Type 10Z4EB – 100 foot-pounds torque

South Line : GWE Type 12/4-2 – 100 foot-pounds torque

West Line: GWE Type 12/4-1—100 foot-pounds torque

Interline Connector: GWE Type 12/4—100 foot-pounds

See drawing in Exhibits for further information.

Signs

Note any damaged or illegible signs including, but not limited to, exit directional signs, car marker signs clearance signs, danger signs, signal location signs and signs that define the limits of the

Hi-Rail Accesses

Should be inspected for the following: Missing, loose, or damaged ties, panels, timbers, drive spikes, lag screws or other fastenings.

High ties, lag screws, drive spikes, other fastenings, etc., should be reported immediately. All lag screws should be countersunk or flush with the top of the crossing timbers.

Under no circumstances should the timbers, panels, fastenings, pavement, lag screws or drive spikes extend above the top of the running rail. If this condition is observed notify supervisory personnel ASAP.

Obstructions in the Hi-Rail Flangeway.

Depth and width of the flangway in the hi-rail access should be at least **1.88".** Any obstructions found must be removed.

Concrete and rubber hi-rail accesses should be inspected in the same manner as wooden accesses noting damaged, loose or missing panels and or fastenings.

Debris in Flangeways

Flangeways shall be kept clear of debris. Any obstructions, including ice and packed snow, shall be removed.

Fencing, Access Gates and Tunnel Doors

Inspect for holes in and under fences. Check for damaged and unsecured access gates and tunnel doors. Also inspect the intrusion lines along the fence. Enter Service Request/ Defect for any discrepancies.

Manhole/Drain covers

Missing covers should be reported. Protective action such as the erection of barricades, flags and lights should be taken for missing or damaged manhole/drain covers so that they are highly visible.

Vegetation

Note and record any and all vegetation that is obstructing any portion of the track, fences, gates, ditches, catch-basins, walkways, or signals.

- Also note trees on or adjacent to the track which might obstruct the track if the tree or any part of the tree fell.
- Dead or dying trees are especially prone to this type of problem and bear in mind the impact that storms or winter icing has on wayside trees and vegetation.

Vegetation found in the ballast area indicates fouled ballast and resulting in poor drainage.

Vegetation that is within or immediately adjacent to the roadbed must be controlled so that it does not:

1. Become a fire hazard;
2. Obstruct visibility of signs and signals;
3. Interfere with employees performing normal track maintenance duties;
4. Prevent proper functioning of signal and communication lines;
5. Prevent employees from visually inspecting wayside equipment;
6. Strike or rub the sides, top or bottom of trains.
7. Infringe into the Train envelop.

It is the responsibility of the Track Walker to keep vegetation out of the track and outside of the train envelope.

Vegetation Control

Undesirable vegetation growing within the roadway shall be removed by chemical or manual means. Chemical vegetation control shall be accomplished as prescribed by the manufactures reconditions.

Crosswalks

Inspect for damaged and high boards. Also note any missing crosswalks or components. Under no circumstances should any part of the crosswalk extend above the top of the running rail. If this condition is observed notify supervisory personnel ASAP.

If part of the crosswalk extends above the running rail take all appropriate action necessary to protect train movements.

ETS (Emergency Trip Stations)

Inspect for burned out or broken lights and blue globes and note on report. Emergency phones should be tested on a as needed bases (when requested) to assure they are operable. Report all emergency phones that do not work to RSCC and Track and Structures Supervisory Personnel.

Tunnel Lights

Report any dark, damaged or flickering tunnel lights.

Structures

Tunnels, aerials, portals, and abutments are also part of the general inspection. Any obvious problems should be noted and reported. Some of these problems include, tunnel leaks, erosion around aerial piers, and unusual cracks. A rule of thumb for these areas is, **"if it doesn't look right, it's probably not".** Do not hesitate to report something that you judge to be a problem. Please note that we have a formal Structural Inspection Program, and the reports will be submitted to the Chief of Structural Inspection for evaluation.

Also report any clogged or obstructed drains within the tunnels. **Clean out obstructions if possible.**

Aerial Structure

Particular attention shall be paid to the condition of the structure, decks, expansion joints, inlets, down spouts, handrails and catwalks.

Storage of Materials and Equipment Along the Wayside

Material and equipment stored along the trackway shall be placed where it will not interfere with the safe operation of the trains. Placement shall be secure so that vibration from passing trains will not allow materials or equipment to move into the train envelope. In addition, material and equipment stored shall be placed such that it will not interfere with:

1. Possible evacuation of passengers and personnel in an emergency
2. Possible actions of emergency personnel
3. Come in contact with rail vehicles
4. Operation of train control systems
5. Operation of switches and special trackwork
6. Traction Power distribution systems; and
7. Contact the running or contact rails

In addition to that shown above, extra precaution shall be taken with items such as rail, pipe and conduit to allow for thermal expansion and contraction.

Proper housekeeping practices shall be maintained in all work areas at all times. This includes the removal of material or equipment when work has been completed in the area.

Report all material left wayside to Rail Service Control Center.

Train Control Devices

Advise RSCC of any damaged, dark or improperly lit signals.

In the course of routine track inspections, it is important that the condition of Wee-Zee bonds and the associated cable connections to the running rails are checked.

Although the bonds are the responsibility of the Automatic Train Control Department (ATC), damage from hanging train equipment or track maintenance should be brought to the attention of supervisory personnel. Special attention should be given to the cable leads. If the insulation on the cables is damaged or the cable appears to be crushed or broken, it should be noted. Most importantly, cable connections to the running rail web should be inspected.

The CAD welded connection at this location is a common sight of rail defects which typically develop internally. As such, they are not detectable by eye. However, often the defect develops into cracks in the web which, if not detected, can become broken rails. Generally, the breaks happen suddenly when the rail is subject to a concentrated impact load such as from a flat wheel or the thermal stresses placed on the rail due to temperature changes.

Any unusual conditions should be brought the attention of supervisory personnel. The location of disconnected leads should be noted in the track inspection database.

Track Clearances

All track clearances shall be maintained as required for the safe operation of train traffic. Any indication of trains or equipment striking wayside objects requires prompt action.

Any violation to personnel clearances must be promptly communicated to the responsible department, and marking of the affected area shall be performed as soon as possible.

Special attention must be paid to reductions in overhead or lateral clearances caused by the installation of conduits, pipes, cables or any other wayside equipment. Clearance measurements shall be made if indications show that the track has been moved too close to any wayside object. See exhibit.

Standard height clearance in tunnels is 13’ 6” from the top of the running rails to the top clearance area of the tunnel. See exhibit.

Minimum track center measurement for mainline track is 14’ 9”. Check the System Track Charts for the exact track centers in your area of concern. See exhibit.

Ballasted track that has been re-aligned due to track maintenance should be inspected to see that the minimum track centers are within standards. Buckled track should be inspected to see if two trains passing at the same time will not infringe into each others train envelope. If the train envelope is infringed then trains cannot pass each other at the same time.

Track to Platform Clearance:

Location of the track in the platforms can be configured from the centerline of the track to the edge of the platform. That measurement is 64" using the tool designed to measure that distance. Or measure 33 " from the field side of the running rail to the edge of the platform using a tape measure and a plum bob.

- See exhibit.

Platform Height:

From the top of the running rail to the floor level of the platform is 44" + or - 1 inch.

See the Exhibits for further information and measurements for track to platform dimensions.

Platform Distance from Track Centerline or Field Side of Rail

	Designed Centerline	Minimum Centerline	Maximum Centerline
Track to Platform	64 inches	63 inches	65 inches

	Design Field Side of Rail to Edge of Plat-form	Minimum Design Field Side of Rail to Edge of Platform	Maximum Design Field Side of Rail to Edge of Platform
Track to Platform	33 inches	32 inches	34 inches

Height of Platform from Top of Running Rail

	Platform Height Design	Minimum Platform Height	Maximum Platform Height
Platform Height from Top of Rail	44 inches	43 inches	45 inches

See Exhibit on how to measure platform height and centerline/field side.

Rail Lubrication

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

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.

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

Turnout and Switch Inspection

Each switch and turnout in class 1 through 4 track shall have a monthly detailed inspection conducted by a Qualified person.

During each detailed switch and turnout inspection the Track Walker will have that switch points exercised (thrown normal and reverse) to insure that the switch points seats properly to the stock rail in both directions. **No gap between stock rail & switch point is allowed. Report any gap to Track and Structure Supervisor and ATC immediately.**

All inspection data is to be entered into CMMS vis the test result function of FA Suite (Maximus) EAM system the same day as the inspection.

Each switch and turnout will undergo a general inspection during the twice weekly track inspection or as directed by Track and Structures Management.

TURNOUT INSPECTION

Orientation

Right and left hand switches are determined by standing in front of the switch points, looking toward the frog. If straight rail is on your left, then the turnout is right-handed. If the straight rail is on your right then the turnout is left-handed. (See exhibits).

Switch—Surface

Sight the straight rail (line) from a position approximately **30 ft**. in front of the switch points, looking towards the frog, with eyes near the level of the top of the rail. If deviation is judged to exceed **1",** use **62' cord** to determine the exact deviation. Note measurement on comments page and diagram. The same standards that apply for track surface on tangent track apply to all turnouts.

Switch—Alignment

Stand **30 ft**. In front of switch points, directly over the top of the straight (line) rail and look toward the frog. Observe this rail for any alignment deviations. If a noticeable deviation is seen, then use a **62' cord** to determine the exact deviation. Note measurement on inspection report. If alignment is off more than **.75"** notify ASAP. The same standards that apply for alignment on tangent track apply to all turnouts.

Switch—Crosslevel

Check at locations indicated on diagram and record in FA Suite Test Results. All readings should be zero crosslevel. If readings are not zero, refer to this book for remedial action. The same standards that apply for crosslevel on tangent track apply to all turnouts.

Switch - Gauge

Check at locations indicated on diagram for crosslevel, gauge, flange measurement for the guard rail, check gauge and record in FA Suite Test Results. Check entire switch and record every fifth (5th) reading on the Turnout Gauge Reading form.

Stock Rails

Check Stock rails for gauge side overflow in the switch point area (Lipping) or obstructions which could prevent proper mating of the stock rail and switch point. Check to see that the stock rails are correctly seated within the riser plates. Check to see that there is no lateral or vertical movement of the stock rails under traffic or when the switch points are thrown.

Switch Points

Enter a Service Request/Defect for any broken or badly worn points. Indicate right-hand or left-hand switch and right or left switch point.

Any gap between the points and stock rail within the first 6” should be noted and reported to ATC and Track Supervisory Personnel ASAP.

Immediate train protection and prompt corrective action are necessary when a switch point is found to be gapped from the stock rail.

- Clamp switch point tight to the stock rail, notify RSCC or the Yard Tower Supervisor that the switch is clamped, stating reason and notify them that the switch can only be used in the present switch position.
- Inspection personnel must monitor and flag all trains through the switch and inspect switch point and clamp after each passing train or until relived by ATC personnel.

Replace all missing or broken lock washers and cotter pins in the castle nuts and bolts.

Switch points must be replaced when the raised portion of the switch point is worn down to the top of the stock rail (the raised portion of the switch point starts after the 2nd switch rod and ends past the heel of the switch, the maximum raise of the point over the stock rail is .25”). In addition, if the top of the switch point with the point set against the stock rail is higher than the top of the stock rail then both the point and the stock rail must be replaced.

During the detailed switch inspection have RSCC or Yard Tower Supervisor exercise each switch to see that both switch points seat properly to the stock rails.

Switch Points & Stock Rails

1. Each stock rail must be securely seated in switch plates, but care shall be used to avoid canting the rail by over tightening the rail braces.
2. Each switch point shall fit its stock rail properly, with the switch machine or stand, in either of its closed position to allow wheels to pass the switch point. Lateral and vertical movement of a stock rail in the switch plates or of a switch plate on a tie shall not adversely affect the fit of the switch point to the stock rail. Broken or cracked switch point rails will be subject to the requirements of Defective Rails, except that where remedial actions require the use of joint bars as joint bars cannot be placed on the switch point due to the physical configuration of the points. Action **A** from the Remedial Action Table will govern, taking into account any added safety provided by the presence of reinforcing bars on the switch points.
3. Each switch shall be maintained so that the outer edge of the wheel tread cannot contact the gauge side of the stock rail.
4. The heel of each switch rail shall be secure and the bolts in each heel shall be kept tight. (Heelblock)

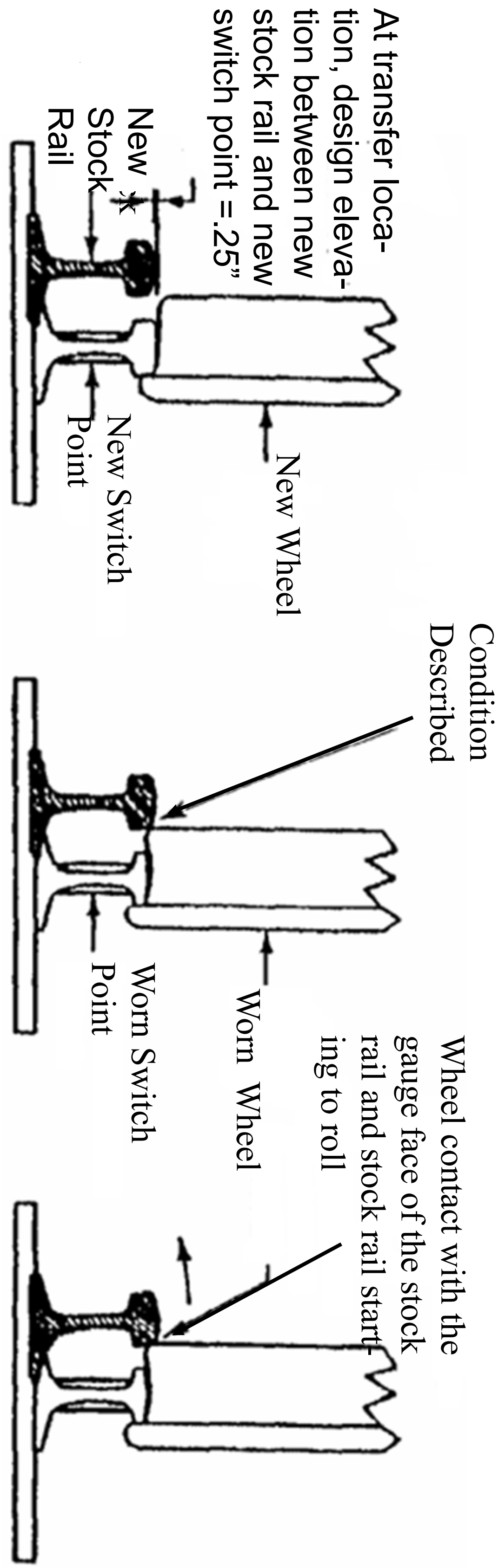
Check to see if switch machine or hand throw moves when points are thrown. If there is movement see section on Switch Machines & Hand Throw Switches for guidance.

Check to see if all locks are locked and latches are secured and in place.

- Each switch machine or switch stand and connecting rod shall be securely fastened and operable without excessive movement of the switch machine or switch stand.
- Each hand throw lever shall be maintained so that it cannot be operated with the lock or keeper in place.
- Metal flow shall be removed to insure proper closure.

Direction. Inspectors are to examine the seating of stock rails in the switch plates to ensure that the outer tread of a wheel cannot engage the gauge side of these rails. Grease lines or slight groves running at a slight angle on the tread of a stock rail can provide Inspectors with clues about the wheel/rail interface. These marks can be found in the area where wheel treads transition from the switch rail to the stock rail. When found, Inspectors should closely examine the gauge side of the stock rail to make sure the outer edge of wheel treads are not contacting the gauge side of the stock rail.

As shown in the drawing, this type of defect can occur when a worn switch rail and switch plates remain in place after a stock rail has been replaced. This causes the switch rail to drop down from the same level as its corresponding stock rail; the danger associated with this condition is the possibility that the outer edge of a wheel can contact the gauge side of the stock rail during a trailing movement through a switch, thereby turning over the stock rail.



Connecting Rods and Switch Rods

(1) These parts shall be installed and maintained to allow unobstructed motion when the switch is thrown. Rod ends and clips shall not contact adjacent ties. Damaged parts shall be replaced, and improperly installed parts shall be adjusted. Washers or similar spacers shall not be permitted between the switch clip and the switch point.
(2) If the connecting rod, switch rod, or switch clip is insecurely fastened or is damaged, operations through the turnout shall not be permitted.
(3) The jam nut at the switch stand end of the connecting rod shall be kept tight against the switch stand clevis.
(4) Where washers or similar spacers are between the clips and switch point, operations through the turnout shall not exceed 10 mph.

Connecting Rod Bolts and Switch Rod Bolts.

Connecting rod and switch rod bolts shall be installed with the nut on top and cotter keys in place. Clip bolts shall have cotter keys. All bolts shall be kept tight.

Rail Braces.

(1) Rail braces are essential to provide proper lateral support to the stock rails. Rail braces shall be fully secured to the tie or pad and tight against the outside of the stock rail on both sides of the turnout.
(2) It is recommended that rail braces be installed on each tie from the point of switch to within two ties of the switch heelblock.
(3) If there are less than four rail braces fully secured to the tie and tight against the outside of each stock rail, operations through the turnout shall not exceed 5 mph.
(4) Each stock rail must be securely seated within the uniform riser plates. Care needs to be taken to avoid canting of the stock rail because of over tightening of the rail braces.

Frog Point Wear

Measure 6.50” behind the .50” point (chisel mark). Use frog flangeway check gauge. If the gauge will not fit into the flangeway, note in comments section that the frog needs to be ground. Note all visible cracks in the casting. Note excessive wear in the wing area.

Frog Point Tread Wear

If the tread portion of a frog point casting is worn down more than three-eighths inch below original contour, operating speed over that frog shall not be more than **10 m.p.h.**

Direction. This paragraph specifically refers to the amount of tread wear from the original contour of the frog point casting. The original contour can be determined in a variety of ways depending upon the frog design.

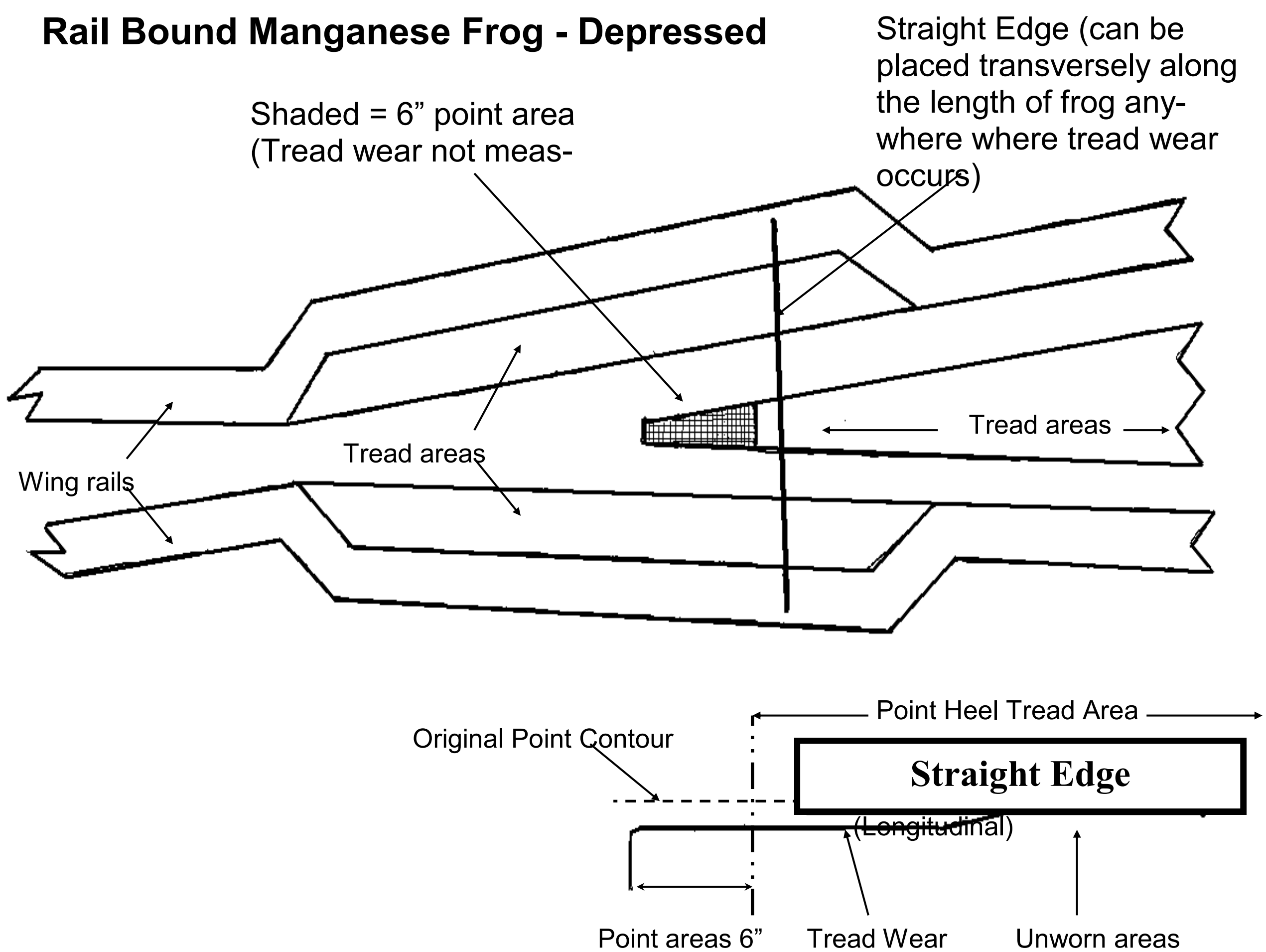
The tread of the frog point is considered to be any portion that is contacted by the tread of the wheel except for portion of the frog from the actual point to a position 6 inches back towards the heel.

The measurements of the portion of the tread portion of the frog point further back than the 6 inch position may be taken by placing a straightedge positioned longitudinal or transverse. Drawing on the following page shows a rail bound manganese frog design with an actual frog point that is .19 Called a depressed point, the tread will taper up to the top of the rail profile in the direction toward the frog heel in a distance equal to one-half the frog number in inches, but not less than 5 inches.

Broken or Damaged Frog Point

If a frog point is chipped, broken, or worn more than five-eighths (.63”) inch down and 6 inches back, operating speed over that frog shall not exceed **10 mph.**

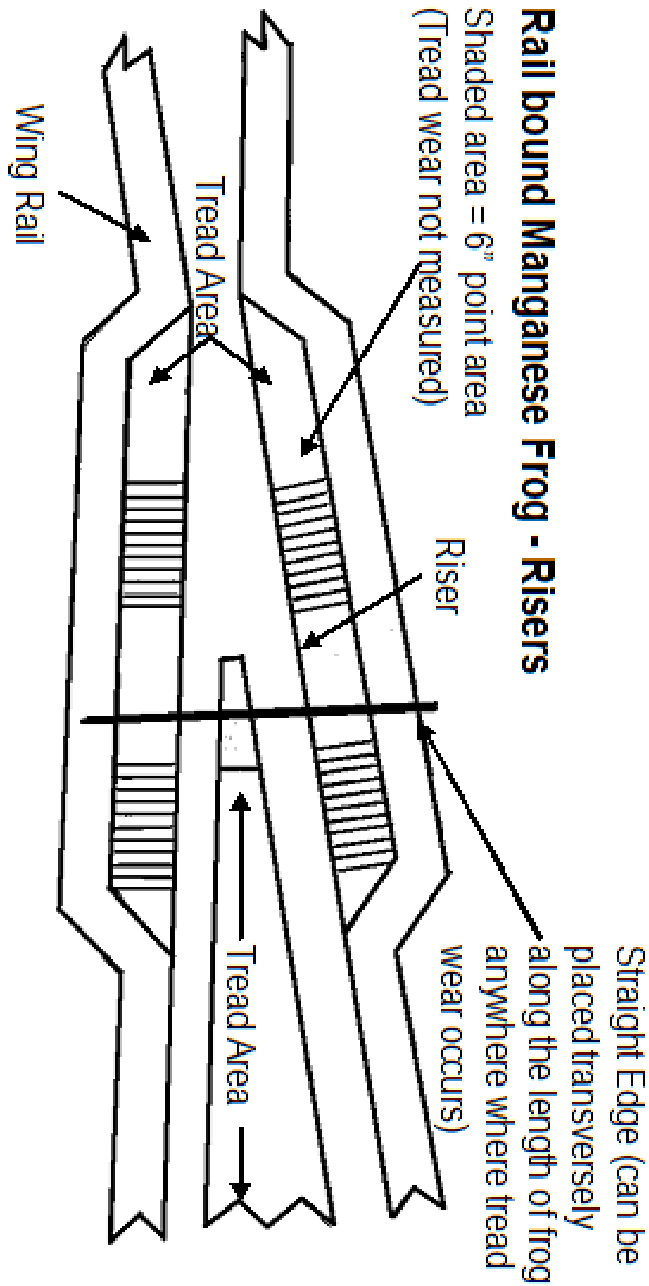
When measuring the frog tread wear, the distance from the bottom of the straight edge to the worn tread at the riser is measured. Various types of gauges such as a folding leaf gauge with different degrees of taper or a wedge-type gauge may obtain this measurement. Tape measures are also frequently used to measure tread wear.



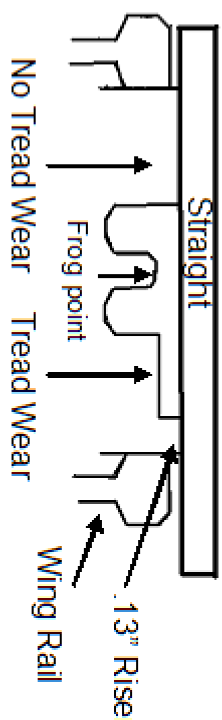
If the tread is worn more than .38 inch, the corresponding flangeway depth may also be reaching critical limits. Since the manganese insert is typically designed to be about 2 inches thick at the wall of the flangeway and about 1.38 inches or less at the bottom of the flangeway, wear in this condemning range could result in structural failure of the frog.

Frogs frequently exhibit small spalling (pitting) in the tread. Usually, this type of spalling is not hazardous. Measurements of tread wear should be made over a length that is worn down due to abrasion or plastic flow of metal not at the bottom of small spalls.

An alternate rail bound manganese frog design includes a profile whereby the tread portion of the casting adjacent to a frog point is manufactured to a plane .13 inch above the top of the rail profile (wing wheel riser).



These design characteristics need to be considered when measuring tread wear as discussed here.



