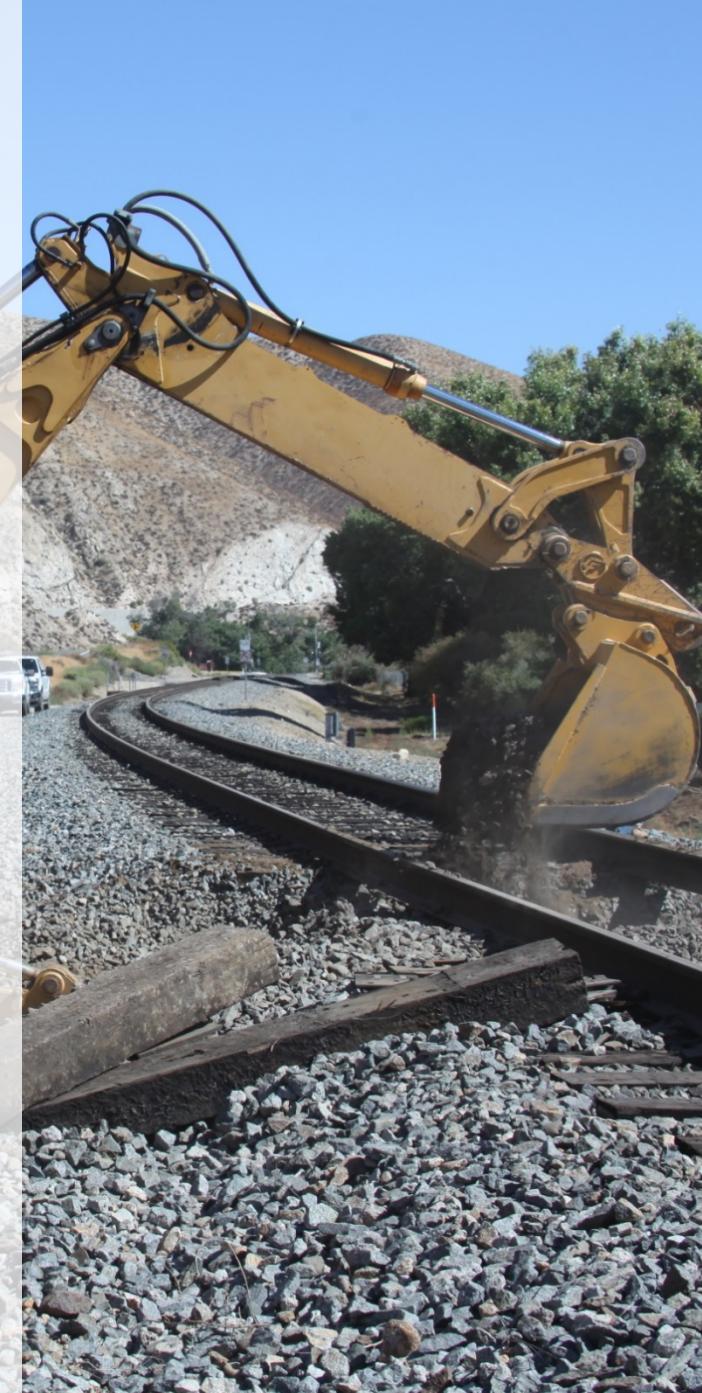




METROLINK®

TRACK MAINTENANCE MANUAL



FINAL

January 27, 2020

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SCRRRA Track Maintenance Manual

Revision Log

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Date: 1/27/2020

SCRRA Assistant Director, Track and Structures

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Appendix to CWR Procedures**Appendix A – Definitions****Appendix B – Tables****Appendix C – Other Forms****Appendix D – Derailment Response and Analysis – Track Inspection Team**

(For fillable PDF forms and Post-Derailment excel file, click the paperclip/attachment icon within Adobe/Bluebeam)

1.0 Introduction

1.1 Executive Summary

This manual is a complete overhaul of the prior SCRRRA versions to better match Class 1 railroad practices and procedures. This manual is primarily based upon the UPRR Engineering Track Maintenance Field Handbook dated April 1, 2016. It also incorporates elements from the past SCRRRA Track Maintenance, Right-of-Way And Structures, Engineering Instructions issued 06-30-2000 and revised 02-12-2009. A few other elements from the BNSF Engineering Instructions dated March 1, 2018, Caltrain Track Maintenance Manual, and FRA Part 213 have also been incorporated herein. This manual was developed by a committee of subject matter experts from SCRRRA, consultants, and contractors through many workshops and several iterations of this manual to issue it in its current form.

The target audience of this manual is an experienced track maintenance person who is unfamiliar with SCRRRA procedures and requirements. This manual is not intended to train someone new on general track maintenance principles and practices.

Track inspection has two basic purposes: First, it allows employees to detect, correct, and protect deviations from established track standards and to ensure safe train operations at authorized speeds. Second, it allows a planned program of repairs and improvements to ensure that employees are productive and use materials efficiently.

Perform at least the minimum required track inspections. If you are unsure about the need to inspect, consult your supervisor. If that is not possible, perform an inspection.

Qualified track inspectors as well as qualified managers, engineers and track subject matter experts have the authority and responsibility to determine the condition of a section of track. The track inspector on his or her own, or supported by qualified managers, engineers and track subject matter experts, will certify that the track condition complies with this manual as well as other applicable SCRRRA Standards and FRA Regulations for the speed and type of rail traffic for operation.

Note: In this Track Maintenance Manual, defects are classified as Critical and Urgent (as further defined in Chapter 3). These defect classifications apply to this entire manual. Critical defects remain FRA defects and require immediate corrective or remedial action. Urgent defects require that corrective action be taken within 60 days or a remedial action is required restricting the track speed to the next lower class that complies with SCRRRA urgent requirements.

1.2 Suggested Manual Changes

If you have a suggestion or requested change to this manual, please email your suggestions to TRACK&STRUCTURES@SCRRRA.NET.

1.3 Acronyms

For terminology and definitions, see Appendix A, Chapter 9 CWR, and Section 5.10.4 Joint Inventory Definitions.

ART	Adjusted Rail Temperatures
ATS	Automatic Train Stop
BB	Broken Base
BH	Bolt Hole Break
CF	Compound Fissure
CH	Crushed Head
CTC	Centralized Traffic Control
CWR	Continuous Welded Rail
DOC	Dispatch Operations Center
DF	Detailed Fracture
DMG-R	Damaged Rail
DPW, DFW,	Defective Weld
DIW, DWG	
EBF	Engine Burn Fracture
FBF	Flange Bearing Frog
FR	Flattened Rail
FRA	Federal Rail Administration
GCOR	General Code of Operating Rules
GRMS	Gage Restraint Measurement System
HH	Head Hardened
HMAC	Hot Mix Asphalt Concrete
HSH	Horizontal Split Head
HW	Head-Web Separation
MCO	Mid-Chord Offset
MPF	Movable Point Frog
MPH	Miles Per Hour
NRT	Neutral Rail Temperature
OTM	Other Track Material
OWLS	One Way Low Speed
PCC	Point of Curve Center
PCS	Point of Curve Spiral
PR	Piped Rail
PRLT	Preferred Rail Laying Temperature
PS	Point of Spiral
PSC	Point of Spiral Curve
PSI	Pounds per Square Inch
PT	Point of Tangent
PTC	Positive Train Control
PTLF	Portable Track Loading Fixture
PUC	Public Utilities Commission (California)
RBM	Railbound Manganese Frog
RCF	Rolling Contact Fatigue
RNT	Rail Neutral Temperature
RT	Rail Temperature

SBD	Signal Bond Drilled
SBE	Signal Bond Electric
SBT	Signal Bond Thermite
SCRRRA	Southern California Regional Rail Authority (Metrolink)
SGSM	Self-Guarded Solid Manganese Frog
SH	Secondhand
SR	Sudden Rupture
SS	Standard Strength
SSC	Shell, Sliver Corrugation
SSC-W	Battered Weld SSC
SW	Split Web
T and T	Track and Time
TF	Transverse Fissure
TMM	Track Maintenance Manual (this document)
TSS	Track Safety Standards (Part 213)
UT or U.T.	Ultrasonic Test or Ultrasonically Tested
VSH	Vertical Split Head
WILD	Wheel Impact Load Detectors
WSM	Welded Spring Manganese

1.4 Train Control Change and Configuration Management - Check Before You Change

All changes to the physical characteristics of the track structure, turnouts, track geometry, grade crossings, track speeds, changes to wayside signals or signs must be approved through the Change and Configuration Management Process prior to making such changes as these may compromise the safety and accuracy of the Positive Train Control system (49 CFR Part 236, Subpart I Section 236.1015(d)(9)). Figure 1-1 includes a list of items that affect the PTC system and must be approved through the Change and Configuration Management Process in prior to changing. For more PTC information and a guide for configuration management, field measurements and auditing for accuracy and maintenance of the PTC Track Database, see the Field Instructions For The Positive Train Control Track Database document.

Any changes to the physical characteristics as a result of an emergency repairs must be reported to the Chief Dispatcher at 1-888-446-9715 immediately after making repairs, noting the PTC component changed or modified. In case of a major accident or derailment, do not enter the scene until it is known that is it safe to do so. Investigation and documentation must be performed by the investigating team and SCRRRA approval must be received before proceeding with repairs. Make note of all changes or modifications including the subdivision, MP limits, location, name, track or tracks affected, permanent or temporary condition. See Appendix D for more instructions on derailment procedures.



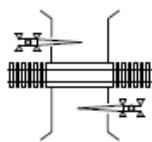
CHECK B4 U CHANGE

CHANGE COORDINATION BOARD APPROVED*

COORDINATION IN PLACE

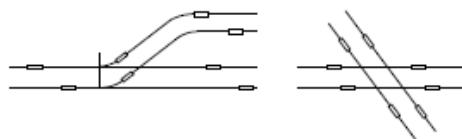
* IF UNSURE, CHECK WITH YOUR MANAGER

CHANGES TO A GRADE CROSSING



- STREET WIDENED
- NEW PANELS
- CHANGES TO GATES - INCLUDING PEDESTRIAN GATES
- QUIET ZONE
- APPROACH TIMING
- TRAFFIC SIGNAL & INTERCONNECTION

CHANGES AT A TURNOUT / DIAMOND



- ADDING OR REMOVING A TURNOUT OR DERAILS
- CHANGING INSULATED JOINTS**
- REPLACING POINTS**
- ANY CHANGES TO THE GEOMETRY
- CHANGES TO TYPE OF SWITCH:
 - a. POWERED
 - b. ELECTRICALLY LOCKED
 - c. HAND OPERATED
 - d. WITH LEAVING SIGNAL
 - e. NON-CLEARING
- TYPE OF DERAIL

** EMERGENCY REPAIR, PROCEED WITH REPAIR AND CONTACT 1-888-446-9715 AS SOON AS COMPLETE. NOTE PTC COMPONENT CHANGED OR MODIFIED.

CHANGES TO SIGNALS & WAYSIDE DETECTORS



- TYPE OF SIGNAL
- OPERATION OF SIGNAL
- SIGNAL ASPECTS
- NUMBER OF HEADS AND LOOPS
- SIGNAL PROGRAMS
- LOCATION OF SIGNAL
- ABSOLUTE SIGNAL
- NUMBER PLATED
- P-PLATE
- ANY CHANGES TO A CP

CHANGES TO SIGNS



- SPEED SIGNS
- LIMIT SIGNS
- MILE POST
- WHISTLE SIGNS
- DAMAGE OR REMOVE TRACK MARKING

CHANGES TO TRACK/GEOMETRY

- ALIGNMENT
- SUPERELEVATION
- REMOVAL OR MOVING**

CHANGES TO SPEEDS

- PASSENGER OR FREIGHT
- TONS PER OPERATIVE BRAKE
- SUBDIVISION SPECIAL SPEED RESTRICTIONS

ANY & ALL CHANGES TO THE PHYSICAL CHARACTERISTICS

** EMERGENCY REPAIR, PROCEED WITH REPAIR AND CONTACT 1-888-446-9715 AS SOON AS COMPLETE. NOTE PTC COMPONENT CHANGED OR MODIFIED.

*Revisions or recommendations to this document?
email: scrracm@scrrra.net*

Figure 1-1

1.5 Documents/Items Sent to TRACK&STRUCTURES@SCRRA.NET

Summary of all items that are required to send to TRACK&STRUCTURES@SCRRA.NET.

Section 1.2 - Suggested Manual Changes

If you have a suggestion or requested change to this manual, please email your suggestions to TRACK&STRUCTURES@SCRRA.NET. The manual is planned to be a beta version and the final version is planned to be finalized by approximately March 2019.

Section 3.0 - Track Geometry

The Track Geometry Car shall produce on-car printouts of exceptions found with Critical (Priority 1) and Urgent (Priority 2) designations. Critical defects shall be verified within 24 hours, and immediate corrective action shall be taken to repair or protect the defect with the appropriate slow order. After corrections are made, a report shall be submitted to SCRRA at TRACK&STRUCTURES@SCRRA.NET. The Urgent Track Geometry Car data should be utilized as a guide for planning corrective maintenance programs.

Note: Critical defect findings must be documented on the FRA Track Inspection Report form and sent to TRACK&STRUCTURES@SCRRA.NET. Urgent defects identified will be documented on the Urgent Defects form in Appendix C and used to generate the maintenance program.

Section 3.1 - Geometry Measurements

Critical defect findings must be documented on the FRA Track Inspection Report form and sent to TRACK&STRUCTURES@SCRRA.NET. Urgent defects identified will be documented on the Urgent Defects form in Appendix C and used to generate the maintenance program.

Section 5.2.4 - Rail Wear Limits

The maximum acceptable rail wear limits are listed in Table 5-3. Curves having $\frac{1}{2}$ inch Side Wear or greater will be considered for replacement. Excessive rail wear should be tracked on the bi-annual curve inspection reports. Rail wear measurements shall be made utilizing a Rail Head Wear Gage and documented on Semi-Annual Curve Inspection Report form in Appendix C. Send reports to TRACK&STRUCTURES@SCRRA.NET.

Section 5.19.5.6 - Main Line Maintenance Replacement Rails

Report all rail change outs and replacements using Disturbance Report form found in Appendix C and submit to TRACK&STRUCTURES@SCRRA.NET.

Section 5.19.5.7 - Service Failure/Broken Rail

Using a digital camera, capture pictures of the rail while still in track and pictures of each full rail end. Email photos and CWR Stress Adjustment/Disturbance Report to: TRACK&STRUCTURES@SCRRA.NET.

Section 5.21.3 - Inspection and Maintenance

Lubricators shall be inspected monthly, recorded on the Rail Lubricators form in Appendix C, and submitted to TRACK&STRUCTURES@SCRRA.NET.

Section 8.5 - Inspection Methods

Inspection of track reconstruction must be performed on foot by the contractor's supervisor in charge of the work, the contract operator, and SCRRRA representative before returning the track to service or before the next train over the segment of track affected. Inspection must be documented, signed by all parties making inspection and submitted to SCRRRA at TRACK&STRUCTURES@SCRRRA.NET.

Section 8.6 - Track Inspector Responsibilities

Track Inspectors will complete required inspection reports and submit to TRACK&STRUCTURES@SCRRRA.NET.

Section 8.6.1 - Track Inspection Frequencies

Main Tracks and Sidings

Inspect all main tracks at least twice weekly with at least 1 calendar day interval between inspections. Each main track must be traversed by the inspection vehicle or inspected on foot at least once every week and documenting how each inspection was completed on the inspection form. Make additional inspections as provided in these instructions and in other sections of this manual as required. Report weekly inspections on the track inspection report form located in Appendix C. Send reports to TRACK&STRUCTURES@SCRRRA.NET.

Turnouts

Inspect each turnout on foot at least monthly. Quarterly inspections conducted jointly with signal department are also required. All turnout inspections must be documented on the Turnout Inspection Form attached in Appendix C. Send reports to TRACK&STRUCTURES@SCRRRA.NET.

Section 8.8 - Track Inspection

Notify SCRRRA at TRACK&STRUCTURES@SCRRRA.NET of any encroachments, development on adjacent land or dumping by outsiders on the right-of-way.

Section 8.8.6 - Rail Defects

Note: Notify TRACK&STRUCTURES@SCRRRA.NET immediately of rail defects. Rail defects will be remediated in accordance with FRA requirements. Any rail defect shall be removed from the track as soon as practical.

Section 8.8.8 - CWR Rail Joints

All rail joint bars and insulated joints shall be documented at TRACK&STRUCTURES@SCRRRA.NET per form in Appendix C.

Section 8.8.16 - Bridges

Conditions on bridges that do not comply with Urgent limits require documentation. Refer also to the Bridge, Culvert and Tunnel Safety Management Program manual.

Inspectors should look for and report to TRACK&STRUCTURES@SCRRRA.NET if any of the following conditions are found:

1. Marginal tie conditions that exist at an open deck bridge.
2. Marginal tie conditions on the approach to the bridge.
3. Any geometry condition on a bridge which could be an indicator of a more severe condition.
4. Combustible materials in or around any bridge structure.
5. Any drift built up on the up-stream side of bridge.
6. Excess silting of water channel.
7. Any missing or loose ballast retainers.
8. Any damage seen on the superstructure.
9. Any evidence of scouring of back wall and piers.

If there is any concern as to the safety of train operations place a speed restriction, or if necessary, remove from service.

Section 8.8.17 – Main Line Curves

Advise the TRACK&STRUCTURES@SCRRRA.NET of all serious track defects requiring prompt corrective action.

Section 8.12.5 – Conditions Reported by Trains

The DOC shall notify the track inspector whenever an irregular track condition is reported by trains. The track inspector will immediately arrange to have the track inspected and report sent to TRACK&STRUCTURES@SCRRRA.NET. Protect train operations until any necessary repairs are completed.

Section 8.13 – FRA Inspections

A SCRRRA representative shall accompany an FRA Inspector making a track inspection on the territory. When this is not possible, SCRRRA representative may designate another employee.

A copy of the inspection reports from the FRA must be sent to the TRACK&STRUCTURES@SCRRRA.NET no later than the next business day after completion of the inspection.

Section 9.6.3.2 – Installing CWR

A record of rail temperatures of installed rail will be maintained by SCRRRA. When installing CWR, follow all rail installation requirements and document the required information on the CWR Stress Adjustment/Disturbance Report found in the Appendix and submit to TRACK&STRUCTURES@SCRRRA.NET.

Section 9.6.3.3 – Instructions for Taking Rail Temperature (RT)

Measure rail temperature on the web of the shady side of the rail. Take an average of a minimum of four readings: One at each end with two equally spaced in the middle. Each new string of rail requires its own average temperature on documentation. Record rail temperature notes and installation temperatures on the Record of Rail Installation Temperatures form and submit to TRACK&STRUCTURES@SCRRRA.NET.

Section 9.8.1 – Destressing Rail Procedure

Fill out a CWR Stress Adjustment/Disturbance Report found in the Appendix and submit the completed report to TRACK&STRUCTURES@SCRRRA.NET.

Section 9.8.3 – Destressing CWR After a Track Buckle

Fill out a CWR Stress Adjustment/Disturbance Report found in the Appendix and submit the completed report to TRACK&STRUCTURES@SCRRRA.NET.

Section 9.14.1 – Report of CWR Installations

Records necessary to provide an adequate history of installing and achieving rail neutral temperatures using this procedure will be maintained for at least one year. These records will include the date of installation, location, rail and length, initial rail temperature, designated RNT, expansion, and adjusted RNT and must be recorded on the prescribed forms Record of Rail Installation Temperatures and the CWR Stress Adjustment/Disturbance Report in the Appendix and submitted to TRACK&STRUCTURES@SCRRRA.NET by the qualified person-in-charge. These forms must be retained for at least one year after installation and will be provided by SCRRRA upon request.

Section 9.14.2 – Report Maintenance Work in CWR

The qualified person-in-charge of work being performed on the track shall retain original of report and shall forward a copy to SCRRRA at TRACK&STRUCTURES@SCRRRA.NET. If box marked "Corrective Action Required" is checked, a second report shall be submitted to TRACK&STRUCTURES@SCRRRA.NET within 30 days to indicate the corrective action and shall refer to the original report by date and milepost location.

Record of each designated cut or break location on the CWR Stress Adjustment/Disturbance Report in the Appendix and submit to TRACK&STRUCTURES@SCRRRA.NET. In areas where rail was added, the RNT must be adjusted and documented, per Section 9.6 CWR Installation Procedures and Section 9.8 Track Buckling Prevention, within 30 days. Records must be retained for 365 days after final corrections are made.

Any of the conditions above must be recorded on a CWR Stress Adjustment/Disturbance Report found in the Appendix and must be filled out by a qualified person-in-charge and submitted to TRACK&STRUCTURES@SCRRRA.NET. SCRRRA must monitor these records to ensure necessary corrections and adjustments are made. If rail is not adjusted to the PRLT before hot weather or forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25 MPH must be placed.

1.6 SCRRA Standards Summary

Go to <https://www.metrolinktrains.com/about/agency/engineering--construction/> for full index of drawings for SCRRA Standard Plans.

SCRRA ENGINEERING STANDARDS INDEX SUMMARY			SCRRA ENGINEERING STANDARDS INDEX SUMMARY			
ENGINEERING STANDARD NO.	DESCRIPTION	CURRENT REVISION	ENGINEERING STANDARD NO.	DESCRIPTION	CURRENT REVISION	
1000 GENERAL			STRUCTURES			
1000	1000 Drawing Index		6000	6000 Bridges		
	1100 Abbreviations			6100 Signs for Structures		
	1200 Symbols			6300 Culverts		
2000 TRACK			MAINTENANCE AND LAYOVER FACILITIES			
2000	2000 Roadbed Sections		7000	7000 Walkway Clearances		
	2100 Clearances			7100 Facilities		
	2200 Track Geometry			7200 Compressed Air Facility		
	2300 Rail Sections			7300 Power System		
	2350 Rail Fasteners		SIGNAL			
	2400 Ties		8000	8000 Highway-Rail Grade Crossings		
	2450 Tie Plates			8100 General		
	2500 Joint Bars and Bolts			8300 Crossings		
	2600 Derails			8400 Gate Arms		
	2700 Switch Stands, Rollers and Rods			8500 Signal Apparatus		
	2800 Turnouts			8600 Switch Apparatus		
3000 STATIONS				8700 Detectors		
3000	3000 Station Configuration			8800 Signal Facility Retaining Wall		
	3100 Mini High Platforms		COMMUNICATIONS			
	3300 Station Signage		9000	9000 General		
	3400 Station Communication Equipment			9100 Data Radio System		
	3500 Customer Information System (CIS)			9200 Voice Radio System		
	3600 Video Surveillance System (VSS)			9300 Base Stations		
4000 GRADE CROSSINGS				9400 Communications Shelter		
4000	4000 Pedestrian Facilities			9500 Fiber Optic - Inside Plant		
	4200 Precast Concrete Panels			9600 Fiber Optic - Outside Plant		
	4300 Temporary Traffic Control			9700 Microwave Radio		
5000 RIGHT-OF-WAY				9800 Leased Telephone Circuits		
5000	5000 Pipeline Standards			9900 Products		
	5100 Fence Standards					
	5200 Construction Project Signs					
	5200 Wayside Signs					

Figure 1-2

2.0 Roadbed

2.1 Cross Section

Maintain roadbeds, embankments, and excavations according to SCRRRA Standard ES2001, ES2002, and ES2003 when practical.

2.2 Drainage

2.2.1 *General*

To achieve proper drainage that diverts water away from the track, either direct the water parallel to and/or across the roadbed, or intercept and divert the water before it reaches the roadbed. To provide adequate drainage, consider the following:

1. Maximum expected runoff from rain, melting snow, or other sources
2. Track and roadbed conditions that will develop during freezing temperatures

Keep water-carrying devices clear of debris to make sure that water can flow freely. Notify SCRRRA if obstructions outside the railroad right-of-way interfere with water flow.

During heavy rainfall or runoff, monitor water-carrying devices to make sure they handle the flow of water. Report drainage facilities that cannot handle the water flow to SCRRRA to be considered for enlargement.

Do not allow adjacent land owners or other parties to divert water from their property into existing water-carrying devices or to construct such devices on the railroad right-of-way. Immediately report such activities to SCRRRA.

2.2.2 *Grade*

The slope of the grade adjacent to the track structure directs water away from the track toward natural or man-made water-carrying devices. To ensure the correct grade:

1. Construct and maintain subgrade to a 2% cross slope. Ditches, subsurface drains, perforated pipe, rock drains, or other water-carrying devices should be installed and maintained at a minimum slope of 3 inches in every 100 feet of length.
2. When water-carrying devices run parallel to the track, make sure they conform to whichever of the following requirements is greater:
 - 2.1. The requirements in step 1
 - 2.2. The established grade of the track

2.3 Surface Drainage

2.3.1 *Ditch Construction and Maintenance*

Third party contractors must obtain an SCRRA right of entry permit before proceeding with any work on SCRRA right of way.

All contractors (third party or maintenance) must do the following:

Before performing work, call SCRRA before you dig hotline (909) 592-1346 (SCRRA's signal department) to determine if there are any fiber optic cables or other utilities in the work area.

Call SCRRA Signal Department at 909-592-1346, a minimum of five days prior to beginning construction to mark signal and communication cables and conduits. Then contact the California call before you dig hotline at (811) at least 48 hours before performing any work. The state one-call center will notify all utility owners within the work area. SCRRA is not a member of Dig Alert.

Do not begin excavation or construction along the railroad's right-of-way until all utilities in the work area have been located and protected by their owners.

Maintain ditches in earthen soils as shown in SCRRA Standard ES2001.

Direct the outlet ends of ditches away from the track structure to prevent erosion to ditches or the roadbed.

2.3.2 *Ditch cleaning*

1. Start removing waste material from the outlet or bottom end of the ditch.
2. Whenever possible, use removed material to widen narrow embankments or replace material eroded from the roadbed.
3. When placing material on an embankment, distribute it evenly on the face of the slope by terracing up from the base of the fill.
4. When removing waste material from ditches, do not put it in the following locations:
 - 4.1. On the slopes of cuts or other locations where it will wash back into the ditch or track
 - 4.2. On the right-of-way where it will obstruct natural roadbed drainage
 - 4.3. On the track's ballast section
5. When disposing of removed earthen material:
 - 5.1. Grade it smoothly.
 - 5.2. Do not raise shoulders above the existing subgrade.
6. If the waste material could be environmentally dangerous:
 - 6.1. Isolate the waste material from the waterway.
 - 6.2. Cover the material with plastic.
 - 6.3. Consult with an environmental representative on how to dispose of the material.

2.3.3 *Drainage Facilities*

Annual inspections are required of all drainage facilities. Reinspect all drainage facilities prior to forecasted storm events and clear obstructions that may have developed.

2.3.4 Culverts

Note: Ensure the cover thickness over the top of the culvert to the bottom of the tie is at least one-half the thickness of the culvert diameter

1. Keep culverts clear of obstructions at all times.
2. Make sure there are enough culverts and they are large enough to handle the maximum anticipated water flow.
3. If the roadbed appears to block the flow of water from one side of the track to the other, consider installing additional or larger culverts.
4. When a washout occurs during heavy runoff, determine whether existing devices are obstructed.
 - 4.1. If existing devices are obstructed, remove obstructions
 - 4.2. If existing devices are not obstructed, report condition to SCRRRA and recommend upgrade

2.3.5 Grade Crossing Drainage

Follow the requirements in SCRRRA Standard ES4201-02 to establish subsurface drainage at grade crossings.

2.3.6 Erosion Control

1. Seed embankments or other locations graded on the right-of-way with native grasses when directed by SCRRRA.
2. Use an apron of concrete or rock to protect the outlet ends of perforated pipes that direct water onto embankments.
3. Do not excavate material from the slopes of embankments.
4. Place rock or riprap at locations where material is being eroded and the water flow cannot be slowed or diverted.
5. When selecting the best size of material for controlling erosion, consider the following:
 - 5.1. The amount and force of the water the material will be exposed to.
 - 5.2. The equipment available for handling the material after it is unloaded.

2.4 Subsurface Drainage

Install underground drainage systems in locations where side ditches cannot be effectively maintained, such as wet or narrow cuts, tunnels, station platforms, or yard tracks.

1. When laying pipe as part of a subsurface drainage system, place the pipe at true grade so that the pipe outlet will drain water away from track structure.
2. When installing catch basins, risers, or manholes that are tied to drainage systems, set them at an elevation to adequately drain the intended area.
3. Place subsurface drainpipe at least 18 inches (where practicable) below ground level or the bottom of the rail.
4. When placing pipe into an excavated ditch:
 - 4.1. Line the bottom of the ditch with compacted material.
 - 4.2. Place the pipe on top of the compacted material and center it between the ditch sidewalls.
 - 4.3. Backfill the ditch entirely with coarse ballast and place at least 24 inches of ballast (where practicable) on top of the pipe.

2.4.1 *Perforated Pipe*

Install perforated pipe in road crossings per SCRRRA Standard ES4201-02 where required by contract agreement with public agencies or as otherwise provided in project plans.

When installing perforated pipe for subsurface drainage:

1. Make sure that connectors and elbows are the proper size and dimension for connecting standard length pipe sections.
2. Wrap perforated pipe in filter fabric before installing.
3. Place perforated pipe with the perforations facing down.
4. Keep perforated pipe ends clear of debris.
5. When burying perforated pipe beneath track to drain water laterally, wrap the open end of the pipe with filter fabric.
6. Ensure that pipe outlets are installed at proper grade to allow water to flow away from the crossing.

Note: When needed, install perforated pipe to supplement rock drains. Backfill all pipe installations with coarse ballast to restore the roadbed to its original profile.

2.5 Embankments

When unloading material on embankments, distribute the material evenly on the face of the slope and include associated benches and begin from the base.

Do not leave riprap or other fill material in the following locations:

1. On the top of embankments where the additional weight could cause a sudden and catastrophic failure
2. Near the track where it could interfere with ballast regulators as they dress shoulders

2.6 Ballast, Subballast, Rip Rap

Ballast from preapproved sources may only be used on SCRRA Property.

2.6.1 *Ballast Section*

Maintain the ballast section according to SCRRA Standard ES2001, for wood tie track, concrete tie track, and industrial track.

1. Maintain tie cribs with ballast to a level 1 inch below the rail base. Maintain the ballast line on an even plane for the full length of the tie.
2. Maintain the side slope of the ballast line from the outermost edge of the shoulder to the top of the subgrade or subballast with a uniform 2 to 1 slope as shown in SCRRA Standard ES2001.
3. Construct the intersection of the ballast side slope lines between multiple tracks in a "V" shape as shown.

Note: Areas between the body tracks of yards in terminals or other switching locations where employees frequently perform work between tracks, shall be leveled off.

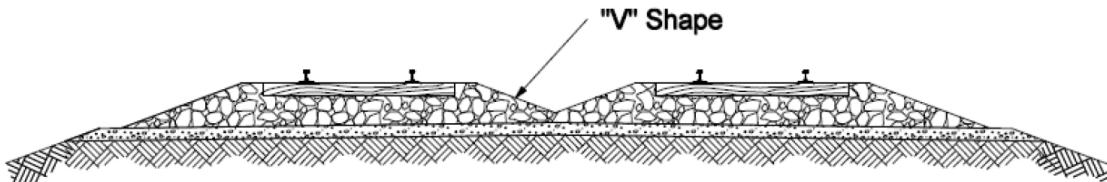


Figure 2-1

4. Keep flange ways clear of ballast through switches, derails, diamond crossings, and grade crossings.
5. Remove ballast from tie cribs to provide a minimum 3-inch clearance between the ballast and the operating linkage of turnouts and other devices. Maintain this clearance for the entire area through which the linkage travels during its operation.
6. Maintain the ballast shoulder per SCRRA Standard ES2001.
7. Maintain ballast to the specified depth as measured below the horizontal surface of the tie bottom.

Note: Measure downward from the center section of the tie and not from tie end

2.6.2 *Distribution*

Distribute enough ballast to provide the designated shoulder width, shoulder slope, depth under ties, and full tie cribs.

Note: Determine the required quantity of ballast based on the grade raise or track profile you want to achieve.

Precautions:

Avoid moving trains over skeletonized track. However, if movement is necessary, ensure that the train speed does not exceed 5 MPH.

When preparing to unload air dump cars, ensure that the proper adapter hose is available.

2.6.3 *Unloading Ballast*

Whenever possible, distribute ballast before ties are distributed for capital tie projects.

Before unloading ballast, verify how much ballast will be needed before unloading. Regulate control-flow doors on ballast cars to minimize the amount of ballast that is redistributed by ballast regulators.

Ballast should never be left higher than top of rail within 5' from the center of the track on either side, and should be regulated below the ball of the rail before returning track to service. If ballast piles or ridges are above the top of the rail where they could be struck by rolling stock equipment, promptly level to top of rail before returning track to service.

When unloading heavy amounts of ballast, precautions must be taken to prevent the derailment of a ballast car due to excessive ballast on the track.

Note: Immediately remove ballast from bridge walkways, station platforms, grade crossings, and any part of turnouts that interferes with their use.

To keep an evenly distributed load in a ballast car with control flow doors, simultaneously regulate ballast flows from opposite sides of the car.

Note: Avoid unloading the ballast car to one side only, particularly in curves. This can cause a wheel climb derailment or can cause the car to overturn.

Minimize or avoid distributing ballast in segments where:

1. The existing ballast shoulders exceed designated width.
2. There is a large amount of ballast between adjacent tracks.
3. Track raises are restricted to maintaining their existing grade.

Note: These locations include open-deck bridges, snow sheds, station platforms, diamond crossings, interlocking, tunnels, overpasses, grade crossings, or other locations where track raises are restricted by vertical clearances.

Plow out and regulate ballast unloaded between rails within 90 days of unloading.

Note: Ballast left between rails deteriorates ties, accelerates spikes working up in wood ties, inhibits inspections, and promotes ballast fouling.

When regulating ballast into track do not pull fouled ballast or dirt into the track structure.

Best Practice: Place temporary barriers in between open switch points, hollow steel ties, and connecting rod cribs to minimize ballast.

2.6.4 *Stock Piling*

Ballast should be kept free of soil and other contaminants. When stock piling ballast near crossings, ballast should not interfere with vehicle sight distance per the vegetation distances shown in Figure 7-1.

2.6.5 *Walkway Rock*

For existing facilities, minimum walkway requirements shall be met per CPUC General Order 118. For new facilities, follow SCRRRA Standards ES2001 and ES2002 for the minimum walkway widths and requirements.

2.7 Hot Mix Asphalt Concrete (HMAC) underlayment

HMAC underlayment is required unless an exception is approved by SCRRRA for rehab and new construction projects in the following areas:

1. Turnouts
2. Diamond Crossings
3. Road Crossings
4. Bridges
5. Track Adjacent to Platforms

Refer to SCRRRA Standard ES2004 and ES2105 for HMAC requirements for turnouts and bridges. Refer also to the SCRRRA Design Criteria Manual and SCRRRA standard specifications for further details and requirements.

3.0 Track Geometry

The Track Geometry Car shall produce on-car printouts of exceptions found with Critical (Priority 1) and Urgent (Priority 2) designations. Critical defects shall be verified within 24 hours, and immediate corrective action shall be taken to repair or protect the defect with the appropriate slow order. After corrections are made, a report shall be submitted to SCRRA at TRACK&STRUCTURES@SCRRA.NET. The Urgent Track Geometry Car data should be utilized as a guide for planning corrective maintenance programs.

3.1 Geometry Measurements

Track inspections will be performed to ensure compliance with required SCRRA maintenance standards. SCRRA track shall be maintained, at minimum, to the limits defined as Urgent in this manual.

Urgent Condition: At a minimum, track conditions must meet the Urgent Conditions defined herein. Corrective action must be taken within 60 days or a remedial action is required restricting the track speed to the next lower class that complies with SCRRA urgent requirements.

Urgent Geometry Measurements: A track condition that may require that immediate corrective action be taken. Track geometry shall be maintained to a minimum of the urgent limit described in Table 3-1. These conditions must be verified within 7 calendar days to determine whether immediate remedial or corrective action is required. The following conditions require corrective action within 30 days or a remedial action is required restricting the track speed to the next lower class that complies with SCRRA urgent requirements. At no time shall track geometry conditions or speeds exceed the allowable conditions or speeds required under the FRA Track Safety Standards.

1. Alignment
2. Runoff
3. Profile
4. Crosslevel
5. Twist in a 31ft Chord
6. Wide Gage
7. Warp in a 62ft Chord

Critical Condition: A track condition that may require immediate remedial or corrective action be taken prior to any movement of trains once defect is identified. This condition must be verified within 24 hours.

Note: Critical defect findings must be documented on the FRA Track Inspection Report form and sent to TRACK&STRUCTURES@SCRRA.NET. Urgent defects identified will be documented on the Urgent Defects form in Appendix C and used to generate the maintenance program.

See Table 3-1 for all track condition requirements on SCRRA for maximum limits.

Class Specific Track Geometry and Rail Defects											
Track Condition	Description	Measurements may not exceed:									
		Class 1 15/10		Class 2 30/25		Class 3 60/40		Class 4 80/60		Class 5 90/80	
		Urgent (in.)	Critical (in.)	Urgent (in.)	Critical (in.)	Urgent (in.)	Critical (in.)	Urgent (in.)	Critical (in.)	Urgent (in.)	Critical (in.)
Alignment, 62 ft.	Deviation from uniformity measured with a 62 ft. Chord	4	5	2 1/2	3	1 1/2	1 3/4	1 1/8	1 1/2	5/8	3/4
Alignment, Curve, 62 ft.	Deviation from uniformity measured with a 62 ft. Chord	3 1/2	5	2 1/4	3	1 1/4	1 3/4	1	1 1/2	1/2	5/8
Alignment, Curve, 31 ft.	Deviation from uniformity measured with a 31 ft. Chord	2 3/4	N/A	1 1/2	N/A	7/8	1 1/4	3/4	1	3/8	1/2
Gage	Maximum Limits. (Minimum Gage shall not be less than 56")	57-13/16	58	57-5/8	57-3/4	57-5/8	57-3/4	57-3/8	57-1/2	57-3/8	57-1/2
Runoff in 31 ft.	Ramping of track	2 5/8	3 1/2	2 1/4	3	1 1/2	2	1 1/8	1 1/2	3/4	1
Surface Profile, 62 ft.	Mid-ordinate Deviation in 62 ft. on top of rail	2	3	2	2 3/4	1 1/2	2 1/4	1 1/4	2	3/4	1 1/4
Twist	Difference in crosslevel in spirals per 31 ft.	1 3/4	2	1 1/2	1 3/4	1	1 1/4	3/4	1	1/2	3/4
Harmonics	Difference in crosslevel in six consecutive pairs of joints; created by 7 joints	N/A	N/A	1	1 1/4	1	1 1/4	1	1 1/4	1	1 1/4
Crosslevel	At any point on tangent, deviation from zero crosslevel...	2 1/4	3	1 1/2	2	1 1/4	1 3/4	1	1 1/4	3/4	1
Warp	Difference in crosslevel within 62 ft.	2 1/4	3	1 5/8	2 1/4	1 1/2	2	1 1/4	1 3/4	1	1 1/2
Tread - Rail End Mismatch		3/16	1/4	3/16	1/4	1/8	3/16	1/16	1/8	1/16	1/8
Gage Face - Rail End Mismatch		3/16	1/4	1/8	3/16	1/8	3/16	1/16	1/8	1/16	1/8

Table 3-1

3.1.1 *Post Derailment Track Measurements*

See Appendix D for the Derailment Response and Analysis – Track Inspection Team instructions and forms.

3.1.2 *Determine Designated Rail*

When reading geometry or detector car reports and trying to determine which rail is the right rail and which rail is the left rail, position yourself with your back to the lower MP. While facing the higher MP, the rail on your right is the right rail and on your left is the left rail.

3.1.3 *Geometry Car Testing Program*

Geometry cars shall operate over all main line tracks, siding tracks, revenue tracks, turnouts, and crossovers in accordance with the frequency below:

1. Passenger Routes: Three times per year, with at least four months, but no more than six months, between tests.
2. Freight Only Routes and all other routes: Once a year, or as directed by SCRRA.

Track Geometry cars operated by Amtrak, FRA, or Freight Railroads, may not be used to fulfill this testing frequency requirement. An SCRRA representative and the Track Inspector must ride the Track Geometry(s) Car while on SCRRA property.

3.2 Track Alignment

Track alignment is the uniformity of rail on both tangent and curved track. Alignment may not deviate from uniformity more than the amount prescribed per Table 3-1.

3.2.1 *Designated Line Rail for Curved Track*

The outer or high rail of curves is the line rail for referencing alignment

3.2.2 *Designated Line Rail for Tangent Track*

Designate the line rail for referencing alignment on tangent track as follows:

1. Single Main Track—Use the right rail when facing in the direction of increasing Mile Post.
2. Two Main Tracks—Use the outside rail of each track.
3. Three Main Tracks—Use the outside rail of the outer tracks. Use the right rail as the line rail for referencing alignment on the center track.
4. Four Main Tracks—Use the outside rail of the outer tracks. Use the inside rail of the inner tracks as the line rail for referencing alignment on the center tracks.
5. All Other Applications—Use the most practical line rail. Use this same rail throughout the tangent segment.

When lining tangent track between two curves of the same direction that are less than 1/4 mile apart, use the same line reference rail.

When lining into a fixed object that is less than 1/4 mile from the curve, use the same line reference rail as used in a curve.

Note: Examples of fixed objects are open deck bridges, diamond crossings, turnouts, tunnels, or other immovable objects.

3.2.3 Designated Line Rail for Turnout and Crossovers

Use the straight side of turnouts as the designated line rail for referencing alignment through the straight side of switches when turnouts exist entirely on tangent track as shown in Figure 3-1.

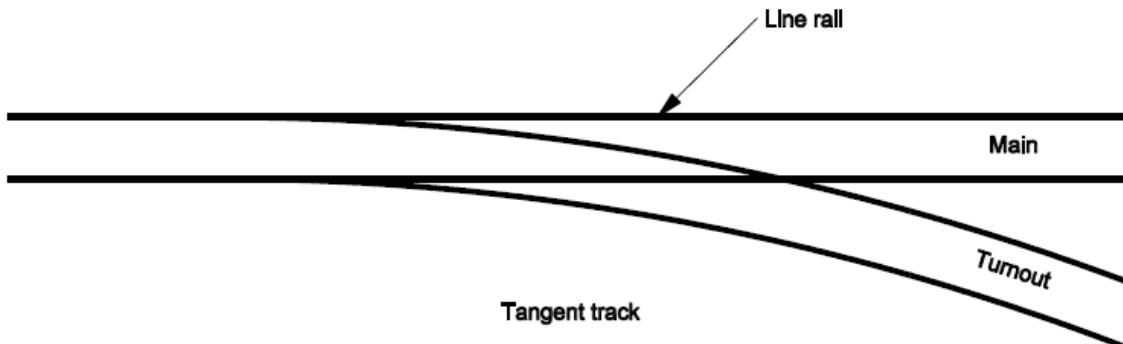


Figure 3-1

When any portion of a turnout is located on a curve, use the high or outer rail of the curve as the designated line rail as shown in Figure 3-2.

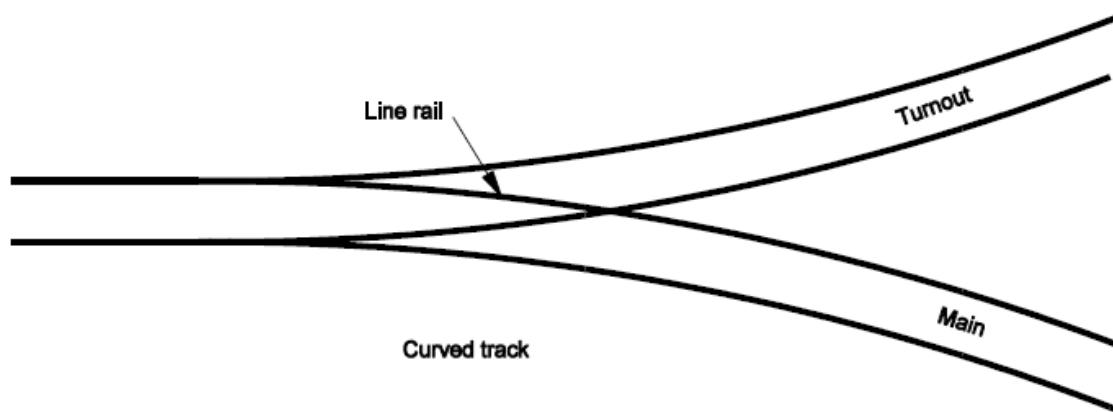


Figure 3-2

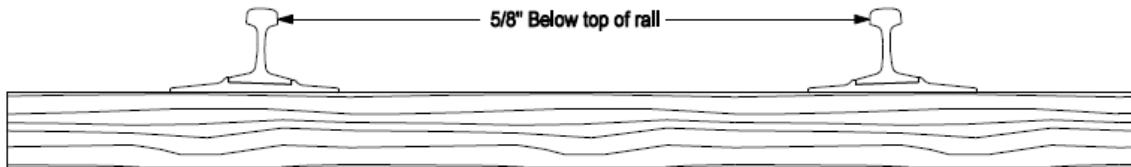
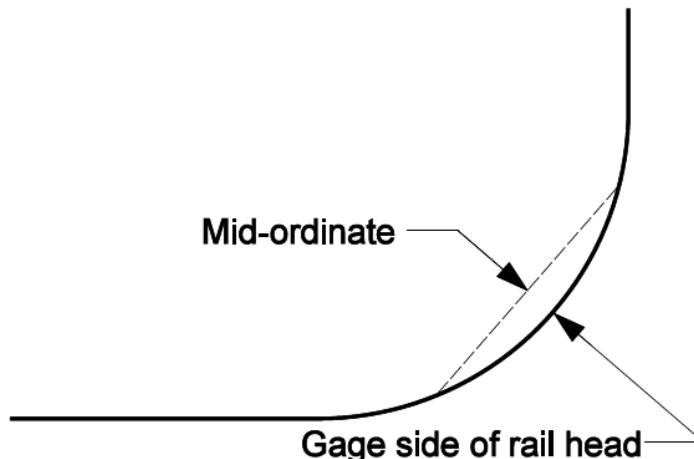
3.2.4 Measuring Alignment

Alignment deviation can be detected visually or located by incrementally moving the chord along the track until the point with maximum deviation is found.

Inspectors must be aware that a 62-foot chord may be “blind” to short alignment conditions, whereby a 31-foot chord can detect those noncomplying conditions.

When measuring alignment:

1. Measure alignment on the designated line rail on the gage side of the rail head. Measure at a point 5/8 inch below the top of the rail head as shown in Figure 3-3.
2. Record measurements at 15-1/2-foot intervals on the same rail for the full length of tangent and curved segments.
3. Use a 31-foot, 62-foot length to obtain track alignment measurements as shown in Figure 3-4.

*Figure 3-3**Figure 3-4*

Alignment in Curves

In curves, the mid-ordinate, also called mid-chord offset (MCO), require "stations" to be marked at regular intervals on the high rail in both directions from the point in question. The term MCO is used interchangeably for "mid-ordinate" and "mid-offset" and represents the distance from the rail to the chord at the mid-point of the chord. In curves, a 62-foot chord is used in Classes 1 through 5; in addition, a 31-foot chord is also used in Classes 3 through 5 track. Alignment defects for Classes 3 through 5 track can be identified with either or both chord lengths. A 31-foot chord is particularly necessary for determining short alignment deviations.

Alignment in Tangents

In tangent track, the MCO is measured directly with a 62-foot chord.

Using Shims

To measure alignment on tangent track, you may need to place 1-inch or greater shims at the gage side of the rail where the ends of the 62-foot chord would normally contact the rail head. Subtract the shim thickness from the mid-ordinate measurement to determine the exact reading

Note: Shims offset the 62-foot chord to take the measurement at the mid-ordinate without contacting the rail head along the chord.

3.2.5 Restoring Uniform Alignment

To restore uniform alignment:

1. Correct track alignment in ballasted track by laterally shifting the track to uniform alignment while referencing the designated line rail.
2. Use laser systems with automatic tamping machines when surfacing long segments of tangent track or track with horizontal line swings.
 - 2.1. Place the laser on fixed track structures such as open deck bridges or other immovable objects.
 - 2.2. Verify track centers where the laser is placed before starting lining operations.
3. Correct track alignment of fixed track structures such as open deck bridges or other immovable objects by spike lining the designated line rail to uniform alignment.

Note: When spike lining to adjust alignment, monitor track gage and adjust as necessary to conform with established gage standards.

4. When aligning crossover switches that have long switch ties that extend under both tracks:
 - 4.1. Reference the designated line rail on the straight side of the crossover switches.
 - 4.2. To correct alignment of all other designated line rails in the crossover requiring adjustment, spike line the rail to uniformity.
5. When laterally shifting switches to uniform alignment:
 - 5.1. Reference the designated line rail on the straight side of switches.
 - 5.2. To correct alignment of the other designated line rail in the turnout requiring adjustment, spike line the rail to uniformity.

3.2.6 Line Ordinates in Turnouts and Crossovers

If no standard drawings are applicable, the following procedure shall be used:

The designated line rail for referencing alignment through the turnout side of switches is the turnout side closure rail. See Figure 6-1. The closure rail connects the switch point to the frog and continues from the heel of the frog through the last long switch tie.

When establishing alignment in turnouts and crossovers:

1. To establish alignment through turnout side of switches through the last long switch tie, use line ordinates provided in SCRRA Standard for each size turnout.

Note: Line ordinates denote the specific spread distance between gage lines of curved closure rails and adjacent rails on the straight side of turnouts. The spread distance establishes the proper alignment for the turnout side of switches

2. Establish alignment for the turnout side of switches not having published ordinates as follows:
 - 2.1. Align the straight side of the turnout to the desired alignment.
 - 2.2. Stretch a string between the heel of the switch and the toe of the frog along the gage line.
 - 2.3. Measure the overall distance and divide into four equal parts.
 - 2.4. Offset the center ordinate at a right angle to the string 6 inches and spike in place.
 - 2.5. Offset each quarter ordinate at a right angle to the string 4-1/2 inches and spike in place as shown in Figure 3-5.

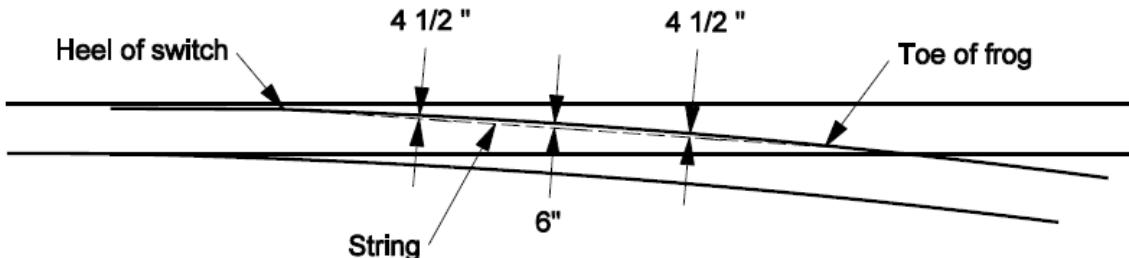


Figure 3-5

3.2.6.1 Line Ordinates Behind Frog

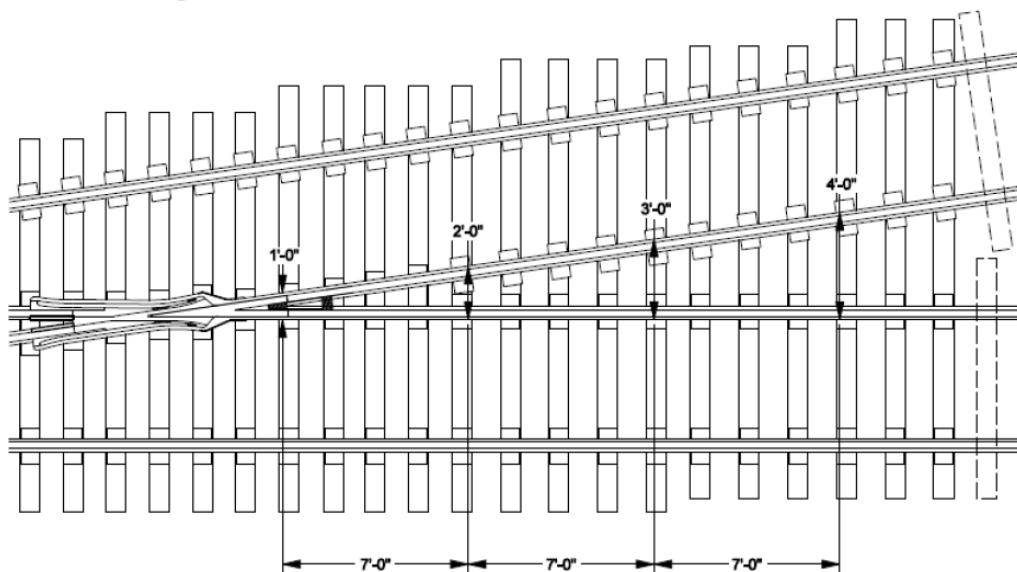
Line ordinates behind the frog spread apart over a given distance at a rate determined by the frog size. See Table 3-2.

If Frog Size is...	The Spread Increases 1 foot every...
7	7 feet
8	8 feet
8.5	8.5 feet
9	9 feet
10	10 feet
11	11 feet
14	14 feet
15	15 feet
20	20 feet
24	24 feet
30	30 feet

Table 3-2

When determining line ordinates for behind the frog:

1. Locate the point where the frog's heel spread measures 1 foot between the gauge lines.
2. From this point measure away from it down the straight side of the turnout. Measure the number of feet that equals the frog size.
3. At this point, spread the gauge lines and spike them 2 feet apart.
4. Continue this process until you establish all ordinates and spike through the last switch tie as shown in Figure 3-6.



No. 7 Turnout Example

Figure 3-6

3.2.7 Measuring Degree of Curvature

The distance between the mid-ordinate or center of a 31-foot or 62-foot chord and the gage side of the rail head determines the degree of curvature.

1. When using a 31-foot chord, multiply readings by four.
2. When using a 62-foot chord, note that the measurement in inches equals the degree of curvature, as shown in the examples in Table 3-3.

Examples of Converting Measurements to Degrees of Curvature		
Measurement	31-foot Chord	62-foot Chord
1 inch	4 degrees	1 degree
1-1/4 inches	5 degrees	1 degree - 15 minutes
1-1/2 inches	6 degrees	1 degree - 30 minutes
1-3/4 inches	7 degrees	1 degree - 45 minutes
2 inches	8 degrees	2 degrees

Table 3-3

3.3 Track Gage

Track gage is the distance between the two running rails of the track structure.

3.3.1 Designated Gage Rail

The rail opposite the designated line rail of track or turnouts is the designated gage rail.

3.3.2 Standard Gage

Standard track gage is 56-1/2 inches.

3.3.3 Measuring gage

When measuring gage:

1. Measure gage between the heads of the rail at right angles to each other. Measure at a point 5/8 inch below the top of the rail head as shown in Figure 3-7.

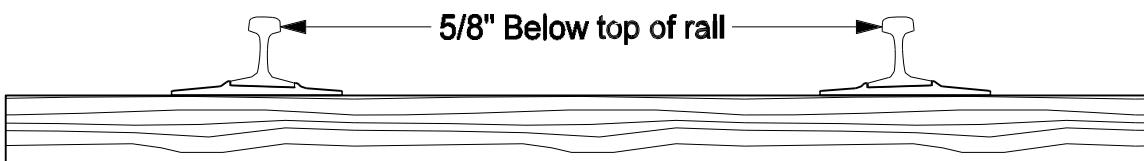
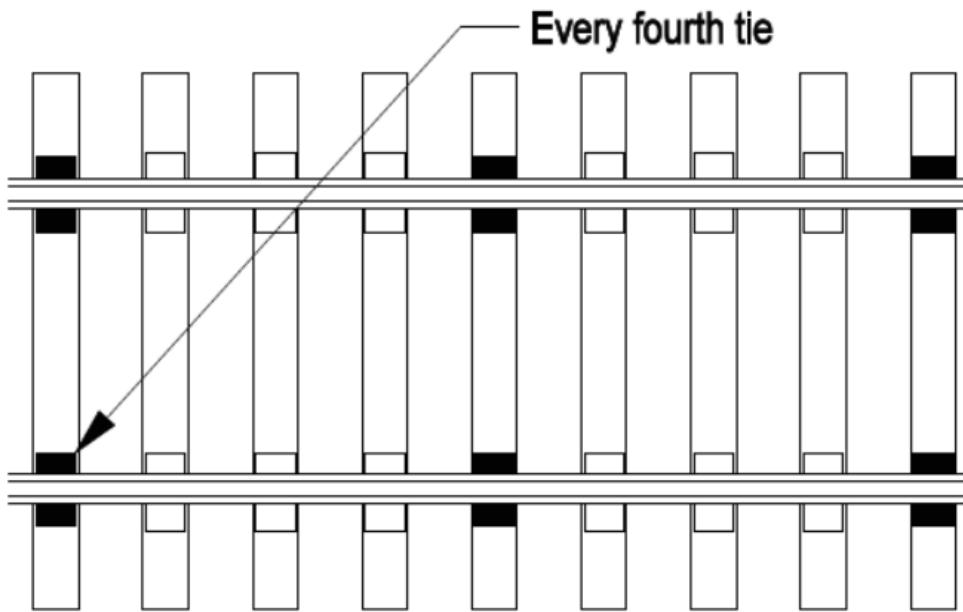
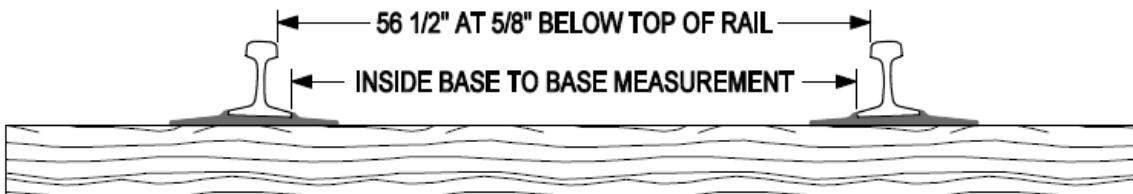


Figure 3-7

2. Use an approved track gage every fourth tie when adjusting or checking gage, spiking ties, relaying rail, or constructing new track to conform to standard gage as shown in Figure 3-8.
 - 2.1. Measure the track gage with a tape measure to verify its accuracy before use.
 - 2.2. Do not force the track gage between rails.

**Figure 3-8**

3. Before replacing or transposing rail back into tie plates without re-gaging, take inside base-to-base measurements to ensure that installing full-balled rail will not create narrow gage. Take these measurements as shown in Figure 3-9 and Table 3-4.

**Figure 3-9**

Rail Section	Rail Seat Cant	Base-to-Base Gage	Base-to-Base Gage Not More Than
141 lb.	1:40	53-3/4 inches	54-1/4 inches
136 lb.	1:40	53-3/4 inches	54-1/4 inches
133 lb.	1:30	53-7/8 inches	54-3/8 inches
112 to 119 lb.	1:40	54 inches	54-1/2 inches

Table 3-4

3.3.4 *Gage Limits*

Maintain gage to the urgent limits in Table 3-1. Minimum track gage shall not be less than 56 inches on any class of track.

Note: If track gage measures more than 58 inches, immediately remove the track from service until repairs are made.

3.3.5 *Restoring Standard Gage*

1. Perform spike pulling and re-driving along the designated gage rail.
2. Plug spike holes before re-driving spikes.
3. Prior to gaging track in curves, it may be necessary to correct geometry conditions such as superelevation, profile, and alignment. It may be necessary to line spike joints on the high rail to correct alignment deviations. Proper gage can be achieved by gaging the low rail to the high rail.
 - 3.1. At locations where repeat gaging has been performed ensure high rail spikes are pulled and plugged prior to gaging low rail.
4. To correct wide gage caused by canted or tipped rail from sand or ice build-up between the base of the rail and the top of the tie plate, remove the material to restore the rail to a level plane. If in cut spike locations, pull spikes, plug and re-spike ties. Make sure to install at least four line spikes per tie plate, adding spikes if required to strengthen and prevent re-occurrence.
5. To correct wide gage caused by worn insulators, replace worn insulators in concrete or steel tie track. Do not remove insulators and fasteners on more than three consecutive ties at one time.
6. To correct wide gage caused by curve rail worn beyond the allowable limits, transpose or replace rail. See Table 5-3 Rail Wear Limits.
7. To correct narrow track gage caused by skewed ties, return the ties to right angles to the running rails before adjusting the gage. Box anchor the tie to prevent recurrence.

Note: It may be necessary to replace defective ties in order to restore standard gage.

3.3.6 Correcting Gage Caused by Canting Deficiencies

1. Differential plate cutting is another cause of wide or narrow gage. A differential plate cutting of $3/8"$ on one rail can cause track to be out of gage by $3/16"$.
2. Nominal cant for 1:40 is $+1.42$ degrees and 1:30 cant is $+1.90$ degrees.
3. On wood tie track a differential plate cutting of $3/8"$ toward the field side will show a cant of 0° .
4. Plate cutting toward the gage side of $7/16"$ will show a cant of $+3.5^\circ$. Refer to Figure 3-10.

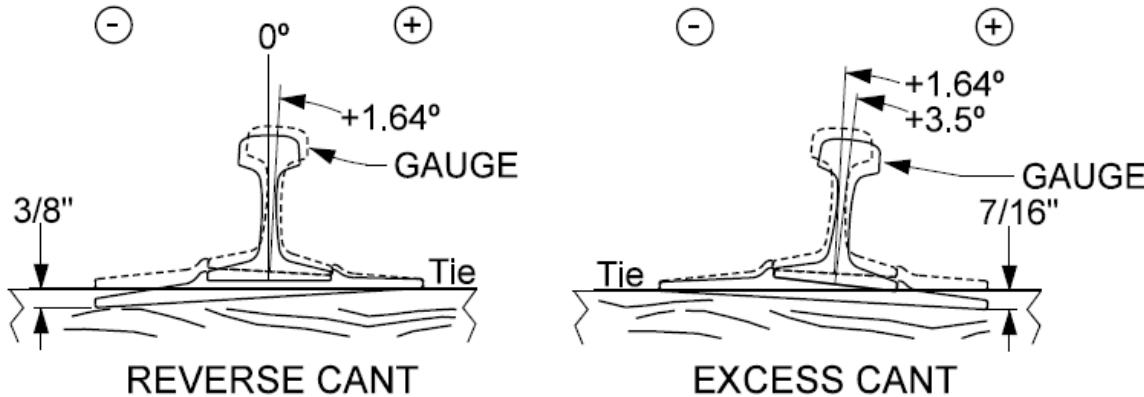


Figure 3-10

5. To correct this type of exception, the tie plates must be removed, and the plate-bearing surface of the ties must be adzed to a level plane.
6. Rail Cant Thresholds for Wood and Concrete Ties:

	Urgent	Critical
Wood	-1.5 deg	-2.0 deg
Concrete	3.5 deg	4.5 deg
Concrete	-0.5 deg	-1.5 deg

Table 3-5

3.4 Clearances

Maintain adequate spacing between tracks to enable trains to safely pass or meet rolling stock on adjacent tracks. Maintain sufficient horizontal and vertical clearance to enable trains to clear wayside structures and facilities. Track alignment changes or raises with horizontal or vertical clearance limitations shall not be made at tunnels, stations with platforms, center fences, and bridges.

3.4.1 *Measuring Track Centers*

1. To measure track centers between two adjacent tracks, measure from the gage line of a rail of one track to the same rail of an adjacent track as shown in Figure 3-11.



Figure 3-11

2. Check track centers at the beginning of surfacing and every 528 feet (1/10 mile) or less behind automatic tamping machines where adjacent tracks are present. Check track centers every 264 feet (1/20 mile) or less through spirals and the full body of curves.

3.4.2 *Minimum Track Centers*

1. Maintain existing track centers to the current design. When surfacing and lining long sections of track in multiple track territories, measurements must be taken to assure that existing track centers are not reduced.
2. Then standard track center for newly constructed track is 15 feet.
3. At no time shall track centers be less than 14 feet with the exception of tunnels, bridges, and structures where conditions are pre-existing. At no time shall track centers be less than 13 feet.
4. Maintain adjacent track centers in curves to allow for car tilt and overhang due to curvature per SCRRA Standard ES2207. Maintain track centers throughout the entire length of the curve and for 80 feet beyond the curve.

3.4.3 *Minimum Clearances*

Maintain horizontal and vertical clearances according to SCRRA Standard ES2101 displayed in Figure 3-12.

Maintain clearances not shown on this SCRRA Standard ES2101 to a minimum clearance per SCRRA Standard ES2102 shown in Figure 3-13 and Figure 3-14.

Where overhead and lateral obstructions are present, such as overpasses, tunnels, bridges, rock cuts, slide fences, platforms etc., track must not be raised without prior SCRRA approval and never raise the track above the top of rail markers or alter alignment from stakes.

Where clearances are close, do not perform track raises without approval from SCRRA. Surfacing at locations with close clearances shall be skim raises to correct crosslevel.

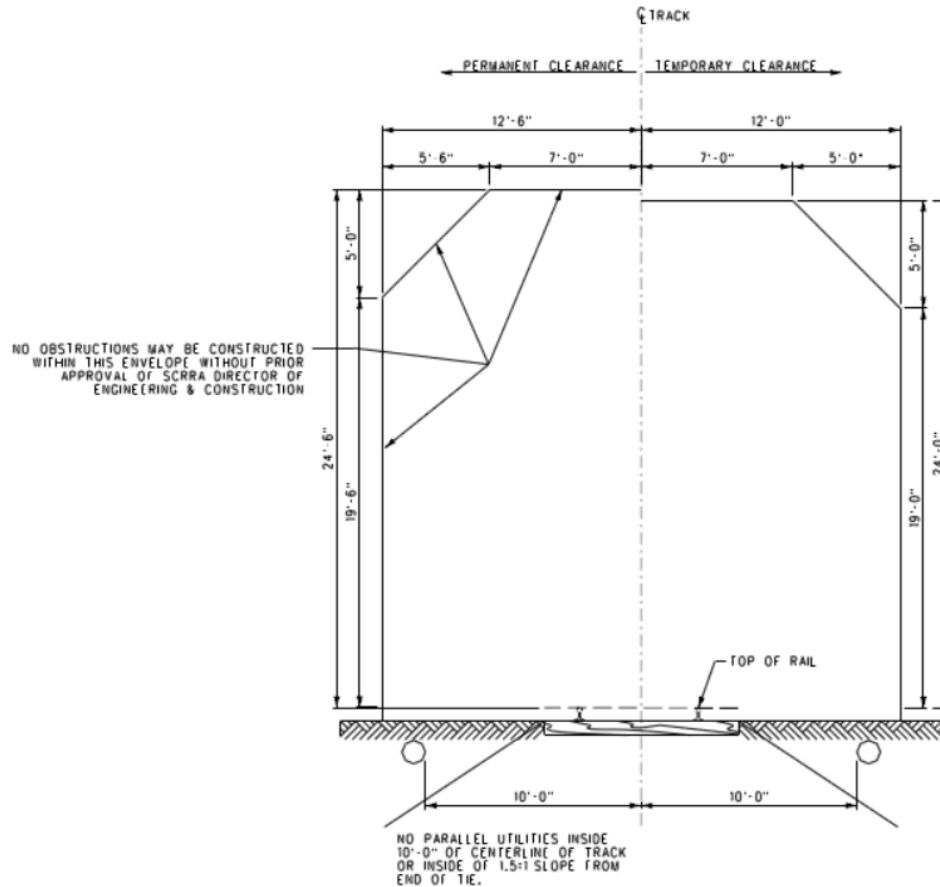


Figure 3-12

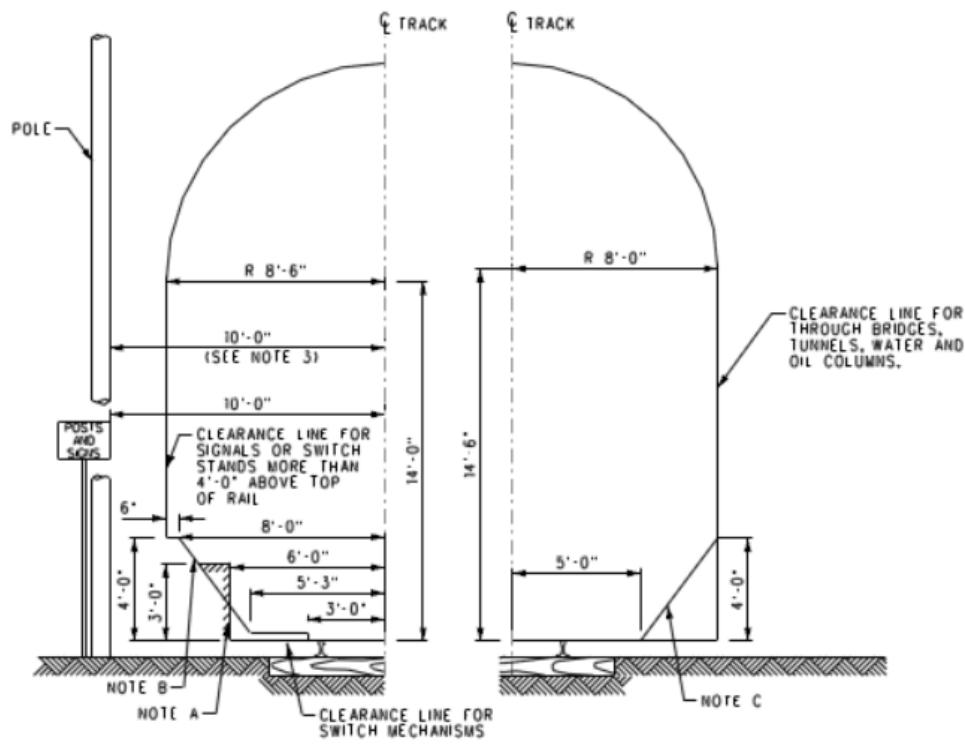
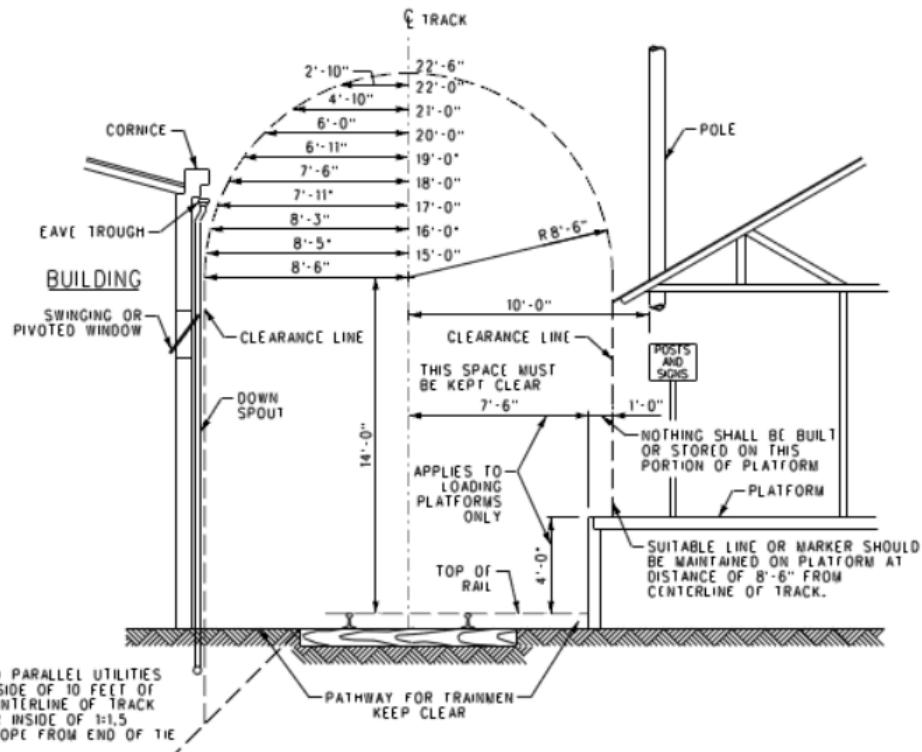


Figure 3-13

**Figure 3-14**

3.5 Grade

Track grade provides a uniform plane that allows trains to negotiate uphill and downhill terrain. Grade is preserved when uniform track raises occur during normal surface and lining operations.

3.5.1 *Designated Grade Rail*

The inner or low rail of curves is the designated reference rail for maintaining grade.

3.5.2 *Grade Stakes*

Grade stakes will be provided for relocated or newly constructed tracks to help establish the proper grade.

When necessary, grade stakes will be provided to re-establish or modify existing grade.

3.5.3 *Multiple Track Crossings*

Establish and maintain grade crossings to a uniform plane across all tracks as follows:

1. Where practicable, establish and maintain the difference between the top-of-rail elevation of adjacent tracks to within 1 inch of each other:

Through grade crossings where track centers are within 20 feet of each other as shown in Figure 3-15.

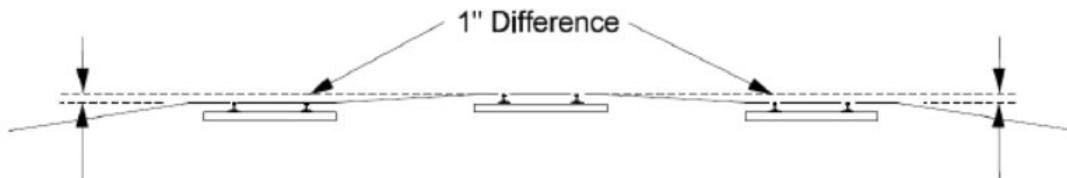


Figure 3-15

Through grade crossings that exist in curved track that contains superelevation as shown in Figure 3-16.