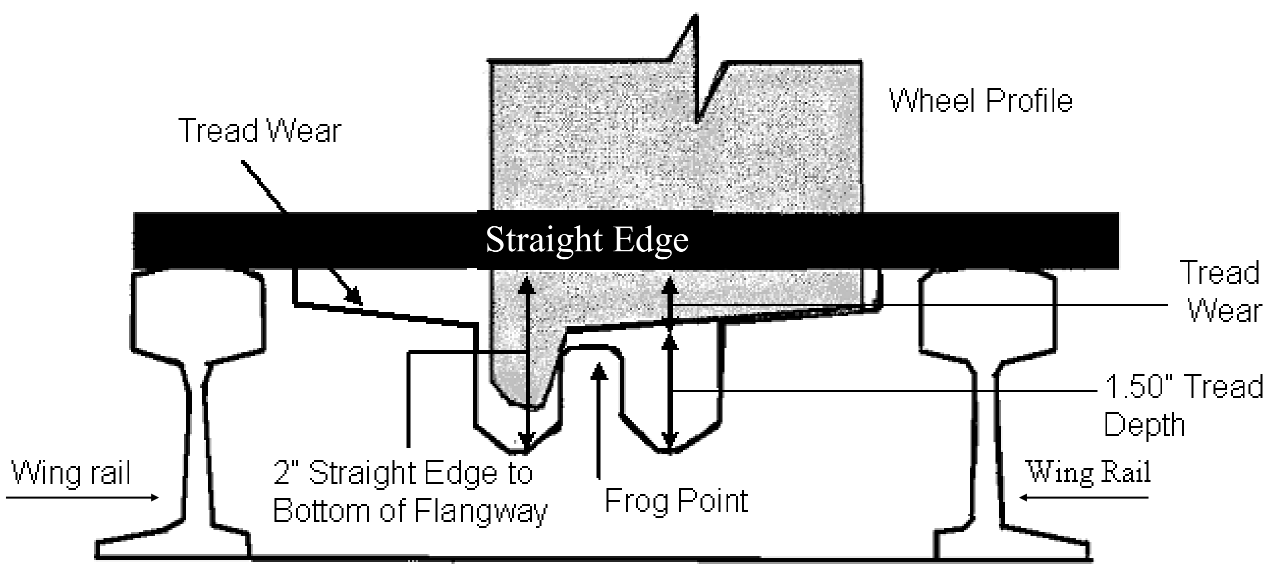
To measure flangeway depth, place a straight edge across the frog at the area of concern. Measure the space between the underside of the straight edge to the bottom of the flangeway and the space between the underside of the straight edge and the tread. As shown in above, subtract the tread value from the flangeway value to obtain the actual flangeway depth

When a railroad wheel approaches the frog in the facing direction, the weight of the wheel is supported on the tread of the frog opposite the point until the wheel reaches the transition point, about 6 inches back from the actual point. At this location, the weight is transferred to the frog point.

Frogs Flange-Way Depth

New or rebuilt frogs will have a standard flange-way depth of 1.88”. The frog flange-way depth is measured from a plane across the wheel-bearing area of a frog. Flange-way depths shall be maintained as follows:

1. Where operating speeds do not exceed Class 1 the Flangeway depth shall not be less than 1.38”;
2. Where operating speeds exceed Class 1 the Flange-way depth shall not be less than 1.50”.



Minimum Frog Flangeway Width

Flange-way opening at turnouts shall be at least **1.50 inches**.

Use your frog gauge to measure depth and width of all frogs. Report all that fail to meet minimum standards to Track & Structural Supervisory personnel ASAP.

Frog Bolts/Huck Bolts

Check all frog bolts. Note loose or broken bolts in comments on the switch inspection report

Guard Rails

At a typical switch the running rail must be interrupted at the frog in order to make it possible for the wheel flange to pass through the rail. At this gap, the wheel on the frog side passes from the point of the frog to the wing rail.

- The wheel load should be supported by the wing rail and the point of the frog until the point is heavy enough to support the wheel.
- The wheel on the frog side cannot be controlled by the wheel flange face.

When operating over this point it is necessary to prevent the striking of the frog point or the deviation of the wheel into the wrong opening and causing a derailment. Therefore, guardrails have two major functions; (1) safety of operations and (2) protecting the integrity of the geometry of the turnout.

Guard Rail Measurements

All measurements should be made **6.50”** behind the **.50”** point of frog. Measurements of the Guard Rail Flangeway that exceeds 2” should be reported ASAP. Check Gauge and Guard Face Gauge measurements should be taken & compared to standards when flangway measurement exceeds 2”.

Guard Rail Standards

The dimension from the gauge of the frog point to the face of the rubbing side of the guard rail (called the guard check gauge) must always be kept at 54.63". If the guard check gauge is greater than 54.63" the wheel flange on the frog side would strike the throat of the frog and guardrail.

Guard face gauge is the distance between the guard lines of the guardrail and the guard line of the frog.

Guardrails may be made from rail sections or other suitable shapes. The ends of all guardrails should be undercut or machined to an inclined plane to avoid catching dragging equipment. The ends of the guardrails should flare away from the running rails to guide the wheels into the flangeway between the running rail and the guardrail.

Guard Rail Flangeway Width

Flangway width is limited at its maximum only by Track Gauge, Check Gauge and Guard Face Gauge. Make sure that Standard Track Gauge, Guard Check Gauge and Guard Face Gauge measurements are within acceptable parameters for the class of track for that turnout.

- **When flangway measurement reaches 2 inches or greater, report to Track Supervisory personnel ASAP.**

Direction. Wear on the guarding face of the guard rail is not usually a serious problem in the majority of the cases.

Wear on the guarding face can be a source of concern if it develops to a point that the gauge limits are threatened or if the mechanical action that produces it loosens the guard rail fastenings or weakens the guard rail to a point where it may break .

A guard rail must be maintained in the proper relative position to the frog in order to accomplish its critical intended safety function.

Track Walkers should examine guard rails carefully to see that they are adequately fastened, and when measuring guard rail gauge, fully consider any movement of guard rail or frog when under traffic conditions.

Guard Rails and Guard Faces Gauge.

The guard check and guard face gauges in frogs shall be within the limits prescribed in the table

When measuring guard check gauge, it is important to consider the path of wheels through the frog because the function of a guard rail is to keep wheel flanges from striking the actual frog point.

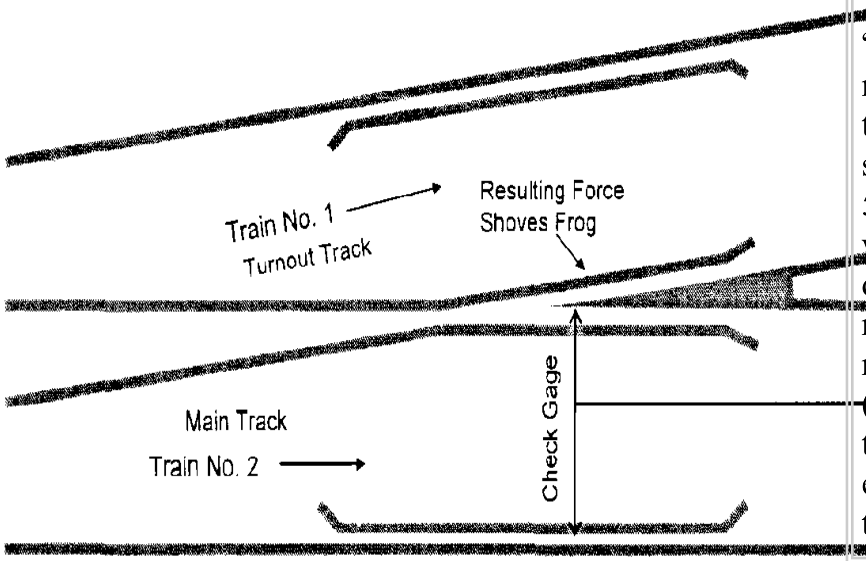
- As reference, standard check gauge on a set of wheels is set at approximately 54.50 inches.

While the minimum guard check gauge is less than wheel check gauge in lower classes of track, the condition of the actual frog point in relation to the path of wheels through a frog is a good indicator of the effectiveness of a guard rail.

The critical area where guard check gauge must be measured is at the actual point of frog. Inspectors must also consider any unusual wear that may exist at the actual frog point and position the track gauge or other measuring device accordingly.

See Exhibit for detailed drawing.

When measuring guard check gauge, dynamic lateral movement of the guard rail and or the frog must be considered. In the case of a frog that is moving laterally under train movement (floating), it is important to consider the most restrictive measurement. Specifically, if measuring guard check gauge in a turnout where the frog can move toward the track being measured due to train movement on the other track, that dynamic frog position would be considered.



Without train, frog sits "Floating" at 54.25" for the main track. Train #1 on the turnout track side of the frog shoves the frog "down to 54". In some cases the frog will not float back to 54.25" due to thermal or mechanical reasons. Therefore the most restrictive check gauge (dynamically loaded from the turnout side) as train #2 enters the frog on the main track would be 54"

In severe cases where a frog is severely floating (moving laterality under load), and there is an accompanying condition (i.e., deteriorated crossties or ineffective fasteners), Inspectors should cite the defect for the accompanying condition (i.e. Crossties or Rail fastenings). Guard face gauge is a dimension that becomes critical when the distance between two opposing guard rails, or a guard rail and a frog wing rail, become larger than the distance between the back of wheel sets. This would occur by improper installation or a condition such as a severe alignment defect. Normally, guard face gauge would be measured in the same vicinity as check gauge. However, Inspectors should consider measuring guard face gauge at other points in special track work where there may be an indication that wheels are being "**pinched**."

Check Gauge and Guard Face Gauge

Class of Track	**Guard Check Gauge** The distance between the gauge line of the frog to the gauge line[1] of the guard rail measured across the track at right angles to the gauge line[2] may not be less than -	**Guard Face Gauge** The distance between guard lines[1] measured across the track at right angles to the gauge line[2] may not be more than -
Class 1 track	54.13 inches	53.25 inches
Class 2 track	54.25 inches	53.13 inches
Class 3 track	54.38 inches	53.13 inches
Class 4 track	54.38 inches	53.13 inches

Note:
1) A line along that side of the flangeway which is nearer to the center of the track and at the same elevation as the gauge line.
2) A line .63 inch below top of the center line of the head of the running rail or corresponding location of the tread portion of the track structure.

Derails.

1. Each derail shall be clearly visible.
2. When in a locked position, a derail shall be free of lost motion which would prevent it from performing its intended function.
3. Each derail shall be maintained to function as intended.
4. Each derail shall be properly installed for the rail to which it is applied.

Derails are of various designs and may be of the following types: switch point, spring switch point, sliding, hinged, and portable. MARTA requires derails to be clearly visible. They must be visible to Wayside employees, and a derail dark in color and obscured by vegetation would not be in compliance.

Derails can be operated by various means: electrical, hand throw, lever, and mechanical rod from a point other than at the derail. They should be installed to derail rolling stock in a direction away from the track or facility to be protected.

A derail that is installed to derail equipment toward a main track that should otherwise be protected would constitute an improperly installed derail.

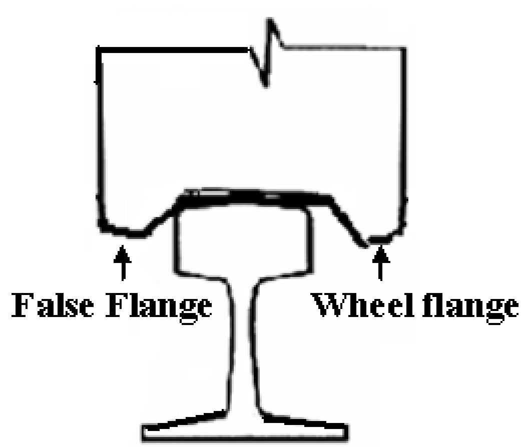
False Wheel Flange

When the brakes on a train lock in the closed position it will cause wear to the center of the rail wheel. If the vehicle continues in service with this condition, a false wheel flange will develop on the field side of the wheel.

You should look for these on passing trains especially when you hear a radio transmission concerning a friction brake or other brake related issues or if you smell the burning odor that occurs from brake pads.

If you find several C-Bonds broken off this may be an indicator of a false flange.

If you spot drag marks across the frog insert (frog point) or the stock rail that may also indicate a train is on the system with wheels having a false flange.



These marks are made by the false flange being dragged across the frog point or stock rail. Report to RSCC and T & S Supervisory Personnel ASAP.

Reference Guide for Switch Inspection

1. Inspect insulated joints, gauge plates, and switch machine rods for broken or deteriorated insulation, metal shavings, or loose or missing hardware.
2. Inspect traction power return cables, rail clamps, pin bonds and welds for defective cable insulation, rust, corrosion, damage and loose or missing hardware.
3. Inspect marker coils for loose or missing mounting hardware and cracked or otherwise damaged housing.
4. Inspect switch points for an accumulation of debris underneath the switch points.
5. Inspect snow melt system equipment for defective insulation, rust, corrosion, missing components, damage, and loose or broken connections.
6. Inspect switch machine components and layout for defective insulation, rust, corrosion, damage and loose or missing hardware. Remove any ballast or debris from the switch layout.
7. Inspect the switch points for proper closure. Inspect the heels and switch points for binding, chipping, wear, bends and loose or missing hardware.
8. Inspect stock rail and guardrails for unusual wear, loose or missing rail braces, hardware, tie straps, and damaged or worn mounting pads or ties.
9. Inspect frogs for wear, chipping, loose, broken or missing hardware or huck bolts.
10. Inspect and observe switch layout for unusual vibrations, excessive pumping or lateral movement or other abnormal movements as a train passes.
11. Inspect the interlocking for any condition that may interfere with or block the view of any personnel or signal equipment. Such as vegetation within the train envelope.
12. Inspect snow melting system for defective insulation, rust, corrosion, damage and loose or broken connections.

Switch Rail Joints (Including Heelblocks)

Note all missing, loose or broken bolts, nuts, bars, flat washers and lock washers. **Repair if possible**

There must be a minimum of two (2) sound tight bolts in each rail in each joint.

- **If less than two (2) sound tight bolts, impose a 25 M.P.H. slow order repair if possible and notify Track & Structural Supervisory personnel ASAP.**

For a broken shoulder bolt, impose a **25 M.P.H.** slow order and notify Track Supervisory Personnel ASAP. Inspect heelblock, heel of switch point and heelblock bolts after each train passes.

Replace all missing or broken cotter pins in the shoulder bolts.

Replace all cracked or broken lock washes.

Note all chipped, broken, or battered rail ends. If judged excessive, measure as explained on exhibit in the back of this book.

Note all standard joint gaps which exceed **.25".** Note if gap overflow needs grinding.

Measure gap between the underside of the rail head and the top of the heelblock. If this exceeds **.06",** note in comments.

Report any heelblock which exhibits excessive movement under train traffic or when switch point is thrown. Excessive noise under train traffic is a good indicator of this condition.

Switch Rail Fastenings

Inspect rail fastenings such as: rail braces, bolted clips, spring clips, and spikes. Note any broken or missing components.

All loose or broken fastenings, as described above, should be repaired by the Track Walker, if it is possible to accomplish without disturbing the running rail or interfering with rail traffic.

If three (3) or more consecutive fastenings on the same side of the rail are loose, broken or missing, notify the Track Inspection Supervisory personnel ASAP. Loose rail braces can cause the stock rail, under load, to roll over because its not properly supported. If two (2) or more consecutive rail braces are loose, repair immediately, if unable to repair, notify the Track Supervisory personnel ASAP.

Switch Tie Plates or Fasteners

Check for proper fit between the plate or fastener, the rail and the concrete or wood tie. Note lateral or vertical movement which exceeds **.25".**

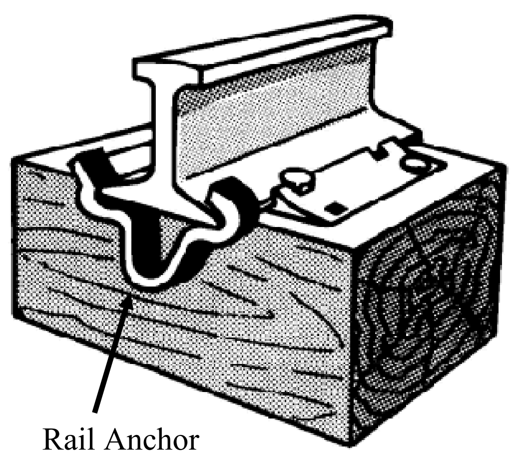
Check for adequate lubrication on riser plates.

Always use plate or fastener number, and approximate location when reporting defect.

Note and record locations of all loose, missing or broken anchor bolts and lag screws. Note and record location of all broken or missing fasteners or plates.

Rail Anchors

Are installed on the rail base securely against the side of the tie. Anchors are designed to resist the longitudinal movement of the rails under traffic. They also maintain proper expansion and contraction forces that build up in continuous welded rail. Without anchorage, the rail will run irregularly.



At locations where expansion forces concentrate, the track can buckle or warp out of line or surface. At locations where contraction forces concentrate, the field welds can be broken or the bolts can be sheared. All rail anchors are to be placed tight to both sides (boxed) to the crosstie.

Rail Anchors are used in Rail Yards only.

Rail Anchors (Maintenance Standards)

Rail anchors are designed to fit tight on the base of the rail. Rail anchors help prevent the longitudinal movement of rails commonly known as "running" or "creeping." Rail anchors should be used at locations where the track is subject to serious longitudinal movement from thermal stresses (rail expansion) or traffic conditions.

Rules for Anchor Application

General rules on the use of rail anchors are:

(1) Anchors shall be applied to the gauge side of the rail base against the same tie face on opposite rails.
(2) Anchors shall grip the base of the rail firmly and have full bearing against the face of the tie.
(3) When the bearing of the rail anchor against the tie has been disturbed by removal of the tie, the anchor shall be removed and reapplied to the new tie.
(4) Anchors shall not be moved by driving them along the rail.
(5) Skewed ties shall be straightened before applying rail anchors.

Rail anchors not meeting requirements stated above should be removed and reapplied or replaced.

Switch Stand

Maintenance standards require the switch stands to be fully secured to the head block ties to prevent any unintentional movement of the switch points. Where operations through the switch result in visible lateral movement of the switch stand or opening of the switch points (point gap), safety standards require Operations through that switch to be discontinued until repairs have been made or precautions made to protect movements through that switch (blocking, clamping or spiking the switch points in the proper position).

Switch Stand Lever Latches and Point Locks

Safety standards require turnouts with latches that are missing, damaged, insecure, or otherwise inoperative, to be **"No Operation."**

Switch Machine and Hand Throw Switches

Record any defects and comments. Inspect closely the ties or the concrete second pour which support the switch machine. Inspect the switch machine and layout for any condition that may interfere with the operation of the equipment.

Inspect the switch machine for damage, rust, corrosion, and missing or loose components and hardware. Inspect rod connecting pins and ensure cotter pins are in place and spread properly.

Inspect switch machine for damage, cracks, breaks, defective latches, missing or damaged locks, hinges, covers, and loose, deteriorated, or damaged conduit connections, and hardware.

Operate switch in both directions to ensure there is proper switch point seating to the stock rail (no gap) and that it has proper locking indication. Observe that covers and locks are in place and secured.

When switch machine is in operation, watch to see if the switch machine or switch stand moves on the tie or second pour while in operation.

An unsecured switch machine or switch stand can cause the switch points not to seat correctly allowing a gap between the switch point and the stock rail. A derailment is possible.

If the switch machine or switch stand move when in operation, block and clamp the switch point in its normal operating position.

No switch point gap is allowed. Notify RSCC or Yard Tower Supervisor that the point has been blocked & clamped and that the switch is out of service for any move other than the normal alignment now set for the switch. Notify Track & Structures personnel ASAP.

Diamond Crossovers

1) Sub-grade under crossovers must be well drained. Clean crushed ballast must be maintained where applicable.

2) rack gauge and flangeways in the crossovers must be maintained as prescribed within these Track Safety Standards for switch frogs.

3) Guard check gauge and guard face gauge shall be maintained to standards that are applicable for frogs as stated within these Track Safety Standards.

4) If the frog point is chipped, broken or worn more than five-eighths inch (.63”) down and 6 inches back. Operating speed over the frog shall not be more than 10 mph.

5) If the tread portion of a frog point casting is worn down more than 3/8” below the original contour, operating speed over that crossing may not be more than 10 mph.

6) Crossovers must be fastened as prescribed within these standards for crossties or direct fixation fasteners.

7) Metal flow on frog points shall be kept ground off to maintain proper gauge and to prevent chipping or cracking.

8) When necessary, repairs by welding shall be made on the frog point and wing rails in accordance with approved MARTA methods.

9) Line, surface and gauge of track through and approaching crossovers must be accurately maintained as prescribed within these standards.

10) When taking marked measurements for the Diamond Crossover frogs begin with the frog closest to Five Points Station and work away from there.

11) All standards for rail, surface, alignment, joints, gauge, ties, fasteners and ballast that apply to standard frogs also apply to the frogs within a diamond crossover.

Measurements for Diamond Crossover frogs are the same as for standard frogs. Crosslevel, gauge, flangway, check gauge and guard face gauge measurements are taken and recorded. Use frog gauge when taking marked measurements.

See exhibit for the marked measurement locations.

Diamond Crossover Locations

Location	From	To	Track Centers
North Line			
Civic Center	64+64	66+59	14.75’
Arts Center	139+49	141+31	43.00’
Canterbury	329+50	329+79	14.75’
Chamblee	613+58	614+70	36.00’
Buckhead	454+58	454+88	14.75’
Northland Dr.	623+30	623+58	14.75’
Medical Center	686+35	686+64	14.75’
Dunwoody	741+71	743+34	40.00’
North Springs	835+27	836+90	40.00’
South Line			
West End	106+50	106+80	14.75’
East Point	350+10	352+22	36.00’
Airport	480+91	482+69	42.00’
East Line			
King Memorial	60+29	60+58	14.75’
Avondale	369+98	370+30	15.00’
Indian Creek	544+56	546+20	40.02’
West Line			
H.E. Holmes	246+37	246+67	14.75’

Crossover Operating Speeds:

Turnout Number	Type of Turnout	Maximum Operating Speed of Crossover
8-Y	Equilateral	25 mph
8	Lateral	18 mph
10	Lateral	25 mph
20	Lateral	50 mph

Negative Return Cable

The chart identifies the cables that are designed to return of the negative current to the sub-station. These cables are identified by having the area around the pin cable which is attached to the running rail painted a bright **YELLOW**. Report all negative return pin cables that are missing, broken or damaged ASAP to Track & Structure Supervisory Personnel.

Station	DC Breaker & Pothead	Engineer-ing Station	Quaintly	Rail location
WXP 6 awg wire (W135)	Negative Return	WR-90.89	1	North Running Rail
WXM 6 awg wire (W205)	Negative Return	WL-153.90	1	South Running Rail
EFX 6 awg wire (E105)	Negative Return	ER-17.40	1	South Running Rail
EEZ 6 awg wire (E145)	Negative Return	EL-204.50	1	South Running Rail
EZE 6 awg wire (E147)	Negative Return	EL-234.84	1	North Running Rail
EXW 6 awg wire (W225)	Negative Return	EL-357.11	1	North Running Rail
EXE 6 awg wire (W225)	Negative Return	EL-370.76	1	South Running Rail
SFX 6 awg wire (S105)	Negative Return	SR-12.70	1	South Running Rail
SYX 6 awg wire (S215)	Negative Return	YR-27.05	1	South Running Rail
NXN 6 awg wire (N125)	Negative Return	NR-67.50	1	North Running Rail
NXT 6 awg wire (N145)	Negative Return	NR-142.30	1	West Running Rail
NFX 6 awg wire (N215)	Negative Return	NL-330.68	1	West Running Rail
NXC 6 awg wire (N245)	Negative Return	NEY-640.14	1	West Running Rail

Contact Rail (3rd Rail) Standards

Defect	Green	Yellow	Red	Action
Joints	Any visible cracks or joint wear	One bar broken or joint wear affecting collector shoes	Both bars broken Top level joint wear causing buildup of broken collector shoes	If the receiving rail is high, drop operating speed to 10 mph & observe. If causing damage **Stop** all trains
Breaks		Visible fissures (Cracks)	Complete break at the top level	If the receiving rail is high, drop operating speed to 10 mph & observe. If causing damage **Stop** all trains
Insulator Assembly	1 non-supporting insulator in a 40 foot area	2 non-supporting insulator in a 40 foot area	3 non-supporting insulator in a 40 foot area** or 1 insulator at an end approach**	**Reduce operating speed to 25 mph observe and notify T&S Management ASAP
Clearance Running rail to 3rd rail-25.50 inches standard	25 to 26 inches	24.50 to 26.50 inches	Over or under 1 inch from Standard**	**Reduce speed to 25mph, observe, notify T&S Management ASAP

Check Severity Estimator for action to take for Green—Yellow—Red defects

Defect	Green	Yellow	Red	Action
End Approach	1.50 inches or less above the running rail	1.50 inches to 1.75 inches above the running rail	*1.81 inches or greater above the running rail*	If the receiving rail is high, drop operating speed to 10 mph & observe-if causing damage, take out of service*
Coverboard	Cracked or damaged	Missing	*Coverboard touching the top of the 3rd rail & knocking off col-lector shoes	Remove coverboard if possible No speed restrictions necessary for missing coverboard.
3rd Rail Height	3.50 inches or less above the top of the running rail	3.50 to 3.75 inch-es above the top of the running rail	Greater than 3.75 inches above the top of the running rail or Knocking off collector shoes*	*Take track out of Service

Inspection of Third (3rd) Rail Insulators

Insulators should be checked for cracks, breaks and any misalignment that may occur due to temperature changes or equipment striking the third (3rd)) rail. Any defects found in the 3rd rail insulators must be reported immediately.

The insulators should be kept clean of metal shavings and brake dust to prevent excessive leakage of third rail current.

Check for broken insulators, large cracked areas, and excessive dirt and grease. Insulators which are broken or cracked and judged unable to structurally support the contact rail should be recorded for replacement.

If three (3) non-supporting insulators are found in a row, train operations over that third rail shall be limited to 25 mph and replacement scheduled.

If five (5) or more non-supporting insulators are found in a row, train operations over that third rail shall be limited to 10 mph and all train operations over the affected area must be supervised until the condition is corrected.

- **The area must be inspected after each train to make sure that there is no further loss of support for the 3rd rail.**
- **Report condition immediately to T&S management**

Insulator assemblies must be considered defective if they are no longer able to support the 3rd rail to its proper position.

If the displacement of the 3rd rail occurs examine to see if insulators are cracked, broken or missing.

Third rail insulators should be inspected for signs of tipping.

Check the placement of the third rail in the insulator cap to observe any rail movement.

Contact Rail (3rd Rail)

General. Carefully inspect all contact rail to ensure that it is firmly and securely seated in the insulators. The rail should also be visually inspected for obvious cracks or breaks especially at weld areas.

The Contact Rail (3rd Rail) is installed in relation to the running rail. See exhibit.

- 25.50 inches from the gauge corner of the running rail to the gauge corner of the 3rd rail

The Third Rail must be inspected as part of the daily visual walking inspection for breaks, defects and collector shoe build-up. The Contact (3rd) Rail must be maintained within the proper tolerances as prescribed within these standards.

If the maximum horizonal deviation exceeds + or - 1 inch or the vertical deviation exceeds + .50" then the maximum allowable operating speed is 25 mph, observe trains passing through the area and notify Track & Structures management ASAP.

Third rail must be kept in its correct position so that its height and distance from the running rail is within limits of tolerances previously referred to. (See drawing in Exhibit)

Verify the contact rail has proper horizontal and vertical relation to the adjoining running rail.

Inspect the welds and mechanical connections (particularly the rail end weld/pin/clamp connection) for cracks, corrosion, and bond fraying.

Impedance bonds are installed to maintain the continuity of the traction return currents in signalized territory. Check bonds for damage.

Contact (3rd) Rail Wear

	Green	Yellow	Red
Mainline Tracks	Up to .25”	25” to .38”	Over .38”
Yard Tracks	Up to .50”	.50” to .63”	Over .63”

Third Rail Expansion Joints

Expansion joints must be inspected to see that the third rail moves freely within that expansion joint to allow for the expansion and contraction that occurs due to temperature changes.

This thermal expansion and contraction can be aided by having the third rail expansion joint lubricated with grease.

Check for adequate lubrication and for loose bolts. Check for adjustment to ensure that both rails have not reached the end of their adjustment range.

Check rail ends for excessive scarring which would indicate undesirable collector shoe contact. Check cable connections.

Power cables should be checked to ensure proper connection and all bolts, nuts and cotter pins inspected.

Any bolt that is broken, nut loose or missing or cotter pin broken or missing needs to be reported immediately for repairs.

Coverboard

Check all coverboard components for proper fit and missing pieces. Also check for cracked and broken sections (especially around hi-rail Access areas).

The coverboard must clear the top of the contact rail by at least five **(5”)** inches.

Check at expansion joints to ensure that the coverboard moves freely. Report all loose or missing coverboard.

End Approaches.

The end approaches must be monitored very closely for correct height. If an end approach is too high it may cause the train collector shoe to break off. An end approach will exhibit scarring from the collector shoes hitting it. There may also be an accumulation of train collector shoes in the area of a high end approach.

At its lowest point, the top of the contact rail at all end approaches should not be more than 1.50 inches above the top of the running rail.

On ballasted track, ties that are pumping can cause the end approach to jump-up out of the insulator when under load. When the end approach jumps-up it will measure higher than the 1.50 inches above the top of the running rail causing the collector shoe to hit the end section of the end approach and possibly knocking off the collector shoes.

All high end approaches must be reported immediately for corrective action.

3rd Rail Anchors

Check third rail anchor arms for signs of excessive stress bows. All over-stressed third rail anchors must be de-stressed immediately to prevent damage to the anchor and the tie or concrete second pour.

Third rail anchors must be checked to see that they are properly anchored to the ties, bridge or aerial structure pedestal and that all 3rd rail anchor rod (arms) are securely fastened to the anchor support and to the third rail itself. Make sure all bolts, nuts and cotter pins are tight and in their proper place.

Exhibits

Turnout Layout

Typical Turnout with Names

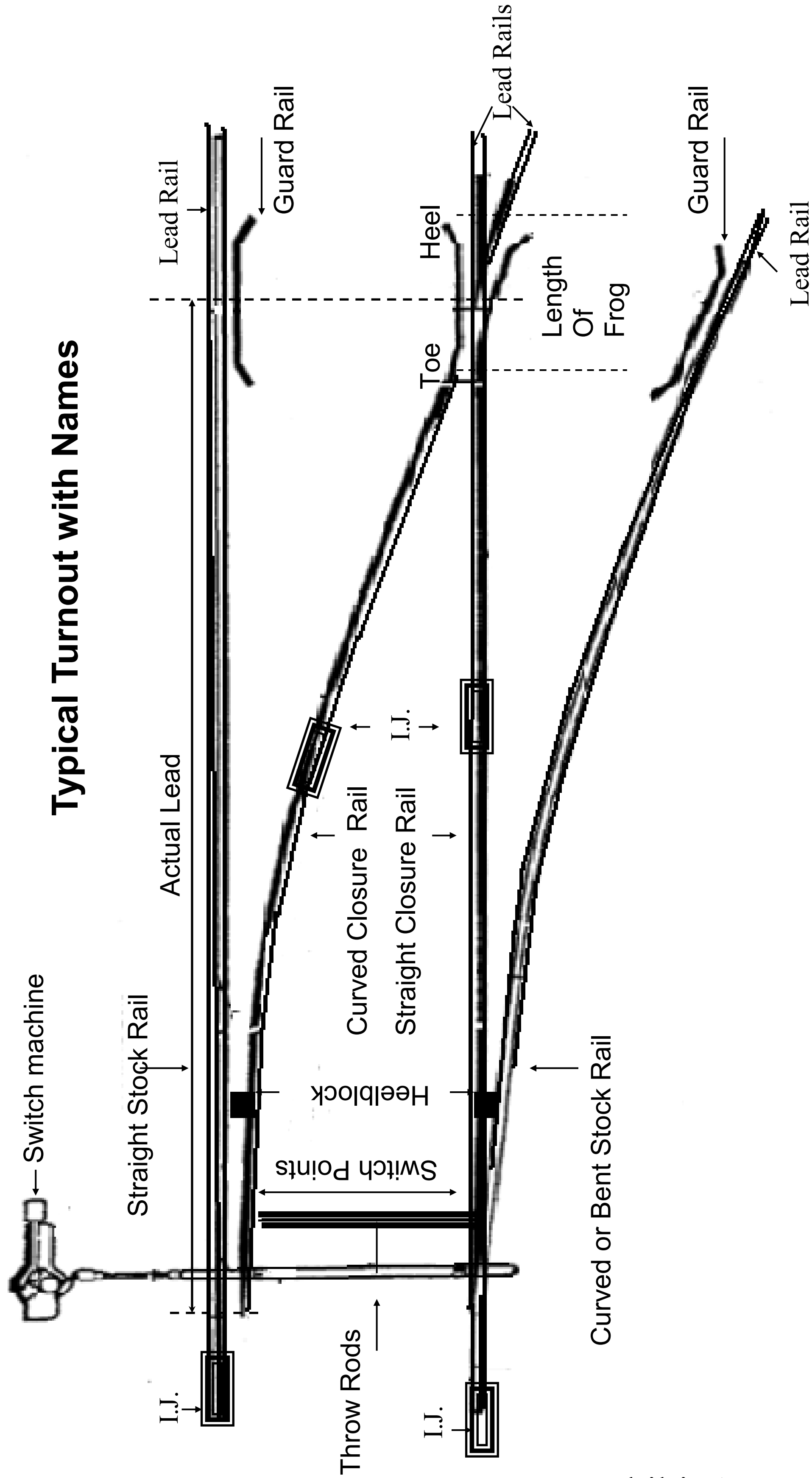
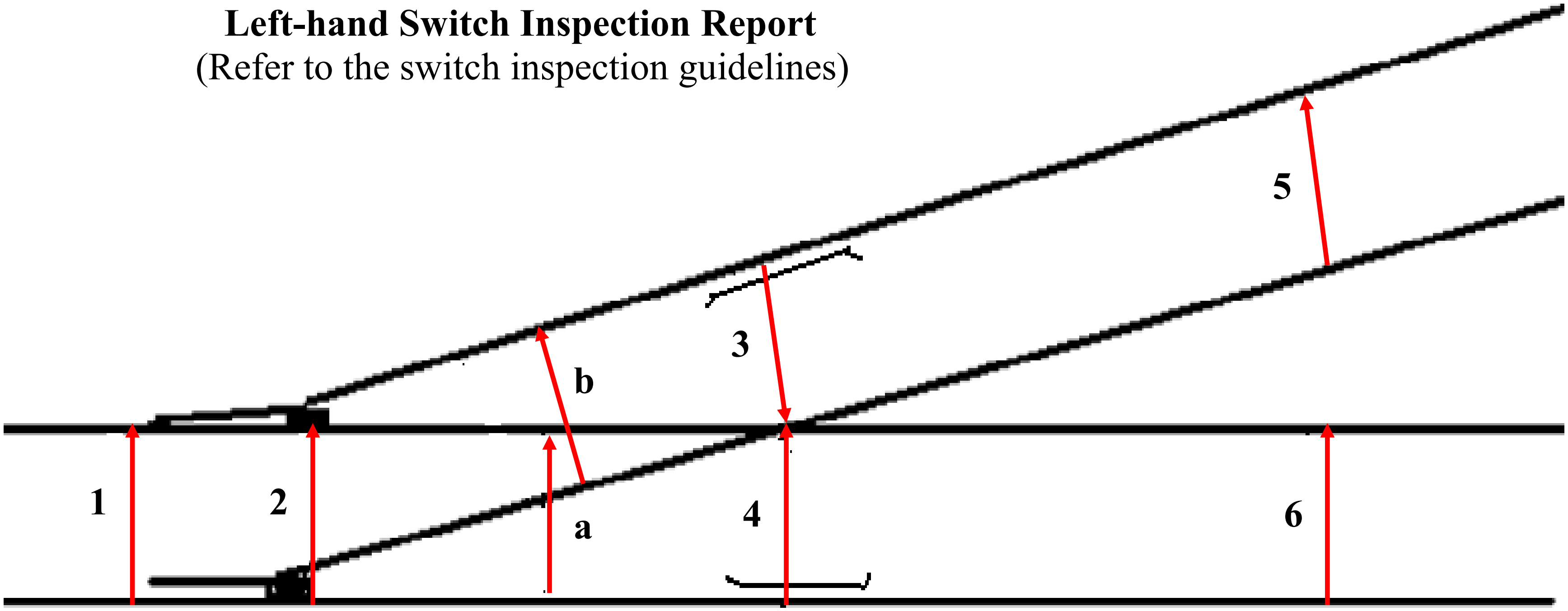


Exhibit 1

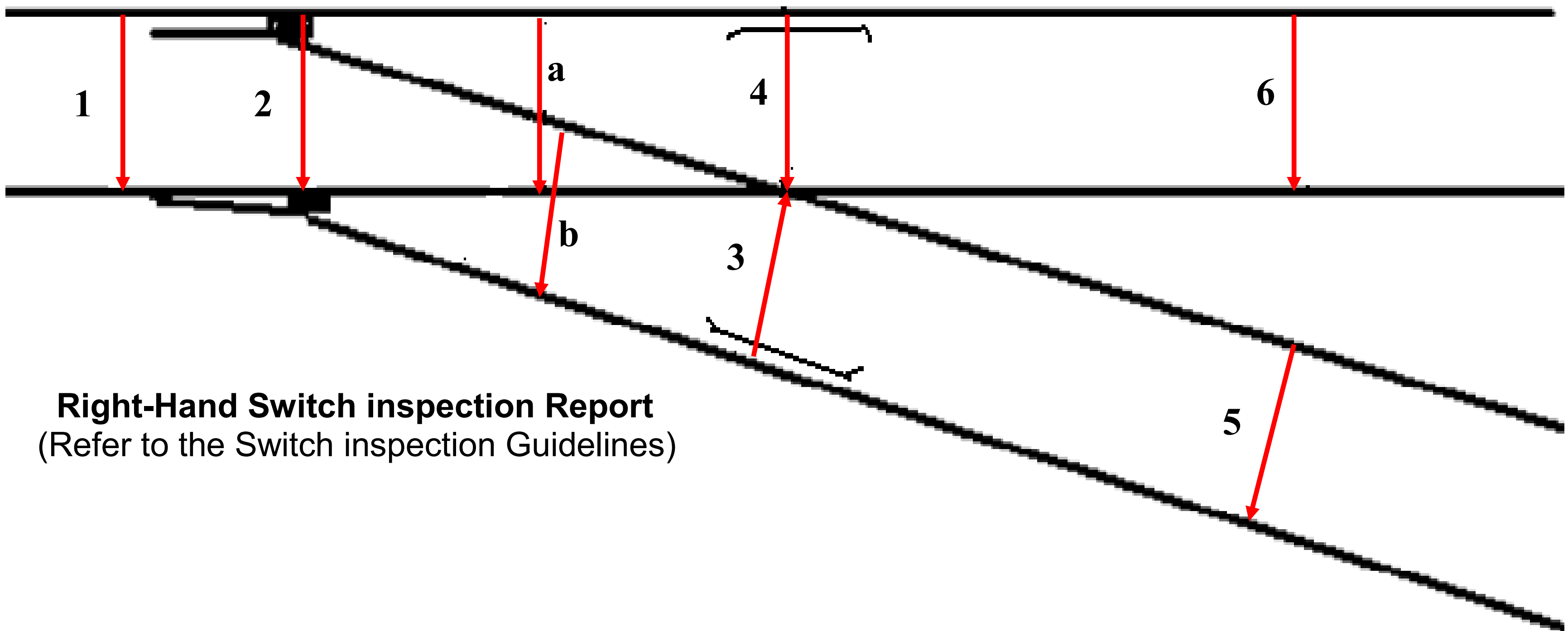
Left-hand Switch Inspection Report

(Refer to the switch inspection guidelines)



# 1.	First fastener or tie immediately preceding the Point of Switch
# 2.	The fastener or tie on the Frog side of the Heelblock
	a) Straight closure rail at the Insulated Joint
	b) Curved closure rail at the Insulated Joint
#3.	6.5 inches behind the ½ inch point of Frog on the reverse side
#4.	6.5 inches behind the ½ inch point of Frog on the straight side
#5.	Last long wooden tie or marked area on Direct Fixation on the reverse side
#6.	Last long wooden tie or marked area on Direct Fixation on the straight side

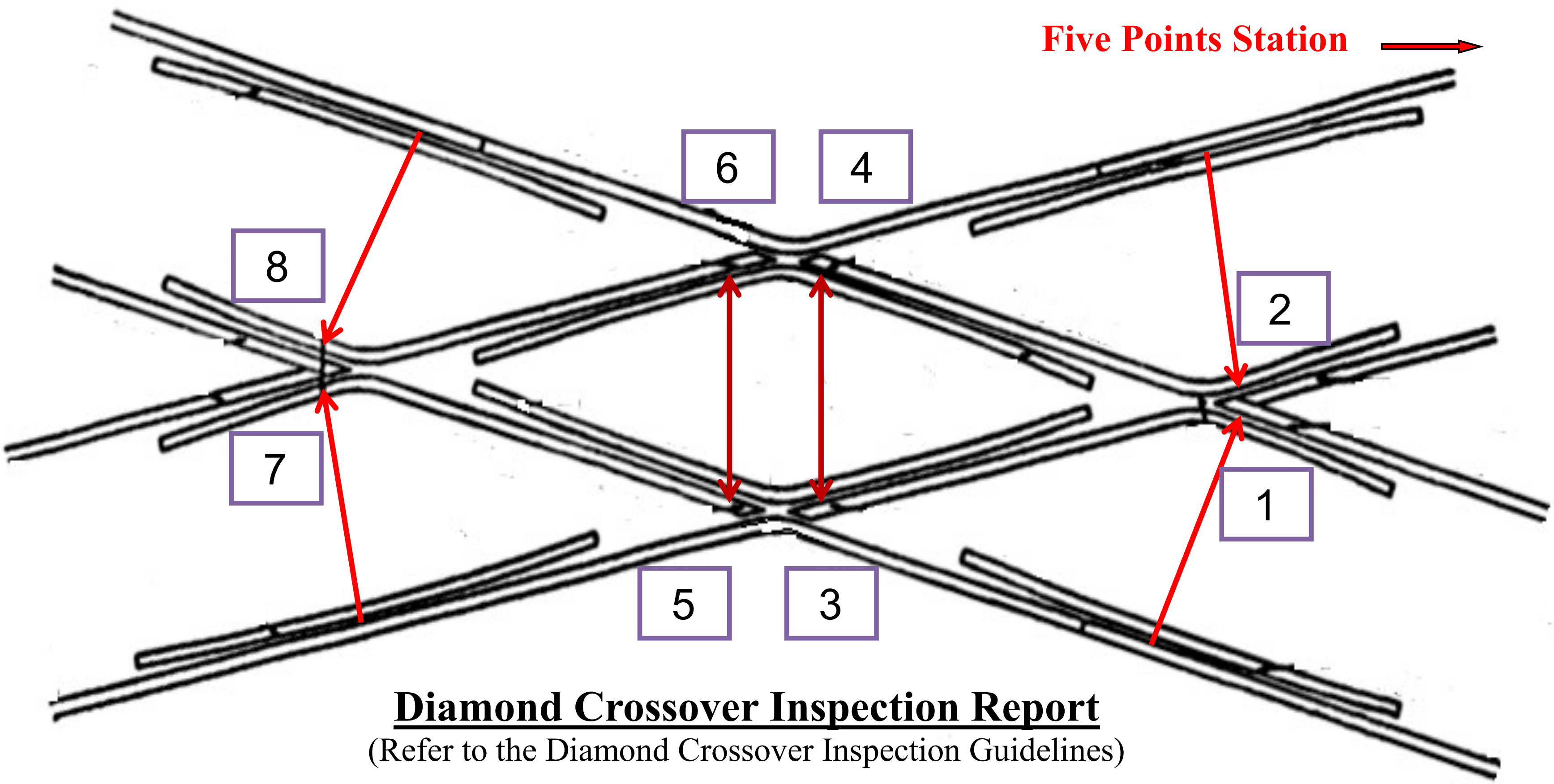
Exhibit 2



Right-Hand Switch inspection Report
(Refer to the Switch inspection Guidelines)

1. First fastener or tie immediately preceding the Point of Switch
2. The fastener or tie on the Frog side of the Heelblock
a) Straight closure rail at the Insulated Joint
b) Curved closure rail at the Insulated Joint
#3. 6.5 inches behind the ½ inch point of Frog on the reverse side
#4. 6.5 inches behind the ½ inch point of Frog on the straight side
#5. Last long wooden tie or marked area on Direct Fixation on the reverse side
#6. Last long wooden tie or marked area on Direct Fixation on the straight side

Exhibit 3



Diamond Crossover Inspection Report

(Refer to the Diamond Crossover Inspection Guidelines)

Beginning at the frog closest to Five Points Station starting on the left-hand side of the frog.
All readings will be taken at the 6.50 inch mark behind the .50 inch chisel mark of the frog.
All the following measurements will be taken at each of the assigned areas.

Gauge Reading
Crosslevel Reading
Flangway Measurement
Check Gauge Measurement
Guard Face Gauge Measurement

Exhibit 4

Gauge, Check Gauge and Guard Face Gauge Drawing

Two of the Arrows (Gauge & Guard Face Gauge) do not represent the areas where the measurements are taken. **All measurements are taken at the 6.50 inch mark behind the 1/2 inch chisel mark.**

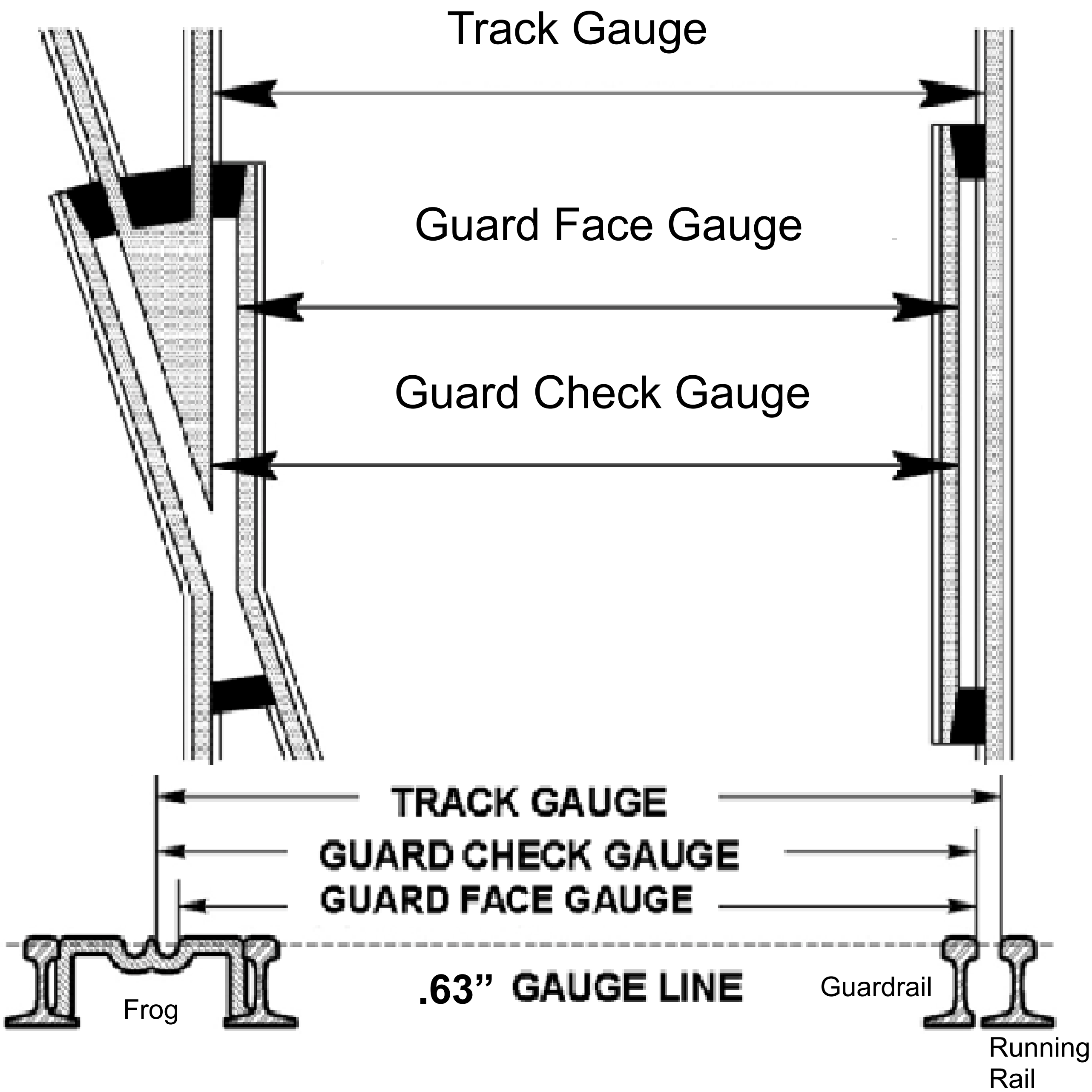


Exhibit 5

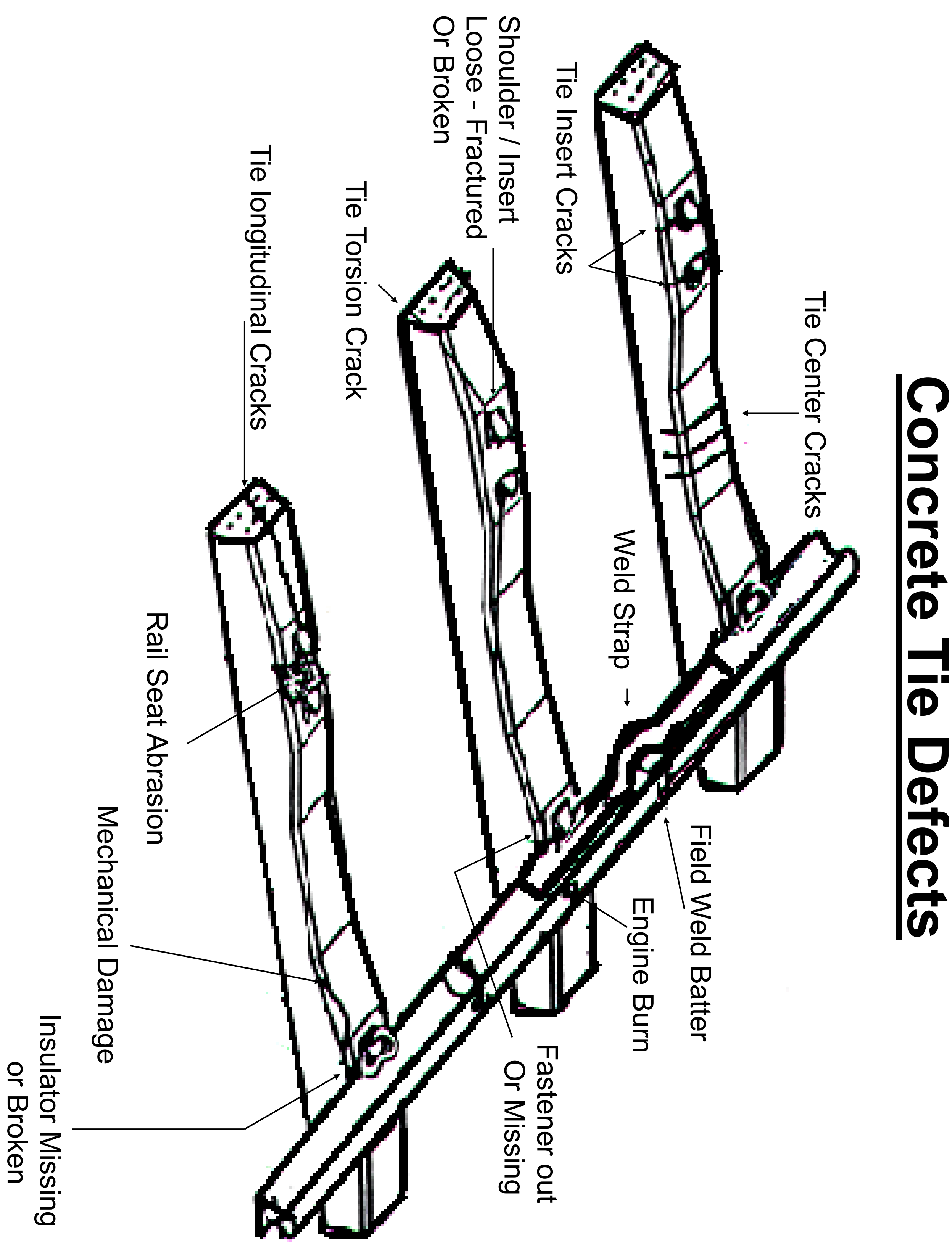

Concrete Tie Defects
Tie Insert Cracks
Shoulder / Insert Loose - Fractured Or Broken
Tie Center Cracks
Tie Torsion Crack
Tie longitudinal Cracks
Weld Strap
Rail Seat Abrasion
Field Weld Batter
Engine Burn
Mechanical Damage
Fastener out Or Missing
Insulator Missing or Broken