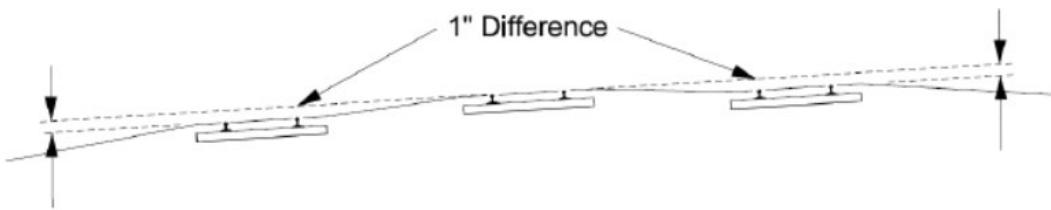


Figure 3-16

2. Stretch a string line across the tops of the rails of all existing tracks to verify the top-of rail relationship through grade crossings. Use the highest track as a reference to determine that the lower tracks conform.

3.5.4 *Turnouts and Crossovers*

The top-of-rail elevation of tracks approaching crossover switches should be as level as practicable with each other for at least 660 feet in advance of main line crossovers.

The top-of-rail elevation of main and diverging tracks must be level with each other through the turnout, and, where possible, for 250 feet beyond the signal or fouling point, whichever distance is greater.

3.6 Surface

Surface is the uniform state of profile, superelevation, and crosslevel as determined by the top-of-rail elevation and the relationship of opposite rails to each other at a specific point.

3.6.1 Measuring Runoff

Runoff is the ramping of track that is a result of trackwork, bridge work, surfacing operations, or track settlement. When surfacing operation are occurring, perform temporary runoffs in accordance with the standards described herein for the class of track. 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. 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. Figure 3-17 illustrates the measurement of runoff of raised track. See Table 3-1 for runoff tolerances.

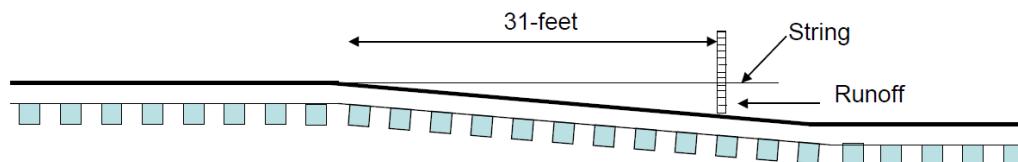


Figure 3-17

3.6.2 Measuring Profile

Track profile is the longitudinal elevation of the running rails. Measure track profile along the top of the running rails as follows:

Use a 62-foot chord (string) to obtain track profile measurements for Class 1-5 track.

Measure the distance between the mid-ordinate or center of the applicable chord and the top of the rail head to determine deviation from uniform profile as shown in Figure 3-18. See Table 3-1 for track standards.

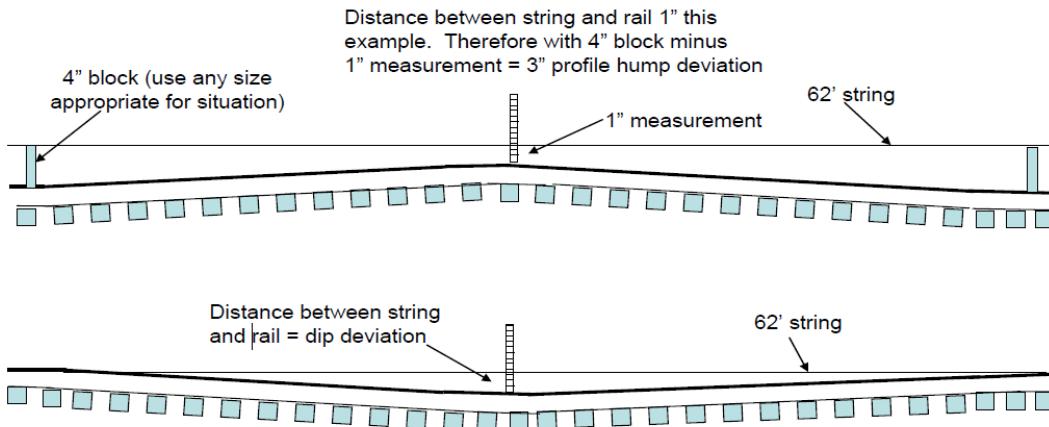


Figure 3-18

If the mid-ordinate of the chord contacts the rail head, place 1-inch or greater shims on top of the rail head at the ends of the applicable chord.

Note: If shims are used, subtract the shim thickness from the mid-ordinate measurement to determine the exact reading.

3.6.3 Measuring Crosslevel and Superelevation

Crosslevel, is measured by taking the difference in elevation between the top surface of one rail and the top surface of the opposite rail. On tangent track, both rails should be the same elevation (zero crosslevel). On spirals and curves, the outer rail must not be lower than the inner rail (reverse elevation).

1. Use an approved track level board to measure crosslevel when track is disturbed for repair work, surfacing, or inspections.
2. Test the level board for accuracy before use by calibrating, per Figure 3-20, as follows:
 - 2.1. Set the level board on a nearly level track.
 - 2.2. Obtain a reading once the bubble is centered. Note the following:
 - 2.2.1.Which rail is shown to be higher.
 - 2.2.2.The crosslevel measurement.
 - 2.3. Turn the level board end-for-end and place it at the exact location where the previous reading was taken.
 - 2.4. Obtain a reading once the bubble is centered. Note the following:
 - 2.4.1.Which rail is shown to be higher.
 - 2.4.2.The crosslevel measurement.
 - 2.5. Determine if both readings indicate the same rail being higher and if the crosslevel measurement was the same for each reading.
 - 2.5.1.If yes, the level board is properly calibrated. Go to step 3.
 - 2.5.2.If not, take the average of the crosslevel measurement and set the level board to that measurement. Adjust the bubble screw in a direction to center the bubble. Once bubble is centered, the level board should be calibrated. Repeat steps 1-5 to verify calibration.
(Example: Initial measurement shows left rail to be higher and a crosslevel measurement of $\frac{3}{4}$ "; after rotating the level board the measurements show the left rail to be higher with a crosslevel measurement of $\frac{1}{2}$ ". Turn knob until a $\frac{5}{8}$ " reading is obtained and zero out the bubble)
3. Measure crosslevel across the top of the two running rails of the track at right angles to the track alignment as shown in Figure 3-19.
4. Check crosslevel at the beginning of surfacing and at regular intervals behind automatic tamping machines.
5. Check tangent track and the full body of curves every 660 feet and at every 1/4-inch superelevation change in spirals of curves.

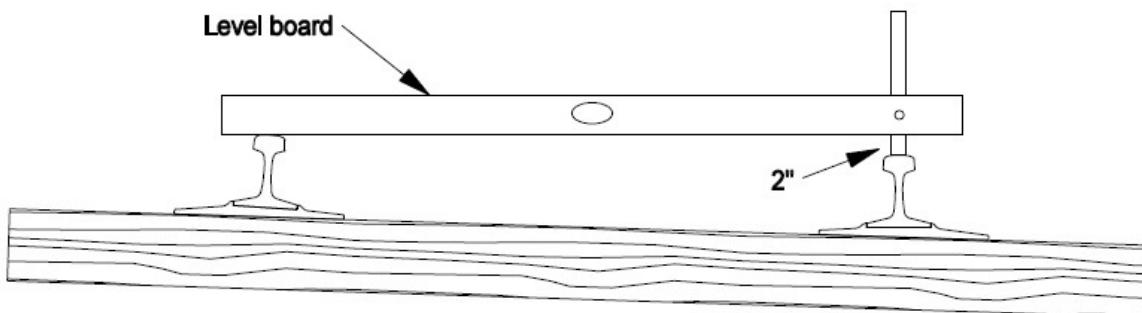


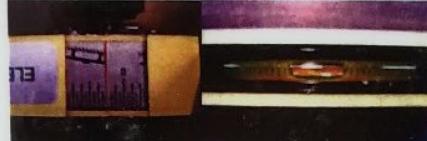
Figure 3-19



Calibrating Geismar RCAT track level

Check levelboard calibration before use

1. Place the levelboard on the track and check the crosslevel value (value #1)



2. Rotate the track level and check crosslevel value (value #2)



If the value #1 and value #2 are equal, the levelboard is calibrated.

If value #1 and value #2 are NOT equal, the levelboard must be recalibrated

Place the levelboard on the track and take the crosslevel reading

Step 1			Value #1 = $\frac{1}{2}$ "
--------	--	--	----------------------------

Rotate the levelboard 180° and take a second crosslevel reading

Step 2			Value #2 = 0"
--------	--	--	---------------

Determine the difference between value #1 and value #2. (In this example $\frac{1}{2}-0 = \frac{1}{2}$.) Half of this amount represents the required adjustment or the amount the device is out of calibration. $\frac{1}{2}$ divided by 2 = $\frac{1}{4}$

Step 3			Set dial to the required adjustment = $\frac{1}{4}$ "
--------	--	--	---

Next using the screw opposite of the bubble, turn to center the bubble

Step 4			Rotate to confirm calibration.
--------	--	--	--------------------------------

Rotate the levelboard 180° to confirm calibration.

If value #1 and value #2 are not equal repeat steps 1-4 above.

Figure 3-20

3.6.4 Measuring Warp (twist)

Warp (twist) is the difference in crosslevel between any two points less than 62 feet apart. Excessive warp contributes to wheel climb derailments.

To determine the amount of warp on tangent track, add the largest two opposite rail measurements within 62 feet, as shown in Figure 3-21.

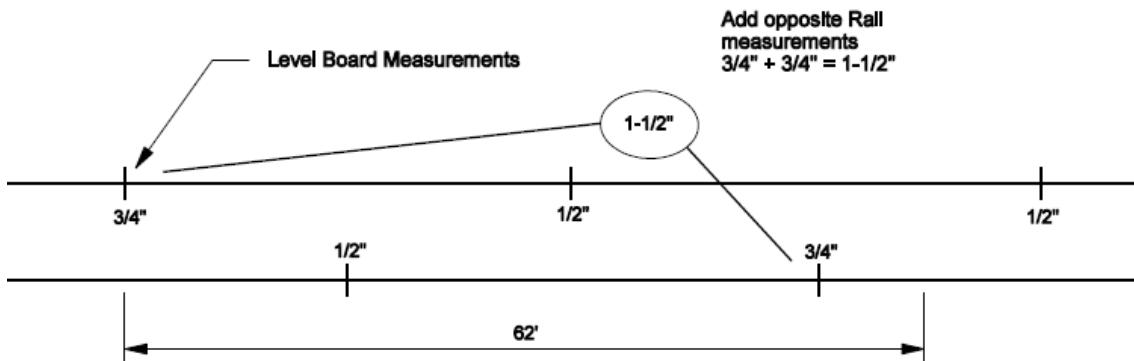


Figure 3-21

To determine the amount of warp in a curve or spiral (Figure 3-22), do one of the following:

1. Subtract largest and smallest same rail measurements within 62 feet.
or
2. Add the largest two opposite rail measurements within 62 feet.

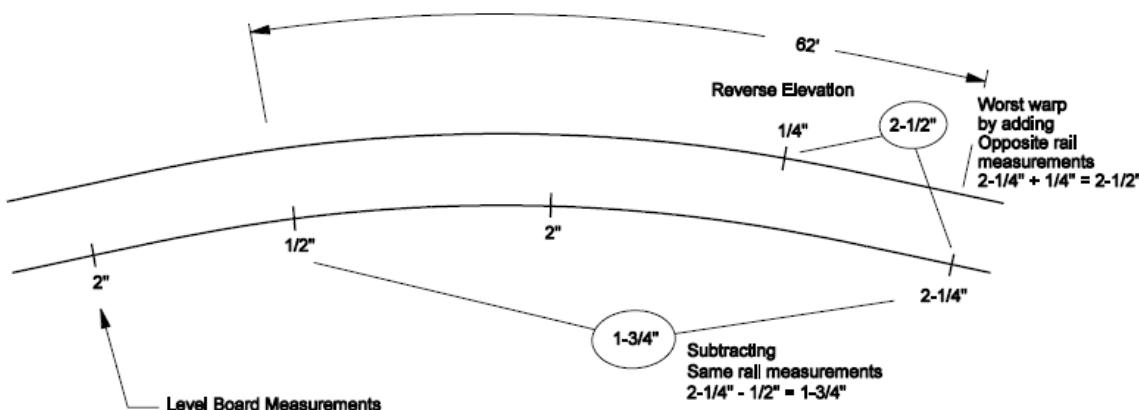
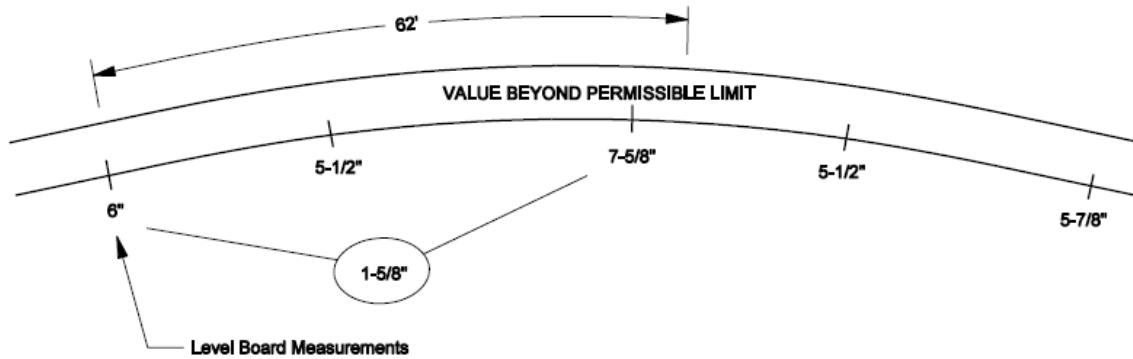


Figure 3-22

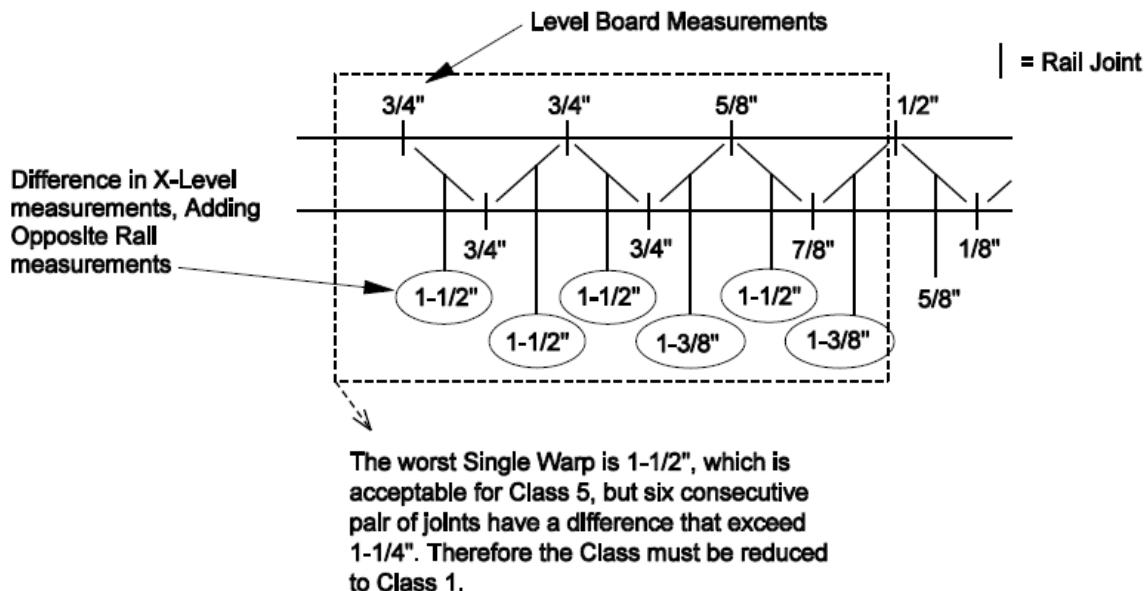
Where the elevation at any point in a curve equals or exceeds 6 inches, the difference (warp) in crosslevel within 62 feet between that point and a point with greater elevation may not be more than 1-1/2 inches regardless of track class. See Figure 3-23.

**Figure 3-23**

Harmonics

To control harmonics on Class 2 through 5 jointed track with staggered joints, ensure that the crosslevel differences do not exceed 1-1/4 inches in all of six consecutive pairs of joints, as created by 7 low joints. See Figure 3-24.

1. Track with joints staggered less than 10 feet shall not be considered as having staggered joints.
2. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints.

**Figure 3-24**

3.6.5 *Track Surface Limits*

Track Surface Limits - Do not allow track surface to deviate from uniform profile and crosslevel more than the following thresholds for the applicable class of track. Measure deviations as prescribed by each category.

1. If maximum crosslevel in a curve is 6" or more and there is a difference in crosslevel between any 2 points less than 62 feet apart of more than 1 ½" the track is not good for any class of track.
2. To control harmonics on Class 2 through 5 in jointed track with staggered joints, the cross-level difference shall not exceed 1-1/4" in all of six consecutive pairs of joints, as created by 7 low joints. Track with joints staggered less than 10 feet shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints for measurement.

Table 3-1 show the Urgent and Critical Limits for Track Surface Limits respectively.

3.6.6 *Spirals*

Spirals designed into curves gradually transition alignment and superelevation from tangents into curves, from curves into tangents, and between curves of varying degrees.

1. Curves of 15 minutes ($00^\circ 15' 00''$) or greater require spirals.
2. The maximum rate of change in superelevation must not exceed that shown in the track charts and must be distributed uniformly over the length of the spiral. Any deviations from the track charts must reviewed and approved by SCRRA. If discrepancies are found on the track charts from field conditions, report this to SCRRA.
3. If the length of the spiral permits, run superelevation off at a uniform rate over the entire length of the spiral, with full superelevation through the body of the curve and no superelevation on tangent track.
4. If no spirals exist, or spirals are too short to meet the required rate of runoff, a maximum of 1 inch of superelevation may be run onto tangent track
5. When the tangent between two curves is too short to provide the minimum length of runoff for the authorized superelevation:
 - 5.1. Divide the tangent into two parts in proportion to the degree of curvature of the adjoining curves.
 - 5.2. If possible, place the longer segment adjacent to the curve of greater degree.
6. Maintain at least 100 feet of level track between reverse curves, regardless of whether tangent track exists or not, to ensure that cars can right themselves between curves.
7. Ensure that compound curves have full superelevation for the higher-degree curve carried through the entire higher-degree portion of the curve and reduced superelevation on the lower-degree portion of the curve within the prescribed runoff rates.

3.6.7 *Superelevation*

Maintain superelevation per SCRRA track charts. SCRRA must approve all changes to designated superelevation.

3.6.8 Curve Markings

Place and maintain curve marker according to SCRRRA Standard ES2206 as follows:

1. Place curve markers in milepost ascending order as identified in Figure 3-25, Figure 3-26, and Figure 3-27. Refer also to Table 3-6.

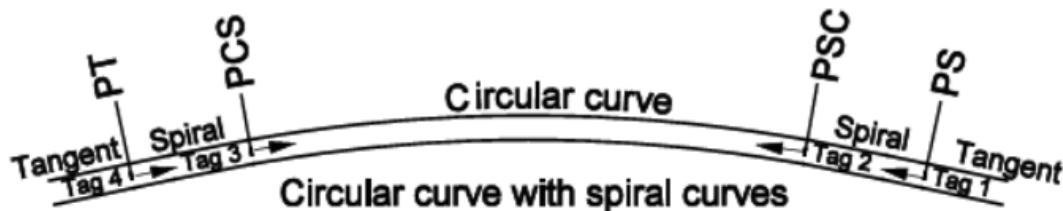


Figure 3-25

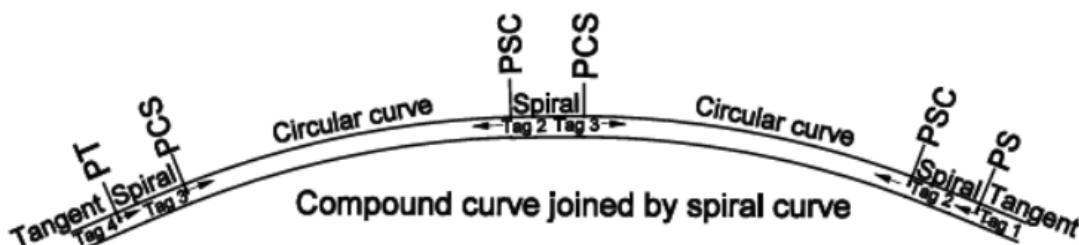


Figure 3-26

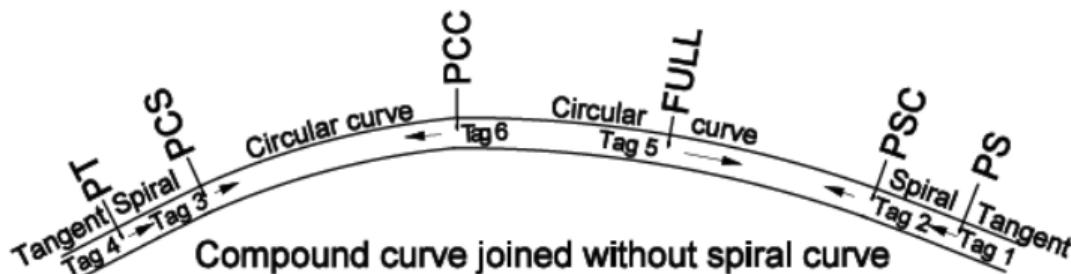
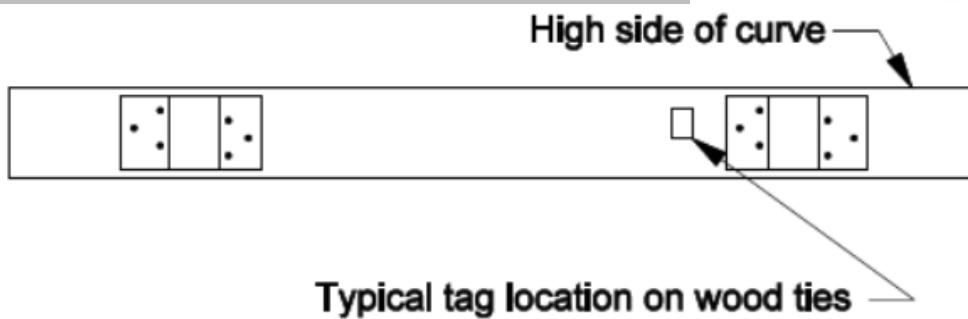
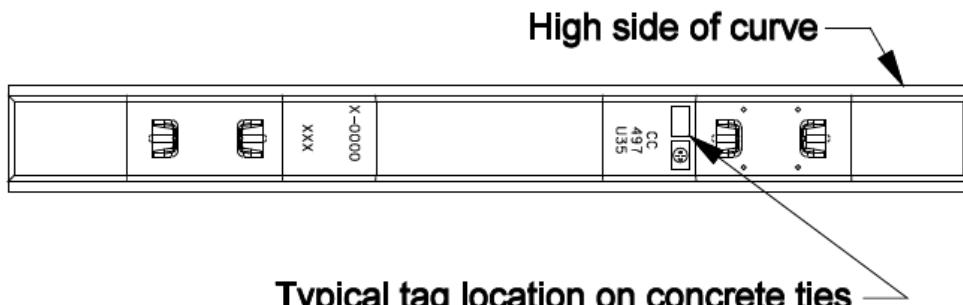


Figure 3-27

Curve Marker Identification		
Abbreviation	Full Name	Description
PS	Point of Spiral	Tangent ends and spiral begins
PSC	Point of Spiral to Curve	Spiral ends and full body begins
PCC	Point of Compound Curve	Curve degree changes with no spiral
PCS	Point of Curve to Spiral	Full body ends and spiral begins
PT	Point of Tangent	Spiral ends and tangent begins

Table 3-6

2. Place curve markers on top of ties 6 to 8 inches from the base of the high rail toward the center of the track. Locations for mounting markers to wood and concrete ties are shown in Figure 3-28 and Figure 3-29.

*Figure 3-28**Figure 3-29*

Note: Track maintenance contractor shall be responsible for the replacement of any missing or displaced curve markings.

3.6.9 Monitoring Curve Movement

Before surfacing and lining a curve on main tracks, stake the curve if the degree of curvature is 3° or more and the rail temperature is more than 50° F below the designated rail laying temperature (or is forecasted to be in the next 24 hours). To stake a curve prior to surfacing and lining, place at least 3 reference points uniformly spaced around the curve. These reference points shall be no more than 200 feet apart.

Inspect curves in CWR after surfacing, especially during large temperature changes. Where curve has been staked and curve has shifted inward more than 3 inches, the curve must be lined out prior to rail temperature reaching the PRLT. If curve is not lined out or destressed, a speed restriction of 40 MPH or less for passenger and freight trains must be placed.

Track buckles are more likely to occur in track with poor surface and line. Lining and surfacing of curves can lead to a track buckle if not done properly. On Class 2 main tracks or higher, curves 3 degrees and greater must be staked. These stakes must be clearly marked and must be used to monitor any curve movement.

The following examples are to be used to identify when, where and how to stake these curves.

1. Staking Process

- 1.1. Stake curves on Class 2 main tracks and above before performing program concrete and/or undercutting projects.
- 1.2. Stake other curves as directed by SCRRA.
- 1.3. When complete ballast renewals or undercutting occur, place offset stakes or offset measurements to adjacent track if applicable.
- 1.4. Stake curves at the curve control points: Point of Spiral (PS), Point of Spiral Curve (PSC), Point of Curve Center (PCC), Point of Curve Spiral (PCS), and Point of Tangent (PT) with no more than 200 ft. between stakes throughout the curve as shown in Figure 3-25 and described in Table 3-6.

2. Rehabilitation Projects

- 2.1. If a curve has been staked by surveyors, line the track to those stakes.
- 2.2. If curve is already staked for monitoring of movement, record measurements from stakes to corresponding base of rail prior to and after trackwork.
- 2.3. If curve is not already staked, the curve must be staked prior to performing work. Offset - stake curves 3 degrees and over when the rail temperature is more than 50 degrees F below the designated rail laying temperature or expected to be in the next 24 hours, before surfacing track.

Example: A curve requires surfacing due to irregular cross level. It is 3-degree 30-minute curve with a rail laying temperature of 110 degrees. Immediately prior to surfacing, the rail temperature is measured to be 48 degrees. Since the curve is over 3 degrees and the rail temperature are more than 50 degrees less than the rail laying temperature for that area (62-degree difference), the curve would require the use of stakes to monitor curve shifting.

- 2.4. All curves must be staked after relaying rail. Place at least three stakes in each curve, with one stake in the middle of the curve and the remaining stakes a maximum of 200 feet apart.
- 2.5. Behind final surfacing pass following program concrete and undercutting work, all curves will be center staked at intervals of 200 feet throughout the entire curve.
- 2.6. Behind final surfacing and destressing operation following new track construction, all curves will be center staked at intervals of 200 feet throughout the entire curve.

3. Maintenance Forces

- 3.1. Ensure all curves in Class 2 Main tracks or higher and 3 degrees and over are staked, either center or offset.
- 3.2. When surfacing and lining is performed in a curve already staked, record measurements from stakes to corresponding base of rail prior to and after trackwork.
- 3.3. If a curve has been staked by surveyors, line the track to those stakes.
 - 3.3.1. Inspect for movement during cold temperatures. Additional focus should be given to curve movement during the first 2 weeks after trackwork especially during periods of large temperature changes.
- 3.4. Line out any curve that has inward movement of 3 inches or more prior to rail temperatures above or forecasted above the designated rail laying temperature or a 40 MPH speed restriction shall be placed. If curve is not lined out or destressed and the inward movement is more than 3 inches, a speed restriction of 30/20 MPH or less must be placed.
- 3.5. If destressing is required on a curve, both rails must be destressed.

4. Procedures to Place Maintenance Stakes around Curves
 - 4.1. For center staking (preferred method), use a minimum of five reference stakes.
 - 4.1.1. Place one reference stake at the Point of Spiral (PS), Point of Spiral Curve (PSC), Point of Curve Center (PCC), Point of Curve Spiral (PCS), and Point of Tangent (PT).

Note: Additional stakes may be required due to the overall length of the curve; the spacing between the stakes should be no more than 200'.
 - 4.1.2. Mark the rail per Section 3.6.8 Curve Markings.
 - 4.2. For offset staking, use a minimum of five reference stakes with 10 to 15-foot offsets.
 - 4.2.1. Place reference stakes at the PSC and PCS of the curve.
 - 4.2.2. Place at least 3 reference stakes around the curve, uniformly spaced, offset a distance between 10 and 15 feet from the field side of the line rail. The stakes should be spread equally around the curve with one stake placed in the middle of the curve.

Note: Additional stakes may be required due to the overall length of the curve; the spacing between the stakes should be no more than 200'.
 - 4.2.3. Mark the offset and location per Section 3.6.8 Curve Markings.

3.6.10 Restoring Surface

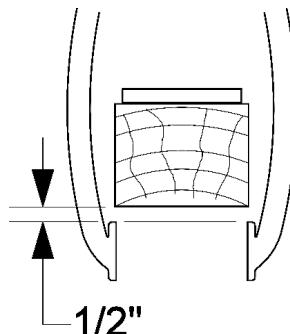
Prior to commencing work, ensure there is sufficient ballast to complete work to SCRRA standards. When restoring surface:

1. Restore zero crosslevel to tangents and designated superelevation in curves when surfacing track.
2. Sight along the ball of the rail to determine surface irregularities.
3. When performing spot surfacing by hand:
 - 3.1. Correct the designated grade rail in curves before re-establishing the designated superelevation in the high rail.
 - 3.2. If necessary, raise the opposite rail to obtain the desired crosslevel or superelevation.
4. Make runoffs from track raises gradually—between 3/8 to 1/2 inch per 39 feet depending on class of track. Runoffs may not exceed allowable tolerances set forth in Table 3-1.
 - 4.1. Start runoffs soon enough to blend into the top-of-rail elevation of fixed objects such as open deck bridges, diamond crossings, or other immovable objects.
 - 4.2. Do not make permanent runoffs in curves or switches.
5. When surfacing switches, do not allow train traffic through the turnout side until it has been tamped.

Tamp both sides of ties for a distance of 15 inches from each side of the rail base. To prevent center-bound track, avoid tamping wood and concrete tie centers.

6. When out-of-face tamping with automatic tamping machines:
 - 6.1. Follow manufacturers recommended squeeze pressure.
 - 6.2. Make at least two insertions per cross tie and three insertions per switch tie.
 - 6.3. Adjust tamper tools to ensure that the top of the blade is 1/2 inch below the bottom of the tie as shown in Figure 3-30. Table 3-7 shows depth of each tie type.
 - 6.4. Avoid striking ties with tamper tools when making insertions.

7. When tamping crossovers that have interlaced long ties and butted ties, consider the following:
- 7.1. Remove the crossover from service.
 - 7.2. From the ties that go under both main tracks remove the rail fasteners on the main track you intend to raise first and on the crossover portion.
 - 7.3. Raise the main track crossover switch as you would any turnout except do not tamp the long ties that you have unclipped.
 - 7.4. Carefully watch your alignment, as it is important not to throw the turnout beyond smooth lining.
 - 7.5. Raise the turnout on the other main track.
 - 7.6. Tamp all the long ties on this track.
 - 7.7. Carefully ensure the plates on the long ties come up under the crossover and other main track while raising and aligning the track.
 - 7.8. Carefully watch your alignment, as it is important not to throw the turnout beyond smooth lining.
 - 7.9. Clip up the long ties.
 - 7.10. Tamp the crossover and long ties on the other main track.

**Figure 3-30**

Tie Type	Depth of Tie
Wood	7"
Composite	7"
Concrete	8 3/4"
Steel	4" to 5"

Table 3-7

3.6.11 *Surfacing Steel Ties Installations*

Steel tie installations require multiple insertions to initially place and compact ballast as follows. Following these steps is critical for long term performance of the ties:

1. Make three insertions in the rail seat area.
2. Make three insertions in the tie center area.
3. Make three or more insertions in the rail seat area to compact the ballast until it is visible at the top of the inspection holes located near the base of the rail.
4. Determine if the ballast is visible at the top of the inspection holes provided.
 - 4.1. If yes, the tie is properly tamped.
 - 4.2. If no, fill tie cribs with ballast and repeat steps 1 to 4.

3.6.12 *Surfacing at Signal Equipment*

Surfacing at or near signal equipment requires extra precautions to prevent damage and service interruptions. Prior to work commencing, SCRRA Signal Department shall be notified to locate and mark out signal cables and wires. SCRRA Signal Department personnel will assist with removing and adjusting of wires and other equipment.

When surfacing is performed in the area of detectors the surfacing should continue through the detector area whenever possible. Surfacing should not skip the detectors, insulated joints, etc.

When surfacing through certain detectors it may be required that tamping equipment be placed into switch tamping mode and slow down. Job safety briefings are critical between the groundman, machine operator, and signal personnel to make sure that equipment will not be damaged.

Wheel Impact Load Detectors (WILD) – These special types of detectors utilize strain gages to pick up wheel impacts. They are intended to find flat or damaged wheels. Due to the configuration of these detectors it is critical that they are surfaced during normal surfacing and a minimum of ONCE ANNUALLY. Proper surfacing will allow these detectors to operate properly.

High Wide Load Detectors – These types of detectors determine if a load is oversized or has shifted prior to a load reaching a section of track that has limited clearances. Every effort must be made to limit the track raise and maintain (0") of crosslevel through High Wide Load Detectors. Once surfacing is completed, SCRRA Signal Department will check for proper calibration of detector.

3.6.13 *Surfacing near Lubricators*

Lubricators are installed to reduce excessive rail wear, reduce noise levels from squealing wheels, and to reduce lateral forces on the rail. Lubricators must be removed prior to surfacing and re-installed within 5 days.

4.0 Ties and Fasteners

A tie is a support made of approved material to which rails can be fastened securely. The material must be strong enough to hold the rail to the proper gage, surface, and alignment to transmit train wheel loads from the rails to the ballast and to the roadbed.

All ties shall meet SCRRRA Specifications including meeting AREMA and APWA Standards for Railway Ties.

4.1 Wood Ties

Note: Do not intermix wood ties with concrete ties to make permanent repairs.

Install new standard 8'-6" x 7" x 9" wood ties on all main tracks and sidings.

Install 24 – 10' wood ties at turnouts, bridges, wood-concrete transitions, and road crossings with precast concrete crossing panels designed for 10ft wood ties. See Section 4.8.1 Switch Tie Standards at Turnouts and Section 4.10 Transition Zones for more details on transition ties.

Reconditioned and industrial grade ties may be utilized on Industrial Leads and Yard Tracks as approved by SCRRRA.

Smashing, splintering, or puncturing ties reduces their life span. Do not puncture treated ties with picks or shovels, and do not drive ties into place with mauls or similar tools. Use only tie spacers, tongs, backhoes, and other properly designed equipment when spacing or inserting ties.

4.2 Distribution

When unloading and distributing ties:

1. Do not place or store ties close to switches, crossings, sidings, or close enough to the track where they will present a danger to trains, equipment or crews.
2. Do not throw ties down high embankments.
3. Do not drop ties on rail or other objects that may chip, splinter, or damage the wood fiber.
4. Do not stage ties where they will obstruct drainage.
5. Avoid excess handling of ties during the unloading process. Stage ties as closely as possible to the tie inspector's marks while unloading.
6. When 12 or more ties are stored within 200 feet of any residential property, they shall be covered with a well-secured impervious tarp or sheet plastic. Observe and comply with signs restricting placement of cross ties.
7. For production tie gangs, ties shall not be distributed more than 30 days prior to installation. Ties replaced under maintenance shall not be distributed more than five days before installation. Old ties must be removed daily, or immediately at end of completion of work.

4.3 Fire Precautions

Tie storage shall be in designated areas only. Area shall be clear of dry grass and vegetation to prevent the possibility of tie fires. When ties are stored near residential areas, ties shall be covered with a tarp or plastic sheet to reduce odor.

4.4 Concrete Ties

1. Only pre-stressed concrete ties, fasteners, pads, and insulators of the types approved by SCRRA shall be installed.
2. Do not operate rubber tire equipment on concrete tie track, unless the rail fastening system has been protected. Ensure that the rail fasteners are monitored and inspected because not all systems are designed to support the weight of such equipment suspended from the rail. Obtain approval from SCRRA prior to the installation of temporary crossings for construction purposes and rubber-tired equipment staging plans.
3. Ballast regulator plows shall be shaped to prevent damage to the elastic rail fasteners.
4. Operators of ballast regulators and other track machines shall observe the elastic fasteners for signs of unintended contact or damage to the track.
5. Whenever rail on concrete ties is transposed or replaced, new rail pads and insulators shall be installed.
6. When new concrete ties are installed replacing wood ties, new concrete tie installation shall meet the following criteria:
 - 6.1. Installation locations approved by SCRRA.
 - 6.2. On 24-inch centers.
 - 6.3. On a standard ballast section with a minimum depth of 12 inches below the bottom of the tie per SCRRA Standard ES2001 and ES2002
7. Concrete ties may be installed over ballasted deck bridges and through tunnels at locations approved by SCRRA.
8. Concrete ties shall be installed at right angles to the running rail.
9. When rail heaters are used during rail laying or destressing, exercise care to keep the heater moving so as not to damage the pads and insulators.
10. Whenever work is done requiring movement of the rail over the tie pads, such as destressing or transposing, risers shall be used between rail and tie pad to prevent pads from becoming displaced.
11. Where clips are installed by hand, exercise care to prevent striking the cast-in-place shoulder or tie with the striking tool.
12. Where clips are installed by machine, the operator shall ensure that the machine is adjusted to install the clip into the hole without binding.
13. When transposing or changing out rail, tie pads must be kept free of dirt and ballast.
14. When mechanically surfacing the track, the tamping heads shall be adjusted for the increased width and depth of the concrete tie. Exercise care to prevent striking the tie or clips with the tamping tool.
15. Special rail fasteners are required to clip rail joints and insulated joints. Appropriate fasteners shall be installed at joints when replacing wood ties with concrete ties. Use of improper fasteners may cause insulated joint failure or may create a "defective tie" per 49CFR213.
16. Concrete and wood ties shall not be mixed. Exception: Special wood ties may be installed to support signal facilities (ATS Inductor, Safety Detector, Etc.) or may be installed in case of emergency. Hollow steel ties may be used (mixed with concrete or wood) in turnouts as required by SCRRA Standards.

4.5 Steel Ties

Do not use steel ties on track unless approved by SCRRRA. Maintain steel ties to manufacturer's standards.

1. Install steel ties at locations in which corrosive materials may be present (i.e. locomotive facilities, rip tracks).
2. When tamping steel ties use the inspection hole to determine that the inside of the tie is full of ballast showing that the tie is fully tamped.
3. When installing used steel ties make thorough inspection of hook-in shoulder holes looking for elongation or cracks.

Steel tie installations require multiple insertions to initially place and compact ballast as follows:

1. Make three insertions in the rail seat area.
2. Make three insertions in the tie center area.
3. Make three or more insertions in the rail seat area to compact the ballast until it is visible at the top of the inspection holes located near the base of the rail.
4. Determine if the ballast is visible at the top of the inspection holes provided.
 - 4.1 If yes, the tie is properly tamped.
 - 4.2 If no, fill tie cribs with ballast and repeat steps 1 to 4.

4.6 Composite Ties

1. Composite ties are utilized in specialty applications only as approved by SCRRRA.

Note: Composite ties may be used in areas where wood tie life is shortened due to environmental conditions.

2. Composite ties can be handled and installed with wood tie equipment. Tie Bed Scarifiers equipped with digger head extensions must be used to scarify the tie bed to a depth that will allow approximately 1" clearance between top of newly installed tie and bottom of rail base. This will prevent unnecessary bending of the composite tie during insertion.
3. Composite ties will generally only be used with pandrol plates and elastic fasteners.
4. Composite ties require predrilling for use lag screw installations.
5. Composite ties can be recycled and should not be placed in a landfill or incinerated.
6. Due to material properties of composite ties, they are able to retain initial holding power more effectively than wood ties. Because of the material properties the use of plugging compound is not necessary. If composite ties need to be re-gaged the only option is to replace the composite tie.

4.6.1 *Markers on Ties*

When removing a tie with bridge number or super-elevation mark or the curve number tag, attach the proper tag to the new tie installed at that location.

4.7 Installation and Spacing

1. Curve superelevations shall be restored to the specifications noted in the SCRRRA Track Charts.
2. Do not replace more than three consecutive cross ties in one pass. Make an additional pass to install ties as necessary.
3. Do not replace more than 50% of the ties in a 39-foot section of track in a single pass of the tie renewal operation.
4. If the rail temperature is forecasted to be above the Preferred Rail Laying Temperature (PRLT), SCRRRA may suspend tie installation operations.
5. Install ties at a right angle to the track's running rails and check gage for accuracy.
6. New ties shall be installed per the standard for the type of tie. Standard ballast section and track geometry shall be restored before the passage of trains at speeds above 30/20 MPH. Shifting of track line and out of cross level conditions shall be avoided to the extent possible and shall be corrected immediately. Refer to Appendix B – Summary of Speed Restrictions for Trackwork.
7. Report tie gang activity on the CWR Stress Adjustment/ Disturbance Report form in Appendix C.
8. When establishing proper tie spacing, mark the inner rail of curves with appropriate tie spacing.
9. Where tracks come together behind turnouts:
 - a. Do not interlace ties unless approved by SCRRRA. When maintenance on interlaced ties is taking place, every effort should be made to replace the interlaced ties with the appropriate sized long tie.
 - b. Maintain at least 3 inches between the ends of ties.
10. Install ties with "sap side" kerf marks (1/8-inch grooves cut into the top of the tie) facing up. This places the ties' harder heartwood down on the ballast as shown in Figure 4-1.

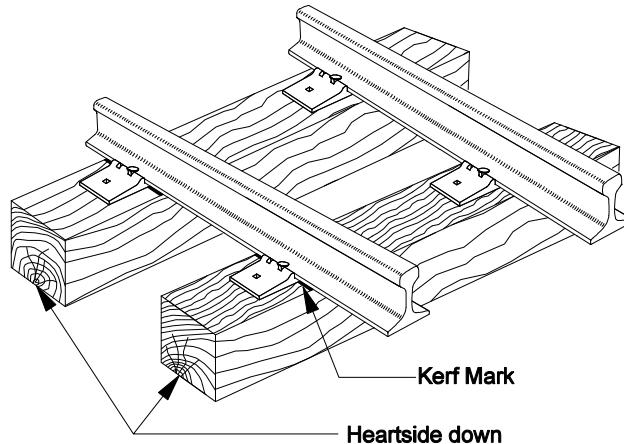


Figure 4-1

11. Align kerf mark in ties with the rail base of the designated line rail. Install non-marked wood ties with the tie ends extending from the outside rail base of the line rail as shown in Table 4-1.

Distance from Outside Rail Base to End of Wood Tie on Line Rail		
Tie Application	Tie Length	Outside Line Rail Base to End of Tie Distance
Cross Tie	8 feet	15 inches
Cross Tie	8 feet 6 inches	18 inches
Cross Tie	9 feet	21 inches
Cross Tie	10 feet	27 inches
Switch Tie	10 to 17 feet	*27 inches
Switch Tie	18 feet	*21 to 27 inches
Switch Tie in Crossover	23 to 27 feet	*21 to 27 inches with ties center under the 2 tracks

Table 4-1

*Note: See Section 4.8 Switch Ties for additional information

12. When wood ties are re-spiked, plug the spike holes with treated tie plugs. Do not plug spike holes in composite ties when re-spiking.
13. Maintain a minimum number of effective ties at the designated spacing in each 39 feet of track as determined by the tie and track type. Wood tie spacing for 8'6" ties and 9' ties are the same (19.5 inches) on all tracks.
14. Install and space ties under rail joints with the centerline of the tie measuring between 9 and 18 inches from the rail end. Ensure that tie spacing will allow for field welding of joints to avoid re-spacing ties.

4.7.1 General Instructions for Tie Gangs

1. Scarifiers must be equipped with digger head extensions to ensure ties are installed without the need to raise the rail significantly for tie plate installation. Scarify the tie bed to a depth that will allow approximately 1" clearance between top of newly installed tie and bottom of rail base. Digger head teeth must be adjusted/replaced in order to allow machine to dig tie holes to proper depth.
2. Regardless of rail temperature, tie extracting operator must take special care not to raise the rail more than necessary to extract ties. Tie extracting operator must not use rail clamps except when necessary to remove plate-cut ties. Foremen and Assistant Foremen must continually monitor tie extracting operator to ensure that rail raises are kept to an absolute minimum.
3. Tie project limits should be surfaced out-of-face, unless otherwise instructed by SCRRA or SCRRA representative.
4. Pull Safe Requirements for Tie Gangs
 - 4.1. Ramp-up for the following production day can be considerably shortened by working spike pullers past the designated stopping point for the day. The Tie Gang Supervisor and Foreman must conduct a Job Safety Briefing regarding the provisions of these requirements, to ensure that the track structure is not weakened enough to impair safe train operations.
 - 4.2. All production tie gang may implement production ramp up plans in advancing prep work to maximize work windows, such plans must be submitted and approved by SCRRA.

Required Number of Line-Spiked Ties Between “Pull-Safe” Ties on Curves:

0° to 1° 59' : 2 Ties

2° to 3° 59' : 3 Ties

4° and greater : Do not “Pull Safe”

- 4.2.1. Do not pull spikes from ties at rail joint locations.
- 4.2.2. Ensure that “pull safe” track is protected by the appropriate speed restriction to allow for safe train operations.
- 4.2.3. Do not leave “pull safe” track during the Tie Gang off-cycle days.
- 4.2.4. The Tie Gang Supervisor or Foreman must perform a walking inspection of “pull safe” track, to ensure that the above requirements have been complied with before releasing the track for train operations

4.8 Switch Ties

The standards that apply to cross ties also apply to switch ties.

Maintain a standard set of switch ties in every turnout according to the applicable SCRRRA Standards.

Do not interlace cross ties in turnouts in place of using the appropriately sized switch ties to make permanent repairs.

Note: Do not cut a switch tie to make it shorter. Cutting a tie exposes untreated surfaces that will deteriorate prematurely. Switch ties should not be bored or adzed.

4.8.1 *Switch Tie Standards at Turnouts*

1. Install 24 - 10-foot transition ties ahead of the switch points in main track and siding switches according to SCRRRA Standard ES2351. In yard track switches, install eight 9-foot switch ties ahead of the switch points.
2. Install 24 - 10-foot switch ties under the full length of the switch points per SCRRRA Standard ES2351. Nine-foot ties may be used in yard track switches where the track configuration does not give enough clearance between tie ends of adjacent track.
3. Ensure that wood switch ties extend 27 inches from the outside base of the designated line rail on the straight side of a switch. See Figure 4-2.
4. Change switch tie lengths to the next longer tie where the amount of tie that extends from the outer rail base on the turnout side becomes less than 21 inches while maintaining the prescribed 27-inch distance on the straight side of the switch. See Figure 4-2.
5. Reduce the amount of tie that extends from the base of the designated line rail on the straight side of a switch to 21 inches on the last few 18-foot switch ties. See Figure 4-2.
 - 5.1. Do this where the amount of 18-foot tie that extends on the turnout side becomes less than 21 inches while maintaining the 27 inches on the straight side.
 - 5.2. Install the remaining 18-foot ties in this manner to where at least 45 inches exist between the outside rail bases of the turnout and straight side rails.

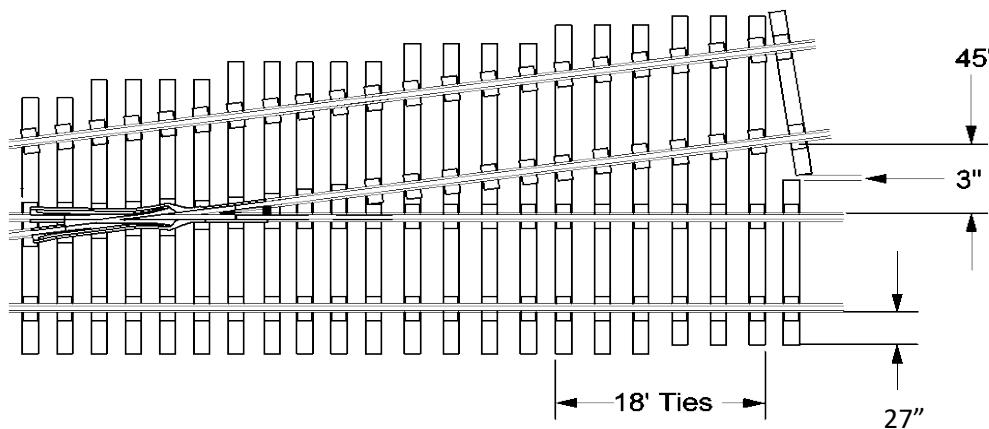


Figure 4-2

4.8.2 *Installing Switch Ties at Turnout Locations*

1. Before installing switch ties, unload enough main line and walkway ballast to:
 - 1.1. Support all switch ties throughout their entire length.
 - 1.2. Fill all cribs.
 - 1.3. Provide enough shoulder ballast throughout the limits of the switch to maintain proper surface and alignment.
 - 1.4. Restore walkways to SCRRRA and CPUC standards.
2. Install switch ties in at least two passes as follows:
 - 2.1. Replace no more than one-half of the ties in the first pass.
 - 2.2. Install no more than two ties in a row in one pass.
3. Fully spike and anchor all ties.

4.9 Head Block and Switch Machine Ties

To install head block and switch machine ties:

1. Install dapped/tapered switch machine ties in power-operated switches where there are dapped gage plates.
2. Hand tamp the entire length of the head block ties if the connecting rod and switch rods are in place to prevent damage to rods.
3. Make sure helper rod assemblies on switches are mounted to switch ties that provide adequate clearance for tampers to surface through the switch point area.

4.10 Transition Zones

Transition zone requirements in SCRRRA Standard ES2351-03 are summarized below:

1. Install 24 - 10' wood ties with elastic fasteners to transition into turnouts and bridges.
2. Install 24 - 10' wood ties with elastic fasteners to provide transition from wood ties to concrete ties.
3. Install 24 - 10' wood ties with elastic fasteners to transition into road crossings.

When transitioning from concrete to wood tie track, do not install transition zones in curves or through road crossings. Instead, extend the concrete beyond these conditions.

Note: Fully box anchored wood ties with cut spikes are required for 200ft in advance of transition tie zones, crossings, turnouts, bridges, and wood tie to concrete tie transitions.

4.11 Tie Drilling

Drill the proper diameter pilot holes into wood ties before installing screw type fasteners. Use drill bit sizes according to the wood type in Table 4-2.

Drill Bit Size Required by Wood Type			
Fastener Size and Type	Softwood	Hardwood	Composite
15/16 x 6 1/2-inch Coach Screw	11/16 inch	3/4 inch	3/4 inch
5/8-inch Torx Head Road Crossing Screw	3/8 inch	3/8 inch	3/8 inch

Table 4-2

*Note: Torx head screw spikes are self-tapping.

Drill ties 1/2 inch below the lowest point where the screw spike fastener will penetrate the tie. Ensure that pilot holes do not extend through the bottom of the ties.

4.12 Defective Ties

4.12.1 *Defective Wood Ties Rating Criteria*

Ties are designed to distribute wheel loads to the roadbed and to interlock with ballast to prevent lateral, longitudinal and vertical movement of the track structure. Table 4-4 definitions utilize the following criteria:

Tie Rating:	Break – Damage or tie deterioration crosswise to grain of the wood. Split – Damage or tie deterioration parallel with the grain of the wood. Deteriorated – Crushed or broken-down grain structure allowing lateral plate movement. Plate Cut – Damage from load and plate movement on tie. Wheel Cut – Any cut like damage from equipment moving across the grain of the wood. Rot or Hollow – Void in tie area may be due to weather or insects.
--------------------	---

Table 4-3
Tie Rating System:

Tie Class			
Condition	1 – Good	2 – Marginal	3 – Replace
Broken	No breaks in tie	Slight separation starting in tie	Broken through less than 50% of Tie
Split or Otherwise Impaired	Slight weather splits but integrity of tie not compromised	Tie holds spikes, some splits deep enough to allow water into tie. If necessary, tie can be plugged and re-spiked. Ballast is working through tie	Will not hold spikes or rail fasteners. Tie must be plugged and re-spiked. Ballast is working through tie
Deterioration allowing Lateral Plate Movement	No plate movement or cut and no sign of deterioration	Less than $\frac{1}{2}$ " FRA of combined lateral plate or rail movement, can be repaired by foam plugging	Greater than $\frac{1}{2}$ " of combined lateral plate or rail movement
Plate Cut Straight	$\frac{1}{4}$ " plate cut or less	Greater than $\frac{1}{4}$ " and up to 1" plate cut depth	Greater than 1" or up to 40% of the tie thickness
Plate Cut Cant	None	Less than $\frac{1}{2}$ "	Greater than $\frac{1}{2}$ ".
Wheel Cut	$\frac{1}{2}$ " or less with no structural damage to tie	$\frac{1}{2}"$ to 2" deep not broken through tie	Greater than 2" deep within 12" of the tie plate
Rotten or Hollow	None	Less than 15% rot through tie. Not hollow or decayed under tie plate.	Substantial amount of wood decayed or missing. Hollow under plate area.

Table 4-4

4.12.2 Non-Defective Tie Distribution

Minimum number of non-defective ties in any 39-foot segment have Urgent and Critical criteria. The FRA Track Inspection Report form must record any variation from the criteria listed in Table 4-7. The Urgent Defects (Scheduled for Maintenance) form must record any variation from the criteria listed in the Urgent defect Table 4-5 and Table 4-6.

Wood Tie – URGENT

Class of Track	Largest Tie Cluster Maximum Number of Defective Wood Ties in a row	Minimum Number of Non-Defective Wood Ties per 39-foot Segment
1	4	12
2	4	14
3	3	16
4 and 5	3	18

Table 4-5

Concrete Tie – URGENT

Class of Track	Largest Tie Cluster Maximum Number of Defective Concrete Ties in a row	Minimum Number of Non-Defective Concrete Ties per 39-foot Segment
1	3	10
2	3	12
3	2	14
4 and 5	2	16

Table 4-6

Wood or Concrete Tie – CRITICAL

Minimum Number of Non-Defective Ties per 39-foot Segment		
Class of Track	Tangent Track and Curves up to 2 Degrees	Turnouts and Curved Track Greater Than 2 Degrees
1	5	6
2	8	9
3	8	10
4 and 5	12	14

Table 4-7

Tie Cluster Defects are not FRA class specific defects. SCRRRA does however require that a remedial action be taken based on the urgent condition. Consider geometry when determining any remedial action concerning tie clusters. Combination defects may exist at tie clusters. Inspectors must use good judgment when writing tie cluster defects.

When FRA geometry deviations exist at tie cluster locations, refer to the Track Geometry Urgent/Critical chart for determining proper remedial action.

4.12.3 *Joint Tie Support*

A minimum number of non-defective ties must support each rail joint. Their centerlines must be within prescribed distances from the centerline of the rail joint for the class of track. If a Critical Joint tie defect exists where the distance from the centerline of a joint measures over 24 inches to the first non-defective tie in both directions, then the only remedial action is 10 MPH per 49CFR213.9(b) if the defect is not repaired. Include the distance to the first non-defective tie when writing a joint tie defect.

Refer to Figure 4-3 and Figure 4-4 for specific details concerning locations of these non-defective ties.

Class 1 and 2 Tracks

Class 1 and 2 tracks shall have at least one non-defective tie whose centerline is within 24 inches of each rail joint (end) location or within 48 inches of the rail joint as shown in Figure 4-3.

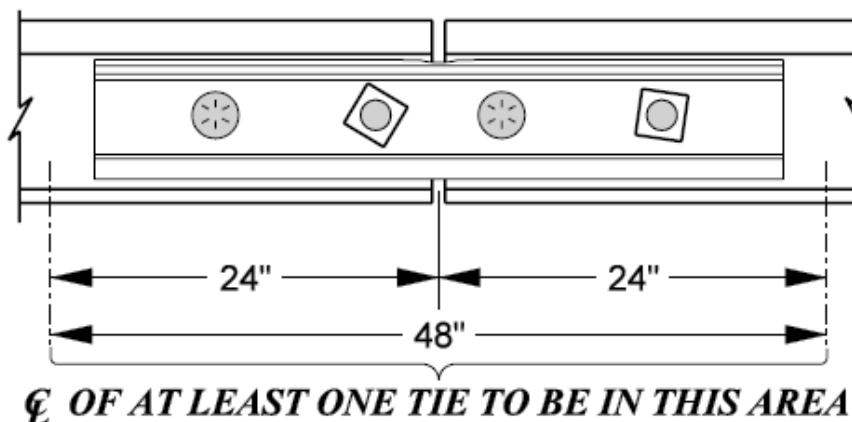
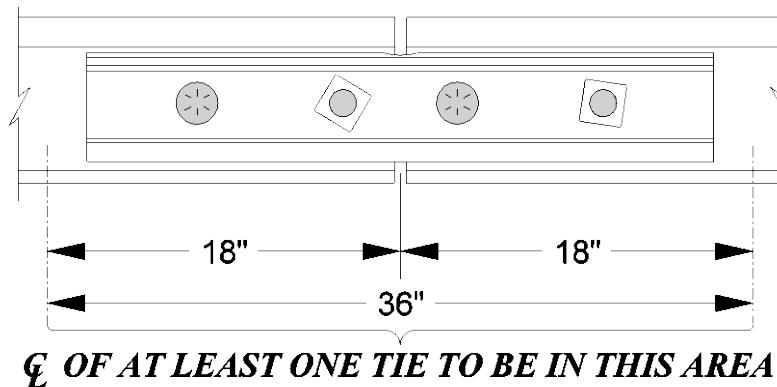


Figure 4-3

Class 3, 4, and 5 Tracks

Class 3, 4, and 5 tracks must have one of the following:

1. One non-defective tie whose centerline is within the 18 inches of each rail joint (end) location or within 36 inches of the rail joint as shown in Figure 4-4.
2. Two non-defective crossties, one on each side of the rail joint, whose centerlines are within 24 inches of the rail joint location as shown in Figure 4-3.

**Figure 4-4**

4.13 Defective Concrete Ties

The following concrete tie defects shall be cause for removal:

1. Deteriorated or broken in the vicinity of the shoulder or insert so that the fastener assembly can either pull out or move laterally more than 3/8 inch relative to the tie.
2. Deteriorated such that the base of either rail is moving laterally more than:
 - 2.1. 3/8 inch relative to the cross tie on curves of 2 degrees or greater
 - 2.2. ½ inch relative to the cross tie on tangent track and curves less than 2 degrees
3. Deteriorated or abraded at any point under the rail seat to a depth of ½ inch or greater.
4. Deteriorated or broken in center section of the tie between rails and steel tendons are exposed.
5. Broken through or deteriorated to the extent that pre-stressing material is visible.
6. Deteriorated such that the crosstie's fastening or anchoring system is unable to maintain longitudinal rail restraint, or maintain rail hold down, or maintain gage due to insufficient fastener toe load.
7. Tie damaged by derailment or dragging equipment should be replaced. Note that quite serious damage can be done to the tie ends without seriously affecting the performance of the tie. Ties are considered damaged if the ends or the center is broken through or if the concrete is chipped such that the pre-stressing strands are exposed.
8. Towers damaged or broken that do not allow for the installation of two fasteners on the same rail.

Note: Cracked ties should not be confused with broken ties. A tie is not broken until the crack extends through the entire depth of the tie.

**Figure 4-5**

4.14 Concrete Tie Maintenance

Surface and line concrete track every 5 years for preventative maintenance. Transitions into wood tie zones, turnouts, bridges, crossings, etc. must be surfaced as part of any surfacing operation near a concrete/wood tie transition.

1. Concrete ties do not perform well in track that retains water.
 - 1.1 Every effort must be made to promote excellent drainage.
 - 1.2 When mud spots develop, it is important to remove fouled ballast to a minimum of 12 inches below the bottom of the tie and replace with clean ballast.
 - 1.3 In areas where mud or fouled ballast re-appears, inspect the location for the root cause. A potential source of the problem is poor drainage in the area. It may be advisable to dig in trench drains or lateral pipes to allow trapped water to exit the track bed.
2. Concrete ties do not perform well under high impacts.
 - 2.1 Eliminate all joints as soon as possible, not to exceed 30 days.
3. Every effort should be made to replace pads that are displaying high amounts of wear in track. Black or Rubber pads do not hold up due to the heavy axle loading and should be watched for signs of wear. Some of the maintenance issues caused by the pad wear and deterioration are:
 - 3.1 Reduced toe load of the elastic fasteners on the base of the rail, which allows rail movement
 - 3.2 Accelerated rail seat abrasion, generated by direct contact of the base of the rail onto the top of the concrete tie and the effect of longitudinal and lateral movement of the rail on the rail seat.
4. Controlling neutral temperature is critical in concrete tie track. Concrete tie track neutral temperatures must be restored to the Preferred Rail Laying Temperature (PRLT) as soon as possible to prevent longitudinal rail movement.

4.15 Rail Seat Abrasion

Rail seat abrasion is the mechanical wearing of the concrete tie surface under the pad assemblies. Once it starts, rail seat abrasion causes rapid deterioration of the rail seat. As the concrete tie rail seat further deteriorates, the aggregate in the concrete becomes more exposed. Rail seat abrasion is caused by the following:

1. Rail movement on top of pad assembly both longitudinally and laterally.
2. Moisture between the tie seat and pad assembly, can cause abrasive slurry to develop between the tie seat and the pad.
3. Deteriorated or incorrect pad assembly.
4. High lateral/vertical forces generated from train operation.
5. Insufficient or excess superelevation in curved track or crosslevel in tangent track.

Inspection for rail seat abrasion on concrete ties is critical. When rail is replaced, the fastening system shall be replaced as well (pads, insulators, clips).

Evidence of rail seat abrasion to inspect for include:

1. Rail cant.
2. Pads that have squeezed-out from under the rail seat, are torn on the ends, or have shown signs of bleeding on the concrete ties.
3. Longitudinal rail movement through the clips.
4. Insufficient toe loads generated from the clips.
5. Crushed or missing insulators.

The pad arrangement in both tangent and curved track must be the latest SCRRRA Standard ES2364 for pad assembly.

The following are some examples of rail seat abrasion:

Figure 4-6 shows light abrasion. The root cause of this abrasion was the incorrect pad. This is typical of tangent track rail seat abrasion. If this rail seat is covered with epoxy and all the voids are filled to the original elevation of the tie, the abrasion will be stopped.



Figure 4-6

The abrasion in Figure 4-7 is beyond what is expected to be repaired. This is the type of abrasion that can be found in curves. Ties with this depth of abrasion need to be replaced.



Figure 4-7

There are various ways to detect rail seat abrasion:

1. In tangent track where the pad is deteriorating, it may be possible to see that the pad is being cut by the base of the rail as in Figure 4-8. As you see the rail is sitting on the tie and is unacceptable.



Figure 4-8

2. In Curved Track, review and evaluate the cant measure by geometry cars.
3. If the cant measurement is zero, the centerline of the rail is straight up, and we have 1.42 degrees of rotation to the field side meaning that there is at least $\frac{1}{4}$ inch of abrasion on the field side of the rail seat.
4. If the measure cant is a negative 1 degree, there is over $\frac{3}{8}$ " abrasion on the field side of the rail seat. This negative cant (reverse cant) does several things to the concrete ties.
 - 4.1. Negative cant of 1 degree makes the gage $\frac{5}{16}$ inch wide
 - 4.2. The field side fastening system has lost toe load on the base of the rail. In addition, the fastening system loses at least one-half of the longitudinal strength.
 - 4.3. With each movement of the passing wheel, the interaction of the rail and the tie generates additional rail seat abrasion.
 - 4.4. Replacement of the field insulator will not correct any gage deviations. The base of the rail will work up under the insulator forcing it off the shoulder.
 - 4.5. The base of the rail, working up and down, will wear the front face of the shoulder off. This makes the fastening system ineffective even after the rail seat has been repaired.

Use the following requirements for determining whether to repair or replace concrete ties:

1. Abrasion less than $\frac{1}{2}$ inch should be repaired with epoxy.
2. Abrasion greater than or equal to $\frac{1}{2}$ inch and less than 1 inch requires the use of a cast plate epoxied to the tie.
3. Abrasion greater than or equal to 1 inch requires tie replacement.

4.16 Concrete Tie Pads

1. Concrete ties come from the tie plant with a three-part pad assembly.
 - 1.1. A foam gasket on top of the tie to seal the tie from moisture.
 - 1.2. The middle plate (steel or nylon) to keep the surface of the tie separated from the pad, to provide protection from rail seat abrasion.
 - 1.3. The pad absorbs impacts generated by dynamic rail loading from the rail to the tie.
2. After epoxy is applied to the rail seat, the foam gasket is no longer required. When replacing pads behind epoxy repairs use a two-part pad assembly.

Note: Do not use a three-part pad assembly. Using a three-part pad during epoxy repairs will prohibit future quality rail abrasion repairs.
3. Use new pads when performing capital or maintenance work on concrete ties.
 - 3.1. When performing maintenance, replace defective and worn pads.

4.17 Concrete Tie Insulators

1. Insulators are used for three purposes: they insulate the shoulders from shunting the track, they function as a wear component between the rail base and shoulder, and gage retention and adjustment. Without this wear component, the shoulder could not withstand the abrasion and lateral forces generated by the rail.
2. Proper insulator maintenance is critical in maintaining concrete tie track, especially in curves. A worn field side insulator on one rail can generate 1/4 inch-wide gage. When the insulator is worn out, the rail base comes in contact with the shoulder. The rail base will then start cutting into the shoulder. Not only does this destroy the shoulder, but at the same time causes rail seat abrasion. Figure 4-9 shows a heavy-duty insulator in track that has failed. If this is evident in a curve, insulator replacement is required.



Figure 4-9

3. Heavy-duty insulators have a metal plate molded into the plastic, which keeps the insulator from getting squeezed out from between the shoulder and rail. Heavy-duty insulators are required for use on the field side of both the high rail and low rail in all curves greater than or equal to 1 degree 30 minutes.
4. Wide post heavy-duty insulators are to be used only at the direction of SCRRRA and are available for correcting wide gage in concrete tie track. The use of a wide post insulator on one rail will give 1/8 inch gage correction. Both rails will give 1/4 inch. When using wide post insulators, it is best to use the old insulators that are worn down on the gage side of the rail or use a narrow post insulator. This allows the added thickness of the field side insulator to fit in the allotted space.
5. Replace insulators when performing program work on concrete ties.

4.18 Elastic Fasteners

Tie fasteners must be in place at all times, replace any missing or defective fasteners upon identification. All elastic fasteners shall have a rust-preventative coating to prevent corrosion.

4.18.1 *Spring Clips*

In elastic fastener track, spring rail clips provide enough toe load to prevent rail roll-over and restrain the rail from moving longitudinally. This is a critical component of the fastening system and must be maintained.

1. Replace clips that have been sprung, bent, broken, or cracked.
2. Clips can and will lose the designed toe load, when this occurs, longitudinal movement may take place.
3. Replace all rail clips when performing program work on elastic fastener ties.
4. Install galvanized spring clips in road crossings, tunnels or other corrosive environments.
5. Ensure spring clips match the fastening system design of the tie and use the components for the various applications in signalized or circuited track.

Note: Joints in concrete tie track directly across from one another cannot be insulated.

4.18.2 *Safelok I Clips*



Figure 4-10

1. Inspect Safelok I Clips to make sure that they are not sprung.
 - 1.1. The top of the inside of the prong should be even with the bottom of the outside of the rail clip. Refer to Figure 4-10 and Figure 4-11.
 - 1.2. The distance between the bottom of clip and the bottom of the prong should be a minimum of $1/8"$ and a maximum of $3/8"$.
 - 1.3. Used on both concrete and wood ties.

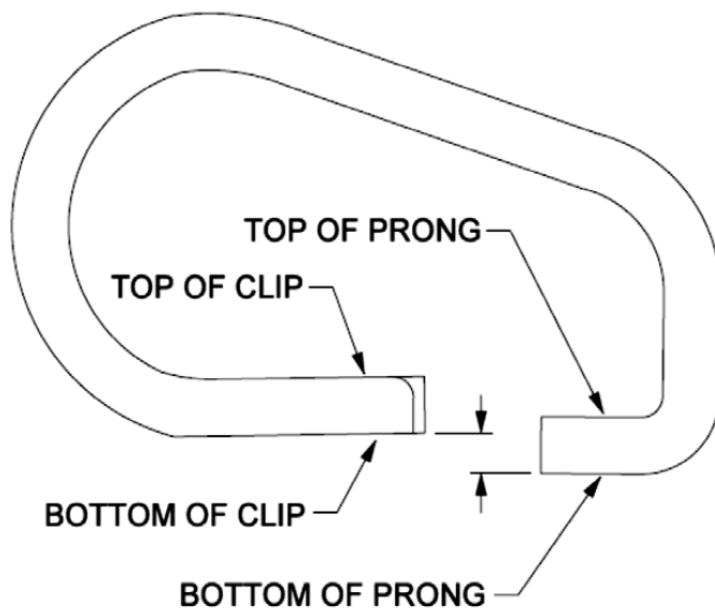


Figure 4-11

2. Do not overdrive Safelok I spring clips. If clips are applied properly:
 - 2.1. The prongs will extend beyond the gage face of the shoulder by 1/8 to 3/16 inch.
 - 2.2. The base will be in full contact with the shoulder as shown in Figure 4-12.

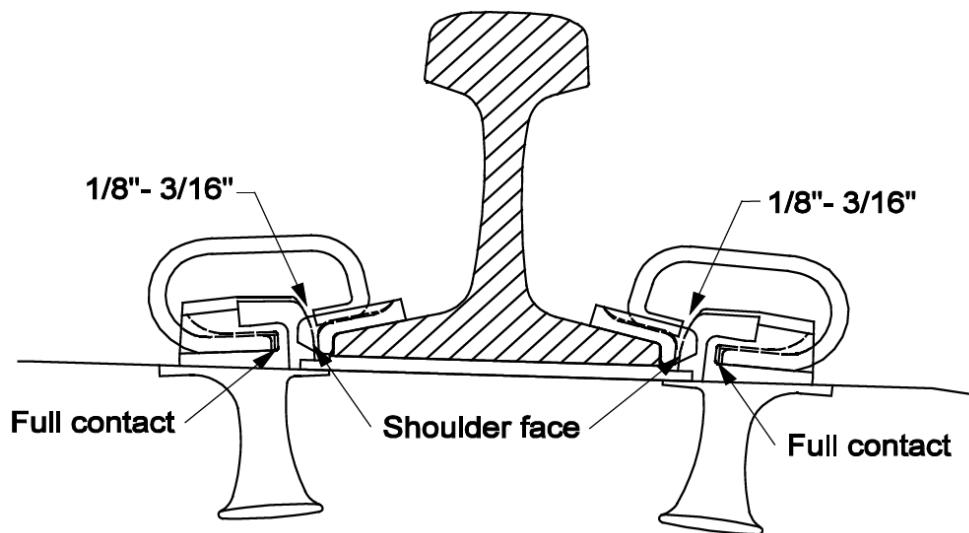
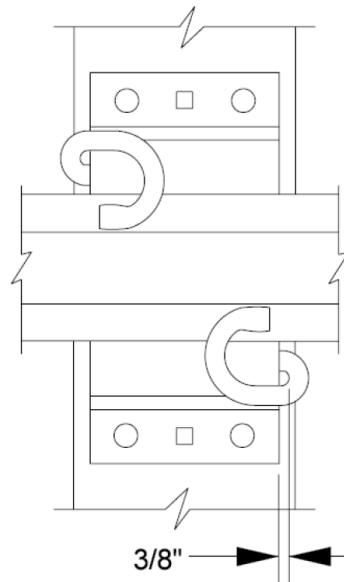


Figure 4-12

4.18.3 *E-Clips*

Figure 4-13

1. Do not overdrive e-clips. If installed correctly there will be a 3/8" clearance between bend in clip and clip housing. See Figure 4-14. Over driving the clip can cause clip breakage over time.
2. E-Clips can be used on concrete or wood ties. See SCRRRA Standard ES2361 for details and application.



A 3/8" GAP BETWEEN THE
BACK OF THE CLIP AND THE
SHOULDER IS REQUIRED.

Figure 4-14

4.18.4 *Fastclip*

Fastclips used on concrete ties (Figure 4-15) on the SCRRRA system are made up of two piece insulators, side post and toe insulators. These can be installed or removed manually with special tools, and mechanized equipment. Refer to SCRRRA Standards ES2365-01, ES2365-02, ES2366, ES2367, and ES2368 for details and applications.