Exhibit 6

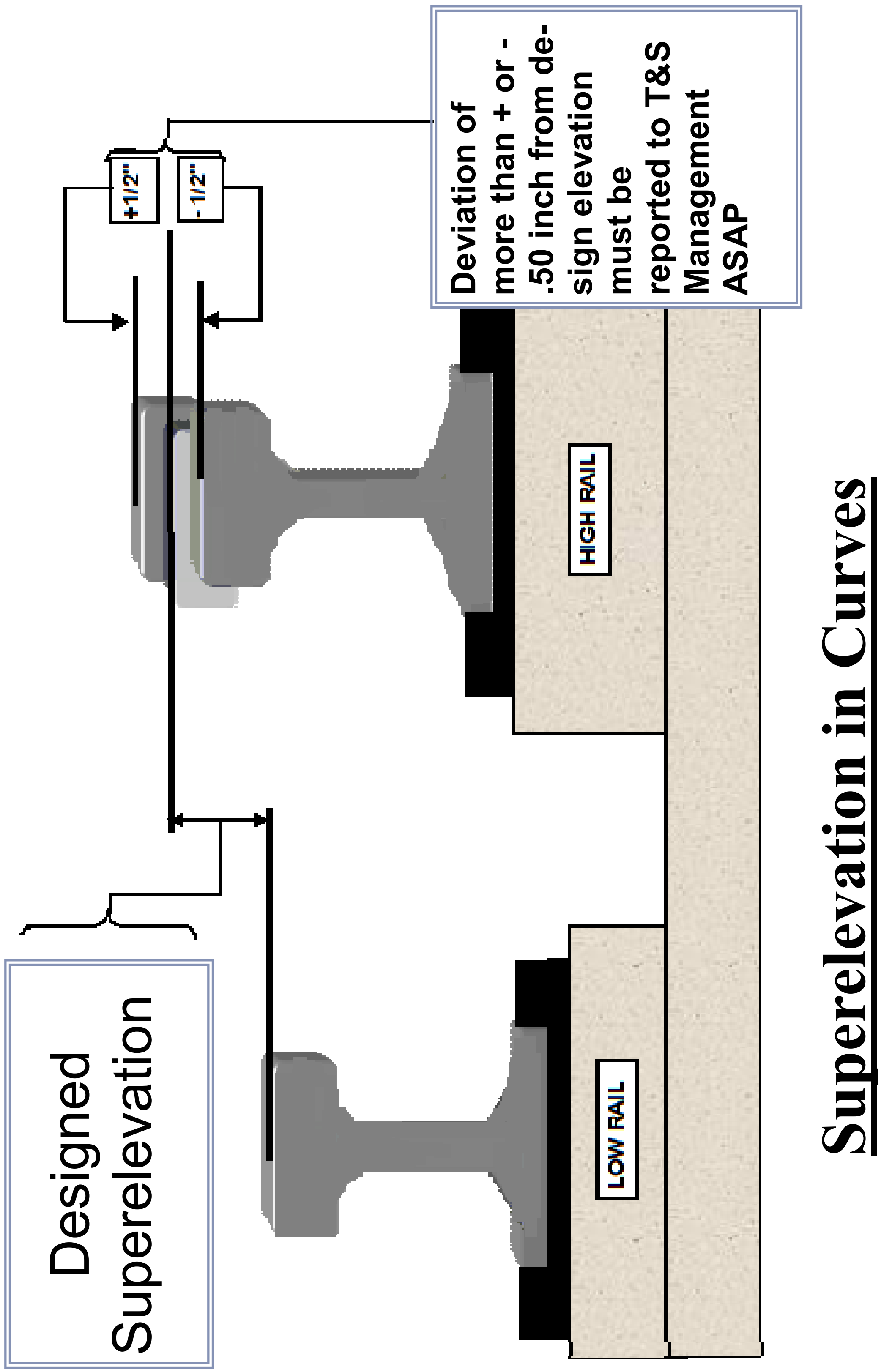
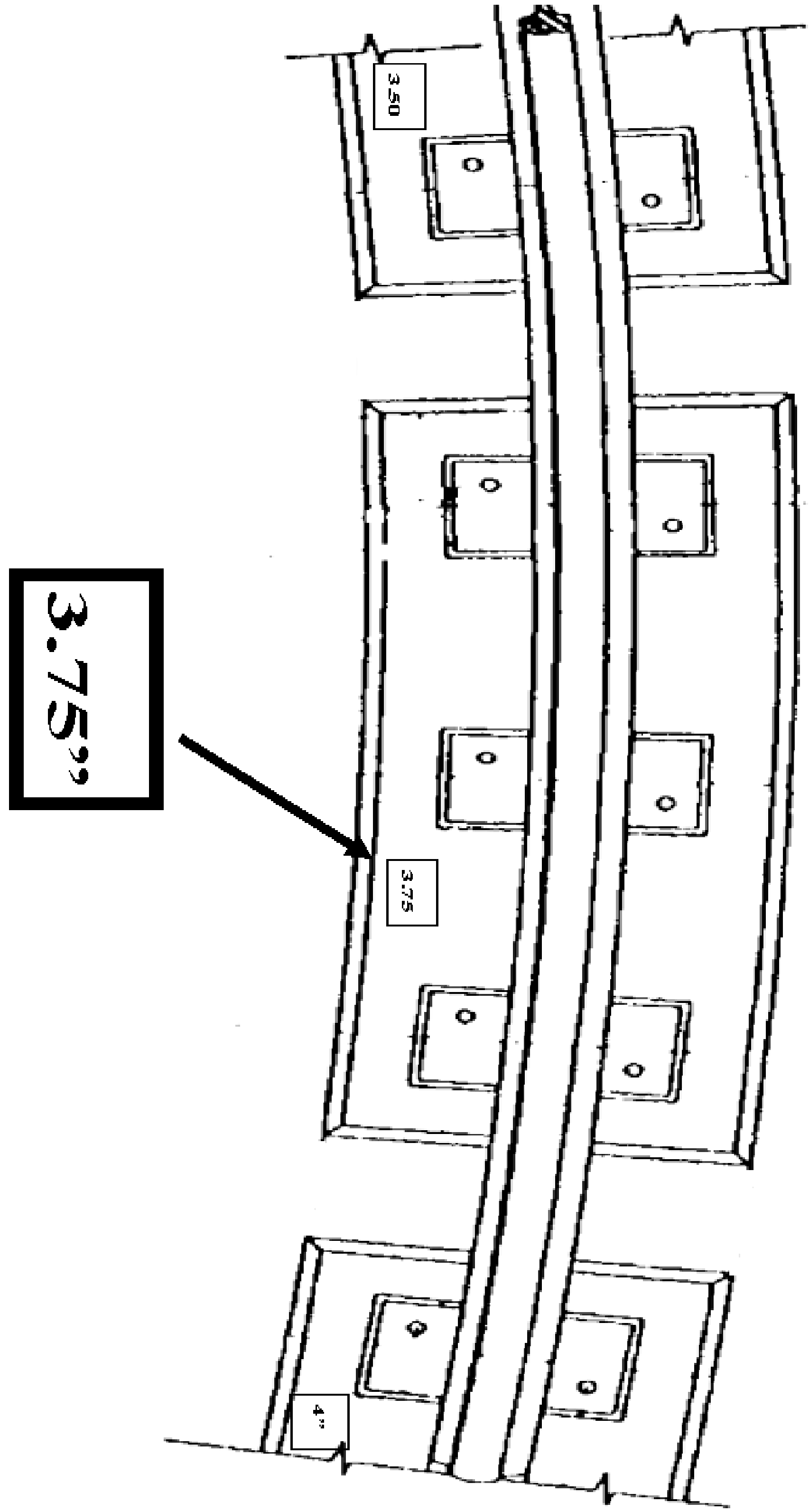

Deviation of more than + or - .50 inch from design elevation must be reported to T&S Management ASAP
+1/2"
- 1/2"
HIGH RAIL
Designed Superelevation
LOW RAIL
Superelevation in Curves

Exhibit 7

Typical Marking of Curve Superelevation



Metal Tags with Embossed Elevation Figures

Exhibit 8

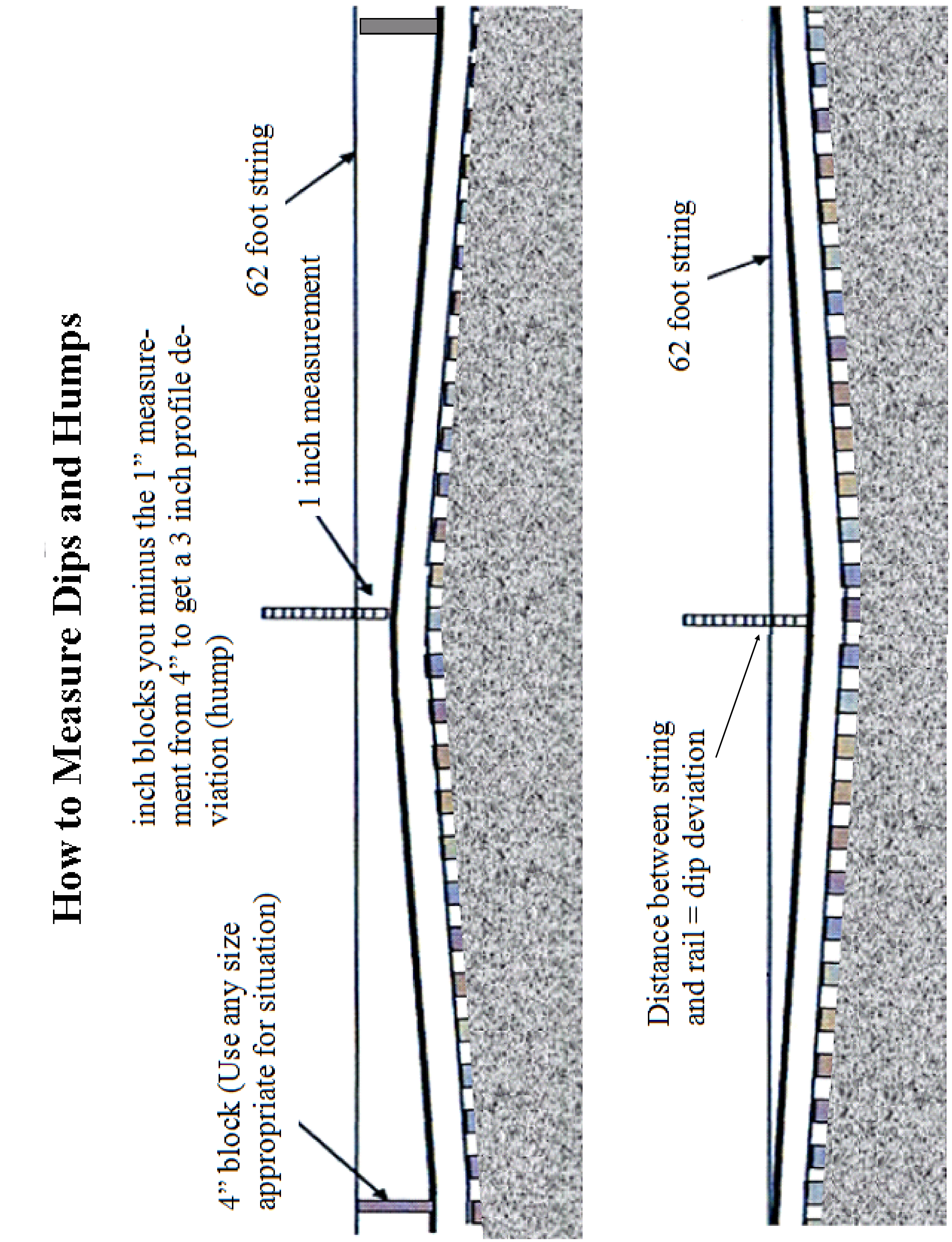

How to Measure Dips and Humps
inch blocks you minus the 1” measure-
ment from 4” to get a 3 inch profile de-
viation (hump)
62 foot string
1 inch measurement
4” block (Use any size
appropriate for situation)
62 foot string
Distance between string
and rail = dip deviation

Exhibit 9

Measuring Track Centers

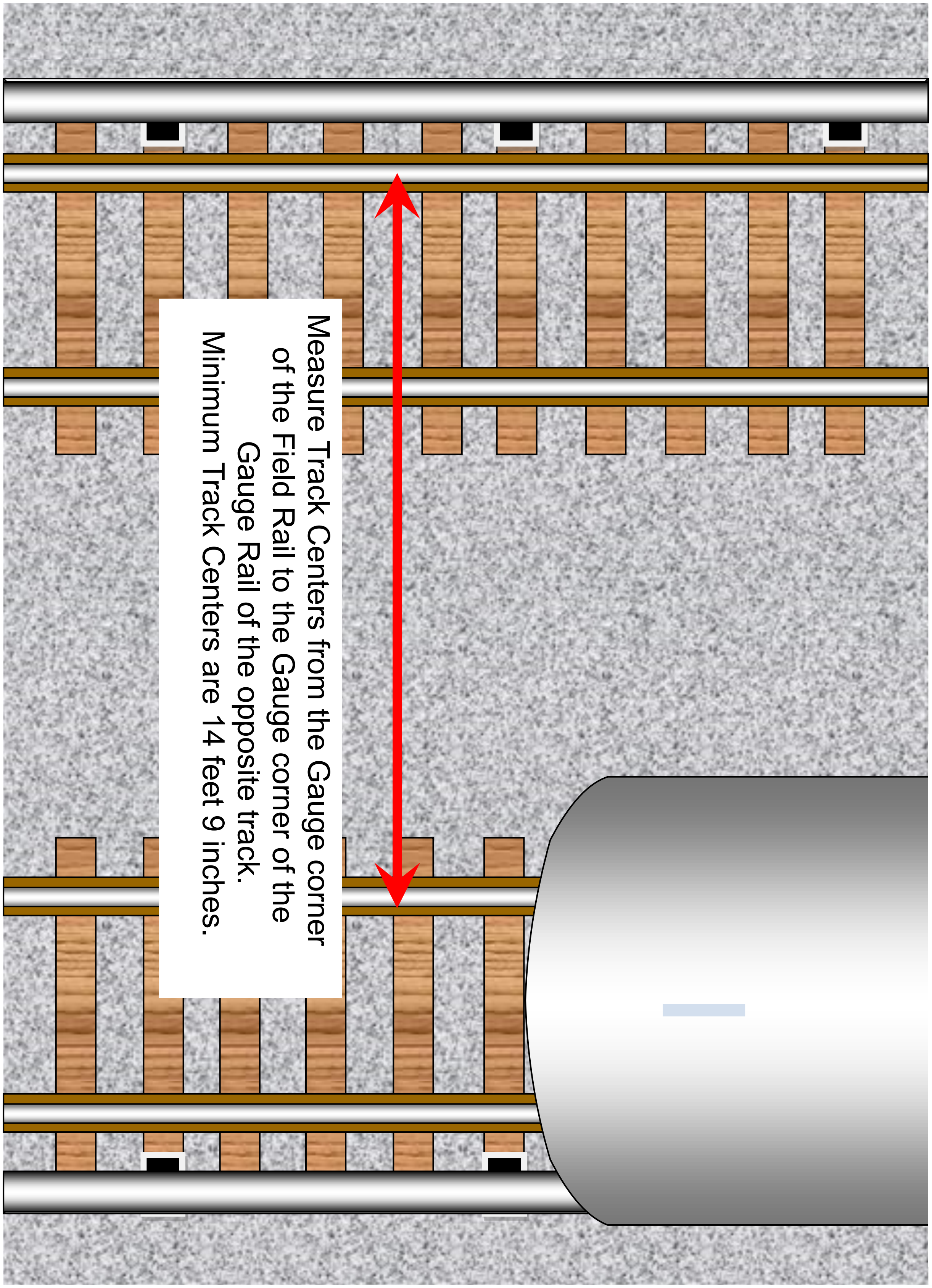
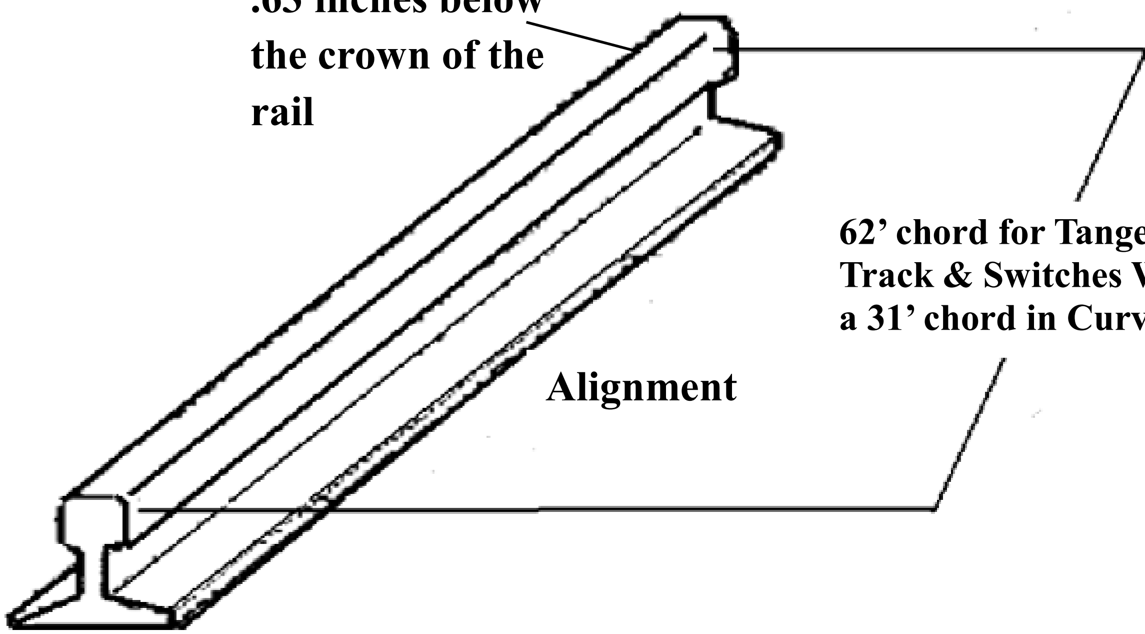
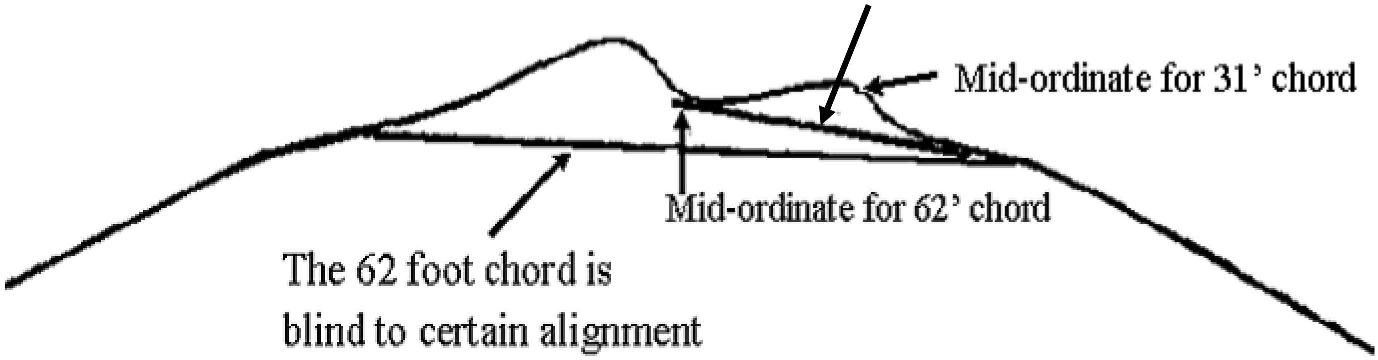


Exhibit 10

Measuring Alignment Deviations on Tangent and Curves





Note: For classes 3 and 4 track, it may be necessary to measure the mid-chord offset for both chords to determine the deviation from uniform (average) alignment.

Exhibit 11

Measuring Line Deviations

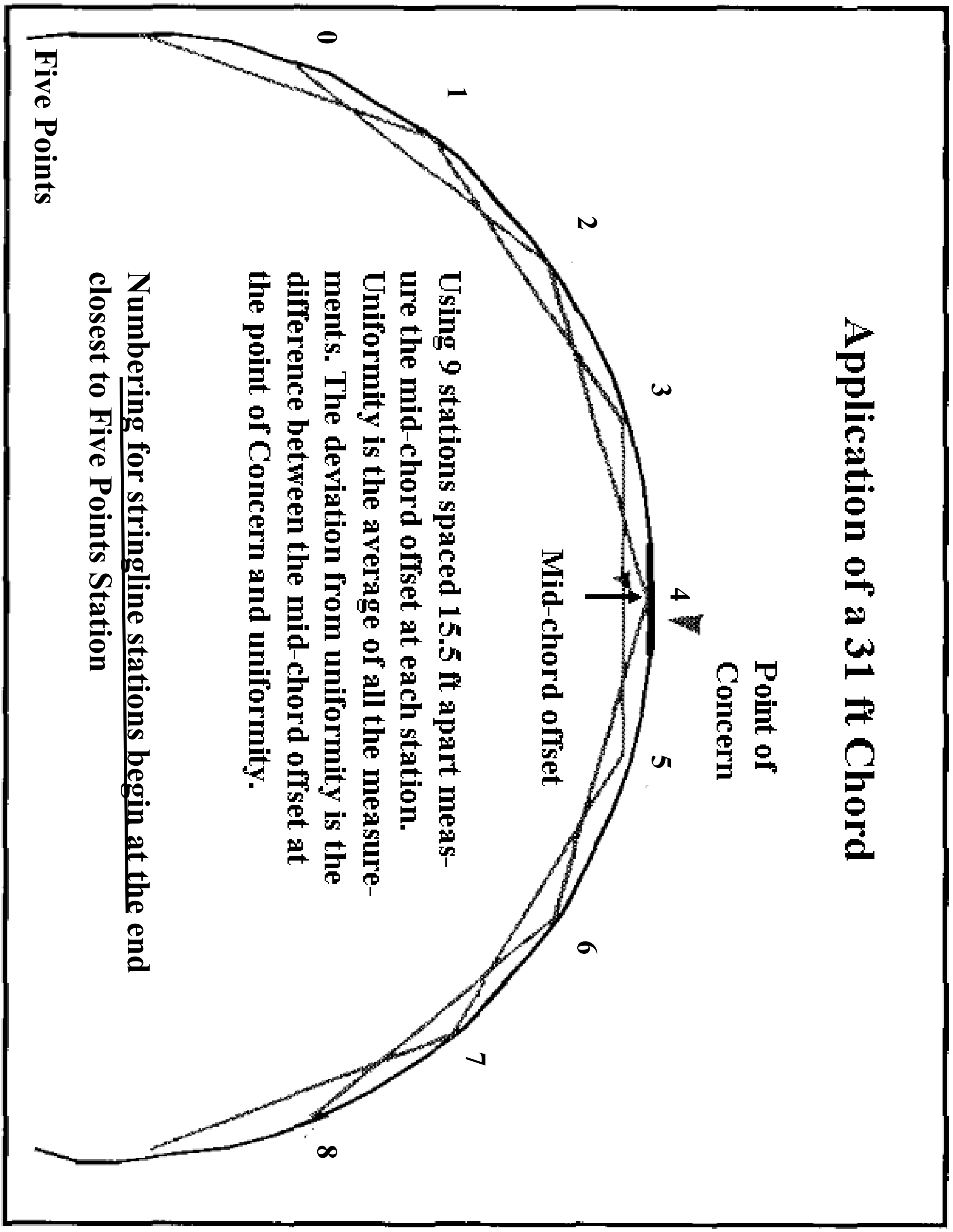


Exhibit 12

Measuring Line Deviations

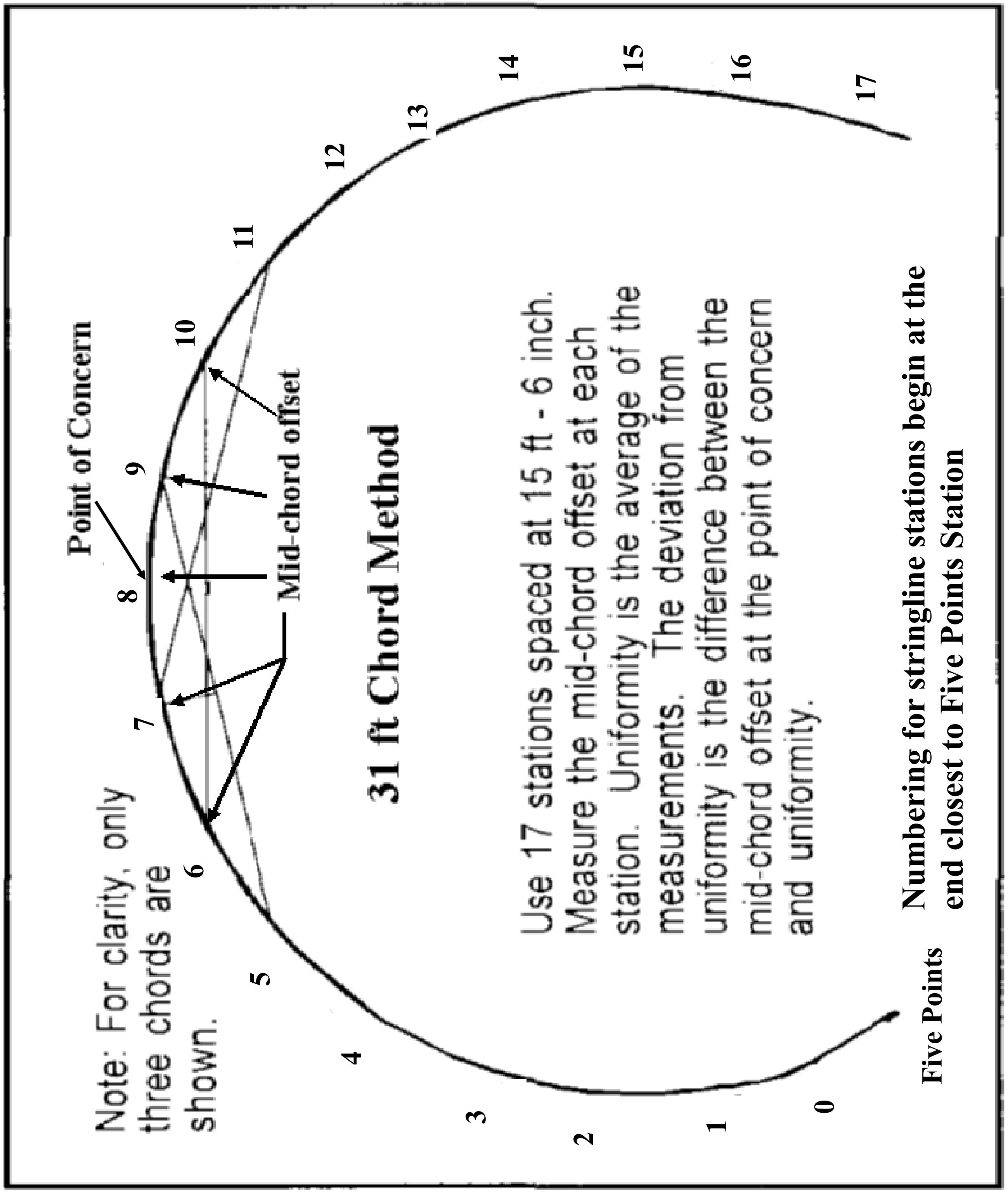


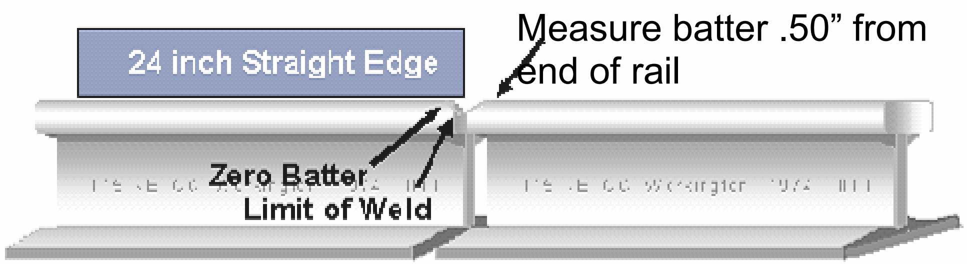
Exhibit 13

Welders Manual

A. Determining limits of Weld

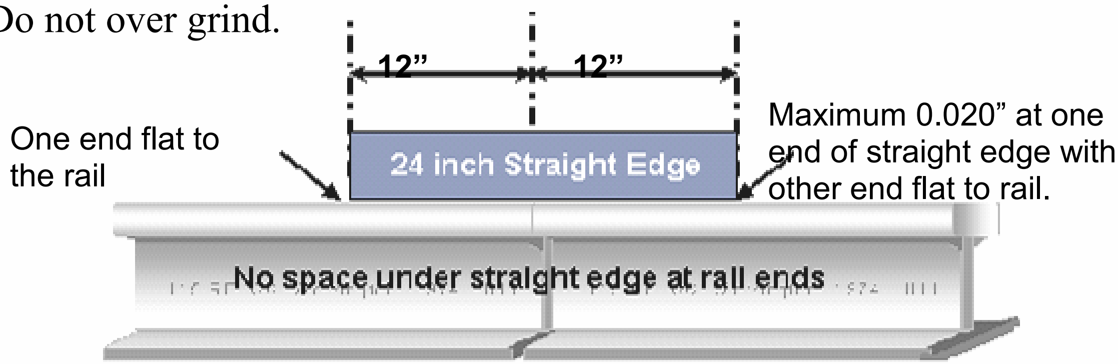
Repairing Rail Ends

Place a 24” straight edge on the end of the rail & mark points where batter is Zero (0). This is the limit of the weld. Do this on each rail.