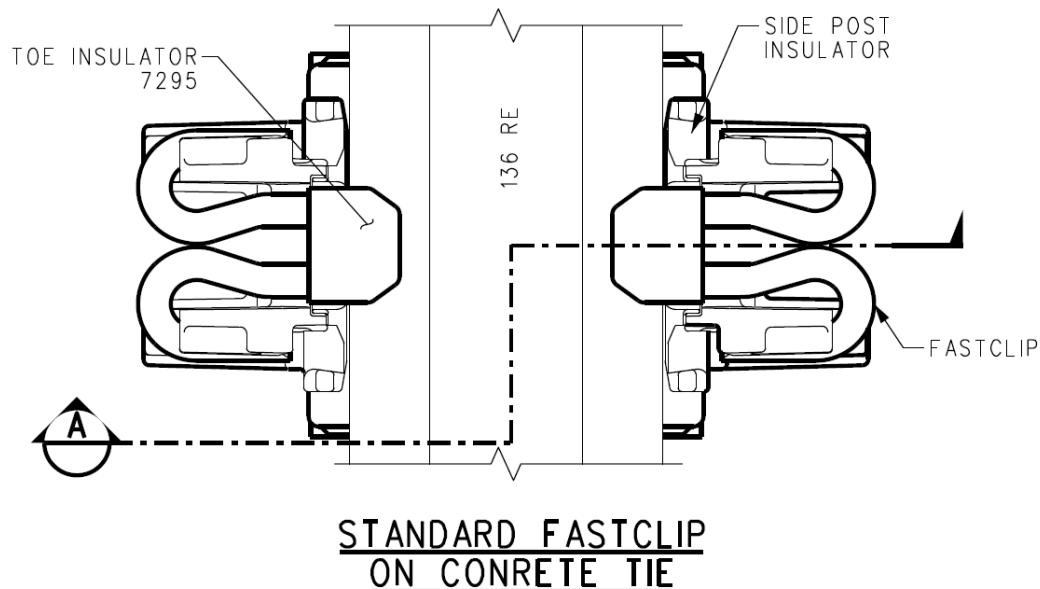


Figure 4-15

4.18.5 *Insulated Joint Fastenings*

Install insulated joint bar insulators between special spring insulated joint clips and the rail base of bonded insulated joints on concrete, steel, or wood ties that use spring clips. See SCRRRA Standard ES2368 for fastclip applications. For an insulated joint e-clip see SCRRRA Standard ES2361.

4.19 Tie Plates

4.19.1 Double Shoulder Tie Plates

A double-shoulder tie plate (See Figure 4-16) is designed to:

1. Protect the wood crosstie from damage by distributing vertical and lateral wheel loads over a wider area.
2. Establish and maintain track gage accurately and securely.
3. Provide inward rail cant for proper positioning of the wheel on the rail head.
4. Resist tie skewing through interaction between the rail base and the plate shoulders.

Typical Tie Plates

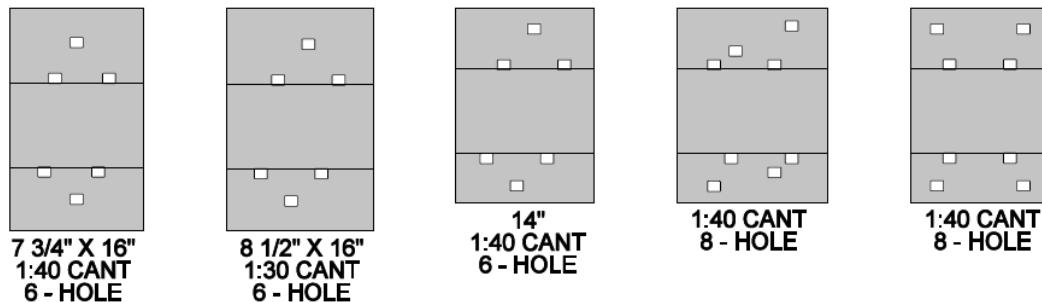


Figure 4-16

4.19.2 Tie Plate Requirements

1. Apply tie plates to all wood and composite ties.
2. Do not intermix plates of different sizes and cant along the same rail.
3. Install tie plates so that:
 - 3.1. Plate shall have full even bearing on the ties.
 - 3.2. Field-side plate shoulder is square against the field-side base of the rail.
 - 3.3. Plate is centered on the tie.
 - 3.4. Proper cant is provided to the rail when the wide side of the plate is on the field side. See Figure 4-17.
 - 3.5. Do not reuse broken, bent, worn, or corroded tie plates.

See SCRRRA Standard ES2451, ES2452, ES2453, and ES2454.

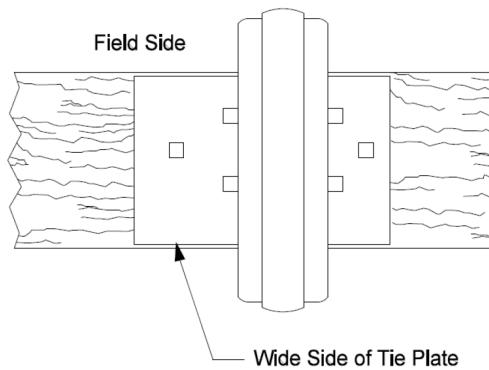


Figure 4-17

4.20 Spikes and Spike Screws

4.20.1 *Spikes*

Spikes fasten rail, tie plates, switch stands and other devices to wood and composite ties. See SCRRRA Standard ES2355.

1. Spike each tie with a minimum of two line spikes per plate.
2. Before driving spikes, properly align ties and center tie plates.
3. Maintain uniform standard track gage when spiking.
4. Use new spikes for line spikes and good second-hand spikes for hold-down spikes when available.
5. Drive spikes vertically with the face in contact with the base edge of the rail.
6. Drive spikes just until they contact the rail. Over driving spikes may damage the base of the rail.

4.20.2 *Installing Joint Spikes*

1. When spiking insulated joints, turn spike heads away from the rail.
2. Do not drive spikes into the slots or holes of skirted joint bars. Do not drive rail spikes within 2 inches of the end of skirted joint bars.
3. When driving line spikes within 2 inches of the ends of non-skirted joint bars, leave the spikes up approximately 2 inches to allow the joint bar to bypass the spike head if rail movement occurs.



4.20.3 Spike Pattern

1. Standard spiking patterns are required during tie renewal, rail relay and new construction, unless SCRRRA has approved an exception.
2. During rail and tie renewals, additional spikes may be required to bring track into compliance with the standard pattern. Track ties not being replaced also may require additional spiking.
3. If conditions warrant, such as wide gage and if rail canting is occurring, additional spikes shall be added to bring the spiking pattern to current standards.
4. Refer to Figure 4-18, Figure 4-19, and SCRRRA Standard ES2460-01 and ES2460-02.

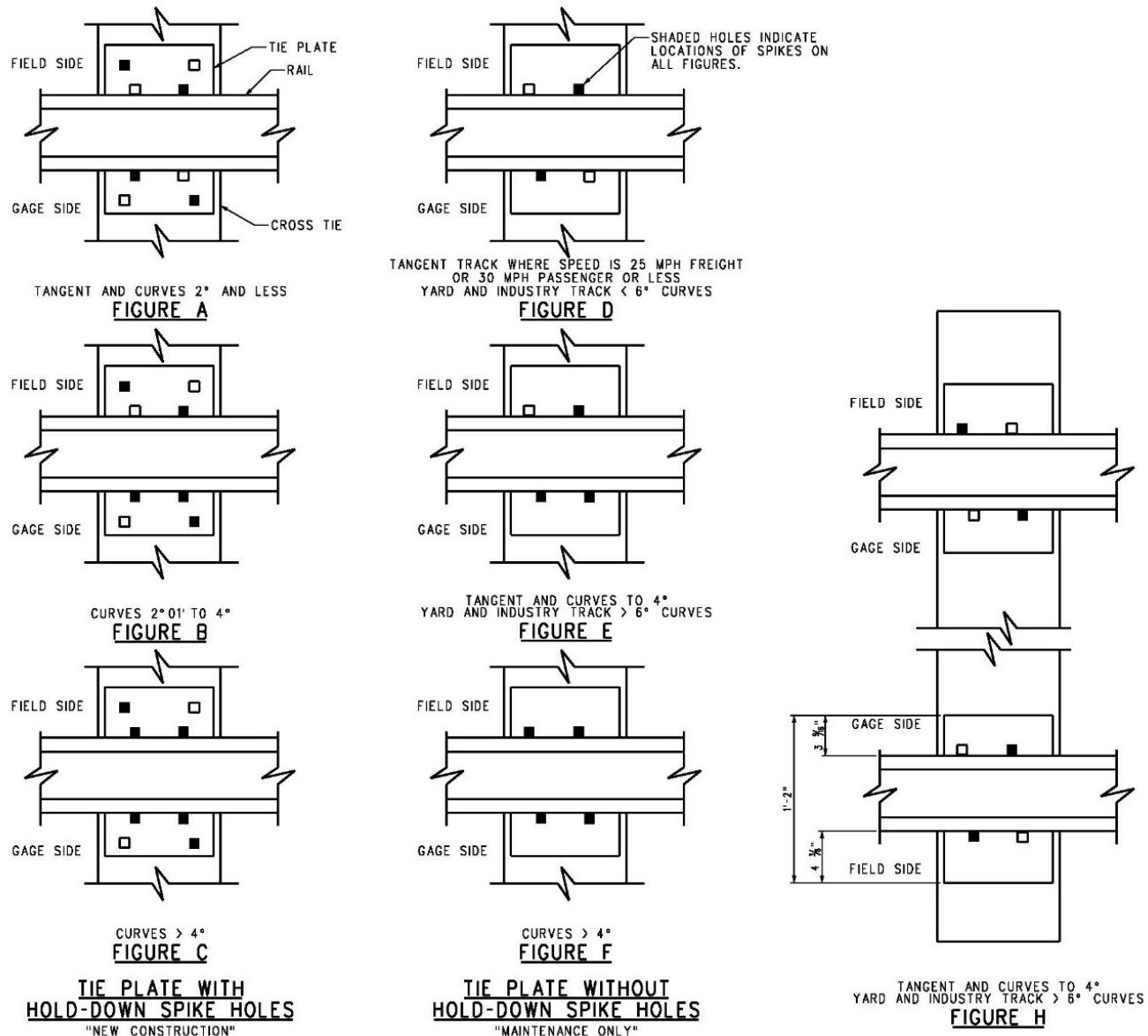


Figure 4-18

For "SP" plates, see the following figure.

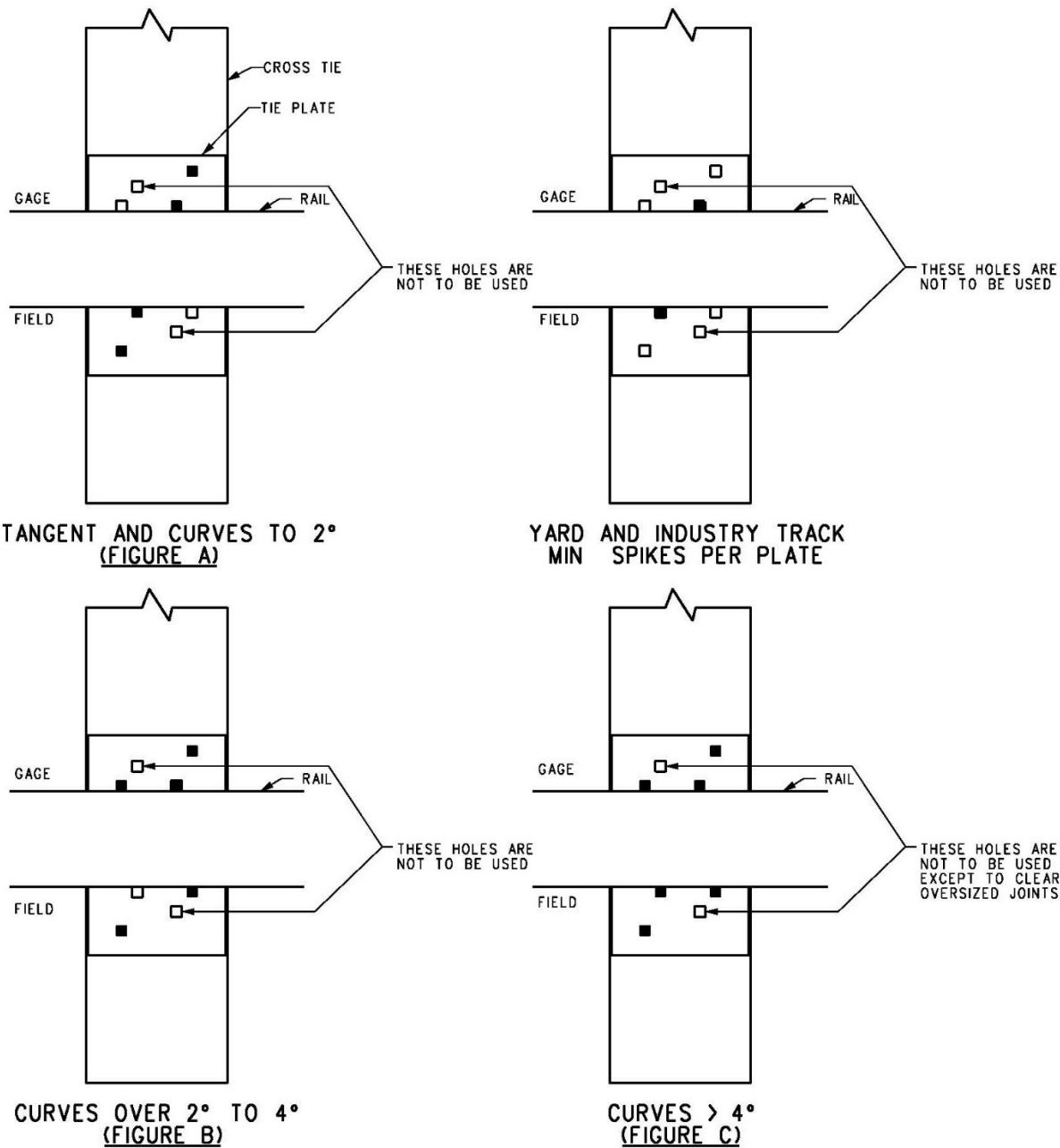


Figure 4-19

4.20.3.1 Spiking Turnouts

When spiking turnouts, use 4 line and 2 hold down spikes per tie on:

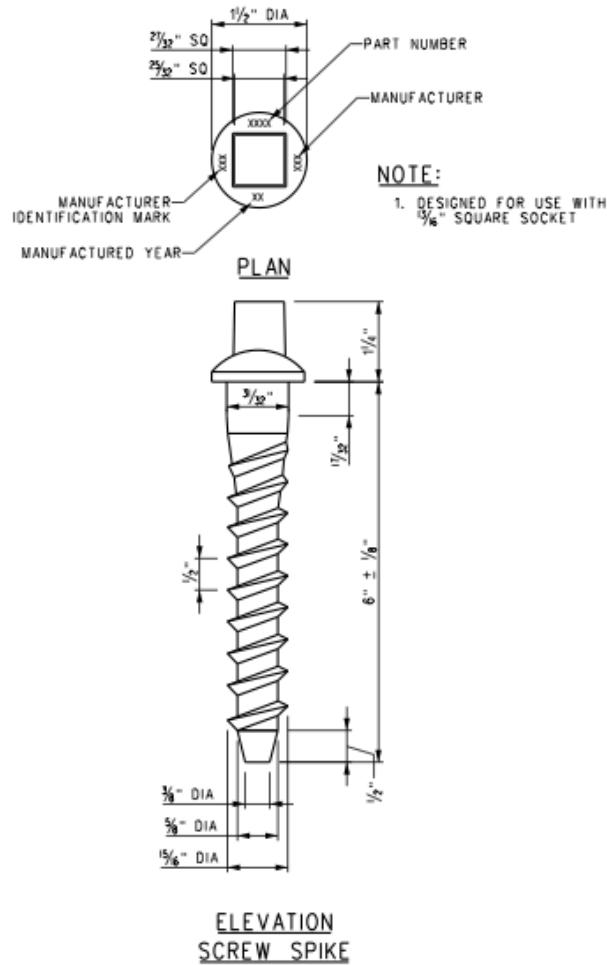
1. All switch ties.
2. 24 ties ahead of switch points.
3. 24 ties behind the last long switch tie on the main line side of the switch.
4. Diverging side of the turn out from the last long switch tie through the reverse curve and for 24 ties onto tangent track.
5. Fully spike all switch, frog, and guard rail plates in wood turn outs.

4.20.4 Screw Spikes

Screw spikes are used in specific applications in curves, crossings, turnouts, and crossovers to secure frogs, gage plates, guardrails, and elastic fastener plates to tie. See Figure 4-20.

1. Ensure screw spikes are inserted to a depth, where the bottom of the head of the screw spikes is touching the top of the plate and securely fastens the plate to the tie.
2. Do not over tighten the screw spikes.
3. Do not drive screw spikes into the tie.
4. Use the proper size drill bit for the type of tie when drilling holes for screw spikes.
5. Drill holes to a depth of 6 inches (Refer to Table 4-2 for drill bit diameters).
6. Do not drill through the bottom of the tie.
7. Do not place track spikes in round screw holes.

See SCRRA Standard ES2355.

**Figure 4-20**

4.20.5 *Evergrip Screw Spike*

Evergrip screw spikes are used in specific applications in curves, crossings, turnouts and crossovers to secure frogs, gage plates, guardrails, and elastic fastener plates to ties. The Evergrip screw spike requires fewer revolutions to fully tighten and have a higher holding power than the standard screw spike. See SCRRRA Standard ES2375.

Note: Follow the same requirements as Section 4.20.4 Screw Spikes for installation.

4.21 Tie Maintenance

Adze the plate bearing surface of a wood tie to the minimum depth required to return the tie plate area to a level plane.

Plug holes in wood ties with treated tie plugs or other approved plugging material before reinstalling spikes. Refer to Section 4.12 Defective Ties for tie rating and maintenance requirements.

5.0 Rail

5.1 General Rail

For CWR instructions, see Chapter 9 of this manual.

Note: See SCRRRA Standard ES5218 for rail marking requirements and SCRRRA Standard ES5230 for track identification markings.

When rail is replaced due to wear or defects, replace any rail identifying track markings in accordance with SCRRRA Engineering Standards ES 5218-02 and ES5230.

Track identifying marking shall be maintained and kept clear and visible at all times, refreshing the stencil/paint marking when they become faded or defaced by MOW equipment.

Mile post and tenth mile markings are stenciled/painted on the field side of the web of each rail. Rail markings shall be restored on the new rail and stenciled/painted on the new rail with corresponding mile post and tenth mile marks. During rail relays, it is a best practice to transpose existing tenth mile markers to ties for ease of restoration to new rail.

Track maintenance contractor shall be responsible for the replacement and restoration of any missing rail stenciling for: tenth mile markers, milepost markers, and track identification at crossings.

5.2 Rail Identification

All rail is branded and stamped on the web of the rail at the time of manufacturing using a unique identification system. One side of the rail is branded and will identify the Rail Weight (size), Rail Section, Tempering Method, Manufacturer, and year/month of manufacturing. On the opposite side of the web the rail is stamped with the hardening method, Hearth Number, Heat Number, Ingot Number, and final heat treatment method (Head Hardened (HH) or Standard Strength (SS)).

5.2.1 *Rail Branding*

Check rail branding and stamping to determine the type of rail before welding. See Figure 5-1 for an example of rail branding.

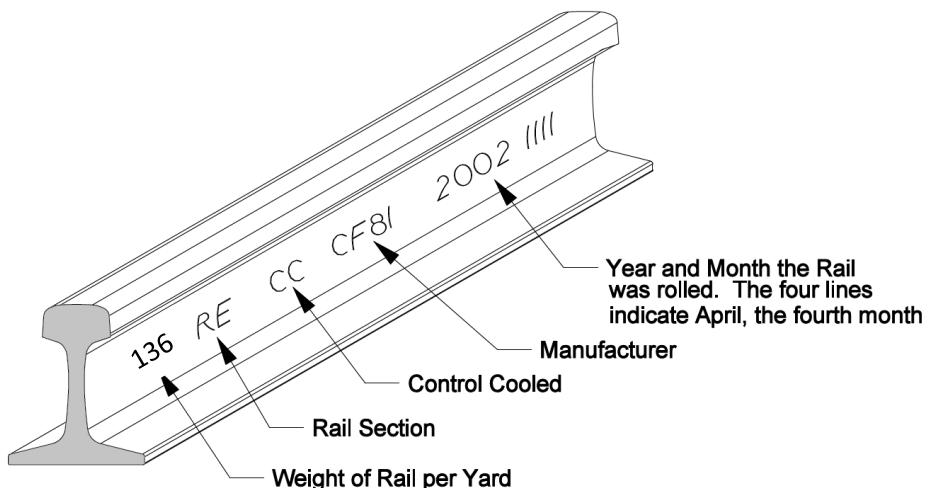


Figure 5-1

5.2.2 Rail Stamping

Rail stampings are imprinted characters on the web opposite the branding side. See Figure 5-2.

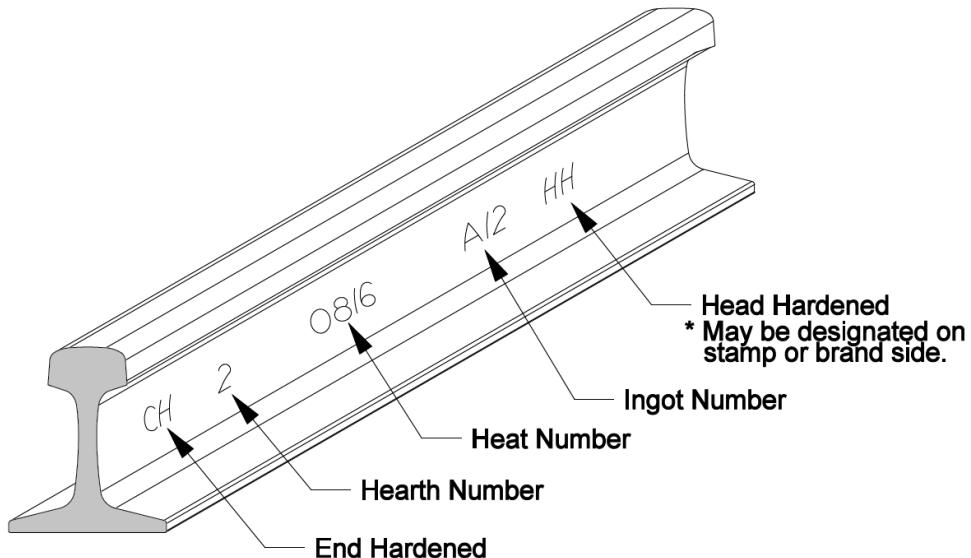


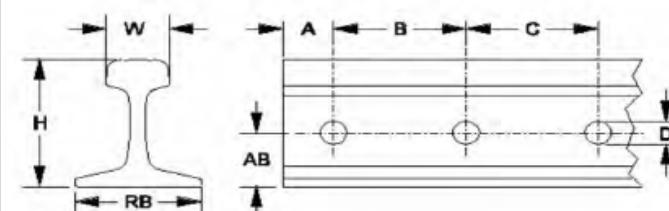
Figure 5-2

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

Table 5-1

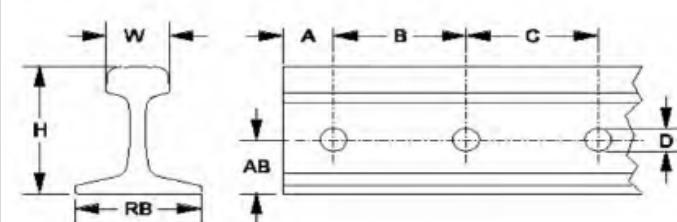
5.2.3 Rail Sections

Rail Sections Table 5-2 lists some of the more common rail sections used in the construction of the railroads throughout their history. Though most of the sections are no longer used, the table can be used as a reference for rail identification and a guide for rail end drilling in repair situations.



Common Rail Section Information

Rail Weight (lbs/yd)	Rail Section Type	"H" Rail Height (inches)	"RB" Rail Base (inches)	"W" Head Width (inches)	Rail End Drilling "A - B - C" (inches)	"D" Hole Dia - (inches)	"AB" Above Base (inches)
75	40 (ASCE)	4 13/16	5	2 15/32	2 7/16 - 5 (UP)	1 1/8	2 15/128
					3 - 6 (WP)		
					2 1/2 - 4 (MP)		
	CS	5	5	2 9/16	2 29/32 - 6 (MP, M&I)	1 1/8	2 1/4
					2 5/8 - 5 1/2 (UP)		
					2 11/16 - 5 1/8 (WP & SP)		
85	40 (ACSE)	5 3/16	5 3/16	2 9/16	2 5/8 - 5 1/2 (UP)	1 1/8	2 17/64
					2 29/32 - 6 (CNW)		
					2 13/16 - 5 (WP)		
					2 15/16 - 6 (MP)		
	50	5 7/32	5 1/4	2 15/32	2 13/32 - 5 (MP)	1 1/8	2 21/128
90	RA (ARA - A)	5 5/8	5 1/8	2 9/16	2 5/8 - 5 1/2 (UP)	1 1/8	2 19/32
					2 13/32 - 5 (MP, WP)		
					2 11/16 - 5 1/2 (WP, SP)		
					2 29/32 - 6 (MP, CNW)		
	CS	5 3/4	5 3/8	2 3/4	2 5/8 - 5 1/2	1 1/8	2 9/16
100	RA Headfree	2 25/32	5 1/8	2 9/16	2 29/32 - 6	1 1/8	2 37/64
					2 5/8 - 5 1/2 (UP)		
	25 RE	6	5 3/8	2 11/16	2 11/16 - 5 1/2 (WP)	1 1/4	2 1/2
					2 13/32 - 5 (MP)		
					2 1/2 - 6 1/2 (CNW)		
110	RE	6 1/4	5 1/2	2 25/32	2 11/16 - 5 1/2 (UP, SP)	1 1/4	2 5/8
					2 29/32 - 6 (MP)		
					2 23/32 - 5 1/2 (CNW)		
	RE Headfree	6 7/16	5 1/2	2 11/16	2 29/32 - 6 (MP)	1 1/8	2 5/8
112	20 RE	6 5/8	5 1/2	2 23/32	2 1/2 - 6 1/2	1 3/16	2 7/8
					2 1/2 - 6 1/2 (SP)		
	RE Headfree	6 3/4	5 1/2	2 11/16	2 1/2 - 6 1/2 (MP)	1 1/8	2 7/8



Common Rail Section Information							
Rail Weight (lbs/yd)	Rail Section Type	"H" Rail Height (inches)	"RB" Rail Base (inches)	"W" Head Width (inches)	Rail End Drilling "A - B - C" (inches)	"D" Hole Dia - (inches)	"AB" Above Base (inches)
113	Headfree	6 13/16	5 1/2	2 11/16	2 1/2 - 6 1/2 (SP)	1 1/4	2 7/8
115	25 RE	6 5/8	5 1/2	2 23/32	3 1/2 - 6 - 6	1 1/8	2 7/8
					2 1/2 - 6 1/2 - 6 1/2 (WP, SP)	1 1/4	
119	RE	6 13/16	5 1/2	2 21/32	3 1/2 - 6 - 6	1 1/8	2 7/8
					2 1/2 - 6 1/2 - 6 1/2 (WP, SP)	1 1/4	
130	PS	6 5/8	5 1/2	3	2 11/16 - 5 1/2 - 5 1/2 (SP)	1 1/4	2 3/4
	RE	6 3/4	6	2 15/16	2 11/16 - 5 1/2 (UP)	1 1/4	2 3/4
131	RE	7 1/8	6	3	2 1/2 - 6 1/2 - 6 1/2 (WP, SP)	1 1/8	3 23/32
					2 15/16 - 6 1/2 - 6 1/2 (UP)		
	28 RE	7 1/8	6	3	2 23/32 - 6 - 7	1 1/8	3 1/4
132	RE	7 1/8	6	3	3 1/2 - 6 - 6 (MP)	1 1/8	3 3/32
					3 1/2 - 6 - 6 (UP)		
					2 15/16 - 6 - 6 (WP)		
133	Headfree	7 5/16	6	2 31/32	2 1/2 - 6 1/2 - 6 1/2 (SP)	1 1/8	3 9/32
133	0 RE	7 1/6	6	3	3 1/2 - 6 - 6	1 1/8	3
136	0 RE	7 5/16	6	2 15/16	3 1/2 - 6 - 6	1 1/8	3 3/32
					3 1/2 - 6 - 6		
140	CF&I	7 5/16	6	2 15/16	2 1/2 - 6 1/2 - 6 1/2 (SP)	1 1/8	3 3/32
141	31 RE	7 5/16	6	3	6 - 3 - 2 23/32	1 1/8	3
141	AB	7 7/16	6	3 1/16	3 1/2 - 6 - 6	1 1/4	3 3/32

Table 5-2

5.2.4 Rail Wear Limits

The maximum acceptable rail wear limits are listed in Table 5-3. Curves having $\frac{1}{2}$ inch Side Wear or greater will be considered for replacement. Excessive rail wear should be tracked on the bi-annual curve inspection reports. Rail wear measurements shall be made utilizing a Rail Head Wear Gage and documented on Semi-Annual Curve Inspection Report form in Appendix C. Send reports to TRACK&STRUCTURES@SCRRRA.NET.

Rail wear that reaches the 'Remedial Action Required' thresholds listed in Table 5-3 shall have a speed restriction of 10 MPH placed within the associated milepost limits until the rail is replaced.

Rail Wear Limits

Rail	Transpose	Replacement Limits		Remedial Action Required	
Weight	Limit	Side Wear	Vertical Wear	Side Wear	Vertical Wear
90	N/A	5/16"	1/4"	7/16"	3/8"
110-119	1/4 to 5/16"	3/8"	3/8"	1/2"	1/2"
132HF	1/4 to 5/16"	3/8"	3/8"	1/2"	1/2"
132	1/4 to 3/8"	1/2"	3/8"	5/8"	1/2"
133, 136	1/4 to 3/8"	1/2"	1/2"	5/8"	5/8"

Table 5-3

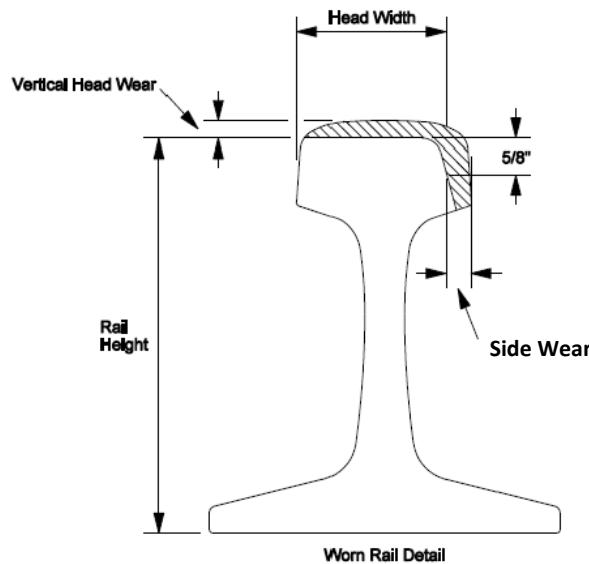


Figure 5-3

5.3 New, Secondhand (SH), Scrap Rail, and Other Track Material (OTM)

Track supervisors and maintenance of way personnel must clearly mark all rail in inventory, showing length, weight, and class. Load and ship surplus of new and secondhand rail as instructed by SCRRRA or as directed in the Contract Documents. Place wooden slats between layers of rail when transported or when rail is in storage.

SCRRRA will determine the disposition of defective rail removed from the track. Stack rail so it can be loaded with a boom truck.

Classify surplus track material as either unsorted scrap or as salvageable secondhand material. All fit for re-use rail (salvageable and secondhand rail) returned to inventory shall be clearly marked "fit for re-use" with the date of the last rail test. After classifying the material, advise who will handle scrap material in accordance with SCRRRA procedures.

5.4 Rail Handling and Placement

5.4.1 *Rail Handling*

When lifting rail:

1. Center mark rail before lifting to balance the load.
2. Use approved rail tongs or grapple buckets when handling rail 60 feet or less.
3. Use a spreader bar when handling rail more than 60 feet.

5.4.2 *Rail Placement*

When unloading rail trains and placing rail in field locations for installation:

1. Place rail as close as possible to the site where it will be installed.
2. Place rail where it will not contact other rail in the track.
 - 2.1 When possible, place rail at the toe of ballast no closer than 8'-6" from the center line of the track. Any rail placed on ties shall be secured by restraining the rail from movement. For example, spikes may be used to restrain the rail from movement. In addition, a tie plate or equivalent is needed at the rail end to create a ramp preventing any dragging equipment from picking the rail. Rest the plate upside down on an angle to the rail end and spike it to the nearest tie.
3. After unloading, mismatch rail ends by placing wooden blocks or other suitable material between the rail ends.
4. Point rail ends on all rail strings away from the track toward the field.
5. Securely fasten and support rail across bridges.
6. Cut only when necessary during rail train CWR unloading operations.
7. Place rail in ditches cut by shoulder plow.
8. Place rail outside of the walking path in walking areas such as yards and other switch locations.
9. If rail is located in the walkway, notify train crews via appropriate bulletin

5.4.3 *Rail Placement for Loading*

When loading rail trains and placing rail for pick-up:

1. Place rail where it will not contact other rail in the track.
2. Place rail a minimum of 6' from the center line of the track when possible.
3. Any rail placed on ties shall be secured by restraining the rail from movement. For example, spikes may be used to restrain the rail from movement.
4. Mismatch rail ends by placing wooden blocks or other suitable material between the rail ends.
5. Point one end of pick-up rail strings away from track toward the field.
6. If rail is placed in walkways, a Form C Track Bulletin advising footing conditions must be issued.

5.5 CWR Track Panels

5.5.1 *Installation of Track Panels*

The term “track panel” includes turnouts, road crossings, rail crossings, and any other installation of track panels.

1. Mark rail cut locations.
2. Apply applicable match marks on each rail that will be cut.
3. Remove existing track panel(s).
4. Install new track panel(s).
5. Determine the total length of the track panel(s) being installed. If the rail temperature at the time of repair is at the PRLT, additional rail adjustments may not be required. If Rail temperature is more than 5 degrees below the PRLT, refer to Chapter 9 for detailed CWR procedures.
6. Ensure standard anchor pattern is installed per Section 5.18 Rail Anchors for anchor requirements.
7. Joints are to be staggered prior to welding no closer than 12 feet apart unless approved by SCRRRA. See Section 5.10.3 Rail Joint Stagger.

5.5.2 *Installation and Adjustment of Track Panels at Derailments*

The installation of track panels at a derailment requires additional steps compared to normal track panel installation due to the fact that match marks cannot be established. The installation of track panels at a derailment requires additional attention pertaining to installation, temporary destressing and final rail relay.

1. When installing multiple track panels be aware of the joint gap between the rail ends, the effectiveness of rail anchors to resist longitudinal rail movement, ambient temperature during panel installation, the correct speed restriction for the condition and the risk of adding rail.
2. Place hardwood shims to provide the correct gap when installing track panels. Use Table 5-4 to determine correct shim thickness.

39-Foot Rail Lengths	
Rail Temperature	Opening
Below 25° F	1/4 inch
25°-50° F	3/8 inch every other joint
51° - 75° F	1/8 inch
Above 75° F	1/8 inch every other joint

78 Root Rail Lengths	
Rail Temperature	Opening
Below 50° F	3/8 inch
51°-75° F	1/4 inch
76°-100° F	1/8 inch
Above 100° F	1/8 inch every other joint

Table 5-4

3. To minimize rail movement in cold weather, adjust or add any missing rail anchors in wood or concrete track at both ends of track panel zone.
4. Record the rail temperature on the web of the rail at the time of panel installation at each end of the panel zone. See Section 9.6.3.6 Marking Joints and Field Welds.

After panels have been installed:

1. In wood tie or concrete tie track, when five track panels or less are laid, limit the maximum allowable speed over the track per Appendix B Summary of Speed Restrictions for Trackwork. Joints must be staggered prior to welding out. When more than five consecutive track panels are laid, limit operating speed in accordance with Appendix B Summary of Speed Restrictions for Trackwork for the initial 24-hour period and not to exceed or a maximum of 40 MPH until the joints are staggered and welded out. See within Section 5.15 Location and Preparation for Thermite Welds for minimum field weld stagger requirements for opposite rails.
2. Rail neutral temperature must be restored when CWR is installed.

At the time of CWR rail relay utilize the following process:

Refer to Section 9.6.3.2 Installing CWR for rail relay CWR procedure.

5.6 Inside Guard Rails

Refer to SCRRA Standard ES2302 and ES2304 to determine which structures require inside guard rails. These drawings also show construction details. See Figure 5-4.