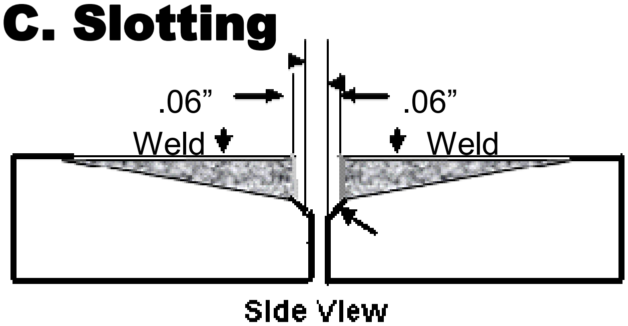


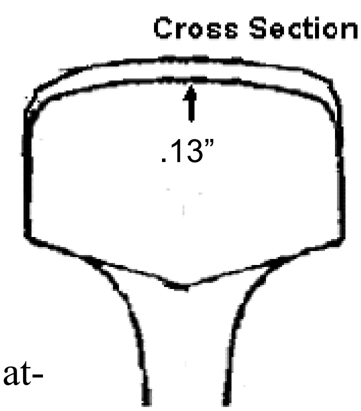
B. Check Finish Grinding

Place 24” straight edge, spaced equally over the rail ends. Rail ends should be straight or with a slight crown, Maximum of 0.010” high. Do not over grind.



C. Slotting

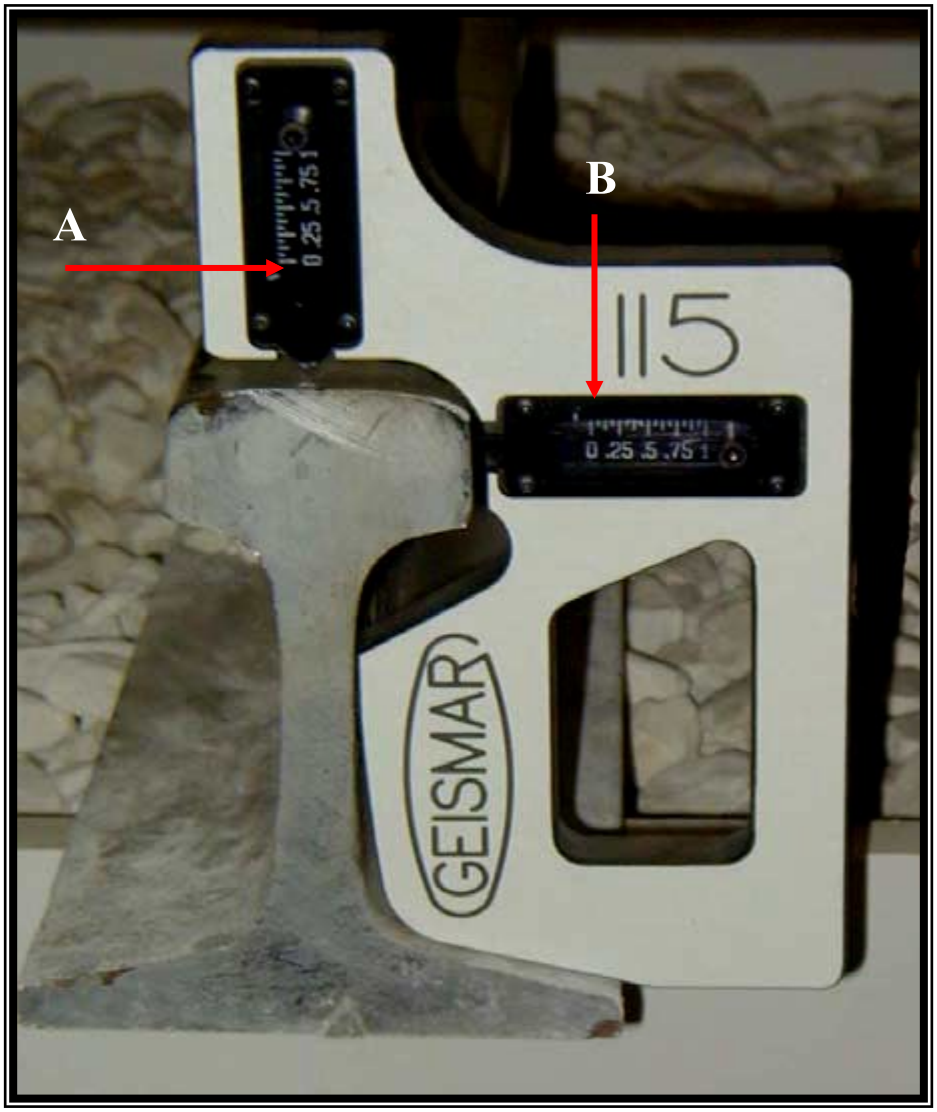




Note. Slotting must be accomplished with the slotting attachment. Freehand slotting is prohibited.

Exhibit 14

Rail Wear Gauge



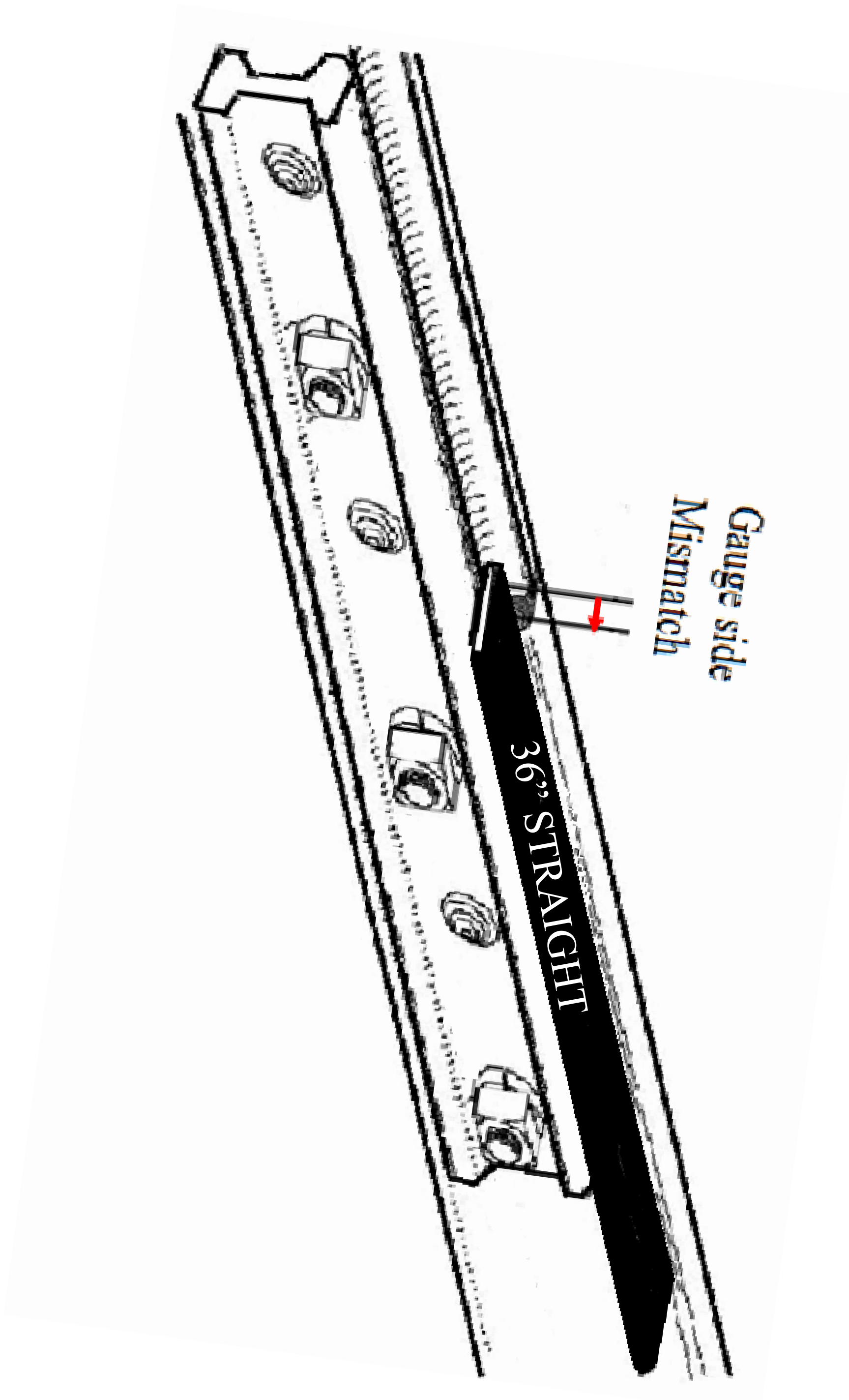
The rail wear gauge is inserted on the gauge side of the rail fitting against the bottom fillet, base and web of the rail.

Head loss is determined by sliding the top gauge indicator **(A)** down so that the feeler touches the top of the rail head. Read the scale to determine the amount of rail head loss.

Gauge face loss id determined by sliding the side gauge indicator **(B)** until the feeler touches the gauge face of the rail head. Read the scale to determine the amount of gauge face wear.

Exhibit 15

Measuring Rail End Mismatch
Rail Surface and Gauge Side of Rail



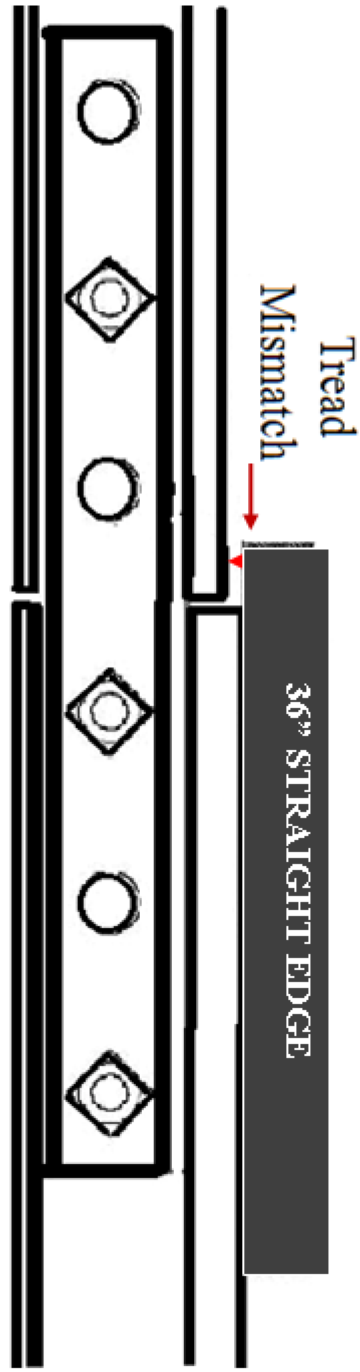
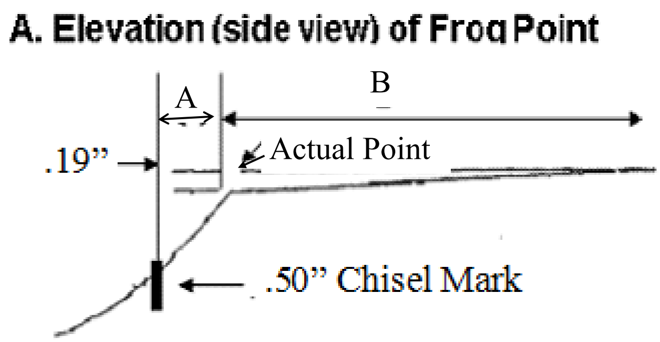


Exhibit 16

Frog Gauge



Frog Number	A	B
8	1”	5”
10	1.25”	5”
15	1.88”	7.50”
20	2.50”	10”

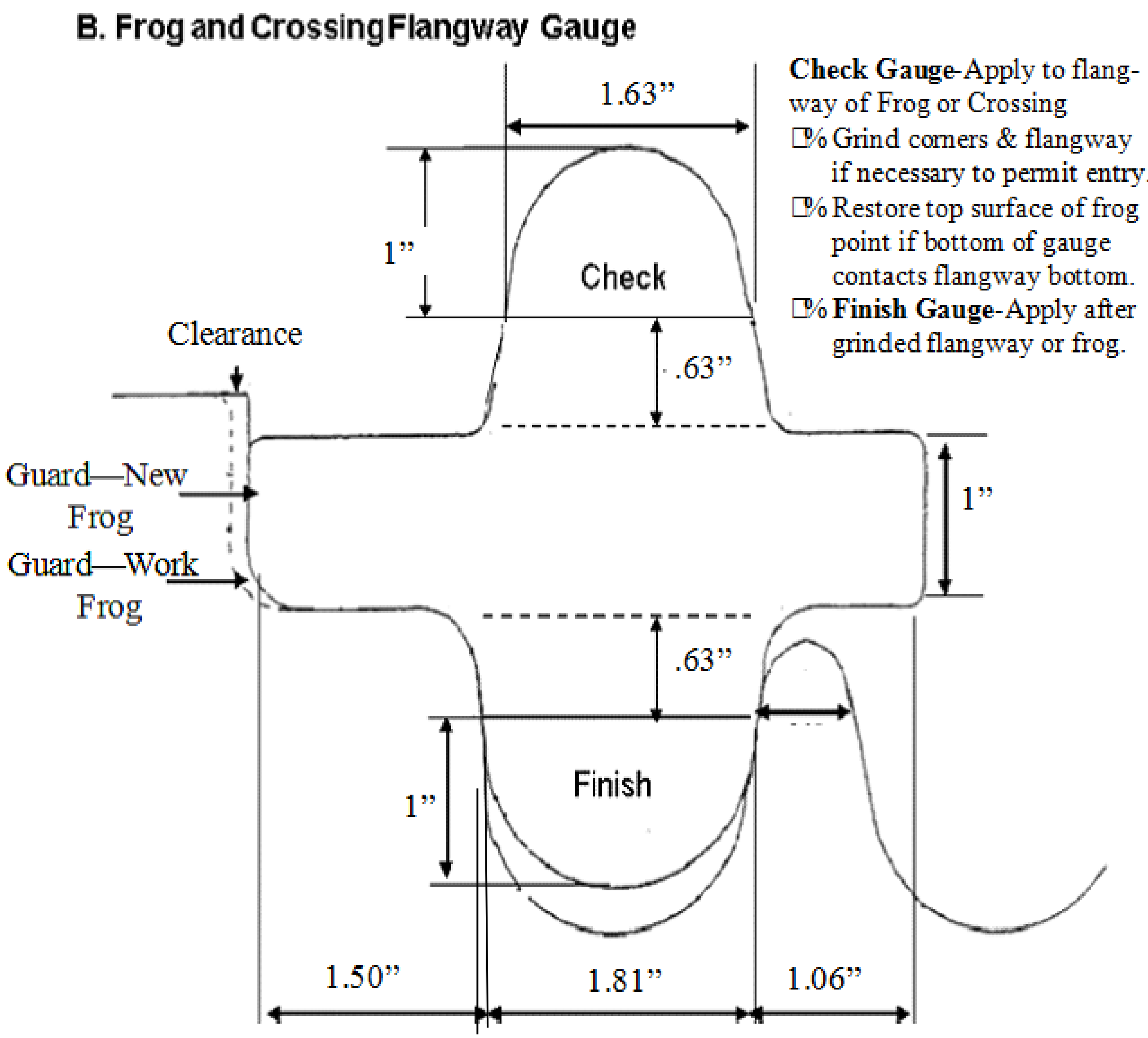


Exhibit 17

Minimal Platform - Trackway Clearances

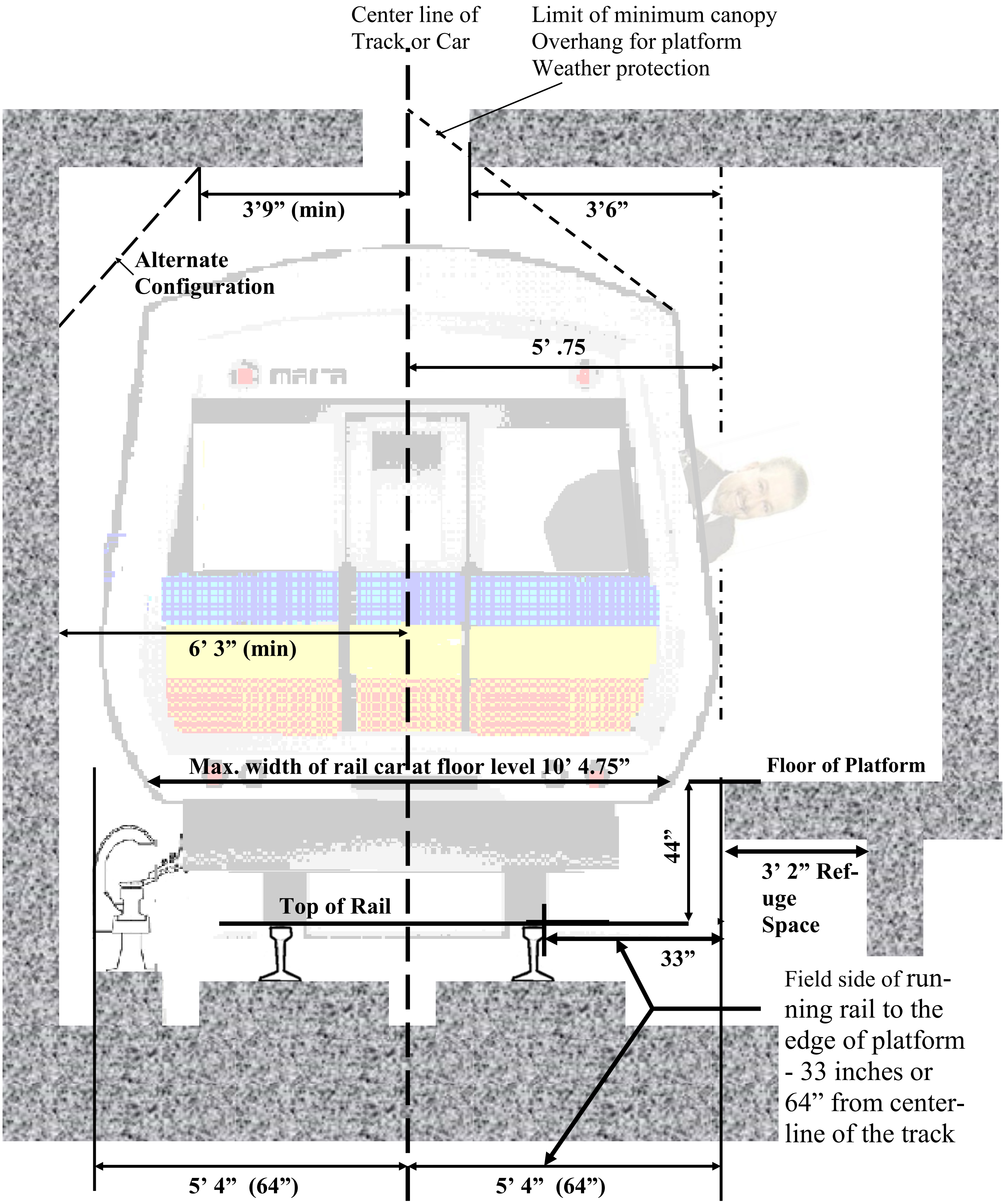
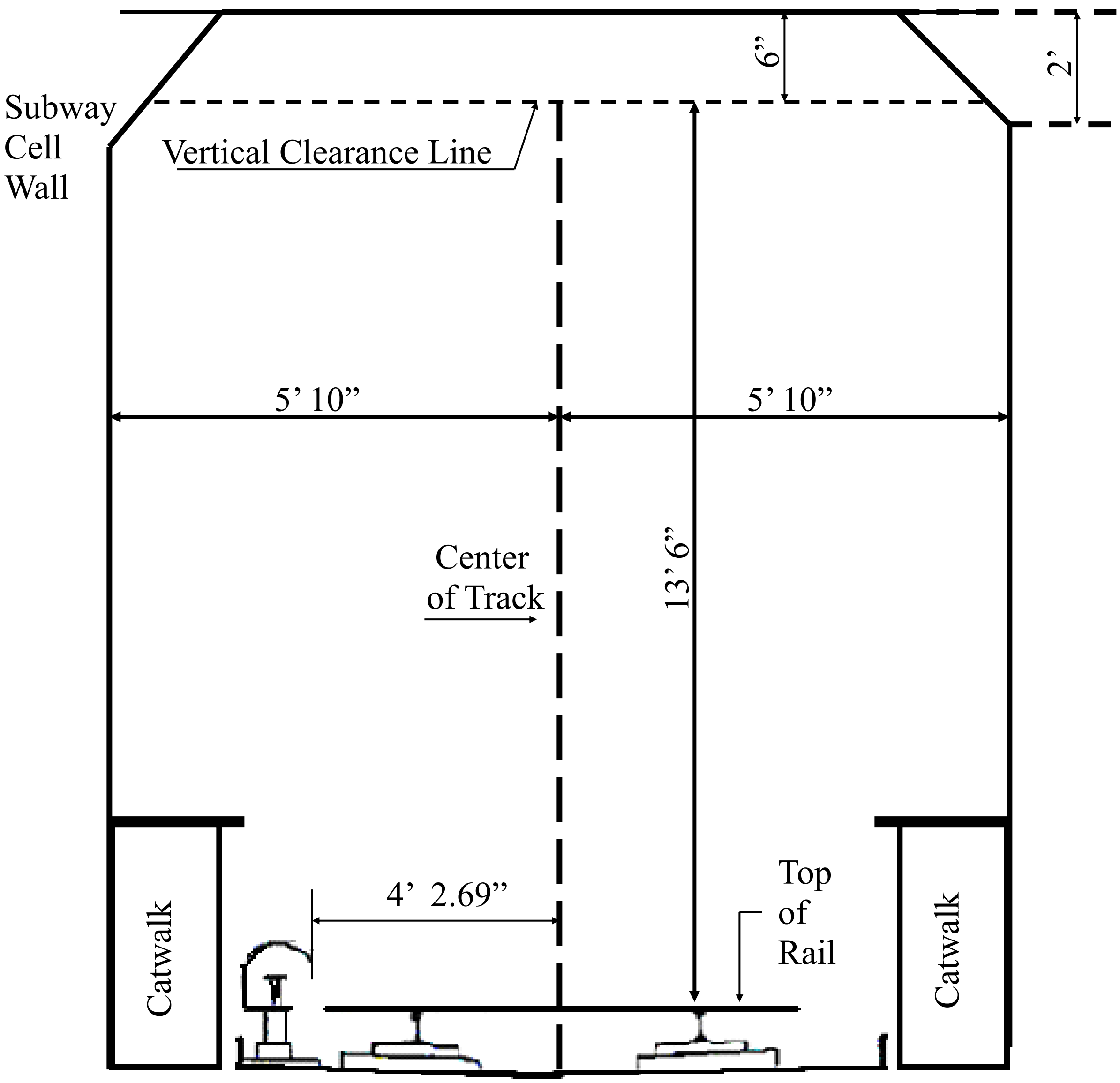


Exhibit 18

Minimum Tunnel Trackway Measurements



All measurements are at minimum standards

Notes:

1. No equipment shall encroach below the plane of the top of the rails while traveling.
2. Clearances have been modified on curves to accommodate the MARTA vehicle.
3. Track through stations are on Tangent track.