1. On wood ties, spike the inside guard rail with two spikes per plate on each rail on the tangent portion, and three spikes per plate on each rail on the curved portion.
2. On wood ties, box anchor two ties near the center of the bridge to restrict longitudinal movement of guard rail.
3. Inner guard rails shall extend 50 feet beyond the span or spans to be protected.
4. On curved track, spike the entire inside guard rail with four rail spikes per plate on each rail.
5. Do not install joints in the curved portion of the inside guard rail except where an insulated joint is required in signalized territory.
6. Guard rail joints, if present, shall be fully bolted using joint bars.
7. Inside guard rails must meet ES2302 and ES2304 requirements. Inside guard rails shall not be smaller than 23 pounds lighter. Inside guard rail shall not be larger than running rails.
8. Inner guard rails shall be installed on any other bridge as directed by SCRRA.

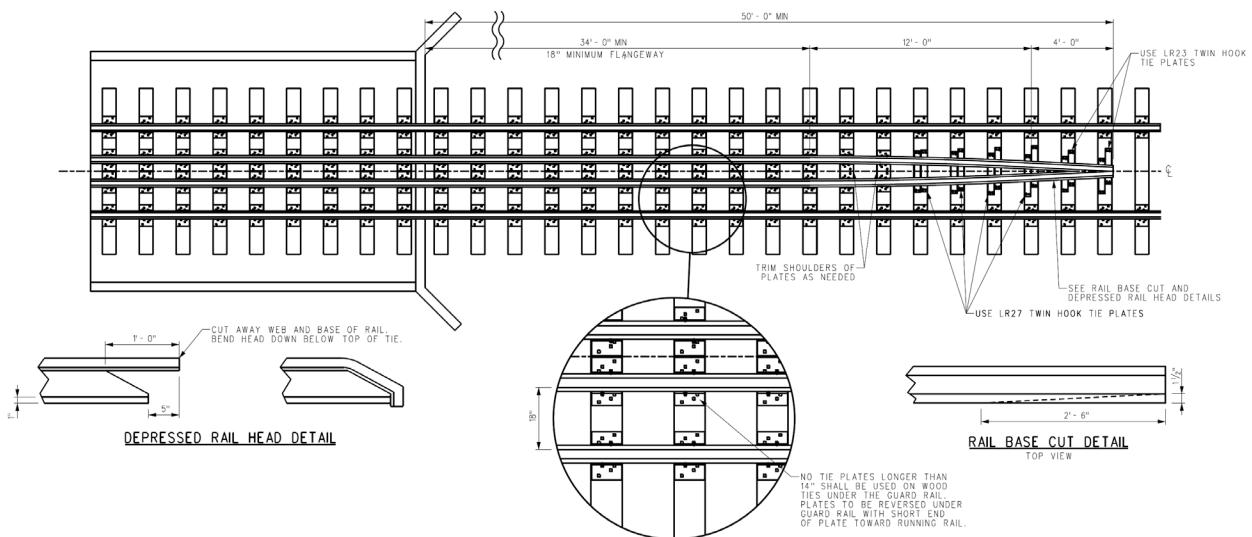


Figure 5-4

5.7 Track Bolts

Bolts secure rails in frogs and joints to minimize rail movement and maintain rail-end alignment. Bolts of proper diameter and length accommodate rail movement and minimize stress in the bolt holes of rail ends.

Note: Keep bolts tight in all applications. Use proper length and diameter bolt.



5.7.1 Track Bolt Sizes

Determine the proper bolt and washer size for a specific rail section from SCRRRA Standard ES2352. See Table 5-5.

WEIGHT AND SECTION OF RAIL	DIMENSION TABLE (INCHES)																		
	BOLT			NUT				SPRING WASHER											
	THREADS		BODY		HEAD			NECK											
	OUTSIDE DIAMETER	LENGTH	NUMBER PER INCH	SHANK DIAMETER	LENGTH UNDER HEAD	DIAMETER	THICKNESS	LONG RADIUS	SHORT RADIUS	MAXIMUM WIDTH	MINIMUM WIDTH	DEPTH	THICKNESS	WIDTH	WEIGHT EACH (BOLT AND NUT)	NUMBER OF BOLTS PER 200 LB KEG	INSIDE DIAMETER		
	d	L2	n	D	L	A	N	R1	R2	O	R	P	U	W	LBS	ID	OD	T	
80 LB ASCE	13/16	1 1/2	10	3/4	4 3/8	1 1/16	5/16			1/16	1 1/32	7/16	3/4	1 1/8	1.09	184	7/8	1 3/4	7/16
75 LB CS & CS REV	15/16	1 7/8	9	7/8	4 3/4	1 1/16	11/16			17/32	1 3/16	1/2	1 1/8	1 1/2	1.56	128	1 1/16	2 1/16	7/16
80 LB ASCE																			
90 LB AREA	"	"	"	7/8	5 1/8	"	"			"	"	"	"	"	1.62	123	1 1/16	2 1/16	7/16
110 LB RE	1 1/16	2 1/8	8	1	5 3/8	1 1/16	3/4			1 1/32	1 5/16	5/8	1 1/4	1 5/8	2.22	90	1 1/8	2 1/8	7/16
130 LB PS, 130 LB RE	"	"	"	1	6 3/8	"	"			"	"	"	"	"	2.45	82	1 1/8	2 1/8	7/16
112 LB, 115 LB, 131 LB RE																			
113 LB HF, 132 LB HF	1 1/8	2 1/2	7	1 1/16	6 1/2	1 5/16	45/64	155/64	43/64	1 17/32	1 1/2	5/8	1 1/8	1 11/16	2.62	76	1 3/16	2 7/32	7/16
119 LB CF&I, 136 LB RE 141 LB RE																			

Table 5-5

5.7.2 Track Bolt Installation

- Replace track bolts that are missing, bent, cracked, or worn more than 1/8 inch in diameter, or that cannot be tightened to compress the washer.
- Install bolts in joints through all holes drilled in rail ends. Use only one washer per bolt.
- Replace bolts in jointed rail as follows:
 - Use only one washer per bolt.
 - Tighten the nut until the lock washer is compressed.
 - Avoid over-tightening bolts.
 - Tighten all the bolts in a joint.
- Tighten bolts in rail joints alternately and equally with a track wrench or power-operated wrench as shown in Figure 5-5 and Figure 5-6.

Bolt Tightening Sequence

6-Hole Joint

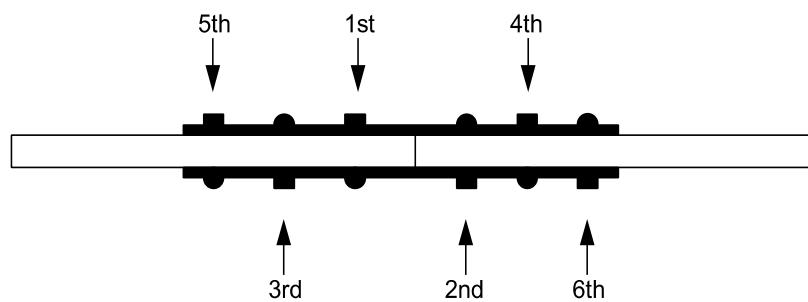
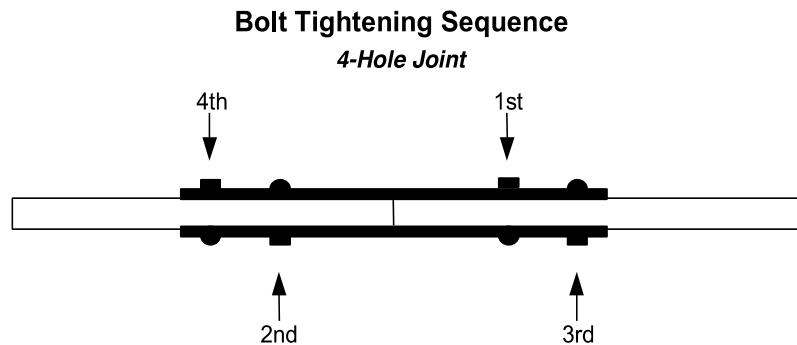


Figure 5-5

**Figure 5-6**

5.8 Joint Bars

1. Connect rails with joint bars of the proper design and dimension for the rail section

Note: Marking on the side of joint bars indicate their rail section design.
2. Visually inspect all joint bars for cracks or damage before use. Cracks may be visible at top or bottom where the bar contacts rail head or base.
3. Joint bars found to be defective shall be identified and scrapped.
4. Never reconfigure joint bars by grinding, welding, or torch cutting.
5. Use a high relief joint bar on the gage side of joint when rail is worn to an extent that the flange of the wheel would make contact with a standard joint bar.
6. When drilling rail ends, do not drill through joint bars.
7. Apply the above standards for joint bars to compromise bars and insulated joints unless otherwise noted.
8. Use insulated joint bars only where necessary to isolate track circuits.

5.8.1 *Installation of Joint Bars*

When tightening bolts in joint bars, use a sledgehammer to tap along the bottom flange of non-skirted joint bars to seat the bar against the rail. Tap along the base of base-supported (skirted) joint bars to seat the bar against the rail to obtain full-base bearing.

5.8.2 Weld Bars

Weld bars shall be used only for temporary repair of broken welds. See Figure 5-7. All train movements across temporary repair must be supervised by a 213 qualified individual until a permanent repair is made.

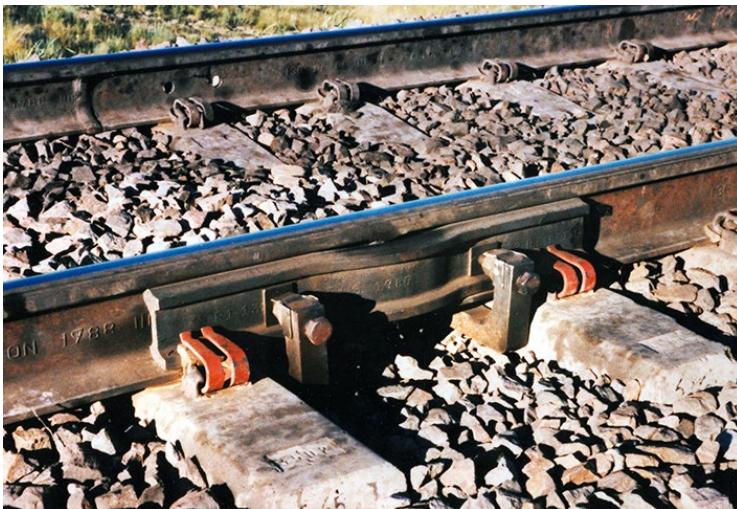


Figure 5-7

5.9 Compromise Joint Bars

Compromise joint bars align the tread and gage lines of adjoining rails of different sizes. When utilizing compromise joint bars (Refer to SCRRRA Standard ES2503 for additional information):

1. Connect rails with compromise bars of the proper design and dimension for the rail sections joined.

Note: Compromise Joint bars are marked with the weight of the rail on each side.

2. Due to various amounts of wear on the rail head, adjoining rails may require build up or grinding. Refer to Section 5.10.7 Rail Mismatch.
3. Never reconfigure compromise joint bars by grinding, welding, or torch cutting.
4. Avoid installing compromise joints that join rails with different size rail bases at these locations:
 - 4.1. Within the limits of curves.
 - 4.2. On open-deck bridges.
 - 4.3. In turn outs on switch ties.

5.9.1 Offset ("Handed") Joints

Offset or "handed" compromise joint bars join and align the tread and gage area of rails of different rail base size. The joint bars are offset to align the gage area of the rails in the joint. Offset joint bars are manufactured in sets identified as right hand and left hand.

Identify the right or left hand of the compromise joint bars as follows:

To determine right hand or left hand joint:

1. Stand with your back to the larger size rail and face the smaller size rail. The joint on your left-hand side would be designated as the left-hand (LH) joint and the joint on your right side would be the right-hand (RH) joint.
2. Use Figure 5-8 to identify and install offset or "handed" compromise joint bars.

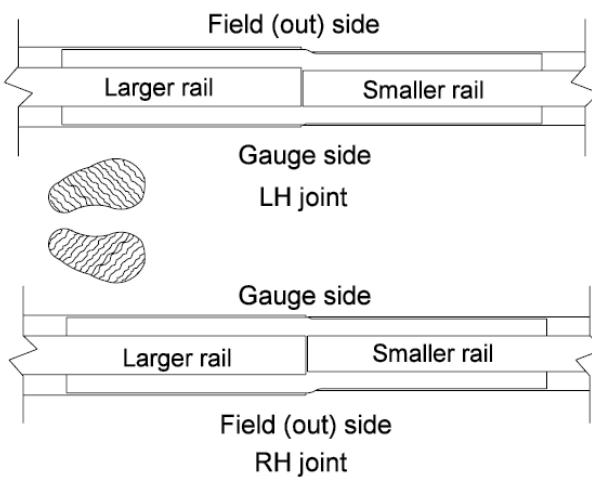


Figure 5-8

5.9.2 Step ("Non-Handed") Joint Bars

1. Step or "non-handed" joint bars align the tread area of rails with the same rail base size. Apply step joint bars when the difference in the width of rails does not exceed 1/8 inch at gage lines.
2. Bars are identified as A and B. Together they make up a joint set that fit either side of the rail.
3. Depending on which rail the joint bars are to be applied, the individual bars will be placed on either the gage side or field side of the rail. See Figure 5-9.

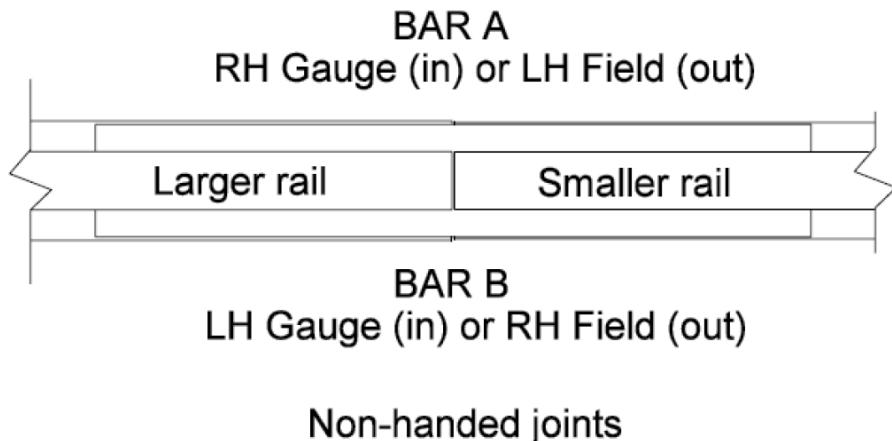


Figure 5-9

5.9.3 Compromise/Transition Rails

Compromise and Transition Rails are manufactured rails that are used to connect rails of different heights and or different rail sections.

In compromise rails, if a defect is found within 30 inches in either direction of the forged area, the entire rail must be replaced.

136# to 115# Compromise/Transition Rails

In all main line applications when joining 136# rail to 115# or 119# rail, use the 136/115# compromise/transition rail. See Figure 5-10. Compromise joint bars are available for temporary installation but never used for permanent installations on main tracks and sidings. Refer to SCRRRA Standard ES2372 and ES2373 for additional information. Follow these instructions when installing Compromise/Transition Rails

1. Measure the height of the rail to remain in the track.
2. Look at the transition rail drawing and determine where the height of rail exists in the tapered area that matches the height of rail to remaining in the track.
3. Locate where the forged area of the rail will be in the track. (Transition area must not be on top of ties).
4. Locate all cuts in tie cribs to facilitate welding.
5. Cut tapered end of rail at the location determined to match height of existing rail in track. (Forged area must not be on top of ties)
6. Make remaining cuts in track and install transition rail
7. Weld all rail joints.

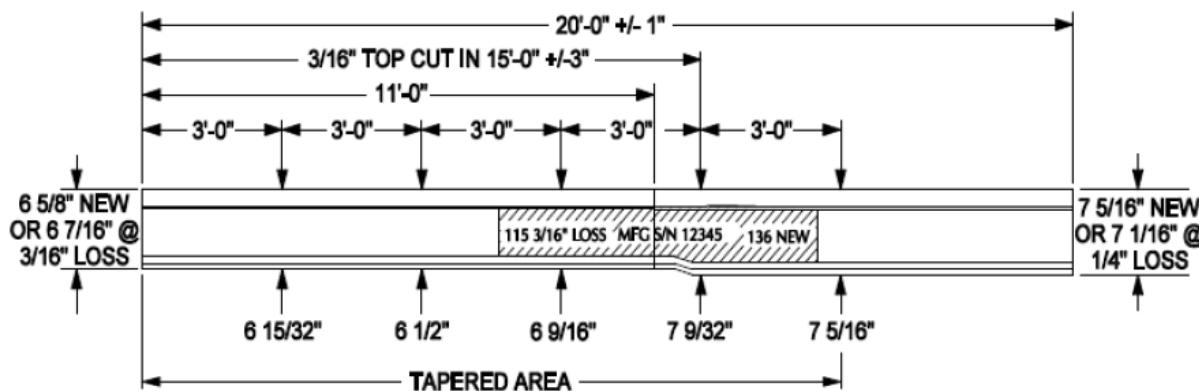


Figure 5-10

5.10 Rail Joints

The rail joint consists of the rail area and Other Track Material (OTM) within the entire length of the joint bars.

Note: If rail has been torch cut, 6 or more inches of rail must be removed with a rail saw before installing rail to make a joint.

5.10.1 *Permanent Joints*

Permanent joints are joints that are not intended to have the rail ends welded together.

Permanent joints include:

1. Insulated joints.
2. Joints in bolted rail territory.
3. Joints in CWR that will remain in track (examples are: Joints in turnouts and diamond crossings).

Permanent joints must be:

1. Fully drilled.
2. Fully bolted.
3. Bolt holes and rail ends to be beveled and slotted
4. Solid box anchored in accordance with Section 5.18.5 Solid Box Pattern.

5.10.2 *Joint Placement and Support*

To enable joint removal in CWR with thermite field welds, do the following:

1. Rail joints must not be located within 36 inches from an existing plant or in-track weld or 19.5 feet from an existing rail joint or field weld.

Note: The only exception to this 19.5-foot rule is in special trackwork around or near turnouts and diamond crossings where because of geometry layout or component spacing, the 19.5-foot is not obtainable.

2. Center joints between tie to enable field welds to be made without moving or adzing tie.
3. Field welds must not be located directly over a tie.
4. In order to prevent weld clusters or a multitude of field welds installed closely together, no more than two (2) field welds are allowed in a 39-foot section of rail.

When installing replacement rail, effort must be made to eliminate thermite welds.

5.10.3 *Rail Joint Stagger*

1. The minimum stagger between consecutive rail joints on opposite rails is 12 feet.
2. Staggered rail joints are preferred but not required on industry leads and yard tracks where the speed does not exceed 25 MPH and the curvature is less than 4 degrees.
3. When staggering rail joints around a curve, use this rule of thumb: For every 80 feet of rail laid, the low rail will become 1 1/2 inches longer for every degree of curvature.

5.10.4 Joint Inventory Definitions

Count only those joints in CWR that can be eliminated by either welding or laying rail (do not include joints in jointed rail territory). Do not count the joints that cannot be eliminated such as non-extended length frogs and insulated joints, although they require inspection as part of the joint inspection process.

Do not put a joint into more than 1 category.

To eliminate double counting of joints, use the following hierarchy to determine the proper category for each joint, even though it may fit the description of more than one category. For example, a joint on concrete ties that falls within 500' of a bridge should only be counted as a bridge joint – not a mainline concrete joint.

Mainline Bridge – Any joint that is on or within 500 feet of a bridge should be counted as a bridge joint, regardless of whether it is in a switch, on concrete ties, etc. (the only exception is heel block joints, that is a separate category)

Mainline Concrete – Any joint that is on concrete ties, except bridge joints (Mainline Bridge), should be counted as a concrete joint.

Turnout – Any weldable joint, other than frog joints, in the Turnout Side

Mainline – All joints that are not included in Mainline Bridge, Mainline Concrete, and Turnout should be counted as Mainline joints. This includes joints in a mainline side running rail of a switch and Dead Insulated Joints of any mainline switch associated with a Main Track Junction, Mainline Connection (any powered turnout connecting track that connects to any mainline tracks), Mainline Siding or Mainline Crossover. See Figure 5-11. (NOTE: Don't count turnout side on Industry, Yard, Setout, or other none mainline tracks). (Turnout Joints that are within 500 feet of a bridge should be included in the Bridge Joint Category).

Jointed Heel Block - Mainline side of switch and also the turnout side of a Main Track Junction, Mainline Connection (any powered turnout connecting track that connects to any mainline tracks), Mainline Siding or Mainline Crossover. The Heel Block Joint is in a category of its own. (Remember heel blocks can be eliminated by use of an extended point).

Dead Insulated Joint(s) – Any insulated joint to be removed (“bond-arounds”). Do not include active joints in this count.

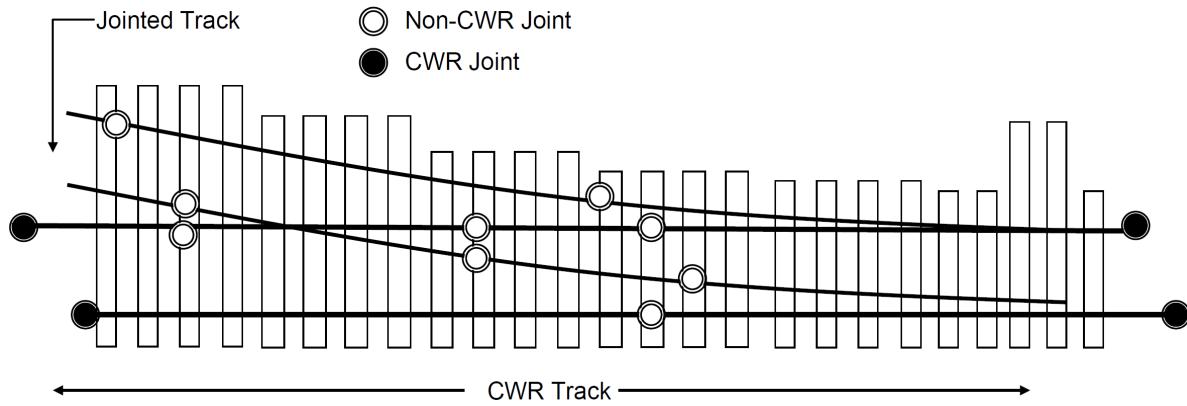
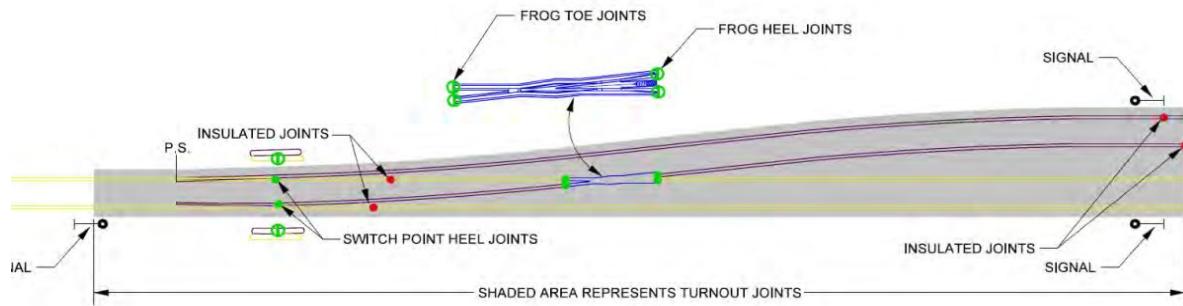


Figure 5-11

MAINLINE TURNOUT JOINTS



LEGEND

- ① INSULATED JOINTS (DO NOT COUNT IN INVENTORY)
- ② ONLY ACCEPTABLE NON-WELDED LOCATIONS (COUNT IF DESIGNED TO BE WELDED)

Figure 5-11 (cont.)

5.10.4.1 CWR Joint Inventory

A comprehensive SCRRRA CWR Joint Inventory List (Table 5-6) shall be maintained and updated as required.

The CWR Joint Inventory List must contain: Subdivision, Date of Installation, Mile Post, Rail Designation, GPS Location, Joint Identification Number, Type of Joint, Rail Size, Track Number, and Date of Joint Inspection.

CWR Joint Inventory List Sample											
SCRRRA - CWR Joint Inventory List											
Line	Date Added	Date Removed	Joint Classification	M.P.	Rail N-S	GPS - Location	Joint ID #	Type	Size	P/T	Tr.#
	11/11/2005			0.4	N	34-00-00N 117-44-55W	V A0.4N	FG	119	P	1
				0.4	S	34-00-00N 117-44-55W	V A0.4N	FG	119	P	1

Table 5-6

5.10.5 Pull-Aparts

Pull-aparts are a result of bolt failure in a joint bar and subsequent excessive gap between rail ends.

1. If a pull-apart is 4 inches or less and the rail ends are not damaged, close the pull-apart by using a hydraulic rail expander or by applying heat.
2. If unable to close rail ends using heat or hydraulic rail expander, or a pull-apart is more than 4 inches, or rail end damage is apparent, install a rail that is 19'6" or longer using match marks and record the rail adjustment. Refer to Section 9.6 CWR Installation Procedures.
3. When repairing pull-aparts, visually inspect each joint bar, install all new bolts and adjust rail anchors tightly against the ties per CWR adjustment requirements.
4. All joints in CWR shall be welded within 30 days or fully bolted with six hole angle bars and solid box anchored 200ft in both directions.

5.10.6 Rail Drilling

For drilling requirements Refer to SCRRA Standard ES2301.

Rail Section	Rail End Hole Spacing (inches)			Bolt Size (inches)	Above Base (inches)	Hole Size (inches)
	Hole 1	Hole 2	Hole 3			
136 lb. MP and WP	3-1/2	6	6	1-1/8 X 6-1/2	3-3/32	1-1/4
133 lb. All	3-1/2	6	6	1-1/16 X 6	3	1-1/8
132 lb. CNW, UP, & MP	3-1/2	6	6	1 X 6	3-3/32	1-1/8
132 lb. WP	2-15/16	6	6	1 X 6	3-3/32	1-1/8
132 lb. MP 4 hole	3-1/2	6		1 X 6	3-3/32	1-1/8
131 lb. MP	2-1/2	6-1/2	6-1/2	1 X 6	3-3/32	1-1/8
131 lb. UP	2-15/16	6-1/2	6-1/2	1-1/16 X 6	3-3/32	1-1/8
131 lb. 4 hole	2-1/2	6-1/2		1-1/16 X 6	3-3/32	1-1/8
119 lb. UP and all others	3-1/2	6	6	1 X 6	2-7/8	1-1/8
119 lb. WP	2-1/2	6-1/2	6-1/2	1 X 6	2-7/8	1-1/8
119 lb. SP	2-1/2	6-1/2	6-1/2	1-1/8 X 6-1/2	2-7/8	1-1/4
115 lb. UP, WP	2-1/2	6-1/2	6-1/2	1 X 6	2-7/8	1-1/8
115 lb. SP	2-1/2	6-1/2	6-1/2	1-1/8 X 6-1/2	2-7/8	1-1/4
115 lb. CNW, all others	3-1/2	6	6	1 X 6	2-7/8	1-1/8
113 lb. SP	2-1/2	6-1/2	6-1/2	1-1/8 X 6-1/2	2-7/8	1-1/4
112 lb. All 4 hole	2-1/2	6-1/2		1 X 6	3-1/16	1-1/8
112 lb. MP 6 hole	3-1/2	6	6	1 X 6	2-7/8	1-1/8
110 lb. UP	2-11/16	5-1/2		1-1/16 X 5-1/2	2-13/16	1-1/4
110 lb. CNW and SP	2-11/16	5-1/2		1 X 5-1/2	2-13/16	1-1/8
110 lb. MP	2-15/16	6		1 X 5-1/2	2-5/8	1-1/8
100 lb. UP	2-5/8	5-1/2		1 X 5-1/2	2-1/2	1-1/8
100 lb. WP	2-15/16	5-1/2		1 X 5-1/2	2-1/2	1-1/8
100 lb. MP	2-13/32	5		1 X 5-1/2	2-3/4	1-1/8
100 lb. CNW	2-1/2 or 2-21/32	6 or 5-1/2		1 X 5-1/2	2-34 or 2-1/2	1-1/8
90 lb. UP	2-5/8	5-1/2		15/16 X 4-5/8	2-9/16	1-1/8
90 lb. UP and CNW	Varies	Varies		7/8 X 5	Varies	Varies

Table 5-7

Note: Do not install rail in the main track that has extra drilled holes. However, you may leave rail with bolt holes in the track when removing joint bars and field welding.

1. Remove joint bars from rail when drilling bolt holes. Do not drill holes through joint bars.
2. Use the correct indexing bar and drill fillet template for the rail section.
3. When using the index bar for setting the hole spacing, set the end of the bar flush with the rail end, as shown in Figure 5-12. Do not "split" joint gap.
4. Fully drill each rail end for the joint bar that will be applied. If the joint will be field welded, drill only the two outermost holes on each rail.
5. In CWR territory, drill the two outermost holes on each rail end only when the joint will be field welded within 30 days. Fully drill the joint if temperature conditions are likely to produce a pull apart.

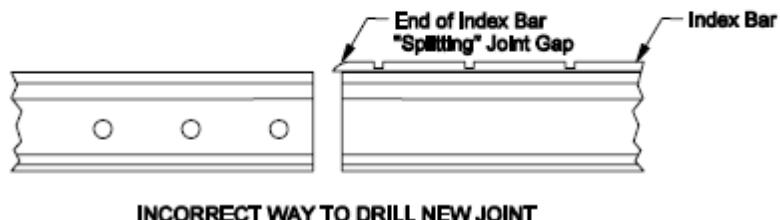
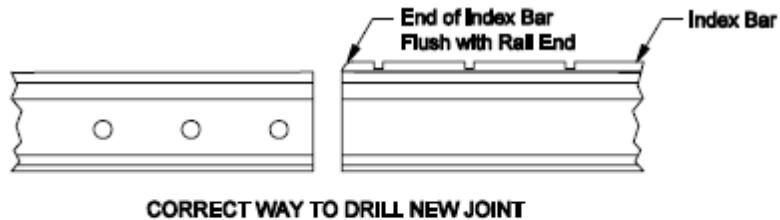


Figure 5-12

6. Holes drilled in rail ends for standard joint bars should be sized 1/16"-1/8" larger than the diameter of the bolt to be used. See Table 5-7.
7. When drilling bolt holes:
 - 7.1. Apply the proper amount of pressure to the drill bit to ensure drill bit does not overheat.
 - 7.2. Keep drill bits lubricated.
 - 7.3. Water is the only recommended lubricant.
 - 7.4. Do not drill holes through the joint bar.
 - 7.5. Bolt holes and rail ends to be beveled and chamfered with bull nose grinding stone or deburred per SCRRA Standard ES2502.

Note: DO NOT torch cut bolt holes under any circumstances.

5.10.7 Rail Mismatch

Rail mismatch is an uneven railhead surface or exposed rail end on the gage or running surface of a rail at a joint location.

1. Except in an emergency, do not install rail ends with a mismatch exceeding 1/4 inch on the tread or running surface or the gage side. See Table 5-8.
2. When replacing rail, select and install a replacement rail that most closely matches both the gage side and running surface. Use the rail wear measuring device.

Joint Type	Class of Track	Tread mismatch of rails at joints more than:	Gage mismatch of rails at joints more than:
Standard rail joint	Class 1 track	0.250" (1/4")	0.250" (1/4")
Standard rail joint	Class 2 track	0.250" (1/4")	0.187" (3/16")
Standard rail joint	Class 3 track	0.187" (3/16")	0.187" (3/16")
Standard rail joint	Class 4 and 5 track	0.125" (1/8")	0.125" (1/8")

Table 5-8

Note: Rail End Mismatch is a class specific defect that requires remedial action be taken if the conditions in Table 5-8 are not met

5.10.8 Rail Joint Gap

The rail joint gap is the distance between rail ends of a bolted joint. The design gap in a rail joint is 1/8".

1. Excessive rail gap is caused by:
 - 1.1. Miss-drilled rail ends.
 - 1.2. Deformed (stretched) bolts due to longitudinal rail forces.
 - 1.3. Insufficient or improperly applied rail anchors.
 - 1.4. Elongated or oversize bolt holes.
 - 1.5. Undersized bolts.
2. Excessive rail joint gap causes large impact loads on the joint system which can lead to:
 - 2.1. Joint bar failure.
 - 2.2. Broken rail ends and rail defects.
 - 2.3. Premature tie failure.
 - 2.4. Ballast degradation.
 - 2.5. Surface geometry defects.
3. Rail joint gaps that do not meet the criteria in Table 5-9, should be repaired within 10 days to achieve a maximum gap of 7/16". Speed restrictions should be applied based on the class of track shown in Table 5-9 .

Class of Track	Maximum Allowable Rail Joint Gap (inches)
Class 4 or 5	1"
Class 2 or 3	1.5"
Class 1	2"

Table 5-9

5.11 Insulated joints

5.11.1 *Installation and maintenance*

When spiking insulated joints, use caution to prevent damage to insulation. When spiking bonded (glued) insulated joints, turn the spike so that the heel is next to the joint bar.

Only new factory glued IJ's are to be installed in main line track unless otherwise instructed by SCRRRA.

Signal and track personnel will coordinate maintenance and repairs of defective insulated joint.

5.11.2 *Preparation for installation*

Before applying bolted insulated joints (such as Portec), remove all scale, dirt and any other matter from the rail ends and joint parts. Obtain a good durable fit with clean, smooth bearing surfaces.

Remove all burrs, lips, and rough edges from rail's ends and bolt holes before applying an insulated joint (taper/grind rail ends).

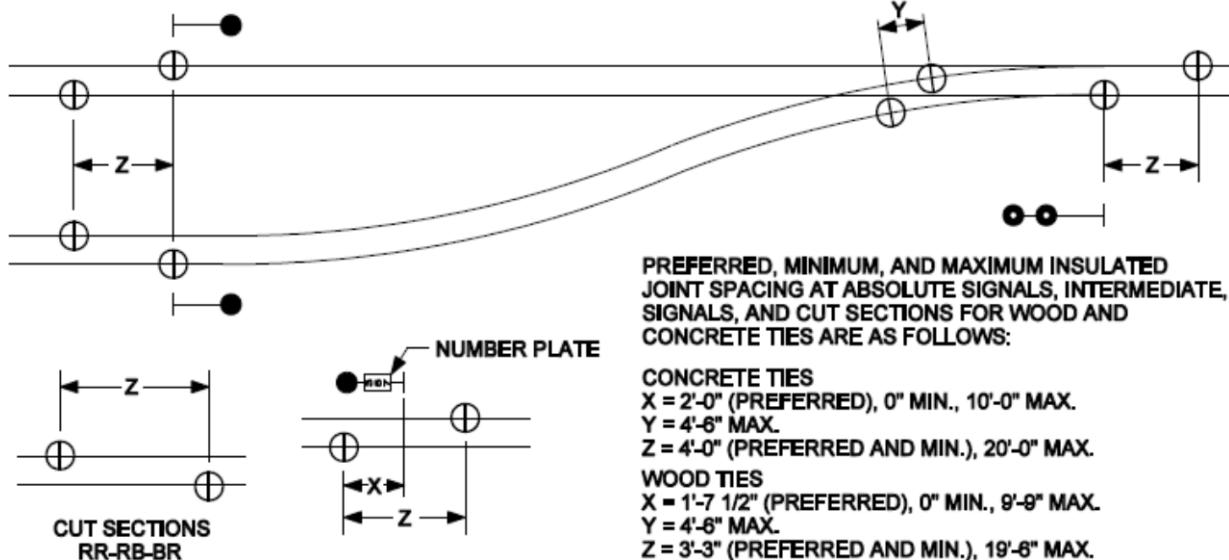
Square rail ends with a rail saw at insulated joint locations. Accurately drill holes.

5.11.3 *Installation*

1. Rail Gap: When necessary, use rail expanders to adjust rail gap.
2. Rail Openings: Do not apply an insulated joint where the opening between rails is too great - greater than 5/8 inch.
3. Do not drive bolts through an insulating bushing. Position rails and joint parts, line bolt holes, and insert bolts by hand.
4. If the end post projects beyond the top or side of railhead, trim it flush before returning track to service.
5. Tie plates must not be located within 6 inches of the rail gap of an insulated joint.
6. Use manufacturer's recommended elastic fasteners for insulated joints installed on concrete ties or on wood ties with elastic fasteners.

When installing IJs:

1. Verify the proper placement of insulated joints with a signal representative before moving their location or installing a new location.
2. The track and signal departments are jointly responsible for installing and maintaining insulated joints.
3. Within 30 days, remove from track any insulated joints that are no longer required due to track circuit changes.
4. On wood tie track, do not place the middle of an insulated joint on top of a tie plate unless an IJ support plate is utilized.

**Figure 5-13**

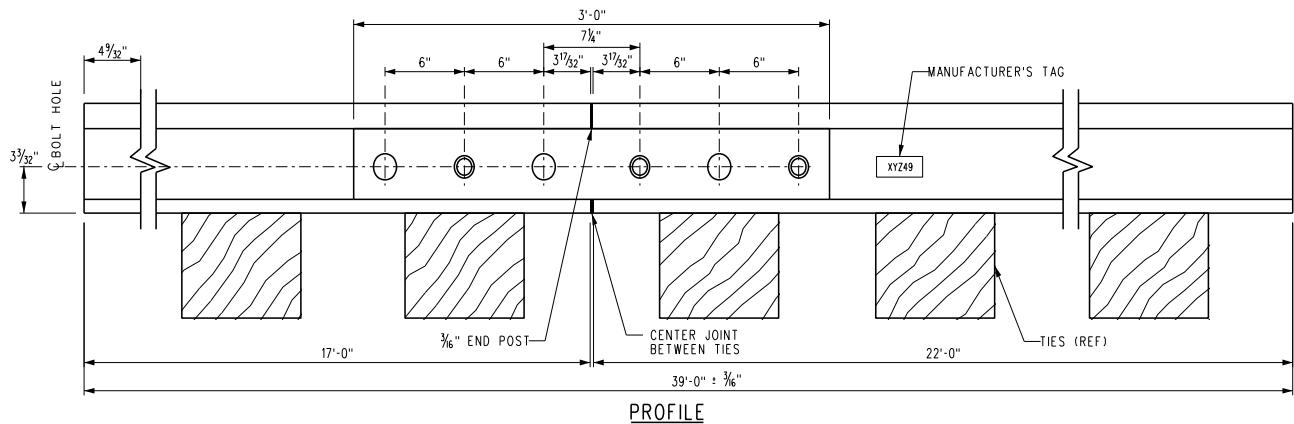
5.11.4 Poly-Coated and Fiberglass Insulated Joints

1. Poly-coated insulated joints may be installed in any jointed rail application.
2. Do not install in CWR territories except as a temporary or emergency repair or unless otherwise directed by SCRRRA.
3. Poly-coated insulated joints may be installed in the turnout side of yard and industry switches in CWR territory.

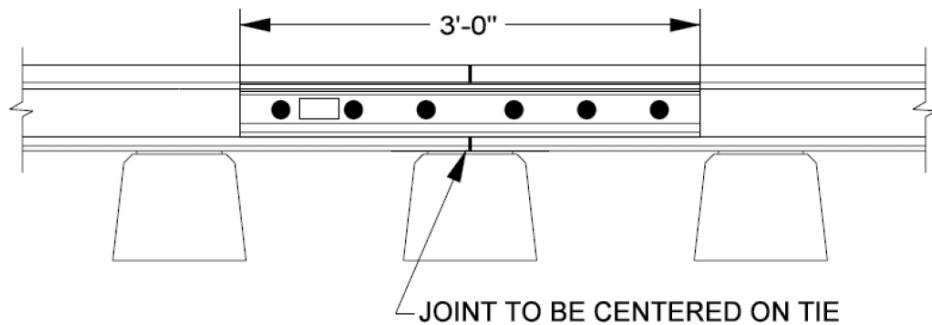
5.11.5 I-Bond Installation

When installing I-Bonds (insulated joint rail plugs):

1. Use I-Bonds in all CWR territories where required by the signaling system.
2. Use 19-foot 6-inches minimum I-Bonds on tangent track and curves up to 2 degree.
3. Use 30-foot or greater I-Bonds where curvature exceeds 2 degree.
4. Crop I-Bonds back in length to allow for future replacement with longer I-Bond rails. I-Bond rail length must remain at least 19-foot 6 inches.
5. Field weld or In-Track weld I-Bonds in place within 30 days.
6. On wood ties with cut spike plates, turn spikes so the spike heads face away from the rail to ensure that spikes do not touch any part of the insulated joint.
7. Use insulated tie plates on ties that are within 2 inches of the end post of all insulated joints except armored-type insulated joints.
8. Suspend joints between ties in wood tie track unless an IJ support plate is utilized. SCRRRA Standard ES2504. See Figure 5-14.

**Figure 5-14**

- For IJ maintenance and capital replacement projects, use supported joint tie arrangement and use appropriate clips per the fastening system utilized, on concrete ties. See Figure 5-15 for installing IJ's on concrete ties.

**IJ LAYOUT FOR CONCRETE TIES****Figure 5-15**



5.12 Slotting Instructions

Grinding Wheels 3/16" thick are standard for slotting and beveling of rail ends.

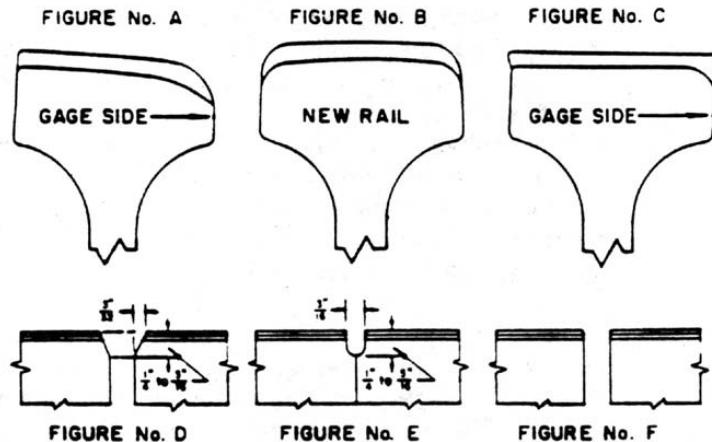


Figure 5-16

FIGURES No. A, B, C are end views of railhead showing the slotting and beveling of rail ends.

1. No. A is worn rail on the high side of curve.
2. No. B is new rail before use or soon after being laid.
3. No. C is worn rail on low side of curve. Note that slotting or beveling must always follow contour of the rail head. Rail ends at closed joints shall be slotted. Rail ends at open joints shall be beveled.

FIGURES No. D, E, F are side views showing the slotting and beveling of rail ends.

1. No. D shows beveling rail ends, giving depth and width.
2. No. E shows tightly closed joint after rail ends have been slotted, giving depth and width.
3. No. F shows rail ends at insulated joint. The flowed metal shall be removed from rail ends leaving ends square or very slightly beveled on top corners of insulated joint. Particles of metal removed by grinding must not be left in insulated joint.

Note: If weld deposit exceeds standard depth of slots, slot must be ground to bottom of weld deposit.

5.13 Matching Rail Wear Conditions

If a mismatch exists, grind a transition at a rate of 1/16" per foot of rail. When replacing rail with head or gage wear in excess of 1/8 inch, grind to match or select and install replacement rail, which provides the best possible match on both the gage side and running surface.

5.14 Cutting

When it is necessary to cut a new or second-hand rail, make a square cut using a rail saw.

Unless otherwise directed by SCRRRA, a cutting torch may not be used. If it is necessary to torch-cut rail, protect the track with a 10 MPH speed restriction and replace the torch-cut rail within 24 hours.

5.15 Location and Preparation for Thermite Welds

1. If rail is torch cut the rail end shall be trimmed back a minimum of 6 inches with a rail saw.
2. When field welding is required, plan in advance to avoid welds being close to bolt holes, bond wire pinholes, plant welds or other field welds with the minimum restrictions specified in Item 6 below.
3. Rail less than 19'-6" shall not be welded in main track, except where designated in SCRRA Standards for special trackwork or approved by Manager, Track and Structures Maintenance.
4. 30 feet is the minimum length of rail than can be field welded in curves 2 degrees and greater
5. Track at the field weld shall be in proper surface and alignment before the weld is made.
6. **Field welds shall not be made:**
 - 6.1. Within 19.5 feet from another field weld.
 - 6.2. Within 3 feet from a plant weld.
 - 6.3. Within 6 inches from bolt hole or bond wire pinhole.
 - 6.4. Within 12 feet of a field weld on the opposite rail (minimum field weld stagger).
7. The rail ends to be welded shall be a minimum of 4-1/2 inches from the ties to permit the proper application and packing of the base plate and mold assembly.
8. Flash butt welds shall be performed to the manufacturer's criteria.
9. Flash Butt welding shall be used when work or project requires the welding of large quantity of consecutive welds, or when welding short rails into long segments of rail, such as 39' or 80' rails into CWR Strings.
10. Flash Butt welding of rails requires the use of contracted services, prepare and test all rail before welding and arrival of welding contractor.

Note: When installing replacement rail, effort must be made to eliminate thermite welds

5.16 Thermite Welding

1. Only properly trained and qualified persons may make thermite welds. A list of qualified and trained welders shall be provided to SCRRA. The welding and certification training program shall be provided to SCRRA upon request.
 - 1.1. Welders so qualified shall follow manufacturer's recommendation for producing field welds and all other instruction contained herein. In case of conflicting instructions, the welder shall request clarification from SCRRA.
 - 1.2. Welder is responsible for maintaining the Adjusted Rail Temperature (ART) of the rail when making a field weld.

Note: Rail shall not be added during the production of field welds.

- 1.3. Welder shall be familiar with the safe operation of hydraulic rail pullers for use in adjusting the rail during the production of field welds.

2. Thermite welding shall not be performed when:
 - 2.1. Air temperature is below 32 degrees F.
 - 2.2. It is raining.
 - 2.3. Rail cannot be properly adjusted.
 - 2.4. Insufficient time exists to allow weld to cool to less than 600 degrees F Before next passing train.
3. Thermite Welding Procedures:
 - 3.1. Thermite welds shall be located between ties, so weld is over tie crib.
 - 3.2. Rail shall be lined up, using wedges or lining plates, so that rail is straight, with a crown of not less than 0.065 inch or more than 0.080 inch when measured using a 3-foot straight edge and taper gage. Clean rail for a distance of 4 inches from end with a torch and wire brush until area is free of lubricant, rust, and other material.
 - 3.3. While the weld is still warm, finish grind the base and head of the weld to conform to the size and shape of the adjacent rail. After finishing grinding, re-space and re-spike ties so that ties are away from edges of the weld. Never place tie plates directly under a weld. Replace anchors no closer than 1 inch from weld. If anchors are within 1 inch of weld, do not apply anchor and remove the opposite rail anchor. Note: Welds shall not be finished ground in the web area.
 - 3.4. Handle molds and base bricks with care at all times in order to prevent breakage and to keep them dry. Store thermite charges only in dry places as recommended by the manufacturer. Never use a thermite oxide charge that is wet, has been wet, or is even suspected of containing moisture. Do not use weld charges or kits after their expiration dates.
 - 3.5. When cutting in short rails on tangent track, do not use rail less than 19'-6" long.
 - 3.6. Visual Testing: Visually inspect field welds immediately after grinding. Pinholes or slag inclusions are indications of a defective weld. Where pinholes or slag inclusions are observed, they shall be immediately removed from the track. Pin holes and slag inclusions less than 1/4-inch deep may be ground out of the head of the rail and repaired with arc welding, using rail end rod (not manganese frog rod).
 - 3.7. Ultrasonic Testing: Field welds (Flashbutt and Thermite) shall be ultrasonically tested within 14 days of the track being placed into service. When field welds are ultrasonically tested, the tested rail shall be painted with "U.T." to indicate ultrasonically tested, the date when tested, and inspector's initials.

Example: UT 4/25/00 RMM

Note: Upon identification of a defective weld refer to Appendix B for proper remedial action.

- 3.8. When constructing track panels, turnouts, or other rail welding off track, welds will be tested prior to placing the panels, rail, or switches in track.
- 3.9. Collect ALL thermite weld debris; remove and dispose from SCRRRA property.

5.17 Weld Tolerance Specifications

To improve overall track geometry and reduce Evaluation Car exceptions, the Thermite and In-Track maximum weld tolerances below must be followed. Where one tolerance is shown, the measurement applies to both types of welds. These are cold (ambient temperature), finish ground specifications.

Use Table 5-10 to determine weld tolerance specifications for Class 1 through Class 5 Tracks.

	Vertical Crown	Vertical Offset	Horizontal Offset	Horizontal Kink	Base (HOS) Horizontal Offset	Base (VOS) Vertical Offset
Thermite	0.040"	0.020" (1)	0.040"	0.025"	0.060"	0.250" (2)
In-Track	0.060"					0.125" (3)

Table 5-10

1. Any vertical offset after welding must be tapered by grinding to provide for a smooth transition and eliminate impact forces.
2. Maximum base vertical offset will not exceed 0.250" on same base width rails.
3. If rail height difference is greater than 0.125", offset top of rail head and grind. Any offset on the top of rail must be tapered to provide a smooth transition.

Combined Vertical crown and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld.

Combined Horizontal Kink and Offset: 0.060 inch maximum expressed as tangential deviation 18 inches from the center of weld as measured on the convex side of the rail.

Note: Maximum allowable rail end mismatch is 0.25" on rail with the same base widths. A transition rail is required if rail end mismatch exceeds 0.25" on rails with the same base widths. A transition rail is required whenever a transitioning between rails with different base widths.

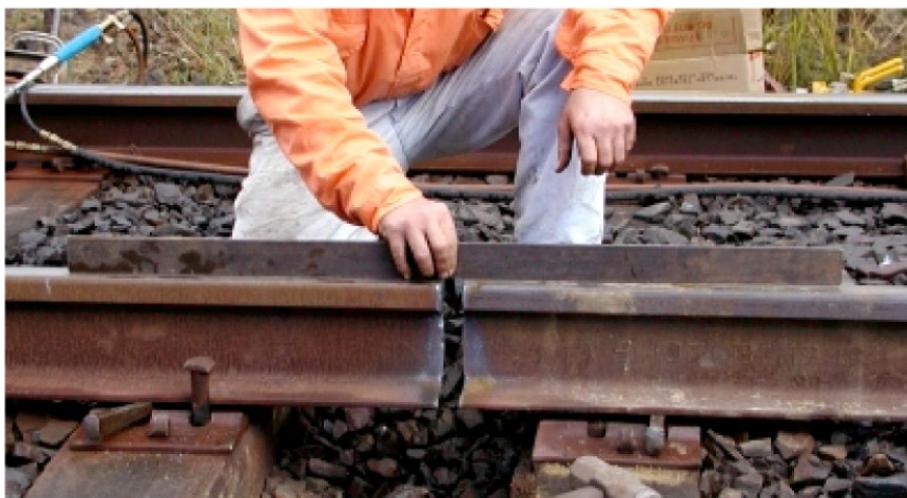


Figure 5-17

Welds with vertical offset of the rail head shall be finish blended over a ramp of which the minimum length is determined by the following formula. See Table 5-11.

1. Minimum Ramp Length (feet) = Offset (thousandths of an inch) 0.008 inches.
2. Vertical Offset Ramp Length 0.030 inch 4 inches 0.060 inch 8 inches 0.090 inch 12 inches 0.125 inch 16 inches.

$$\text{Minimum Ramp Length (feet)} = \frac{\text{Offset (thousandths of an inch)}}{0.008 \text{ inches}}$$

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

Table 5-11

While blending the offset ramp, care must be taken to avoid sharp deviations in transition, avoiding locations of impact loading.

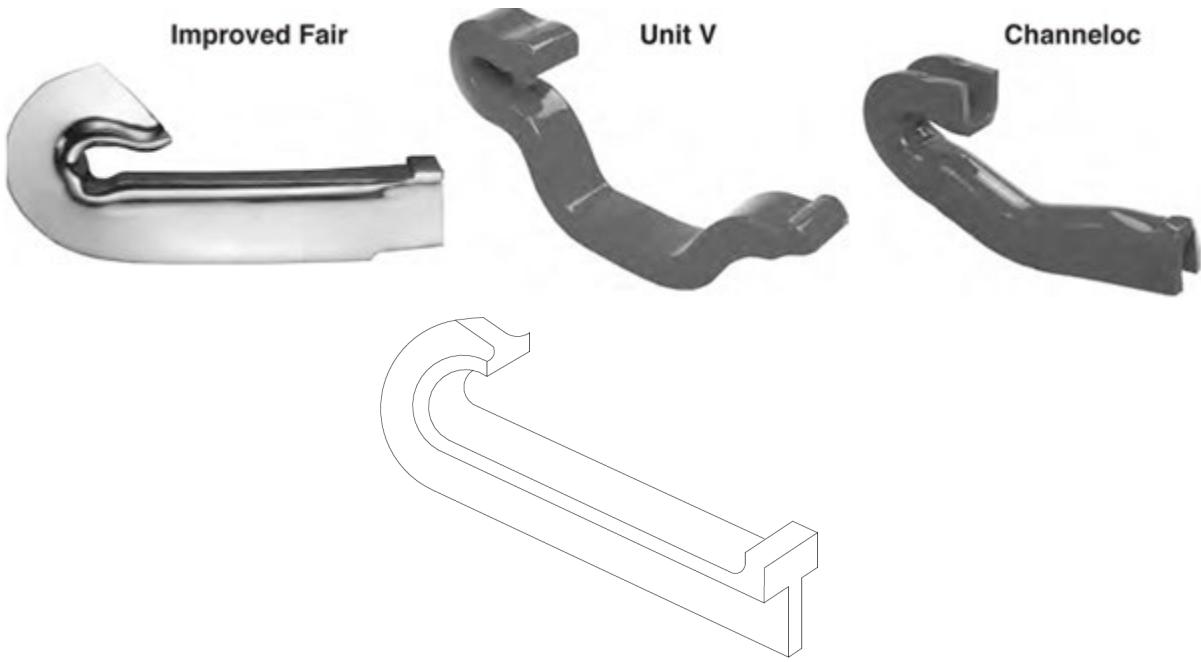
5.18 Rail Anchors

Rail Anchors are applied to the rail base directly and provide a bearing surface against the rail base and tie plate preventing longitudinal movement due to forces in the rail resulting from thermal expansion or train handling.

Anchors are not required on ties with elastic fastening systems unless additional restraint is necessary to control undesired rail movement or ties are in a turnout.

5.18.1 Anchor Types

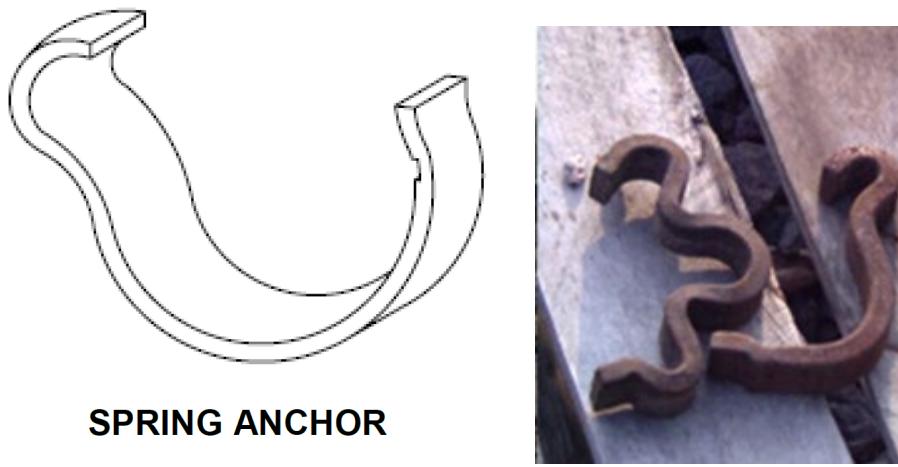
1. The two rail anchor types commonly used are Drive-on type and Unit anchors.
 - 1.1 See Figure 5-18. There are three types of commonly used drive-on anchors: Channeloc, Unit V, and Improved Fair Anchors. Unit V anchors are the most common used due to the low cost.



T-SECTION ANCHOR

Figure 5-18

- 1.2 Spring type anchors are manufactured from spring steel and are commonly referred to as spring anchors. They are available in a variety of shapes. An example is pictured in Figure 5-19.



SPRING ANCHOR

Figure 5-19

1.3 Concrete tie anchors are drive-on type bar stock anchors with a specially designed nylon isolator over the anchor to prevent damage to the tie. An example is pictured in Figure 5-20.



CONCRETE TIE ANCHOR WITH ISOLATOR

Figure 5-20

5.18.2 *Anchor Applications*

Determine the kind of replacement anchor for rail relays on wood and composite ties as follows.

1. New anchors are required when:
 - 1.1. laying new rail on any main track or siding.
 - 1.2. Replacing missing or ineffective anchors from existing patterns.
2. Second-hand anchors are permitted for ordinary maintenance such as:
 - 2.1. Replacing a defect with plug rail.
 - 2.2. Destressing track.

5.18.3 Anchor Installation

1. Properly installed rail anchors provide maximum restraint against rail movement.
2. Second-hand anchors should be inspected before and after installation to ensure they fit the rail properly. Second hand anchors may only be used with approval from SCRRA.
3. Rail anchors should be applied just far enough that the locking lip or groove of the anchor snaps into place on the rail base. Where drive-on type anchors are applied by mechanized equipment, allow a dime-width of space between the rail base and the anchor (shown in Figure 5-21) to compensate for base width tolerances of the rail.

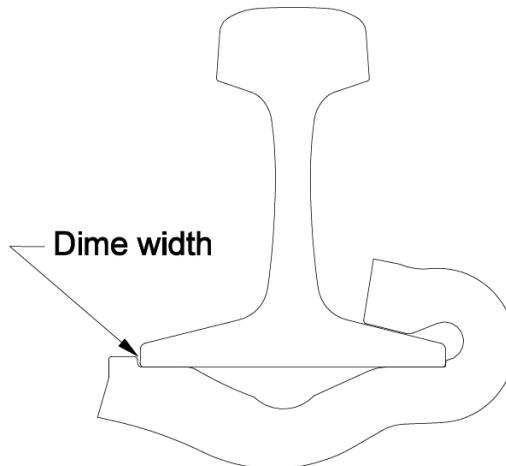


Figure 5-21

When installing rail anchors:

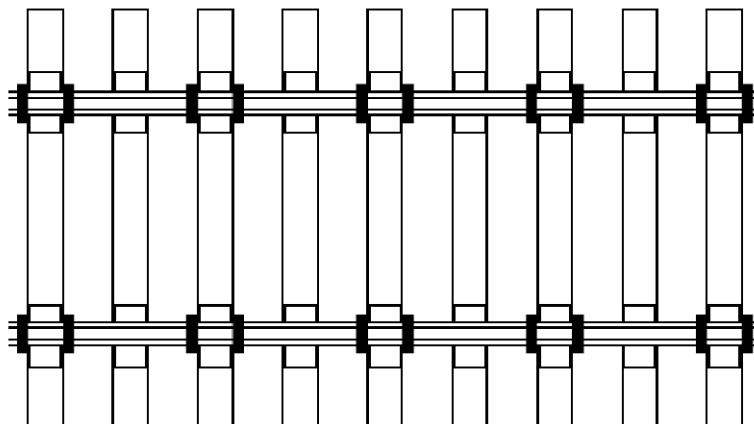
1. Apply rail anchors of the same size as the rail base.
2. If installing or removing drive-on type anchors manually, use a sledge hammer.
3. Apply anchors at a right angle to the rail base.
4. Where practicable, install the anchor from the gage side of rail.
5. Apply on each side of the tie across from one another with full bearing against the sides of the tie.
6. Do not install rail anchors on the rail across from permanent joints, except when box anchoring switch ties in turnouts.

Note: Anchor patterns shall be applied to each rail uniformly.

7. Box anchor each tie on each side of a field weld.
8. Box anchor switch ties to the fullest extent possible.
9. Avoid installing rail anchors within 1 inch of:
 - 9.1. Field welds.
 - 9.2. Joint bar ends.
 - 9.3. Switch rods on turnouts.
 - 9.4. Transducers on hot box detectors.

5.18.4 Standard Box Pattern

1. On all tracks, apply rail anchors along each rail, directly across from each other on the same tie, according to pattern shown in Figure 5-22.



ANCHOR PATTERN NO. 1

Figure 5-22

2. Establish the standard rail anchor pattern shown above on both rails throughout relay limits and for 120 ties on either side of the work limits during:
 - 2.1. Single- or double-side rail relays.
 - 2.2. Double curve rail transpositions.
3. Additional rail anchors may be required to provide additional longitudinal rail restraint.

5.18.5 Solid Box Pattern

1. Solid box anchor every tie as shown in Figure 5-23 for Rail Anchor Pattern No. 2 at specific locations to provide additional restraint against rail movement.

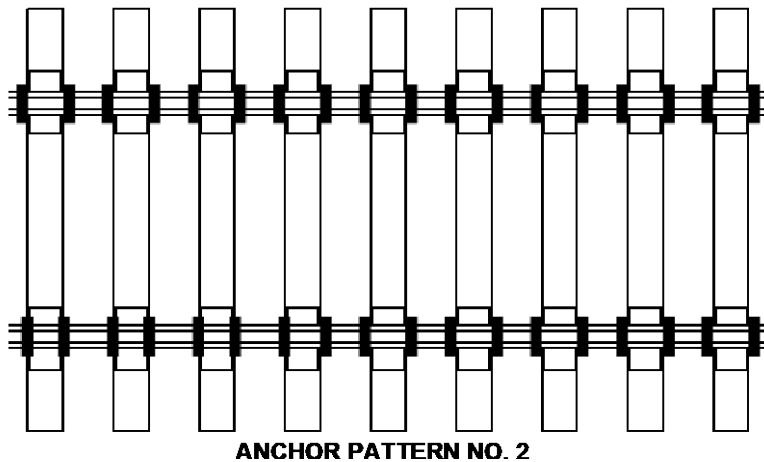


Figure 5-23

2. Use Table 5-12 to determine where box anchoring of every tie is required in wood, composite and concrete tie track. For composite ties, follow the same standards as for wood ties. Also reference SCRRRA Standard ES2351-01, ES2351-02, ES2351-03 and ES2351-04. Where the anchoring function is otherwise provided by an elastic fastening system, rail anchors may be omitted.

LOCATION	RAIL TYPE	REQUIREMENT
Turnouts	CWR or Jointed	All switch ties and 200 feet in both directions
Diamond crossings	CWR or Jointed	200 feet in both directions
Hot Box/Dragging Equipment Detectors	CWR or Jointed	200 feet in both directions
All Permanent and Insulated Joints	CWR	200 feet in both directions
Expansion Joints	CWR or Jointed	200 feet in both directions
Open-Deck Bridges	CWR or Jointed	Box anchor ties that are anchored to substructure only and 200' in both directions from end of bridge
Road Crossings	CWR or Jointed	200 feet in both directions

Table 5-12

5.18.6 *Bridge Pattern*

Ballast deck bridges should be anchored according to SCRRRA Standard ES2351-04. Open deck bridges should be anchored according to SCRRRA Standard ES2351-04. Box anchor ties that are anchored to substructure only and 200' in both directions from end of bridge.

5.18.7 *Turnout Pattern*

When anchoring turnouts:

1. Box anchor all switch ties to the extent that the anchors will not interfere with the proper operation of the turnout.
2. Anchor the switch point and stock rail at the heel block as follows:
 - 2.1 Locate the heel blocks on the mainline and turnout sides, refer to Figure 5-24 and Figure 5-25.
 - 2.2 Anchor the switch point and stock rail on the mainline side as follows:
 - 2.2.1 Begin by installing two anchors next to one tie and two additional anchors next to the other tie in a crib.

NOTE: Solid anchoring of a single crib will require 6-8 anchors.

- 2.2.2 Continue to apply anchors to fill in area between the first four anchors installed. CAUTION: Ensure anchors are tight against the edge of ties with no gaps. If a gap is too small to be filled with an anchor, ensure that gap is in the middle of the anchors.
- 2.3 Repeat step 2.2 for the switch point and stock rail on the turnout side.
- 2.4 In turnouts that utilize a Movable Point Frog the same pattern in the heel block area can be utilized to limit rail movement in the frog. Fully anchor the MPF as shown in Figure 5-26. Care must be taken to not place anchors where they may interfere with point movement. Locations shown may be adjusted, however both point and wing rails must have minimum of one crib on each side fully box anchored.

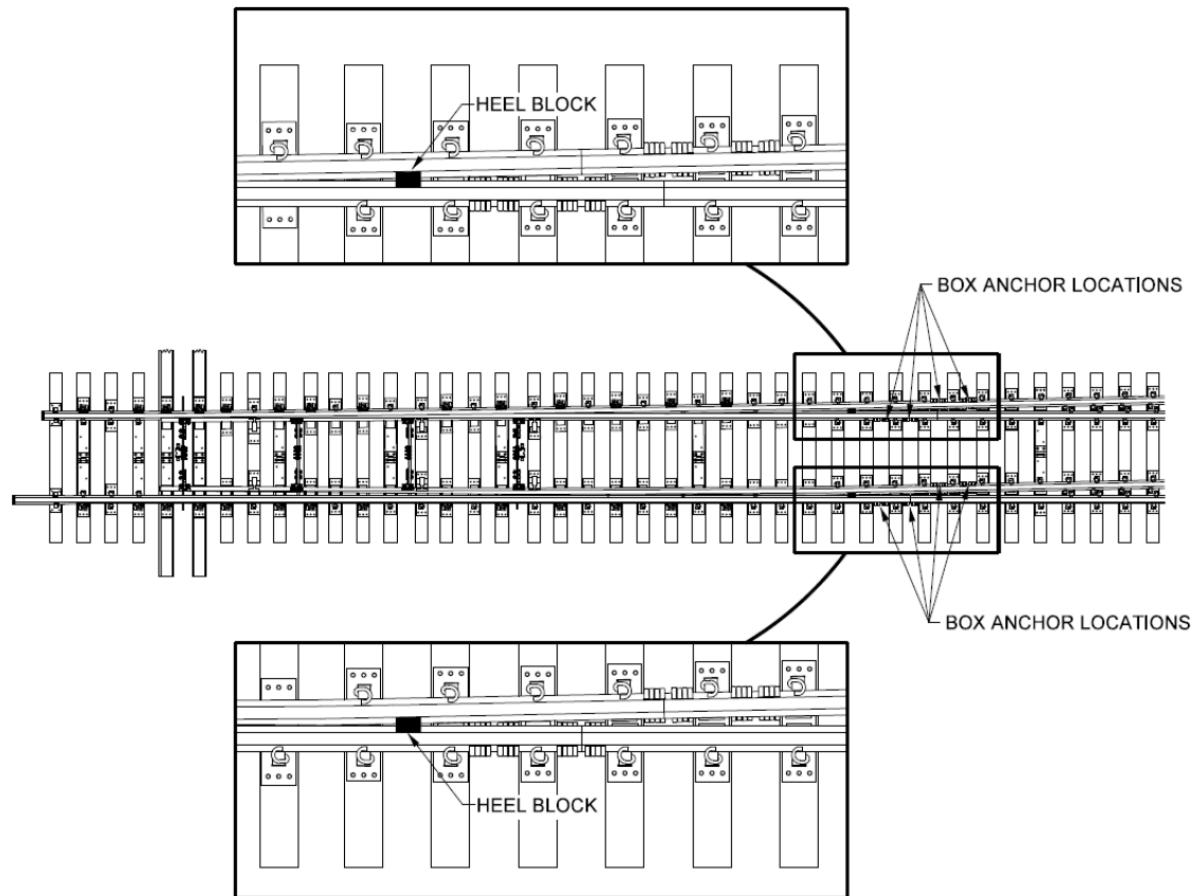
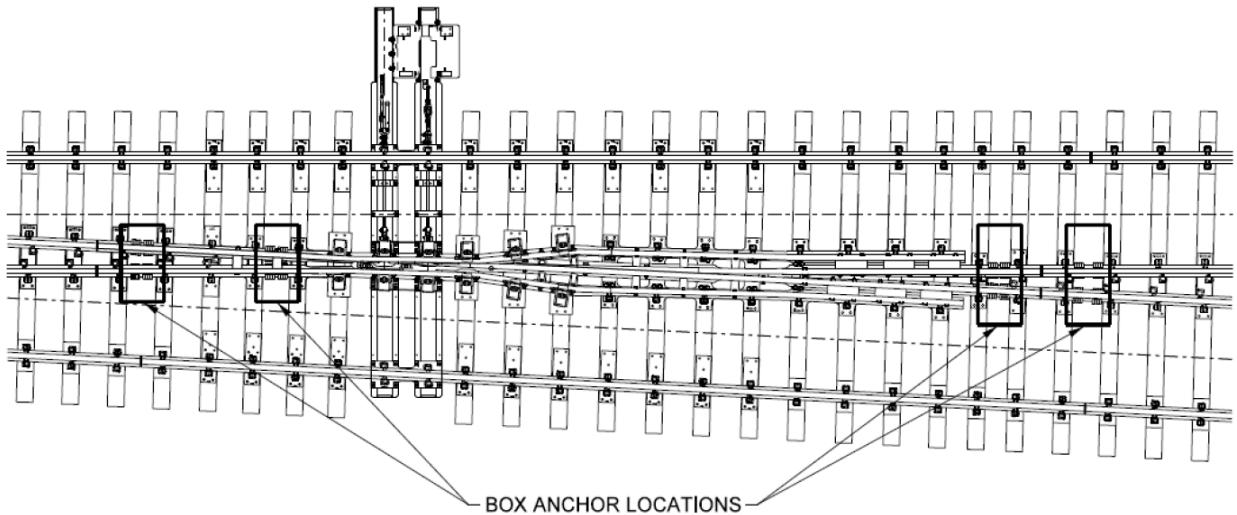


Figure 5-24

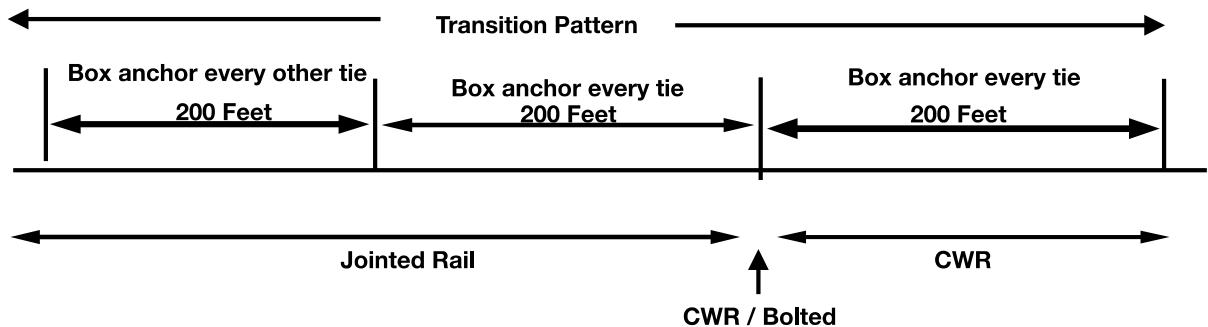


Figure 5-25

**Figure 5-26**

5.18.8 Transition Pattern

1. Transition anchor pattern at locations where CWR connects to jointed rail as shown in Figure 5-27.

**Figure 5-27**

2. When transitioning from CWR to jointed rail:
 - 2.1. Solid box anchor the CWR for 200 ft. before the jointed rail.
 - 2.2. Solid box anchor the first 200 feet in the jointed rail next to the CWR.
 - 2.3. Box anchor every other tie in the next 200 feet in the jointed rail next to the 120 solid box anchored ties.

5.18.9 Adjustment and Maintenance of Rail Anchor Patterns

1. When relaying rail on one side only adjust the anchors on the other rail to the standard anchor pattern.
2. Replace broken, damaged, missing, or otherwise ineffective rail anchors during track maintenance.
3. Adjust rail anchors to provide full bearing against the side of ties during track maintenance.
4. Reapply rail anchors removed during track maintenance.
5. Restore the existing rail anchor pattern when eliminating or relocating joints. Add, remove, or relocate anchors as required.
6. Do not slide anchors along the rail except when adjusting with power-operated equipment.

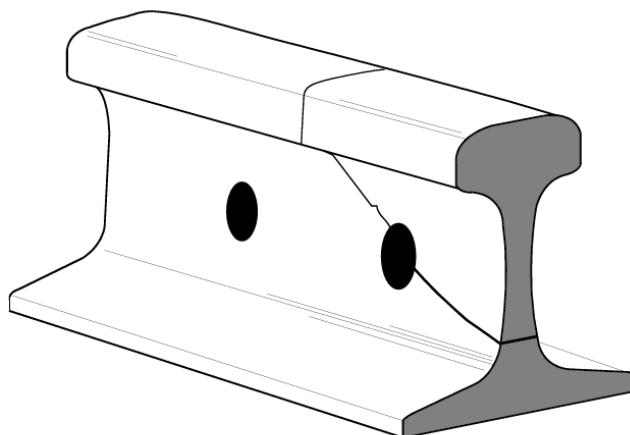
5.19 Rail Defects

5.19.1 Defect Descriptions

Below are the common rail defects and their associated abbreviations.

1. Bolt Hole Break (BH)

A bolt hole break is a progressive crack that spreads in any direction from a bolt hole. This defect is caused by contact between the bolt hole and a bolt. See Figure 5-28.