Exhibit 19

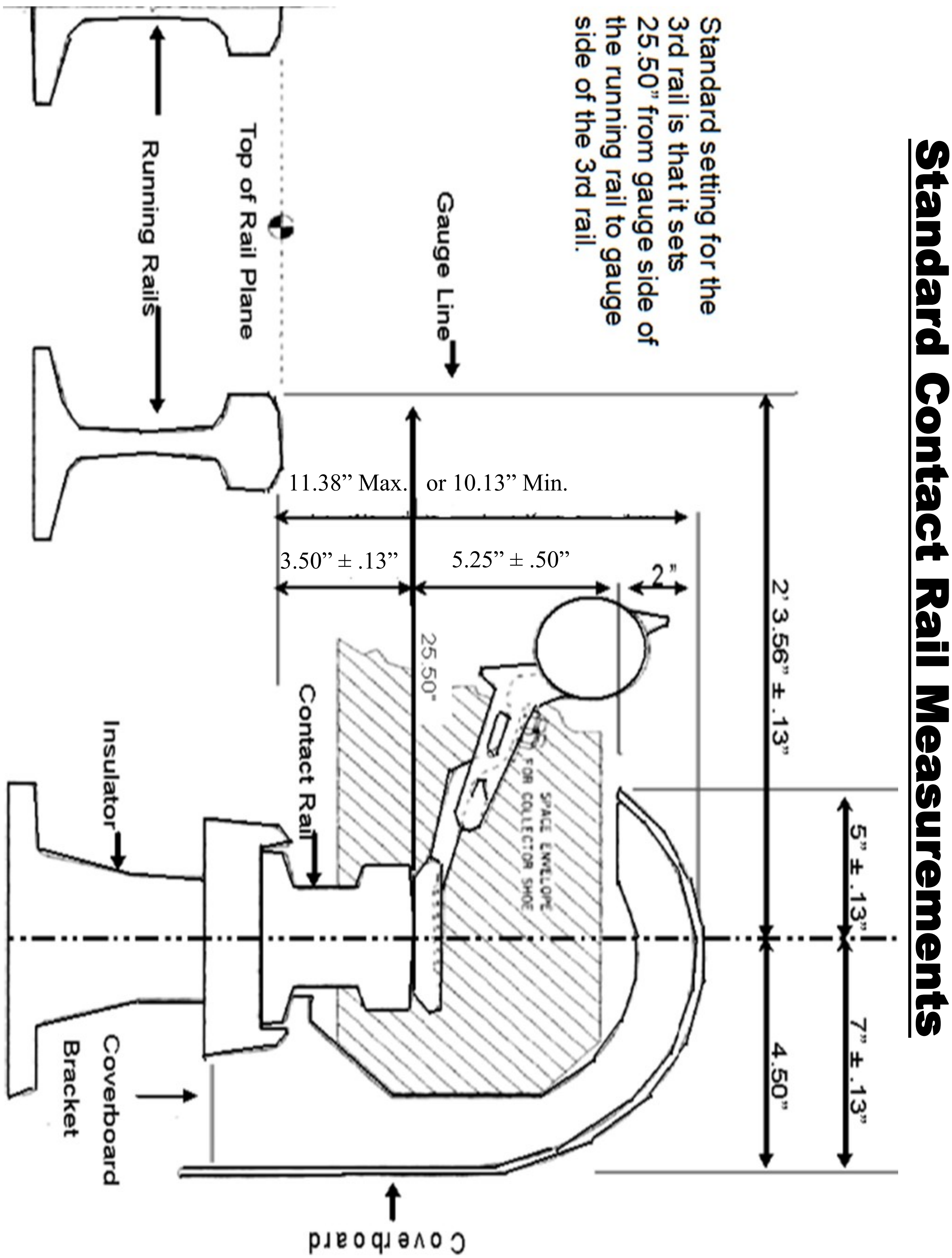
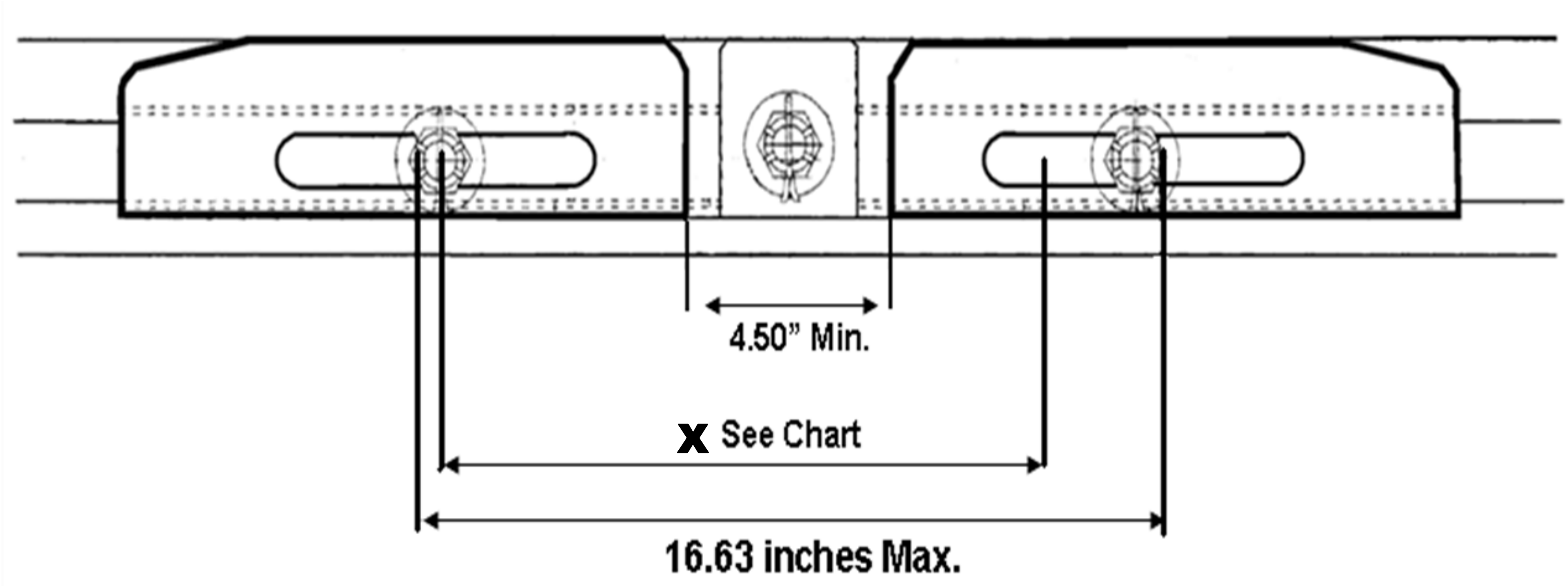

Standard Contact Rail Measurements
Standard setting for the 3rd rail is that it sets 25.50" from gauge side of the running rail to gauge side of the 3rd rail.
Running Rails
Top of Rail Plane
Gauge Line
11.38" Max. or 10.13" Min.
3.50" ± .13"
5.25" ± .50"
2"
25.50"
2' 3.56" ± .13"
5" ± .13"
7" ± .13"
4.50"
SPACE ENVELOPE FOR COLLECTOR SHOE
Contact Rail
Insulator
Coverboard Bracket
Coverboard

Exhibit 20

Third Rail Expansion Joint Gap



Temp. of Contact Rail	-4° F	14° F	32° F	50° F	68° F	86° F	104° F	122° F	140° F	158°F
Dimension X In Inches	16.63	15.38	14	12.63	11.25	9.88	8.50	7.13	5.75	4.50

Exhibit 21

150 Pound Steel Contact Rail

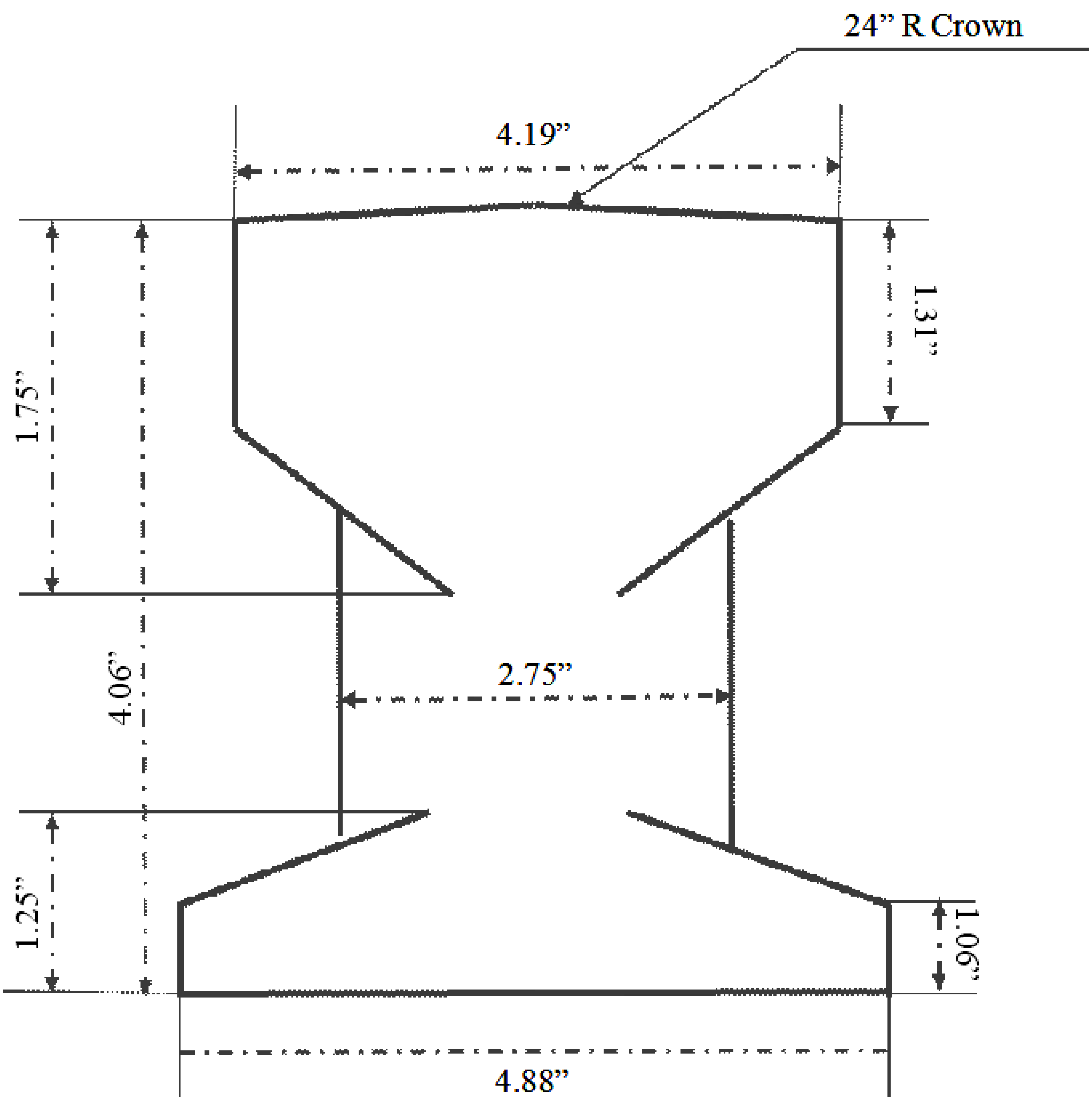


Exhibit 22

115 lb. R. E. Rail

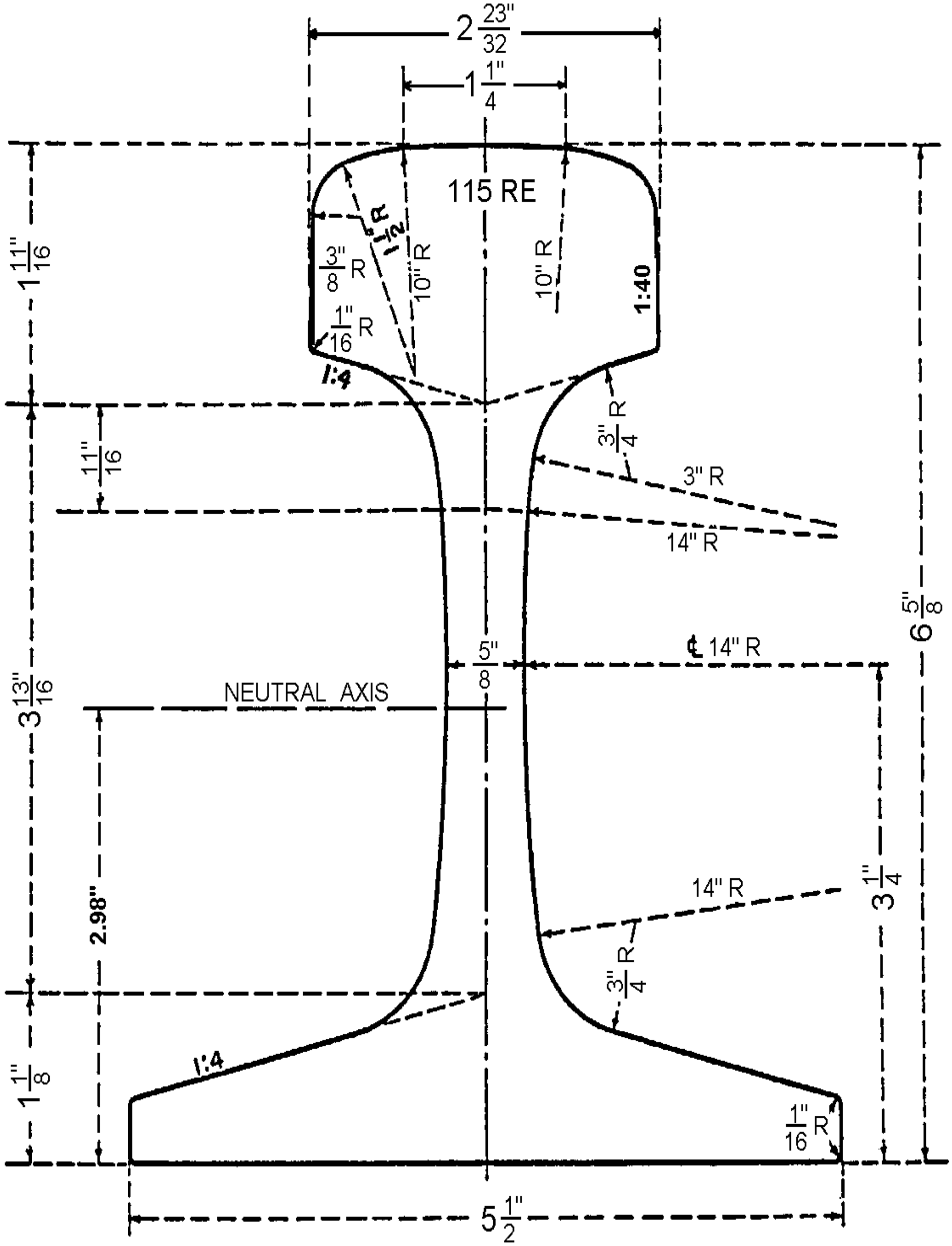
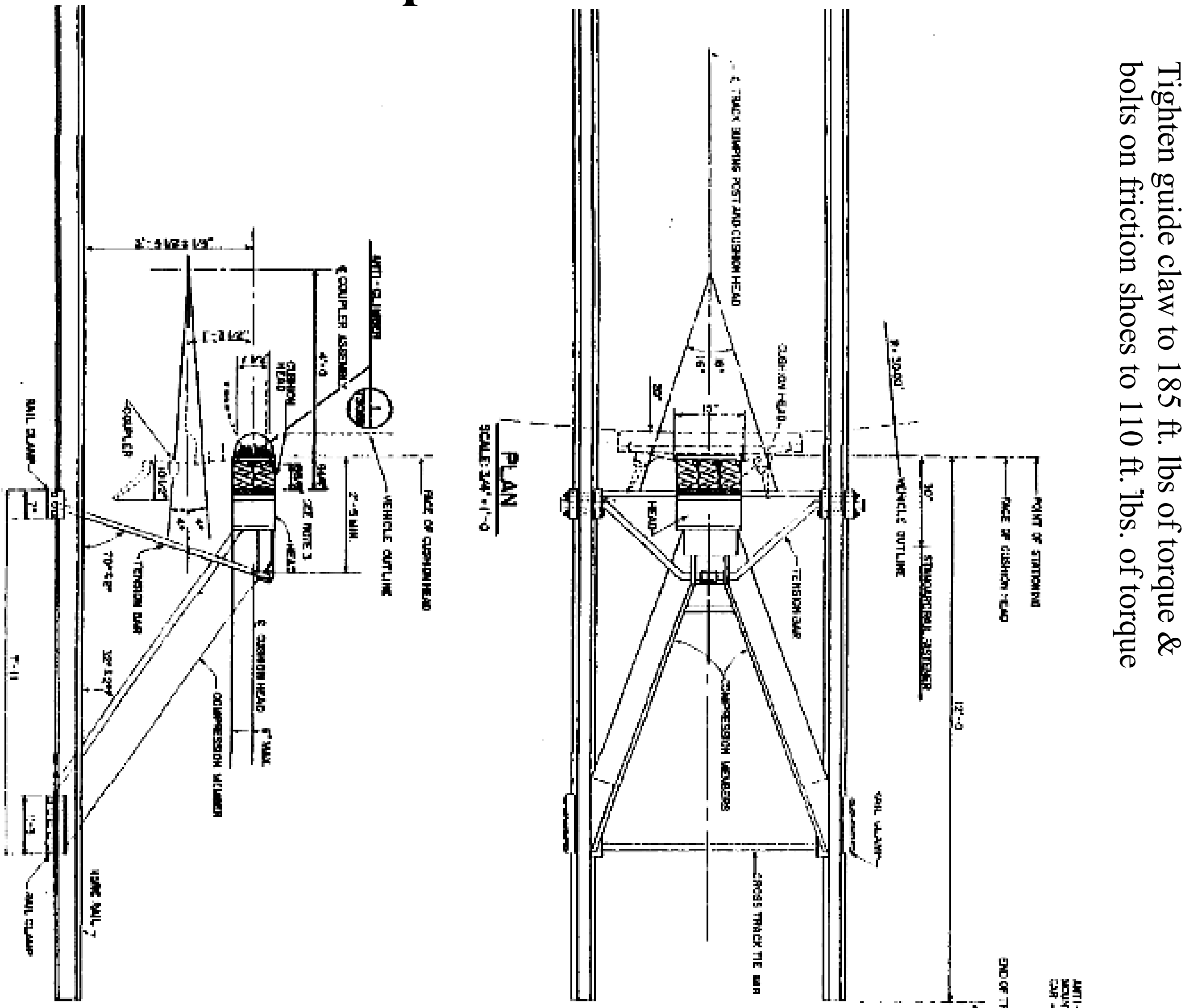
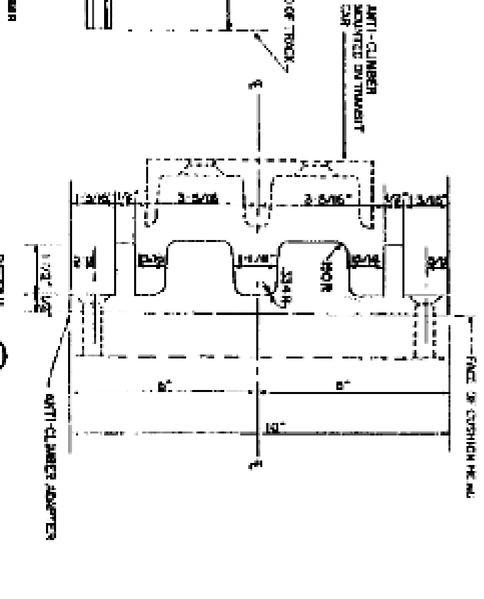


Exhibit 23

Bumper Post Dimensions

Tighten guide claw to 185 ft. lbs of torque & bolts on friction shoes to 110 ft. lbs. of torque





BUMPING POST - DIRECT FIXATION

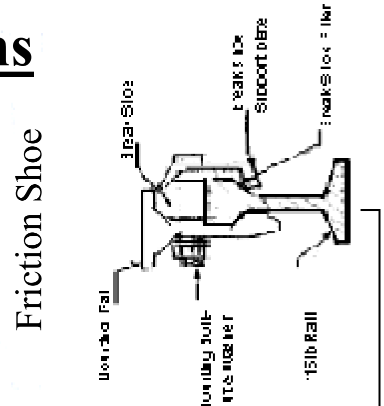
Note:

1. The Bumping Post assembly shall be connected to the Running Rails by use of rail clamps and be suitable for installation on Ballasted or Direct Fixation track.
2. The Bumping post shall be to the General Configuration shown & shall be constructed to have service strength equivalent to the Western-Cullen Hayes Inc. type "WCTS" Bumping Post with shock free head.
3. The cushion head shown is drawn with the springs extended 8.25" in compressed state the spring dimension would be 6.63"

Exhibit 24

Bumper Post Dimensions

Tighten guide claw
to 185 ft. lbs. of torque
Bolts on friction shoes to
100 ft. lbs. of torque



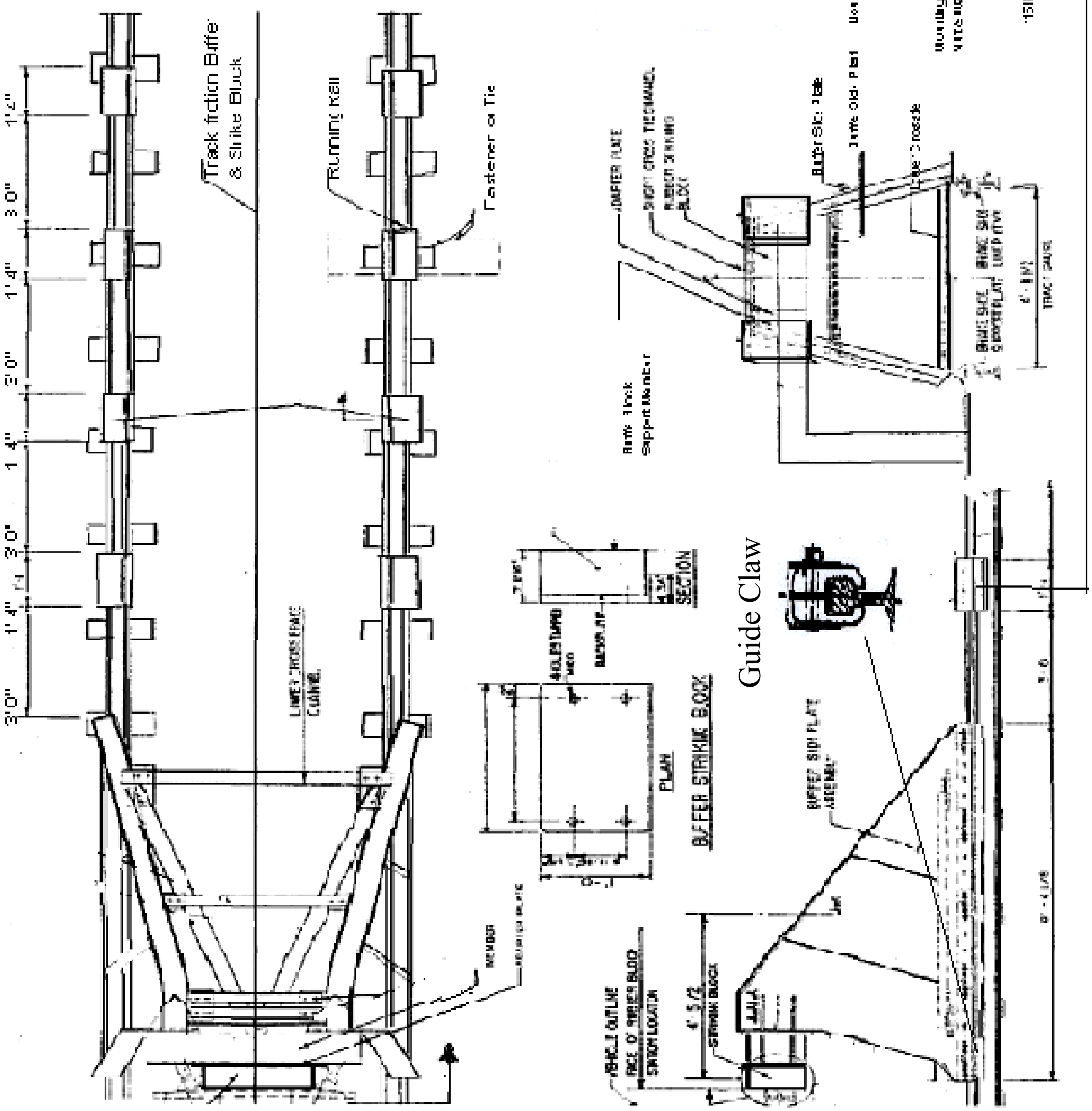


Exhibit 25

MARTA Class of Track & Operating Speeds

Over track that meets all require-ments prescribed in this part for - - -	The allowable operating speed for passenger trains within their class of track is - - -
Class 1 Track	0 to 15 MPH
Class 2 Track	16 to 30 MPH
Class 3 Track	31 to 60 MPH
Class 4 Track	61 to 80 MPH

If a segment of track does not meet all of the requirements for its intended class, (gauge, alignment, surface etc.) that track is reclassified to the next lowest class of track for which it does meet all of the requirements.

Exhibit 26

Converting Fractions to Decimals Chart

Fraction	Decimal		Fraction	Decimal
1/16”	.06”		9/16”	.56”
1/8”	.13”		5/8”	.63”
3/16”	.19”		11/16”	.69”
1/4”	.25”		3/4”	.75”
5/16”	.31”		13/16”	.81”
3/8”	.38”		7/8”	.88”
7/16”	.44”		15/16”	.94”
1/2”	.50”		1”	1.00”

Exhibit 27

Electronic Data Collection

All track defects shall be reported through the FA Suite (Maximus) EAM system. The normal method of defect collection will take place within the Mobile Focus module of FA Suite.

The following information is provided as a guide for using FA Suite/Mobile Focus.

FA Suite Segments are equivalent to MARTA's Rail Lines

Segment ID	Description	Length
E	EAST LINE 5PTS-INDIAN CREEK	56100
EYD	EAST YARD (AVONDALE)	4137
F	F-LINE CANTERBURY-	52466
IC	INTERLINE CONNECTOR	3114
N	NORTH LINE 5PTS-	33359
NE	NE-LINE CANTERBURY-	41898
NYD	NORTH YARD (ARMOUR)	12576
P	P-LINE ASHBY-BANHEAD	8208
S	SOUTH LINE 5PTS-AIRPORT	50100
SYD	SOUTH YARD	8350
W	WEST LINE 5PTS-HOLMES	27000

Electronic Data Collection (Track Assets/Equipment)

Finding linear equipment information in the FA Suite system I accomplished through the Linear Assets Primary Information function found in the Enterprise Portal under Equipment Units/Linear Assets. All track assets begin with the prefix "TRK". By using "TRK" and the "%" sign as a wildcard, all track assets will be displayed. Other filters allow you to narrow your search such as the "Maintenance Class" in which you can sort tracks by TRK-MAIN for mainline tracks, TRK-SECOND for secondary tracks and TRK-YARD for yard tracks.

The table below shows MARTA's 14 Main Tracks with their respective marker/offsets (engineering stations).

Equipment ID	From marker ID	From x offset	To marker ID	To x offset
TRK-EL	0	0	56100	0
TRK-ER	0	0	56100	0
TRK-FL	33359	0	85800	0
TRK-FR	33359	0	85800	0
TRK-NEL	33300	59	75100	80
TRK-NER	33282	0	75100	80
TRK-NL	0	0	33300	59
TRK-NR	0	0	33200	82
TRK-PL	8791	0	17000	0
TRK-PR	8791	0	17000	0
TRK-SL	0	0	50100	0
TRK-SR	0	0	50100	0
TRK-WL	0	0	27000	0
TRK-WR	0	0	27000	0

Electronic Data Collection (Switch Assets/Equipment)

All switch/turnouts assets begin with the prefix “QDR”. By using “QDR” and the “%” sign as a wildcard, all switch assets will be displayed. The equipment ID for MARTA’s switches contain abbreviations that inform the user of the interlocking and track that the switch is associated with. Classes allow filtering by switch size. Example: The class “TRK-T0-DF-10” retrieves all #10 switches that are on Direct Fixation Track. Likewise, “TRK-TO-BAL-10” would retrieve all #10 turnouts found on ballasted track.

If you are looking for a switch at Canterbury Junction, “QDRCANT%” would display all switches at Canterbury. The QDR is an acronym used for “quadrant” which is how a switch or turnout is displayed in the Optram System. Following the QDR is CANT which represents Canterbury Junction and following the CANT you will find individual tracks and switch numbers, i.e. QDRCANTNR13, QDRCANTNL27, QDRCANTNR17, QDRCANTNL23 for the DXO at Canterbury interlocking.

A table is found on the following page listing all interlockings enabling the user to easily find any switch/turnout in the system.

Electronic Data Collection (Switch Assets/Equipment)

Prefix	Interlocking	Prefix	Interlocking
QDR20TO	20 TO	QDREY	Avondale Yard
QDRAPT	Airport	QDRGAR	Garnett
QDRARM	Armour Main	QDRGAST	Georgia State
QDRARTS	Arts Center	QDRHOLM	H.E. Holmes
QDRASHBY	Ashby	QDRHOLTB	Holmes Turnback
QDRAVDXO	Avondale DXO	QDRKING	King Memorial
QDRAVTHT	Avondale Throat	QDRLAKE	Lakewood
QDRBANK	Bankhead	QDRLENX	Lenox
QDRBKHD	Buckhead	QDRLIND	Lindbergh
QDRCANT	Canterbury	QDRMED	Medical Center
QDRCHAM	Chamblee	QDRMOZPK	Mozley Park
QDRCIVIC	Civic Center	QDRNLND	Northland
QDRCPRK	College Park	QDRNSPG	North Springs
QDRCY	Chamblee Yard	QDRNY	Armour Yard
QDRDORA	Doraville	QDRPHIL	Phillips Arena
QDRDUN	Dunwoody	QDRSY	South Yard
QDRE145	E145	QDRVINE	Vine City
QDRE147	E147	QDRWEND	West End
QDREPT	East Point		

Electronic Data Collection (Structural Assets/Equipment)

Structural and other wayside assets can be retrieved using the same principles as with Track and Switches. Listed below are prefixes that will aide in retrieving Track and Structure assets.

BRG-Aerials and Bridges
TUN-Tunnels
PKD-Parking Decks
LUB-Rail Lubricators
CABR-Car Bridge

Electronic Data Collection (Other Assets/Equipment)

ATC and EP&E have wayside assets. Below are some examples that will aide in entering service requests for other MOW assets.

SIG-Signals	LGT-Tunnel Lights
TCR-Train Control Room	DPS-Dispatch Push Button
IMP-Impedance Bond	TKC-Track Circuit
INT-Interlocking	KEY-Key-by
MRK-Marker Coil	STP – Train Stop
SWH-Switch Machine	ETS– Emergency Trip Stations
FAN-Tunnel Fans	

Remember when entering service requests against rail stations or facilities, the station equipment ID's are line and number designations, i.e. E1=Georgia State, N2=Civic Center, etc.

Only Custodial and Landscape Service requests should be charged at the building level, i.e. equipment ID of "E1". Whenever there is a request for door/gate repair, ceiling slats, water/ roof leaks, use the following equipment ID's that are common to all stations and facilities.

E1-DOOR-01 for all walk-thru doors and gates at Georgia State Rail Station
E1-DOOR-02 for all bay and roll-up doors at Georgia State Rail Station.
N1-WALLS for all walls at Peachtree Center Station a facility.

Electronic Data Collection (Other Assets/Equipment)

N5-ROOF% will display all roofs at the Arts Center Station. Roofs are numbered 01, 02, etc. when multiple roofs belong to
W1-CEILING for the ceiling at Phillips Arena Station
S5-FLOORS for the floor of East Point Station
MOW-PLUM for plumbing in the Maintenance of Way building at Avondale.
W5-MISC for miscellaneous or unknown equipment at Holmes Station. (You should use this equipment number for a BS&E service request if you are unsure of the equipment. This is ideal if you needed to report a strange odor in a stations).

Electronic Data Collection (Symptom Codes)

Once the correct equipment ID has been entered on a service request, there must be a symptom code identifying the problem.

To aide the T&S employee when entering service requests against assets owned by other departments, use the guide below for symptom sorting.

FAC% - This will display facility symptom codes which pertain to Building Support and Equipment, the non-wayside portion of Electrical Power and Equipment and Custodial Landscaping service requests.

WTK%- will display Track Inspection symptom (defect) codes.

WST%- will display Structural symptom (defect) codes.

Electronic Data Collection (Symptom Codes)

WEP%- will display EP&E symptom codes for wayside assets

WTC%- will display ATC symptom codes

CCF%- will display symptom codes for radio, telephone, computer and faregates.

WE1%-for T&S equipment symptoms.

Listing of Track Symptom Codes (WTK%)

Symptom	Name
WTK-2NDPOUR-CRK/DAM	2ND POUR CRACKED OR DAMAGED
WTK-3RDRL-ANCHOR-ADJ	3RD RAIL ANCHOR NEED ADJUSTIN
WTK-3RDRL-ANCHOR-DAM	3RD RAIL ANCHOR DAMAGED
WTK-3RDRL-ANCHOR-LOS	3RD RAIL ANCHOR LOOSE
WTK-3RDRL-ANCHOR-MIS	3RD RAIL ANCHOR MISSING
WTK-3RDRL-BATTERED	3RD RAIL BATTERED
WTK-3RDRL-BURNED	3RD RAIL BURNED
WTK-3RDRL-CABLE-DAM	3RD RAIL CABLE DAMAGE
WTK-3RDRL-CORROSION	CONTACT RAIL CORROSION
WTK-3RDRL-ENDAP-HIGH	3RD RAIL END APPROACH TOO HIG
WTK-3RDRL-ENDAPP-DAM	3RD RAIL END APPROACH DAMAGED
WTK-3RDRL-EXJT-BIND	3RD RAIL EXPANSION JT BINDING
WTK-3RDRL-EXJT-DAM	3RD RAIL EXPANSION JT DAMAGED
WTK-3RDRL-EXJT-HIGH	3RD RAIL EXPANSION JT TO HIGH
WTK-3RDRL-EXJT-WIDE	3RD RAIL EXPANSION JT TOO WID
WTK-3RDRL-ICE	ICE ON CONTACT RAIL
WTK-3RDRL-INSUL-DAM	3RD RAIL INSUL DAMAGED
WTK-3RDRL-INSUL-MISS	3RD RAIL INSUL MISSING
WTK-3RDRL-INSUL-PUMP	3RD RAIL INSUL PUMPING
WTK-3RDRL-NOT-SEAT	3RD RAIL NOT SEATED IN INSUL
WTK-3RDRL-PED-DAM	3RD RAIL PEDESTAL DAMAGED
WTK-3RDRL-PTHD-DAM	3RD RAIL POTHEAD DAMAGE

Electronic Data Collection (Symptom Codes)

Listing of Track Symptom Codes (WTK%) Continued

Symptom	Name
WTK-ALIGNMNET	IRREGULAR ALIGNMENT
WTK-ATAS-DAM-MISS	ATAS DAMAGED OR MISSING
WTK-BAL-CONTAMINATED	BALLAST CONTAMINATED
WTK-BAL-EXCESSIVE	BALLAST EXCESSIVE
WTK-BAL-LOW	BALLAST LOW
WTK-BOLT-DAMAGE	BOLT DAMAGED/BURNED
WTK-BOLT-LOOSE/BROKE	LOOSE OR BROKEN BOLT
WTK-BOLT-MISS/CRK	MISSING OR CRACKED BOLT
WTK-CORROSION	CORROSION OF TRACK COMPONENTS
WTK-CVRBRD-DAMAGE	COVERBOARD/BRACKET DAMAGED
WTK-CVRBRD-MISSING	COVERBOARD/BRACKET MISSING
WTK-DERAILMENT	REPORT OF DERAILMENT
WTK-DRAIN-CLOGGED	TRACKWAY DRAIN CLOGGED
WTK-DRAIN-GRATE-MISS	TRACKWAY DRAIN GRATE MISSING
WTK-ENG-BURN	ENGINE BURN RUNNING RAIL
WTK-EROSION	WAYSIDE EROSION
WTK-FAST-DAMAGED	FASTENER DAMAGED
WTK-FAST-ELAST-SEP	FASTENER ELASTOMER SEPARATION
WTK-FAST-LAT-MOVE	FASTENER LATERAL MOVEMENT
WTK-FAST-LOOSE	FASTENER LOOSE
WTK-FAST-MISSING	FASTENER MISSING
WTK-FAST-PUMPING	FASTENER PUMPING
WTK-FENCE-DAMAGED	TRACKWAY FENCE DAMAGED
WTK-FIRE-WAYSIDE	WAYSIDE-FIRE
WTK-FRGPT-DAM/WORN	FROG POINT DAMAGED
WTK-FRGWG-DAM/WORN	FROG WING DAMAGED OR LOW
WTK-GAUGE-TIGHT	TIGHT GAUGE
WTK-GAUGE-WIDE	WIDE GAUGE
WTK-HANDRL-MISS/BR	HANDRAIL MISSING/BROKEN/LOOSE

Electronic Data Collection (Symptom Codes)

Listing of Track Symptom Codes (WTK%) Continued:

Symptom	Name
WTK-HEELBLOCK	HEELBLOCK WORN OR DAMAGED
WTK-LOSSLINE-HANG	HANGING/FALLEN LOSSY LINE
WTK-PROFILE/SURFACE	IRREGULAR PROFILE/SURFACE
WTK-RAIL-BATTERED	RUNNING RAIL BATTERED
WTK-RAIL-BRK/CRK	BROKEN OR CRACKED RUNNING RAI
WTK-RAIL-BURN	RUNNING RAIL BURN
WTK-RAIL-CORROSION	RUNNING RAIL CORROSION
WTK-RAIL-CORRUGATE	RAIL CORRUGATION
WTK-RAIL-DAMAGED	RUNNING RAIL DAMAGED
WTK-RAIL-FLAKING	RUNNING RAIL FLAKING
WTK-RAIL-FLATTENED	RUNNING RAIL FLATTENED
WTK-RAIL-FLOWED	RUNNING RAIL FLOWED
WTK-RAIL-HEADCHECK	RUNNING RAIL (HEADCHECKING)
WTK-RAIL-KINK	KINKED/BUCKLED RUNNING RAIL
WTK-RAIL-LUBE-EXCESS	EXCESSIVE RAIL LUBRICATION
WTK-RAIL-LUBE-INOPER	RAIL LUBRICATOR INOPERABLE
WTK-RAIL-MISMATCH	RUNNING RAIL END MISMATCH
WTK-RAIL-PIPED	RUNNING RAIL PIPED
WTK-RAIL-SHELLING	RUNNING RAIL SHELLING
WTK-RAIL-SLIVER	RAIL SLIVER RUNNING RAIL
WTK-RAIL-WORN	RUNNING RAIL WORN
WTK-RAILJT-BAR-CRK	RAIL JT BAR CRACKED/BROKEN
WTK-RAILJT-BOND	RAIL JT NEEDS BONDING
WTK-RAILJT-C-BOND	RAIL JT C-BOND DAMAGED/MISSIN
WTK-RAILJT-GAP-EXCES	RAIL JT GAP EXCESSIVE
WTK-RAILJT-PULL-PART	RAIL JT PULL APART
WTK-RAILJT-WELDING	RAIL JT NEEDS THERMIT WELDING
WTK-ROUGH-RIDE	ROUGH RIDE
WTK-SWPT-CRK/DAM	SWITCH POINT CRACKED/DAMAGED
WTK-SWPT-GAPPED	SWITCH POINT GAPPED
WTK-VEGETATION	VEGETATION/TREE OBSTRUCTION

Electronic Data Collection (Symptom Codes)

Listing of Track Symptom Codes (WTK%) Continued:

Symptom	Name
WTK-WASHER-CRK/MISS	CRACKED OR MISSING WASHER
WTK-XLEVEL	IRREGULAR CROSSLEVEL
WTK-XTIE-GRADE2	GRADE 2 CROSSTIE
WTK-XTIE-GRADE3	GRADE 3 CROSSTIE
WTK-XTIE-GRADE4	GRADE 4 CROSSTIE
WTK-XTIE-GRADE5	GRADE 5 CROSSTIE
WTK-XTIE-PUMPING	CROSSTIE PUMPING

Electronic Data Collection (Test Results)

As previously noted in this procedure concerning the monthly detailed switch measurements, they shall be recorded in FA Suite using the “Test Results” function. This is available through FA Suite’s Enterprise Portal and via Mobile Focus for hand-held applications.

Track personnel should be familiar with this functionality.
All Track Inspection tests are prefixed with “TS4”. As was the case with the other codes, “TS4%” will display all tests developed for Track Inspection.

Electronic Data Collection (Test Results)

Current list of Track Inspection Tests are as follows:

TS4-COL-SHOE - Used to enter Collector shoes found on wayside.

TS4-SW-Measure– Used for monthly detailed marked measurements and will be associated with a work order.

TS4-STATION-INSP– Used to report cleanliness of MARTA's Rail Stations

TS4-SWITCH-DETAIL– Used for detailed switch inspections enabling capital planning and prioritizing.

Track and Structures Test Results will contain an equipment/ asset ID, work order number, test type ID, marker/segment/ offset (if applicable) and completion of all test elements listed for the test.

ATC Track Circuit Track Speeds and Class of Track

East Line

Track	From	Start	To	Stop	MPH	Class
EL	Five PTS	0+0	King	51+93	37	3
EL	King	51+93	Inman	65+43	50	3
EL	King	65+43	Inman	122+51	60	3
EL	Inman	122+51	Candler	195+27	50	3
EL	Candler	195+27	East Lake	247+39	70	4
EL	Candler	247+39	East Lake	253+32	60	3
EL	East Lake	253+32	Decatur	285+50	50	3
EL	East Lake	285+50	Decatur	322+62	60	3
EL	Decatur	322+62	Avondale	408+15	50	3
EL	Avondale	408+15	Kensington	476+72	60	3
EL	Kensington	476+72	Indian Creek	490+45	50	3
EL	Kensington	490+45	Indian Creek	543+10	60	3
EL	Kensington	543+10	Indian Creek	544+50	50	3
ER	Five PTS	0+0	King	58+98	37	3
ER	King	58+98	Inman Park	65+43	50	3
ER	King	65+43	Inman Park	122+80	60	3
ER	Inman Park	122+80	Candler Park	184+38	50	3
ER	Candler Park	184+38	East Lake	253+40	60	3
ER	East Lake	253+40	Decatur	282+85	50	3
ER	East Lake	282+85	Decatur	322+70	60	3
ER	Decatur	322+70	Avondale	379+44	50	3
ER	Avondale	379+44	Kensington	468+60	60	3
ER	Kensington	468+60	Kensington	483+72	50	3
ER	Kensington	483+72	Indian Creek	533+90	60	3
ER	Kensington	533+90	Indian Creek	543+10	50	3
ER	Indian Creek	543+10	Indian Creek	552+60	25	2
ER	Indian Creek	552+60	Turnback	554+50	15	1

West Line

Track	From	Start	To	Stop	MPH	Clas s
WR	Five Pts	0+0	Ashby	90+92	50	3
WR	Ashby	92+50	West Lake	163+48	60	3
WR	West Lake	163+48	Holmes	183+80	50	3
WR	West Lake	183+80	Holmes	242+07	60	3
WR	West Lake	242+07	Holmes	247+83	50	3
WR	Holmes	247+83	Turnback	256+63	37	3
WL	Five Pts	0+00	Phillips	23+34	50	3
WL	Phillips	23+34	Ashby	98+50	50	3
WL	Ashby	98+50	West Lake	163+46	70	4
WL	Ashby	163+46	West Lake	183+50	50	3
WL	West Lake	183+50	Holmes	242+00	60	3
WL	Holmes	242+00	Turnback	254+75	50	3
PR	Ashby	87+50	Bankhead	90+02	37	3
PR	Ashby	90+02	Bankhead	148+00	50	3
PR	Ashby	148+00	Bankhead	157+00	37	3
PR	Bankhead	157+00	Turnback	161+00	25	2
PL	Ashby	87+50	Bankhead	161+00	50	3

North Line

Track	From	Start	To	Stop	MPH	Class
NR	Five PTS	0+00	Midtown	83+06	37	3
NR	Midtown	83+06	Arts Ctr Portal	149+62	50	3
NR	Arts Center	149+62	Lindbergh	161+65	60	3
NR	Arts Center	161+65	Lindbergh	262+15	70	4
NR	Arts Center	262+15	Lindbergh	278+53	60	3
NR	Lindbergh	278+53	Lenox	313+00	50	3
NER	Lindbergh	313+00	Lenox	366+65	60	3
NER	Lenox	366+65	Brookhaven	397+23	50	3
NER	Lenox	397+23	Brookhaven	433+60	60	3
NER	Lenox	433+60	Brookhaven	480+60	50	3
NER	Brookhaven	480+60	Chamblee	621+13	70	4
NER	Chamblee	621+13	Doraville	643+7	50	3
NER	Chamblee	643+7	Doraville	703+40	60	3
NER	Chamblee	703+40	Doraville	728+35	50	3
NL	Five PTS	0+00	Peachtree	8+90	25	2
NL	Peachtree	8+90	North Ave	81+06	37	3
NL	North Ave	81+06	Arts Center	149+62	50	3
NL	Arts Center	149+62	Lindbergh	177+80	60	3
NL	Arts Center	177+80	Lindbergh	272+83	70	4
NL	Arts Center	272+83	Lindbergh	287+11	60	3
NL	Lindbergh	287+11	Lenox	301+65	50	3
NEL	Lindbergh	301+65	Lenox	375+80	60	3
NEL	Lindbergh	375+80	Lenox	411+28	50	3
NEL	Lenox	411+28	Brookhaven	447+50	60	3
NEL	Lenox	447+50	Brookhaven	480+06	50	3
NEL	Brookhaven	480+06	Chamblee	621+13	70	4
NEL	Chamblee	621+13	Doraville	643+72	50	3
NEL	Chamblee	643+72	Doraville	716+53	60	3
NEL	Chamblee	716+53	Doraville	728+35	50	3

400 Line

Track	From	Start	To	Stop	MPH	Class
FR	Lindbergh	278+53	Buckhead	378+70	50	3
FR	Lindbergh	378+70	Buckhead	407+0	70	4
FR	Lindbergh	407+0	Buckhead	423+60	60	3
FR	Buckhead	423+60	Medical Ctr	449+64	50	3
FR	Buckhead	449+64	Medical Ctr	632+0	70	4
FR	Buckhead	632+00	Medical Ctr	646+30	60	3
FR	Medical Ctr	646+30	Dunwoody	740+41	50	3
FR	Dunwoody	740+41	Sandy Springs	784+0	60	3
FR	Sandy Springs	784+0	North Springs	798+66	50	3
FR	Sandy Springs	798+66	North Springs	824+44	60	3
FR	Sandy Springs	824+44	North Springs	833+87	50	3
FR	Sandy Springs	833+87	North Springs	838+92	37	3
FR	Sandy Springs	838+92	North Springs	845+92	25	3
FL	Lindbergh	287+11	Buckhead	382+10	50	3
FL	Lindbergh	382+10	Buckhead	423+60	60	3
FL	Buckhead	423+60	Medical Ctr	453+44	50	3
FL	Buckhead	453+44	Medical Ctr	463+00	60	3
FL	Buckhead	463+00	Medical Ctr	638+70	70	4
FL	Buckhead	638+70	Medical Ctr	659+60	60	3
FL	Medical Ctr	659+60	Dunwoody	751+00	50	3
FL	Dunwoody	751+00	Sandy Springs	784+00	60	3
FL	Dunwoody	784+00	Sandy Springs	798+66	50	3
FL	Sandy Springs	798+66	North Springs	824+42	60	3
FL	Sandy Springs	824+42	North Springs	838+93	70	4
FL	Sandy Springs	838+93	North Springs	845.92	50	3

South Line

Track	From	Start	To	Stop	MPH	Class
SR	Five PTS	0+00	Garnett	1+13	25	2
SR	Five PTS	1+13	Garnett	27+88	37	3
SR	Garnett	27+88	West End	68+39	60	3
SR	Garnett	68+39	West End	105+35	50	3
SR	West End	105+35	Oakland City	143+70	60	3
SR	West End	143+70	Lakewood	193+90	50	3
SR	Oakland City	193+90	Lakewood	219+55	60	3
SR	Oakland City	219+55	Lakewood	242+85	50	3
SR	Lakewood	242+85	East Point	334+17	60	3
SR	East Point	334+17	College Park	348+67	50	3
SR	East Point	348+67	College Park	433+82	60	3
SR	College Park	433+82	Airport	483+98	50	3
SR	Airport	483+98	Turnback	491+33	25	3
SL	Five PTS	0+00	Garnett	27+88	37	3
SL	Garnett	27+88	West End	36+35	50	3
SL	Garnett	36+35	West End	77+24	60	3
SL	Garnett	77+24	West End	112+70	50	3
SL	West End	112+70	Oakland City	179+57	60	3
SL	Oakland City	179+57	Lakewood	193+72	50	3
SL	Oakland City	193+72	Lakewood	242+85	60	3
SL	Lakewood	242+85	East Point	256+90	50	3
SL	Lakewood	256+90	East Point	334+29	60	3
SL	East Point	334+29	College Park	348+67	50	3
SL	East Point	348+67	College Park	440+28	60	3
SL	College Park	440+28	Airport	491+33	50	3
YR/YL	Collage Park	6.69	South Yard	35.50	15	1
YA	Airport	SR-479.45	South Yard	13.03	25	2
YA	Airport	13.03	South Yard	26.05	15	1

The following Curves are 2 Degrees or Less

Curves of 2 Degrees or Less

Curve #	TS	SC	CS	ST	E
Five Points Station to Peachtree Center Station					
NR-1	1.87	3.12	4.44	5.94	2.50”
NL-1	1.85	2.85	3.79	5.15	2.00”
NR-2	9.36	13.17	15.67		3.50”
Compound	Curve	16.87	20.27	22.57	2.50”
NL-2	9.53	13.13	16.16		3.50”
Compound	Curve	17.56	19.81	22.21	3.00”
Peachtree Center station to Civic Center Station					
NR-5	70.42	71.92	73.71	75.21	2.00”
NL-5	70.42	71.92	73.71	75.21	2.25”
Arts Center Station to Lindbergh Center Station					
NR-12	182.98	187.88	201.75	206.65	6.00”
NR-14	226.84	231.74	236.74	242.24	6.00”
NL-14	226.84	231.72	236.68	242.23	6.00”
NR-15	245.15	248.75	250.90	254.50	4.00”
NL-15	245.15	248.75	250.92	254.53	4.00”
NR-17	273.49	277.49	280.17	284.17	5.00”
NL-17	274.06	278.05	280.24	284.24	5.00”
NX-17	11.88	13.38	18.04	19.54	0.00”
Lindbergh Center Station to Canterbury Junction					
NL-19	303.52	307.55	312.57	316.59	5.00”
Canterbury Junction to Lenox Station					
NER-20	335.29	340.41	357.05	361.25	5.00”
NEL-20	335.20	340.45	356.89	301.07	5.00”
NER-21	363.70	367.70	381.13		5.50”
		382.55	385.01	388.51	5.00”
NEL-21	363.70	367.72	386.06	390.08	5.50”
Lenox Station to Brookhaven Station					
NER-22	406.53	410.23	420.20	423.90	4.50”
NEL-22	406.70	410.70	419.77	423.77	4.75”
TB	407.05	410.79	420.91	423.04	1.00”

Curves of 2 Degrees or Less					
Lenox Station to Brookhaven Station					
Curve #	TS	SC	CS	ST	E
NER-23	426.03	429.93	440.82	444.82	4.50”
NEL-23	425.92	429.82	440.81	444.71	4.50”
NER-24	456.51	460.51	469.40	472.81	5.50”
NEL-24	456.15	460.25	469.13	472.54	5.50”
Brookhaven Station to Chamblee Station					
NER-30	576.01	582.51	588.91	593.41	4.75”
NEL-30	576.01	582.51	588.91	593.41	4.75”
Chamblee Station to Doraville Station					
NER-33	629.88	633.48	636.89	640.50	4.25”
NER-34	645.69	651.59	656.68	661.79	5.25”
NEL-34	645.69	651.61	656.71	661.79	5.25”
Canterbury Junction to Buckhead Station					
FR-20	360.48	362.58	372.72	376.33	3.50”
FL-20	361.14	365.39	371.22	375.37	5.00”
FR-21	379.32	383.92	396.27		4.75”
Compound	Curve	397.27	400.70		5.75”
		401.70	404.49	409.34	5.00”
FL-21	377.63	382.23	388.24		4.75”
Compound	Curve	389.24	404.08	409.85	5.00”
FR-22	413.16	416.51	418.42		4.00”
Compound	Curve	419.42	424.92	429.32	4.50”
FL-22	413.37	416.72	419.40		4.00”
Compound	Curve	420.44	422.63		3.50”
		423.72	429.68	430.89	1.75”
Buckhead Station to Medical Center Station					
FR-23	438.97	441.57	444.79		3.75”
Compound	Curve	445.79	448.78	452.93	4.75”

Curves of 2 Degrees or Less					
Buckhead Station to Medical Center Station					
Curve #	TS	SC	CS	ST	E
FL-23	437.78	440.23	441.77		3.50"
Compound	Curve	442.77	448.35	452.70	4.50"
FR-24	489.04	494.83	500.16	505.95	6.00"
FL-24	489.04	494.85	500.23	506.04	6.00"
FR-25	508.18	513.99	520.94	526.75	6.00"
FL-25	508.18	513.96	520.97	526.66	6.00"
FR-26	589.68	594.18	602.75	607.24	4.00"
FR-28	656.20	659.65	673.26	676.71	5.00"
FL-28	656.20	659.67	673.37	676.84	4.75"
Medical Center Station to Dunwoody Station					
FR-29	687.76	691.21	699.55	705.81	5.00"
FL-29	687.76	691.18	699.52	705.81	5.00"
FR-30	705.81	710.36	717.46	722.01	5.50"
FL-30	705.81	710.33	717.37	721.89	5.50"
Dunwoody Station to Sandy Springs					
FR-34	753.21	756.81	771.81	775.41	4.25"
FL-34	752.53	756.13	771.70	775.41	4.25"
Sandy Springs to North Springs					
FR-35	792.58	798.18	813.70	819.30	4.25"
FL-35	792.58	798.20	813.79	819.41	4.25"
Garnett Station to West End Station					
SR-3	36.28	41.28	46.35		4.50"
Compound	Curve	50.55	64.53		1.00"
		67.53	72.00	75.50	3.00"
SL-3	36.71	41.70	46.36		4.50"
Compound	Curve	50.60	64.61		1.00"
		67.62	72.01	77.23	3.00"
SR-4	77.23	81.13	95.45	97.80	5.00"
SL-4	77.23	81.11	95.25	97.80	5.00"

Curves of 2 Degrees or Less					
West End Station to Oakland City Station					
Curve #	TS	SC	CS	ST	E
SR-6	132.79	135.48	137.89	140.59	3.00”
SL-6	132.79	135.48	137.89	140.59	3.00”
SR-7	156.95	159.38	170.09		3.25”
Compound	Curve	168.60	176.66	177.59	1.00”
SL-7	156.95	159.37	170.00	172.42	3.25”
Lakewood Station to East Point Station					
SR-13	257.73	261.33	275.31	278.91	4.50”
SL-13	257.16	260.76	266.14		4.25”
Compound	Curve	267.27	275.31	278.91	4.75”
SX-13	257.44	261.04	266.22		1.00”
Compound	Curve	267.16	275.31	278.92	1.00”
SR-14	281.50	284.70	291.02	294.22	4.25”
SL-14	281.43	284.63	288.15		4.25”
Compound	Curve	289.15	292.61	296.25	3.00”
SR-15	308.90	312.70	322.14	325.94	4.75”
SL-15	308.90	312.70	322.14	325.94	4.75”
SR-16	327.82	331.02	338.06	341.26	4.25”
SL-16	328.35	331.55	338.75	341.41	3.25”
East Point Station to College Park Station					
SR-20	427.31	432.66	434.61	438.96	5.25”
SL-20	427.21	432.56	434.89	439.53	5.25”
College Park Station to Airport Station					
SR-21	452.02	454.47	460.89	464.26	3.25”
SL-21	454.05	456.85	461.55	464.35	4.00”
SR-22	466.15	469.60	472.76	476.21	4.75”
SL-22	466.54	469.99	473.16	476.61	4.75”
Airport Tail Track					
SR-23	491.67	494.97	N/A	N/A	
SL-23	491.70	495.00	N/A	N/A	

Curves of 2 Degrees or Less					
College Park Station to South Yard					
Curve #	TS	SC	CS	ST	E
YR-1	8.54	N/A	N/A	10.55	0.00”
YL-1	7.92	N/A	N/A	9.79	0.00”
YR-2	14.93	16.48	21.44	22.98	0.00”
YL-2	14.93	16.49	21.55	22.98	0.00”
Airport Station to South Yard					
YA-1	6.34	N/A	N/A	7.34	0.00”
YA-2	7.86	11.29	14.81		1.50”
Compound	Curve	16.06	23.78	26.68	1.00”
Five Points Station to Georgia State Station					
ER-1	3.43	4.53	6.28	7.36	2.00”
EL-1	3.29	4.19	6.14	7.04	1.75”
ER-2	7.39	8.49	9.81	10.81	2.00”
EL-2	7.05	7.95	9.57	10.47	1.75”
EL-3	11.90	N/A	N/A	13.14	0.00”
ER-4	14.12	14.92	16.17	16.97	1.50”
Georgia State Station to King Memorial Station					
ER-6	25.04	26.43	32.47	34.27	3.00”
EL-6	24.93	26.42	32.37	34.18	2.75”
ER-7	40.45	43.05	48.17	50.77	1.50”
EL-7	40.45	43.05	48.17	50.77	1.50”
King Memorial Station to Inman Park Station					
ER-9	108.84	110.94	121.76	125.96	3.50”
EL-9	108.84	110.94	121.76	125.96	3.00”
Candler Park Station to Eastlake Station					
ER-13	180.82	185.72	194.26	198.18	3.75”
TB-14	203.21	N/A	N/A	206.07	0.00”
ER-15	203.06	209.98	227.33	232.23	4.50”
EL-15	205.70	210.60	226.62	231.52	5.00”
TB-15	206.07	208.61	N/A	230.05	0.00”

Curves of 2 Degrees or Less					
Candler Park Station to Eastlake Station					
Curve #	TS	SC	CS	ST	E
ER-16	247.99	252.48	256.28	260.28	5.00”
EL-16	247.99	252.39	256.18	260.18	5.00”
Eastlake Station to Decatur Station					
ER-17/18	268.85	271.66	275.37	278.37	4.25”
Compound	Curve	278.37	278.37	282.01	4.25”
EL-17/18	269.89	271.99	275.37	278.37	3.75”
Compound	Curve	282.01	287.83	292.03	3.75”
ER-19	298.61	303.51	324.01	328.94	4.00”
EL-19	298.61	303.51	324.01	328.94	3.75”
Decatur Station to Avondale Station					
ER-22	359.37	362.87	365.96	369.35	5.00”
EL-22	359.38	363.06	365.15	368.44	5.75”
EB-22	359.58	362.98	365.62	368.98	5.00”
WB-22	359.66	362.98	365.53	368.89	5.00”
Avondale Station to Kensington Station					
EL-24	389.86	391.93	396.57	399.04	3.00”
ER-25	402.98	404.43	406.28	407.73	1.75”
EL-25	400.55	403.66	405.66	408.77	3.75”
ER-26	412.37	418.17	437.50	443.30	4.50”
EL-26	412.37	418.20	438.11	443.43	4.50”
ER-27	448.01	452.17	459.44	463.60	5.00”
EL-27	448.01	452.14	459.33	463.60	5.00”
Indian Creek Turnback					
ER-33	556.34	559.14	N/A	N/A	
EL-33	556.33	559.13	N/A	N/A	
Five Points Station to GWCC/Dome Station					
WR-1	8.04	10.14	13.98	16.08	3.50”
WL-2	6.81	10.21	12.06	15.48	3.25”

Curves of 2 Degrees or Less					
GWCC/Dome Station to Vine City Station					
Curve #	TS	SC	CS	ST	E
WR-2	27.46	29.16	32.45	34.31	2.75”
WL-3	27.54	29.24	32.53	34.39	2.75”
WM-3	27.51	29.21	32.79	34.09	0.00”
Westlake Station to H.E. Holmes Station					
WR-9	185.44	195.44	202.06	212.06	5.25”
WL-9	185.44	195.44	202.06	212.06	5.25”
WR-10	231.32	235.32	240.89	244.89	4.00”
WL-10	231.32	235.30	240.84	244.89	3.25”
Ashby Station to Bankhead Station					
PR-7	89.65	93.19	102.32		
Compound	Curve	103.82	109.00	113.10	4.75”
PL-7	89.58	93.21	102.39		
Compound	Curve	103.89	109.02	113.12	4.75”
PR-8	124.73	129.73	133.78	138.63	5.50”
PL-8	124.73	129.70	133.71	138.63	5.50”

The following Curves are Greater than 2 Degrees

Curves Greater than 2 Degrees					
Peachtree Center Station to Civic Center Station					
Curve #	TS	SC	CS	ST	E
NR-3	29.95	31.05	33.40	34.50	0.00”
NL-3	29.72	N/A	N/A	32.70	0.00”
NR-4	34.50	35.60	37.85	38.90	0.00”
NL-4	35.07	N/A	N/A	38.35	0.00”
North Avenue Station to Midtown Station					
NR-6	89.62	93.30	94.28		1.75”
Compound	Curve	94.89	96.70	102.30	2.25”
NL-6	89.62	93.29	94.27		1.00”
Compound	Curve	94.86	96.67	102.26	2.00”
Midtown Station to Arts Center Station					
NR-7	116.75	N/A	N/A	119.13	0.00”
NR-7	116.75	N/A	N/A	119.13	0.00”
NL-8	128.11	132.61	136.19	137.69	1.50”
NR-8	125.32	126.82	133.39	134.89	1.25”
Arts Center Station to Lindbergh Center Station					
NR-9	151.89	154.29	159.23	161.63	2.25”
NL-9	150.20	152.60	155.54	159.91	2.00”
NR-10	166.31	N/A	N/A	169.21	1.25”
NL-10	165.46	166.46	170.41	171.41	1.50”
NL-11	171.41	172.41	174.63	175.63	1.50”
NL-12	181.76	184.36	190.05		3.50”
Compound	Curve	192.55	201.81	206.73	6.00”
NR-13	215.25	N/A	N/A	218.91	1.75”
NL-13	215.25	N/A	N/A	218.92	1.75”
NL-16	264.12	265.62	267.75	269.25	1.00”
Lindbergh Center Station to Canterbury Junction					
NER-18	294.97	295.97	297.59	298.59	1.00”
NER-19	300.84	301.84	304.39		1.00”
Compound	Curve	307.53	312.50	316.50	5.00”

Curves Greater than 2 Degrees					
Brookhaven Station to Chamblee Station					
Curve #	TS	SC	CS	ST	E
NEL-25	480.73	N/A	N/A	484.74	0.00”
NER-26	494.34	497.54	499.70	502.90	3.25”
NER-27	513.83	515.33	518.11	519.61	1.50”
NEL-27	513.83	515.33	518.11	519.61	1.50”
NER-28	524.91	528.81	535.54	539.44	4.00”
NEL-28	524.91	528.81	535.54	539.44	4.00”
NER-29	563.29	566.79	571.16	574.66	3.50”
NEL-29	563.29	566.79	571.16	574.66	3.50”
NER-31	595.24	598.14	600.38	603.28	2.75”
NEL-31	595.24	598.14	601.46	604.36	2.75”
NER-32	608.61	N/A	N/A	612.29	0.00”
Chamblee Station to Doraville Station					
NEL-33	628.95	631.25	640.19	642.49	4.25”
NER-35	677.96	679.17	681.47	682.68	1.25”
NEL-35	677.96	679.17	681.47	682.69	1.25”
NER-36	685.36	689.03	694.07	697.72	3.75”
NEL-36	685.36	689.03	694.04	697.68	3.75”
NER-37	704.82	706.06	707.97	709.21	1.50”
NEL-37	704.82	705.96	707.70	708.74	1.25”
NER-38	717.33	718.19	719.62	720.48	1.25”
NEL-38	710.56	711.60	714.43	715.47	1.25”
Doraville Station North					
NER-39	738.91	740.16	742.92	744.17	0.00”
NEL-39	740.04	741.29	744.06	745.31	0.00”
NEX-39	740.10	N/A	N/A	744.11	0.00”
NEL-40	747.77	749.02	751.75	N/A	N/A

Curves Greater than 2 Degrees					
Buckhead Station to Medical Center Station					
Curve #	TS	SC	CS	ST	E
FL-26	589.68	594.19	602.80	607.24	4.00”
FR-27	639.47	640.92	651.28	652.73	1.75”
FL-27	639.47	640.91	651.25	652.70	1.75”
FL-31	723.81	725.05	726.87	728.11	1.50”
FL-32	729.61	730.65	732.45	733.19	1.50”
Dunwoody Station to Sandy Springs Station					
FL-33	745.34	746.39	748.26	749.31	1.25”
Sandy Springs to North Springs Station					
FR-36	823.63	824.88	826.71	827.96	1.50”
FR-37	829.79	831.04	832.87	834.12	1.50”
North Springs North					
FR-38	846.19	847.44	849.27	850.52	1.00”
FR-39	852.35	853.60	855.43	856.68	1.50”
Five Points Station to Garnett Station					
SR-1	5.54	N/A	N/A	6.94	0.00”
SL-1	5.54	N/A	N/A	6.94	0.00”
Garnett Station to West End Station					
SR-2	28.12	N/A	N/A	31.07	0.00”
West End Station to Oakland City Station					
SR-5	108.03	110.13	112.47		2.75”
Compound	Curve	115.37	121.03	126.03	4.00”
SL-5	108.03	110.14	112.48		2.75”
Compound	Curve	115.40	121.06	126.03	4.25”
Oakland City Station to Lakewood Station					
SR-8	186.57	187.17	189.00	190.10	1.00”
SR-9	190.10	191.20	192.79	193.89	1.50”
SR 8 & SR-9 are a Reverse Curve					
SR-10	204.14	206.44	208.77	211.07	2.75”
SL-10	204.14	206.43	208.75	211.07	2.75”

Curves Greater than 2 Degrees					
Oakland City Station to Lakewood Station					
Curve #	TS	SC	CS	ST	E
SR-11	224.43	225.83	227.74	229.14	1.75”
SL-11	224.43	225.84	227.75	229.14	1.75”
SR-12	231.47	N/A	N/A	239.96	0.00”
SL-12	229.14	230.54	232.34	233.74	1.75”
East Point Station to College Park Station					
SR-17	356.31	N/A	N/A	362.72	0.00”
SR-18	362.72	364.37	371.90	373.55	1.25”
SL-18	363.82	369.13	371.92	373.55	1.50”
SR-19	381.05	382.60	385.41	386.96	1.50”
SL-19	381.05	382.59	385.41	386.96	1.50”
College Park Station to South Yard					
YR-1	8.54	N/A	N/A	10.55	0.00”
YL-1	7.92	N/A	N/A	10.06	0.00”
King Memorial Station to Inman Park Station					
ER-10	136.60	138.50	152.89	157.39	1.25”
EL-10	136.60	138.50	152.89	157.39	1.00”
EL-11	160.90	N/A	N/A	164.88	0.00”
EL-12	167.00	N/A	N/A	171.07	0.00”
Candler Park to Eastlake Station					
EL-13/14	179.60	182.80	186.98		1.75”
Compound	Curve	190.44	193.31	199.76	5.25”
Decatur Station to Avondale Station					
ER-20	337.71	N/A	N/A	339.90	0.00”
EL-20	337.71	N/A	N/A	339.90	0.00”
ER-21	348.22	350.10	354.51	356.27	1.50”
EL-21	348.22	350.10	354.51	356.27	1.50”
Avondale Station to Kensington Station					
EL-23	380.92	382.32	385.66	387.06	1.75”
ER-24	398.22	399.67	401.52	402.97	1.75”

Curves Greater than 2 Degrees					
Avondale Station to Kensington Station					
Curve #	TS	SC	CS	ST	E
ER-28	465.92	467.17	468.97	470.22	1.50”
ER-29	472.97	473.97	475.47	476.47	1.25”
Kensington Station to Indian Creek Station					
ER-30	491.93	493.38	497.78	499.23	1.50”
EL-30	486.73	488.18	491.58	493.03	1.50”
ER-31	501.98	504.15	511.85	514.02	2.25”
EL-31	501.98	504.15	511.83	514.00	2.25”
ER-32	534.58	536.43	539.23	541.09	2.25”
EL-32	530.48	533.27	535.10	538.90	1.75”
Five Points Station to Dome / GWCC					
WL-1	3.62	4.32	6.11	6.81	1.00”
Vine City Station to Ashby Station					
WR-3	44.08	44.88	48.51	49.31	0.00”
WR-4	49.32	50.12	66.21	67.01	0.00”
WL-4	53.59	54.68	66.22	67.02	0.00”
Ashby Station to Westlake Station					
WR-5 / 6	98.33	120.00	N/A	N/A	0.00”
Compound	Curve	122.76	128.15	130.75	1.75”
WL-5/6	98.33	121.80	N/A	N/A	0.00”
Compound	Curve	123.00	128.16	130.71	2.50”
WR-7	130.75	133.55	137.17	139.97	1.75”
WL-7	130.75	133.55	137.17	139.97	2.75”
WR-7a	139.98	141.33	148.29	149.67	0.00”
WL-7a	139.98	141.33	148.29	149.67	0.00”
WR-8	158.55	162.15	164.29	167.89	2.50”
WL-8	158.55	162.15	164.29	167.89	2.50”
H. E. Holmes Turnback					
WR-11	256.35	257.95	263.26	264.86	0.00”
WL-11	256.35	257.95	263.26	264.86	0.00”

Curves Greater than 2 Degrees					
Curve #	**TS**	**SC**	**CS**	**ST**	**E**
Ashby Station to Bankhead Station					
PR-9	138.63	141.72	154.49	157.44	0.00”
PL-9	138.63	141.72	144.24		0.00”
Compound	Curve	145.09	156.03	157.85	2.50”

Curve PR-8 & PR-9 are Reverse Curves

Curve PL-8 & PL-9 are Reverse Curves

Interline Connector (Georgia State to Garnett)					
X[1]	3.21	3.71	4.73	5.23	0.00”
X2[1]	6.26	7.48	14.54		0.00”
Compound	Curve	14.54	16.71	17.81	0.00”

Curve Radii from Shortest to Largest

Mainline Tracks Only

Curves with a Radius of Less than 1000 Feet

Track	Curve #	Location	Radius 1	Radius 2	Radius 3
IC	X2	Interline Connector	500.00’		
NR	1	Five Pts - Peachtree	750.00’		
NL	1	Five Pts - Peachtree	925.00’		
EL	6	Ga State-King Mem	985.25’		
FR	23	Buckkhead - MedCen	600.00’	2800.00’	
FL	23	Buckkhead - MedCen	800.00’	2515.00’	
YR	2	College Pk-S. Yard	808.00’		
YL	2	College Pk- S. Yard	822.75’		

Curves with a Radius Between 1000 & 2000 Feet

Track	Curve #	Location	Radius 1	Radius 2	Radius 3
ER	1	Five Pts-Ga. State	1400.00’		
ER	2	Five Pts-Ga. State	1100.00’		
ER	4	Five Pts-Ga. State	1700.00’		
ER	6	Ga. State-King Mem	1000.00’		
ER	16	Cand Park-East Lake	1600.00’		
ER	17	East Lake-Decatur	1500.00’		
ER	18	East Lake-Decatur	1600.00’		
ER	22	Decatur-Avondale	1100.00’		
ER	26	Avond-Kensington	1945.00’		
ER	27	Avond-Kensington	1690.00’		
EB	22	Decatur-Avond	1100.00’		
EL	1	Five Pts-Ga. State	1400.00’		
EL	2	Five Pts-Ga. State	1650.00’		
EL	3	Five Pts-Ga. State	1853.00’		
EL	4	Five Pts-Ga. State	1700.00’	*Pocket Track	
TB	14	Cand.Park-E Lake	1000.00’		
EL	15	Cand.Park-East Lake	2000.00’		
EL	16	Cand.Park-East Lake	1600.00’		
EL	17	East Lake-Decatur	1400.00’		
EL	18	East Lake-Decatur	1600.00’		
EL	22	Decatur-Avondale	1100.00’		
EL	26	Avond-Kensington	1960.00’		
EL	27	Avond-Kensington	1670.83’		
WB	22	Decatur-Avondale	1085.25’		

Curves with a Radius Between 1000 & 2000 Feet					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
WR	1	Five Pts-Dome	1400.00’		
WR	10	W Lake-Holmes	2000.00’		
WL	1	Five Pts-Dome	1400.00’		
WL	2	Five Pts-Dome	1100.00’		
WL	10	W Lake-Holmes	1984.25’		
PR	7	Ashby-Bankhead	1230.50’	1793.25’	
PR	8	Ashby-Bankhead	1529.00’		
PL	7	Ashby-Bankhead	1247.50’	1808.00’	
PL	8	Ashby-Bankhead	1514.00’		
NR	2	Five Pts-Peachtree	1060.00’	1250.00’	
NR	5	Civic-North Ave	1800.00’		
NR	17	Art Cent-Lindbergh	1700.00’		
NL	2	Five Pts-Peachtree	1000.00’	1250.00’	
NL	5	Civic-North Ave	1800.00’		
NL	17	Art Cent-Lindbergh	1700.00’		
NL	19	Art Cent-Lindbergh	1514.75’		
NER	20A	Canterbury-Lenox	1699.17’		
NER	21	Canterbury-Lenox	1500.00’	1200.00’	
NER	22	Lenox-Brookhaven	1900.00’		
NER	23	Lenox-Brookhaven	1850.00’		
NER	24	Lenox-Brookhaven	1500.00’		
NEL	20A	Canterbury-Lenox	1684.00’		
NEL	21	Canterbury-Lenox	1514.75’		
NEL	22	Lenox-Brookhaven	1800.00’		
NEL	23	Lenox-Brookhaven	1850.00’		
NEL	24	Lenox-Brookhaven	1500.00’		
FR	20	Canterbury-Buckhead	1710.00’		
FR	24	Buckhead-Med Center	1940.00’		
FR	25	Buckhead-Med Center	1955.15’		
FR	28	Buckhead-Med Center	1200.00’		
FR	29	Med Cen-Dunwoody	1150.00’		
FR	30	Med Cen-Dunwoody	1520.00’		

Curves with a Radius Between 1000 & 2000 Feet					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
FL	20	Canterbury-Buckhead	1657.50’		
FL	24	Buckhead-Med Cent	1955.15’		
FL	25	Buckhead-Med Cent	1940.40’		
FL	28	Buckhead-Med Cent	1214.75’		
FL	29	Med Cent-Dunwoody	1135.25’		
FL	30	Med Cent-Dunwoody	1505.25’		
FL	34	Dunwoody-S Springs	1985.25		
SR	3	Garnett-W End	1940.00’	10000.00’	2981.00’
SR	4	Garnett-W End	1200.00’		
SR	13	Lakewood-E Point	1800.00’		
SR	15	Lakewood-E Point	1760.00’		
SR	20	East Pt-College Pk	1600.00’		
SR	21	College Park-Airport	1800.00’		
SR	22	College Park-Airport	1200.00’		
SL	3	Garnett-W End	1940.00’	10000.00’	2981.00’
SL	4	Garnett-W End	1200.00’		
SL	13	Lakewood-E Point	1829.50’		
SL	14	Lakewood-E Point	1970.00’	3000.00’	
SL	15	Lakewood-E Point	1745.25’		
SL	20	East Pt-College Pk	1600.00’		
SL	21	College Park-Airport	1500.00’		
SL	22	College Park-Airport	1200.00’		
SX*	13	Lakewood-E Point	1900.00’		
NX*	17	Art Center-Lindbergh	1700.00’		
TB*	22	Lenox-Brookhaven	1600.00’	1885.00’	
YA	1	Airport - South Yard	1000.00’		
YA	2	Airport - South Yard	1185.25’	500.00’	
YR	1	College Pk- S. Yard	1432.39’		
YL	1	College Pk- S. Yard	1145.92’		

* Pocket Track

Curves with a Radius of 2000 Feet or Greater					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
ER	7	Ga. State-King Mem	2600.00’		
ER	8	King Mem-Inman Pk	13500.00’		
ER	9	King Mem-Inman Pk	2700.00’		
ER	10	Inman Pk-Candler Pk	3150.00’		
ER	13	Candler Pk-East Lake	2120.00’		
ER	15	Candler Pk-East Lake	2100.00’		
ER	19	East Lake-Decatur	2075.00’		
ER	20	Decatur-Avondale	13060.00’		
ER	21	Decatur-Avondale	5014.00’		
ER	24	Avondale-Kensington	5729.00’		
ER	25	Avondale-Kensington	5729.00’		
ER	28	Avondale-Kensington	8343.00’		
ER	29	Avondale-Kensington	6838.00’		
ER	30	Kensington-Indian Crk	10000.00’		
ER	31	Kensington-Indian Crk	6275.00’		
ER	32	Kensington-Indian Crk	4532.49’		
EL	7	Ga. State-King Mem	2600.00’		
EL	8	King Mem-Inman Pk	13500.00’		
EL	9	King Mem-Inman Pk	2700.00’		
EL	10	Inman Pk-Candler Pk	3150.00’		
EL	11	Inman Pk-Candler Pk	10000.00’		
EL	12	Inman Pk-Candler Pk	10000.00’		
EL	13	Candler Pk-East Lake	3000.00’		
EL	14	Candler Pk-East Lake	2135.00’		
EL	19	East Lake-Decatur	2075.00’		
EL	20	Decatur-Avondale	13060.25’		
EL	21	Decatur-Avondale	5014.00’		
EL	24	Avondale-Kensington	2025.00’		
EL	25	Avondale-Kensington	2255.00’		
EL	30	Kensington-Indian Crk	10000.00’		
EL	31	Kensington-Indian Crk	6260.25’		
EL	32	Kensington-Indian Crk	5730.00’		

Curves with a Radius of 2000 Feet or Greater					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
WR	2	Dome-Vine City	2200.00’		
WR	3	Vine City-Ashby	11300.00’		
WR	4	Vine City-Ashby	11300.00’		
WR	5	Ashby-Westlake	6250.00’		
WR	6	Ashby-Westlake	5800.00’		
WR	7	Ashby-Westlake	*6500.00’*		
WR	7a	Ashby-Westlake	15200.00’		
WR	8	Ashby-Westlake	3000.00’		
WR	9	Westlake-Holmes	2100.00’		
WL	3	Dome-Vine City	2200.00’		
WL	4	Vine City-Ashby	11318.50		
WL	5	Ashby-Westlake	15018.50’		
WL	6	Ashby-Westlake	15000.00’		
WL	7	Ashby-Westlake	6500.00’		
WL	7a	Ashby-Westlake	15200.00’		
WL	8	Ashby-Westlake	3000.00’		
WL	9	Westlake-Holmes	2100.00’		
PR	9	Ashby-Bankhead	2435.00’		
PL	9	Ashby-Bankhead	2449.75’	2640.00’	
NR	3	Peachtree-Civic	8000.00’		
NR	4	Peachtree-Civic	8000.00’		
NR	6	North Ave-Midtown	3832.18’	2700.00’	
NR	7	Midtown-Art Center	16000.00’		
NR	8	Midtown-Art Center	5000.00’		
NR	9	Art Center-Lindbergh	3250.00’		
NR	10	Art Center-Lindbergh	10000.00’		
NR	12	Art Center-Lindbergh	2000.00’		
NR	13	Art Center-Lindbergh	10000.00’		
NR	14	Art Center-Lindbergh	2000.00’		
NR	15	Art Center-Lindbergh	2800.00’		
NR	18	Lindbergh-Canterbury	7000.00’		
NR	19	Lindbergh-Canterbury	7000.00’	1500.00’	

Curves with a Radius of 2000 Feet or Greater					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
NL	3	Peachtree-Civic	23000.00’		
NL	4	Peachtree-Civic	23000.00’		
NL	6	North Ave-Midtown	3832.18	2700.00’	
NL	7	Midtown-Art Center	16000.00’		
NL	8	Midtown-Art Center	5000.00’		
NL	9	Art Center-Lindbergh	3250.00’		
NL	10	Art Center-Lindbergh	6000.00’		
NL	11	Art Center-Lindbergh	6000.00’		
NL	12	Art Center-Lindbergh	8000.00’	2014.75’	
NL	13	Art Center-Lindbergh	8000.00’		
NL	14	Art Center-Lindbergh	2000.00’		
NL	15	Art Center-Lindbergh	3832.18’		
NL	16	Art Center-Lindbergh	16000.00’		
NER	26	Brookhaven-Chamblee	3600.00’		
NER	27	Brookhaven-Chamblee	9000.00’		
NER	28	Brookhaven-Chamblee	2900.00’		
NER	33	Chamblee-Doraville	2000.00’		
NEL	27	Brookhaven-Chamblee	9000.00’		
NEL	28	Brookhaven-Chamblee	2900.00’		
NEL	29	Brookhaven-Chamblee	3400.00’		
NEL	30	Brookhaven-Chamblee	2400.00’		
NEL	31	Brookhaven-Chamblee	4185.25’		
NEL	33	Chamblee-Doraville	3200.00’		
NEL	34	Chamblee-Doraville	2214.75’		
NEL	35	Chamblee-Doraville	11514.75’		
NEL	36	Chamblee-Doraville	3055.25’		
NEL	37	Chamblee-Doraville	9400.00’		
NEL	38	Chamblee-Doraville	9400.00’		
NEL	39	Doraville Turnback	11500.00’		
NEL	40	Doraville Turnback	11500.00’		
FR	21	Canterbury-Buckhead	2490.00’	2000.00’	2340.00’
FR	22	Canterbury-Buckhead	2100.00’	2536.73’	
FR	26	Canterbury-Buckhead	2857.42’		

Curves with a Radius of 2000 Feet or Greater

Track	Curve #	Location	Radius 1	Radius 2	Radius 3
FR	27	Bankhead-MedCenter	5704.47’		
FR	34	Dunwoody-S Springs	2000.00’		
FR	35	S Springs-N Springs	2000.00’		
FR	36	S Springs-N Springs	7500.00’		
FR	37	S Springs-N Springs	7500.00’		
FR	38	North Springs N	7500.00’		
FR	39	North Springs N	7500.00’		
FL	21	Canterbury-Buckhead	2500.00’	2318.75	
FL	22	Canterbury-Buckhead	2100.00’	2555.52	4497.58’
FL	26	Bankhead-MedCenter	2872.17’		
FL	27	Bankhead-MedCenter	5689.72’		
FL	31	MedCenter-Dunwoody	6600.00’		
FL	32	MedCenter-Dunwoody	5475.00’		
FL	33	Dunwoody-S Springs	8500.00’		
FL	35	S Springs-N Springs	2014.75		
SR	1	Five Points- Garnett	7400.00’		
SR	2	Garnett-West End	13000.00’		
SR	5	West End-Oakland	3500.00’	2000.00’	
SR	6	West End-Oakland	2800.00’		
SR	7	West End-Oakland	2555.00’	11000.00’	
SR	8	Oakland-Lakewood	5000.00’		
SR	9	Oakland-Lakewood	5000.00’		
SR	10	Oakland-Lakewood	3200.00’		
SR	11	Oakland-Lakewood	5635.00’		
SR	12	Oakland-Lakewood	15000.00'		
SR	14	Lakewood-East Point	2000.00’		
SR	16	Lakewood-East Point	2000.00’		
SR	17	Lakewood-East Point	13628.77’		
SR	18	East Pt-College Park	7400.00’		
SR	19	East Pt-College Park	7400.00’		
SL	1	Five Points- Garnett	7400.00’		
SL	5	West End-Oakland	3500.00’	2000.00’	
SL	6	West End-Oakland	2800.00’		

Curves with a Radius of 2000 Feet or Greater					
Track	Curve #	Location	Radius 1	Radius 2	Radius 3
SL	7	West End-Oakland	2640.00’		
SL	10	Oakland- Lakewood	3200.00’		
SL	11	Oakland- Lakewood	5649.75		
SL	12	Oakland- Lakewood	5649.75’		
SL	16	Lakewood-East Point	2000.00’		
SL	18	East Pt-College Pk	7414.75’		
SL	19	East Pt-College Pk	7400.00’		
X	2	Interline Connector	10582.16’	500.00’	
WM*	2	Dome-Vine City	22100.00’		

*Pocket Track