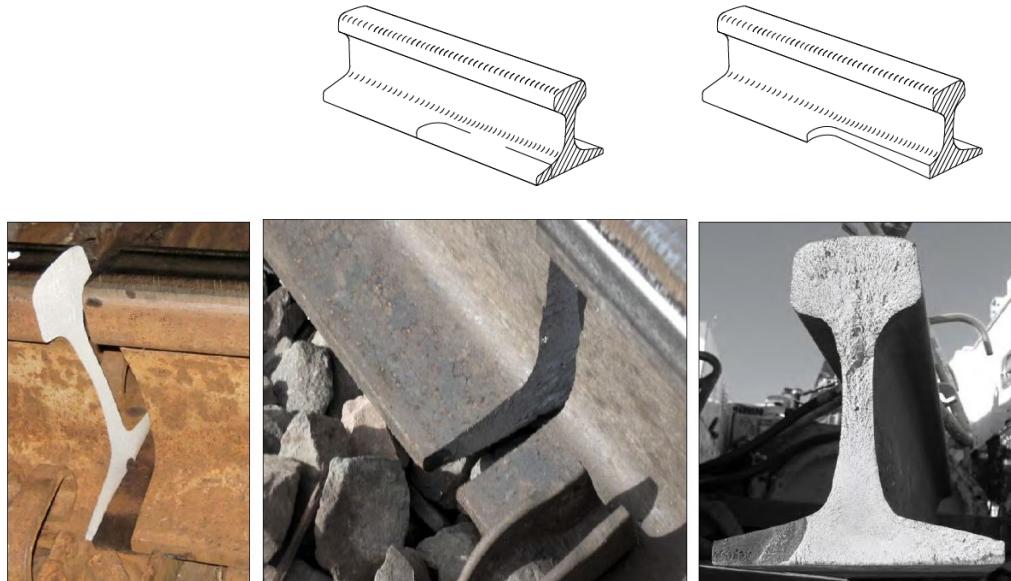
Bolt Hole Break

Figure 5-28

2. Broken Base (BB)

Any type of defect in the base of the rail is called a broken base rail. There are various causes for this type of defect and may be the result of the rail bearing unevenly on a tie plate or a spike under the base of the rail, etc. These defects may also be caused by corrosion or impacts to the base. See Figure 5-29.

Broken Base



Broken Base – Transverse Photo Examples of Broken Base - Transverse

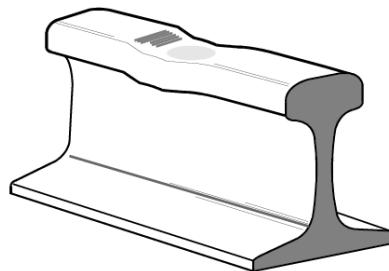
Figure 5-29

3. Crushed Head or Flattened Rail (CH or FR)

A crushed head, sometimes referred to as flattened rail, is a short length of rail that has flattened out across the entire width of the rail head with no repetitive or regular pattern. See Figure 5-30.

Note: Do not classify corrugations or battered rail ends as crushed heads.

Measurements will not include localized chips or pitting.



Crushed Head or Flattened Rail

Figure 5-30

4. Shell, Sliver Corrugation (SSC) and Battered Weld SSC (SSC-W)

Definition: Shell, Sliver, Corrugation are locations where rail defects may originate or may be hidden under surface conditions. These defects are at risk of not being detected by ultrasonic test systems. SSC defects are usually localized surface conditions between 8 inches and one rail length. SSC-W (Battered Welds SSC) defects usually begin within 6" of welds. See Figure 5-31.



Figure 5-31

SSC (Shell, Sliver, Corrugation) condition can be identified by anyone qualified to inspect track. Visual observation of rail condition (excessive spalling, corrugation, head check or shelling) and general track condition (ballast churned out of the cribs, swinging ties, rail out of the plate, battered ties, etc.) are all indications that an SSC condition may exist.

When it is determined by visual observation that an SSC condition may exist, a walking inspection must be made.



Figure 5-32

Any area where rail head deformation is $\frac{1}{4}$ inch or more below the running surface of the adjacent rail head and other more restrictive defects are not present must be marked as an SSC defect. For example, if you slide a 36" straight edge on top of the rail, any location along the straight edge that you can place a $\frac{1}{4}$ inch step gage under the straight edge, you have a defect. If rail surface conditions are persistent down the length of the rail, continue to move the straight edge along the rail until conditions no longer exist. Measurements shall not include localized chips or pitting. If the rail is worn and has $\frac{1}{4}$ inch head loss, the wear will be much more gradual and will not show up as a defect. Examples of more restrictive defects would be a visible VSH, a flattened rail, or break out in the head of the rail.

Pay particular attention to head sag or deflection, "bleeding" rust areas, excessive head flattening and corrugation. Corrugation deeper than .030 (about the thickness of a dime) should be considered an SSC.

In addition to visual detection, an SSC defect can be identified during rail test operations (see Section 5.19.4 Non-Certified Rail Test). Poor rail surface conditions may cause false response (multiple channel surface indications) or lack of expected response (loss of bottom signal, failure to properly indicate bolt holes or other known track structures). These rail surface conditions may prevent performance of a continuous ultrasonic test and result in rail defects not being detected. Locations where these rail surface conditions exist require an on the ground inspection. All ultrasonic indications that appear to be a rail defect must be hand tested and entire area visually inspected. Defects identified during this inspection must be properly marked and remediated. If it is determined during inspection that a continuous ultrasonic inspection cannot be performed due to rail surface conditions the area must be marked as an SSC defect. As with all types of rail defects, pay particular attention at rail ends, dead zones in switches and within 500 feet of structures (bridges, over passes, tunnels, etc).

5. Defective Weld (DPW, DFW, DIW, DWG)

A defective weld is a progressive fracture at or near any weld. This may occur in plant welds, in-track welds, and thermite welds. See Figure 5-33.

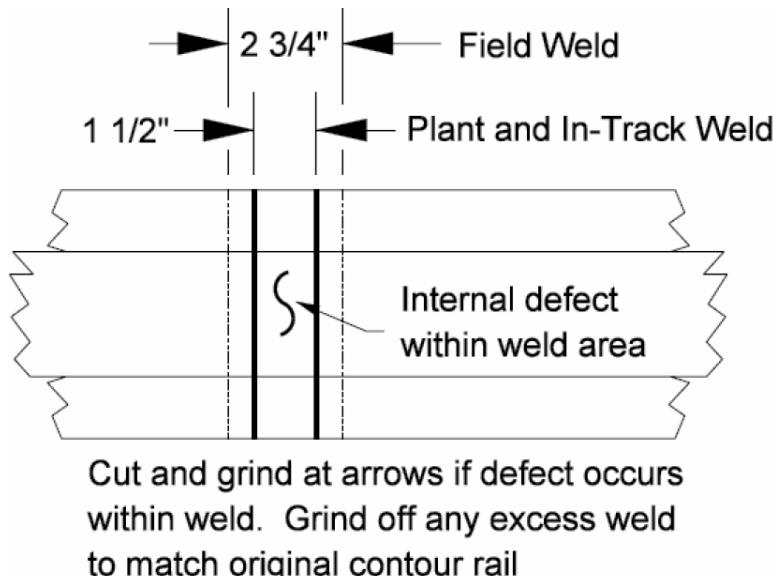


Figure 5-33

Note: When a detector car identifies a defective weld, cut out the weld or apply joint bars or field weld immediately. Cut out a defective plant weld by removing a 1-1/2-inch section of the rail, 3/4 inch on either side of the centerline. Cut out a defective field weld by removing a 2-3/4-inch section of the rail, 1-3/8 inches on either side of the centerline. If field welding, ensure the final gap width is 1 inch for standard welds if destressing or 2-3/4 inches for a wide gap weld.

6. Engine Burn Fracture (EBF)

An engine burn fracture is a progressive fracture starting at the spot where locomotive driver wheels have slipped on top of the rail head. When these fractures spread downward, they resemble compound or transverse fissures. See Figure 5-34.

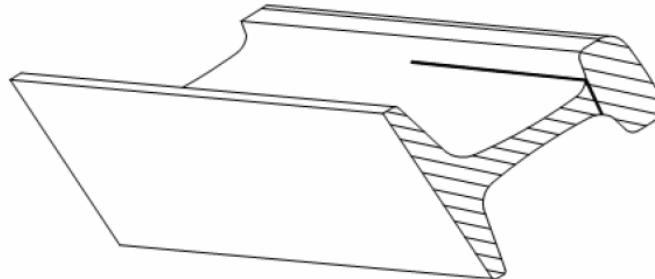


Engine Burn

Figure 5-34

7. Head-Web Separation (HW)

A head-web separation is a progressive longitudinal fracture under the rail head that separates the head from the web. See Figure 5-35.

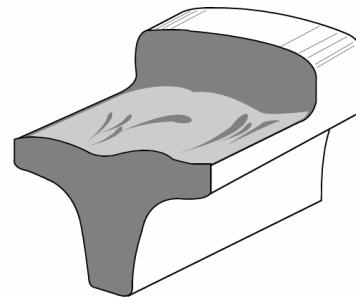


Head-Web Separation

Figure 5-35

8. Horizontal Split Head (HSH)

A horizontal split head is a progressive horizontal defect originating inside the head that moves horizontally in either or both directions. Before breaking out, a horizontal split head will appear as a flat spot on the running surface. There may be a slight widening of the rail head, and a crack will appear lengthwise along the rail when it reaches the surface of the rail head. See Figure 5-36.



Horizontal Split Head

Figure 5-36

9. Ordinary Break / Sudden Rupture (SR)

An ordinary break is a partial or complete break in the rail where there are no visible internal defects. See Figure 5-37.

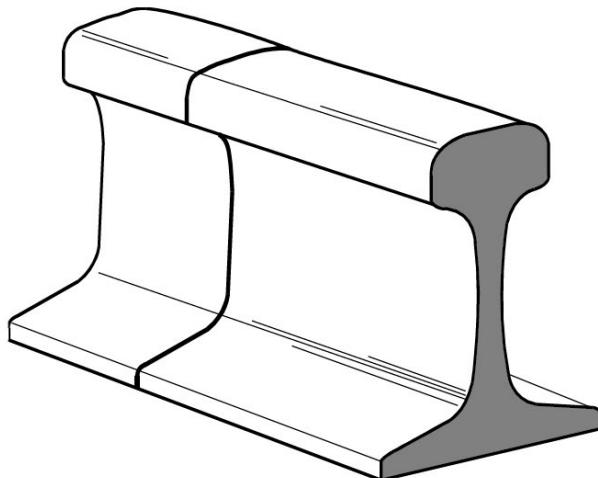


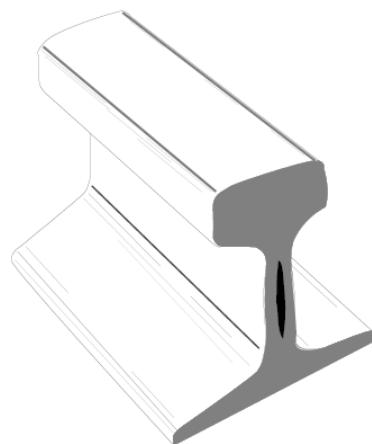
Photo Example
Ordinary Break / Sudden Rupture

Figure 5-37

Note: When encountering an ordinary break, not at a weld, trim rail ends square before applying joint bars or welding.

10. Piped Rail (PR)

A piped rail is a vertical split in the web of the rail caused by a manufacturing defect. See Figure 5-38.



Piped Rail

Figure 5-38

11. Split Web (SW)

A split web is a lengthwise crack running into and through the side of the web. See Figure 5-39.

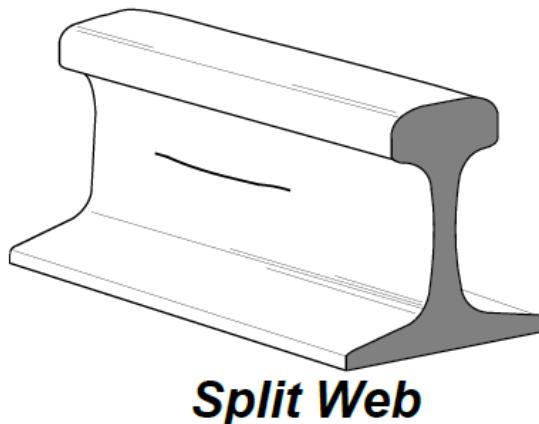


Figure 5-39

12. Transverse Defects

A transverse defect is a group classification applied to defects found by detector cars, of all types of rail defects that have transverse components, such as transverse fissures (TF), compound fissures (CF), and detail fractures (DF).

A transverse fissure (TF) is a progressive fracture from the center of the head that spreads outward and is identified as a smooth, bright or dark, round or oval, at a right angle to the length of rail. It has a crystalline center and a nearly smooth surface. See Figure 5-40.

A compound fissure (CF) is a transverse defect with characteristics similar to the transverse fissure, except that the compound fissure originates in a split in the rail head. See Figure 5-40.

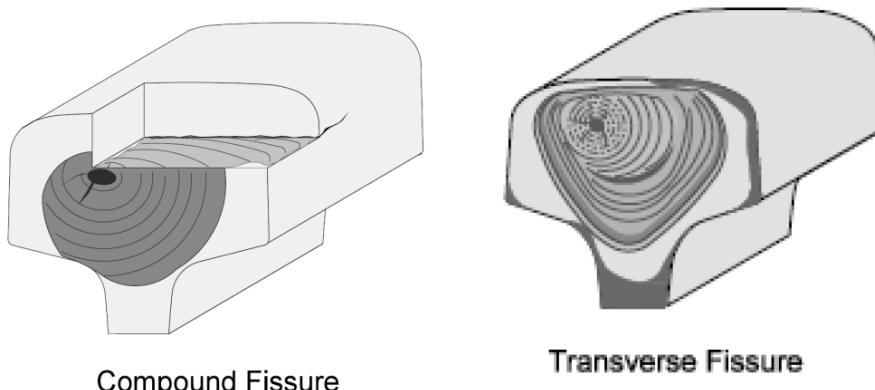
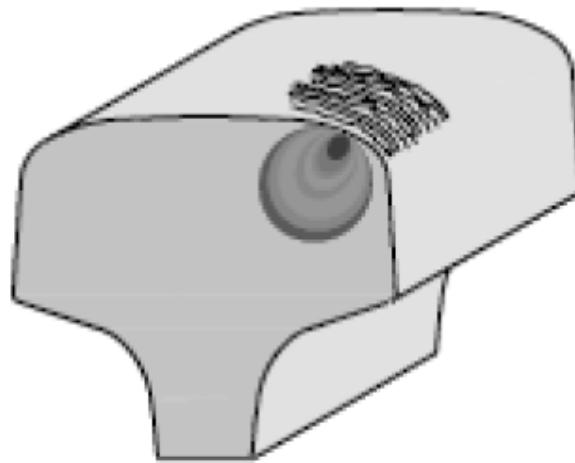


Figure 5-40

13. A Detail Fracture (DF)

A detail fracture is a progressive fracture originating at or near the surface of the rail head. See Figure 5-41.

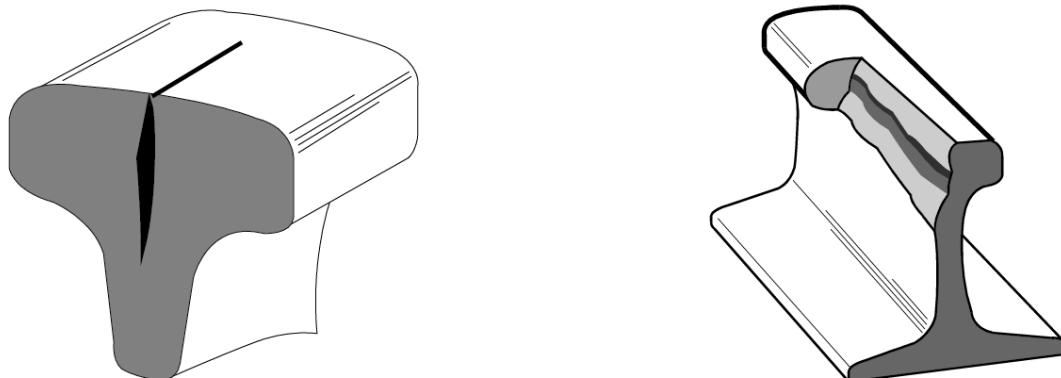


Detail Fracture

Figure 5-41

14. Vertical Split Head (VSH)

A vertical split head is a vertical split in the head of the rail. It can sometimes be detected by a dark streak that appears on the running surface of the rail head. A rust streak may appear under the head close to the web. See Figure 5-42.

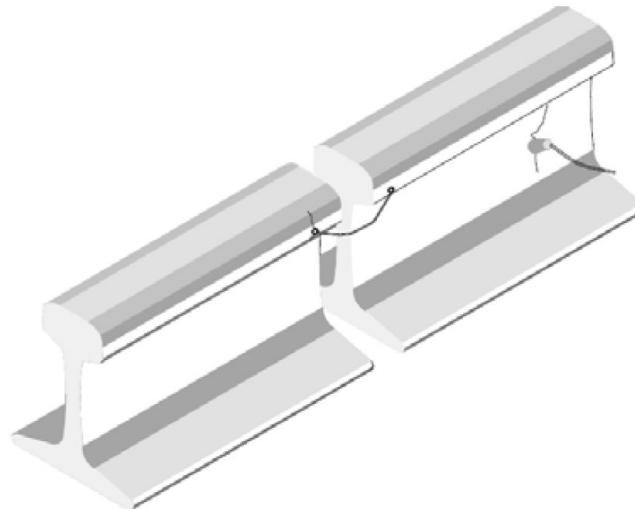


Vertical Split Head

Figure 5-42

15. Signal Bond Drilled (SBD)

A crack in the rail that developed out of a drilled bond wire. Could be in the rail head or web of the rail. See Figure 5-43.

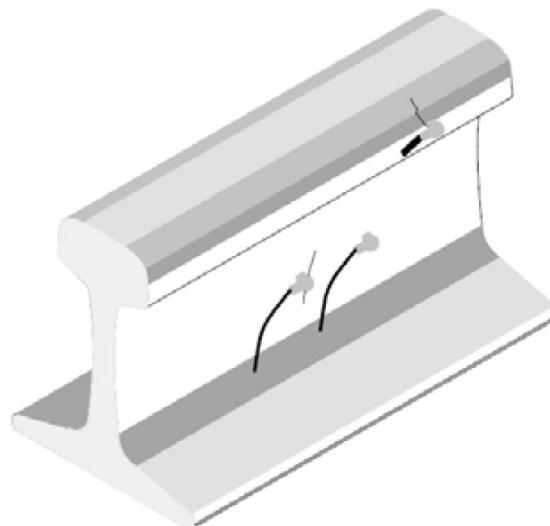


Signal Bond Drilled

Figure 5-43

16. Signal Bond Thermite (SBT)

A crack in the rail that developed out of a bond wire that was welded to the rail. Most common use was the CAD Weld. It could be on the rail head or the web of the rail. See Figure 5-44.

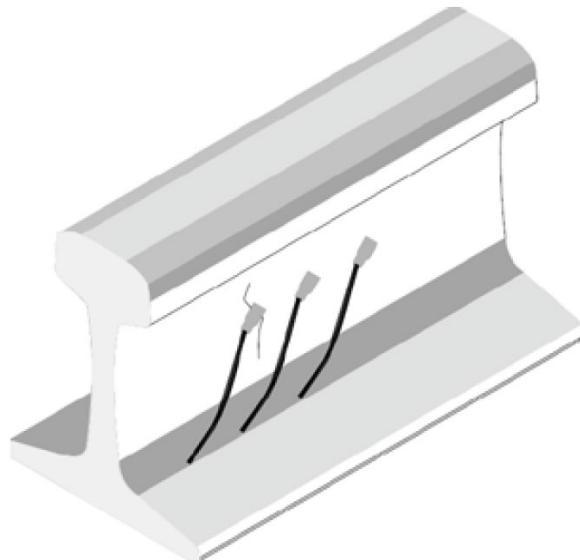


Signal Bond Thermite

Figure 5-44

17. Signal Bond Electric (SBE)

A crack in the rail that developed out of a bond wire that was welded to the rail with electric current. The most commonly used electric bond is the Stanley weld. See Figure 5-45.



Signal Bond Electric

Figure 5-45

18. Damaged Rail (DMG-R)

Rail damaged or broken by wrecks, flat, unbalanced wheels, wheel slipping, or similar causes. See Figure 5-46.

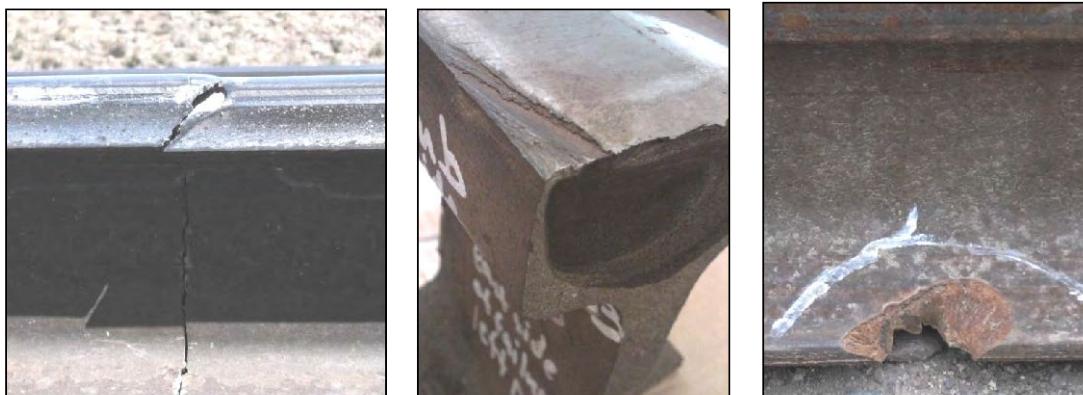


Figure 5-46

5.19.2 Rail Defect Testing Program

Testing of all main lines, sidings, revenue tracks, adjacent drill and lead tracks, turnouts, crossovers, railroad crossings, and branch line turnouts shall be in accordance with the frequency below:

1. Passenger Routes: Four times per year, with at least two months, but no more than three months, between tests.
2. Freight Only Routes: Once a year, or as directed by SCRRRA.
3. Field welds (Flashbutt, Thermite): Ultrasonically test within 14 days of the track being placed into service or as directed by SCRRRA.

5.19.3 Defect Marking and Minimum Rail Removal

If a defective rail is detected by any means remove the defect. If the rail is left in the track temporarily, SCRRRA requirements for Remedial Action must be followed.

1. Minimum amount of rail to be removed shall be marked by detector car personnel on field side of rail head, see Figure 5-47. In addition, defects shall be marked with car number, defect type, number, size, and date detected in 1-inch high letters with white metal marker on web adjacent to defect.
2. Detector car personnel shall mark defects with luminescent spray paint on both sides of the web and base in minimum 2-inch widths. Where one side or sides of the web and base are inaccessible because of permanent features, paint and place highly visible marking on or next to the head of the rail. Paint markings on long defects shall be no more than 6 feet apart, to cover defect area. See Figure 5-47.

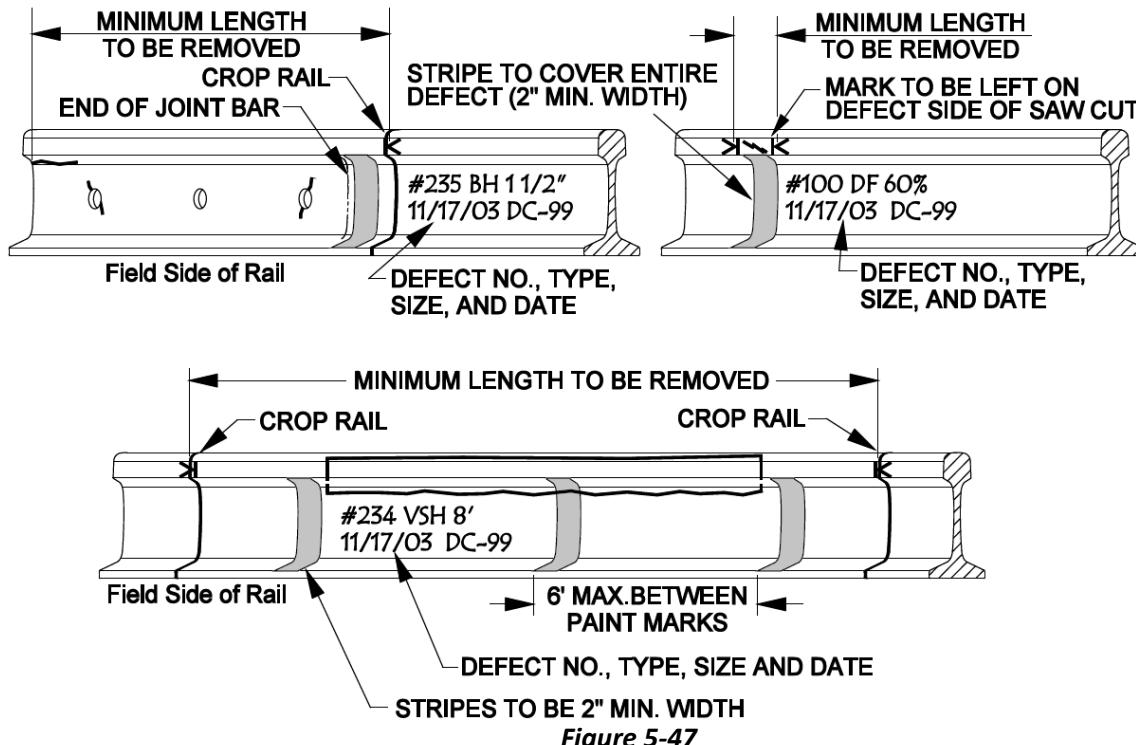


Figure 5-47

3. Defect area shall be visually inspected after cutting to ensure defect has not grown past marked area.
4. Before removal from site, defect must be cropped from rail and cut into pieces no greater than 14 feet in length to prevent future reuse in track. If not practical to cut rail at site, rail must be clearly marked as scrap, on the ball and web of the rail, as to prevent the possibility of reuse.
5. The entire rail, weld to weld, must be removed and scrapped when:
 - 5.1. More than one defect is found within the same length of rail on the same inspection.
 - 5.2. When defects are found in replacement plug rails, the entire plug rail must be replaced.
(Exception to both 5.1 and 5.2 - Bolt hole defects and head and web separations within joint areas do not require entire rail be removed or scrapped).
 - 5.3. VSH or Pipe defects are detected in rail ingot letter "A" sections.
 - 5.4. Any defect is found in the following rails manufactured by "Algoma, British, Workington, Vilru, or Bethlehem FHT."
 - 5.5. Any defect is found in chrome alloy rails manufactured by "Klockner, Thyssen, Krupp and CFI" or any other manufactured chrome alloy rails.
6. Defective rail(s) are to be scrapped and must not be stored with good replacement rails.
7. Luminescent paint or marking must not be removed from defective rails.
8. Rail test operators shall mark defective joint bars with luminescent paint with a minimum 2 inch-wide, vertical mark in the center of the bar.
9. Remove/paint over previous UT-Tested or UT Certified stenciling on rail removed from track.
10. Any rail removed from track that is fit for reuse shall be stenciled with a removal date and the date of the last UT test on the head and web of the rail.

5.19.4 Non-Certified Rail Test

When a valid test cannot be made or completed:

1. Due to rail surface conditions, this section of track is not classified as UT tested.
2. The track, location, limits of the area which a valid test could not be performed, and the date of inspection must be documented.
3. Before the expiration of time or tonnage limits as required by the FRA Track Safety Standard 213.237, place a 30/25 MPH speed restriction on the track until a valid ultrasonic inspection is completed or remove track from service.

Note: An ultrasonic hand testing device may be used to perform a valid test over a section of rail.

5.19.5 Rail Repair and Maintenance Plug Rail Replacement

Use Table 5-13 to determine defect repair / correction options.

Rail Defect Repair Matrix - For the Reduction of Joints Installed in CWR					
Defect Type	Cut Out Defect and Weld		Cut Out Defect and Wide Gap Weld		Cut and Weld in a Plug Rail (2- Welds)
Repair Options =>>	Option #1		Option #2		Option #3
CF - Compound Fracture					X
TF* - Transverse Fissure	X (preferred)	or	X	or	X*
DF* - Detail Fracture	X (preferred)	or	X	or	X*
DPW* - Defective Plant Weld	X (preferred)	or	X	or	X*
DIW* - Defective Flash Butt Weld	X (preferred)	or	X	or	X*
DIW*-H - Defective Flash Butt Head Repair Weld					X*
DFW - Defective Field Weld		or	X (preferred)	or	X
DWG-B - Defective Wide-Gap Field Weld - Boutet		or	X	or	X*
EBF - Engine Burn Fracture					X
BH - Bolt Hole Crack					X
HW - Head Web Separation					X
SW - Split Web					X
SBT, SBE or SBD - Signal Bond (Thermite, Elec, Drill)					X
HSH - Horizontal Split Head					X
VSH - Vertical Split Head					X
PR- Pipe Rail					X
CH or FR - Crushed Head or Flattened Rail					X
SSC - Shell, Silver, Corrugation					X
SSC-W - Shell, Silver, Corrugation @ Weld	X (preferred)	or	X	or	X*
DMG-R - Damage Rail					X
BB - Broken Base (Longitudinal break)					X
BB - Broken Base (Transverse break)	X (preferred)	or	X	or	X*
SR - Ordinary Break/Sudden Rupture	X (preferred)	or	X	or	X*
All Repairs to be made in option order (Option #1 first and Option #3 last).					

Table 5-13

* When repairing DF, TF, DIW, DPW or DFW, refer to Section 5.16 Thermite Welding for detailed joint and weld placement information.

5.19.5.1 Defect Repair Procedure

Defect Repair Rail test operator will mark outermost limits and centerline of defect on side of rail head.

1. If cutting rail for immediate thermite welding, follow steps #1 through #5 in Section 5.19.5.2 Immediate Thermite welding.
2. If not setting up rail ends for immediate welding, but welding is planned, refer to Section 5.19.5.3 Cut and Drill for Joint Bar Application #1 through #4.
3. If welding out a defect that had been cut and drilled, with joint bar application, refer to Section 5.19.5.4 Defect removal with a field weld #1 through #4.

5.19.5.2 Immediate Thermite Welding

1. Use match marks and follow the procedures as outlined in Section 9.6 CWR Installation Procedures.
2. Make saw cuts for weld gap needed. Cuts must be at or beyond the rail test operator's marks to ensure entire defect is removed.
3. When the rail test operator's marks are missing, do the following: Cut and remove 1" minimum, on each side of defect or install replacement rail.
4. Make a visual inspection of the rail ends to make sure there are no cracks or signs of defect still present. If indication of defect is still present, more rail must be removed until no signs are present.
5. When necessary, use a rail puller to hold rail in position or pull rail back together.

5.19.5.3 Cut and Drill for Joint Bar Application

1. Use match marks and follow the procedures as outlined in Section 9.6 CWR Installation Procedures.
2. Make saw cuts needed to remove entire defect marked by the operator. See Figure 5-48.
3. When necessary, use a rail puller to hold rail in position or pull rail back together.
4. Drill only the outermost 4 bolt holes of six hole angle bars and apply joint bars. Bolt holes and rail ends to be beveled and slotted per SCRRRA Standard ES2301 or Figure 5-6.

5.19.5.4 Defect removal with a field weld.

1. Use match marks and follow the procedures as outlined in Section 9.6 CWR Installation Procedures.
2. Two additional saw cuts may be required to remove the defect. Make saw cuts on both sides of the rail gap at or beyond the existing rail test operator's marks to ensure entire defect is removed. Ensure gap is correct for the type of weld to be used (standard or wide gap thermite weld).
3. When defect was not removed with two saw cuts at an earlier time and the rail test operator's marks are missing, do the following: Cut and remove 1" minimum, on each side of defect to install replacement weld.
4. When necessary, use a rail puller to hold rail in position or pull rail back together.

5.19.5.5 Defective weld removal with a wide gap weld

1. Use match marks and follow the procedures as outlined in Section 9.6 CWR Installation Procedures.
2. Make saw cuts on both sides of the defective weld at or beyond the existing rail test operator's marks to ensure entire defect is removed. Ensure gap is correct for the type of weld to be used (wide gap thermite weld).
3. If rail test operators' marks are missing, cut and remove 1-3/8" minimum, on each side of the centerline of the defective weld to install wide gap weld.
4. When necessary, use a rail puller to hold rail in position or pull rail back together.

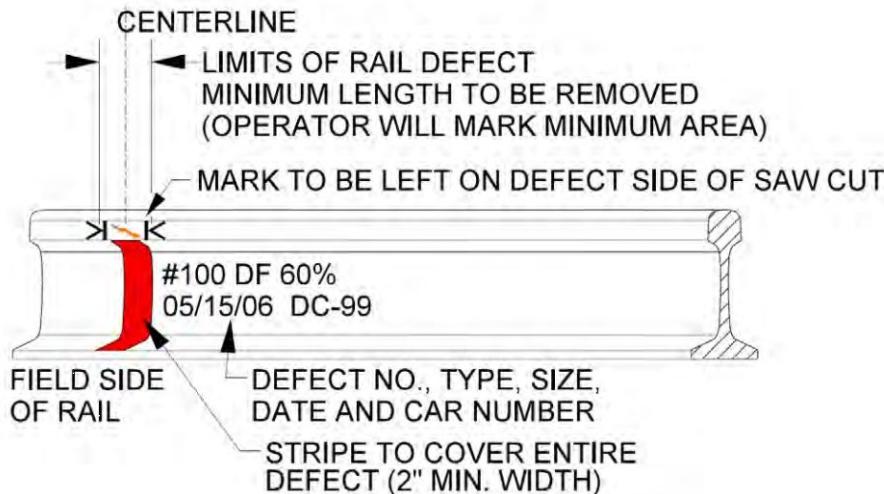


Figure 5-48

5.19.5.6 Main Line Maintenance Replacement Rails

1. When defects are found by a detector car or a service failed rail occurs, replace rail with UT Tested or UT Certified rail as follows: All rails installed are to be consistent with appropriate length, plug rail specification and rail chemistry. Worn rail must not have more than $\frac{1}{4}$ " vertical mismatch or $\frac{1}{4}$ " gage face mismatch. Replacement rail surface condition must be equal or better than adjacent rail in track. Undesirable rail surface conditions include wheel burns, corrugation, shelling, slivers, spalling or heavy head checking, all of which could hide internal defects.
2. Rail in curves shall be inspected periodically to determine whether it shall be replaced due to wear and to determine the actual length of rail to be replaced. Actual wear conditions shall be determined for each curve. Do not rely on rail date information or curve length information in the track chart. The wear rate of rail shall be considered in planning for rail replacement. Generally, rail should be planned for inclusion in the following year's capital maintenance program when the wear reaches a point of about $\frac{3}{16}$ inch less than the limits in Table 5-3, Rail Wear Limits. Rail should be transposed, or replaced, when it reaches the limits in Table 5-3.
3. Rail may be replaced as high side and discard old high side rail; replace high side and set high rail to low and discard old rail; or replace low rail, as indicated by the conditions in each curve. The condition of both rails should be considered when recommending the transposition of a particular curve. This decision will be made by the Manager, Track and Structures Maintenance, or as required in the Contract Documents.
4. Replacement rail shall be 136 lb. rail unless specifically authorized by the Manager, Track and Structures Maintenance. Premium rail, alloy or head hardened, shall be used for curves of three degrees or more and in special trackwork.
5. When 6-inch base rail is installed to replace 5-1/2 inch base rail, or when rail is being replaced on wood ties with curvature of four degrees or more, tie plates shall be elastic fastener 16-inch plates. See SCRRRA standards for tie plate and fastener requirements.
6. Measure side wear at a point $\frac{5}{8}$ inch below top of rail.
7. When replacing rail, or renewing switch points or frogs, carefully inspect the rail ends and bolt holes in the remaining rail before applying angle bars. If cracks or signs of stress are visible in the rail end, or if the bolt holes are excessively deformed or elongated, replace the rail or cut the remaining rail back to a location where sound bolt holes can be drilled. Also replace chipped rail ends with more than a 1 inch chip comprising more than twenty-five percent of the railhead. Be sure that the gage and running surface of rail ends match (CFR49 Part 213.115). Control of thermal expansion of rail requires that there be no net addition of rail. Following replacement or repairs, rails shall be thermally adjusted. When necessary, use a rail expander to close gaps at joints. Report all rail change outs and replacements using Disturbance Report form found in Appendix C and submit to TRACK&STRUCTURES@SCRRRA.NET.
8. Rail shall be UT Certified / Tested and properly marked on each side of the rail web.
9. Restricted Use Maintenance Rail — A-rails and non-controlled cooled rails are to be used in yard, back or industry tracks only (A-rail is identified on the web of the rail following the Heat Number). These rails must be separated in inventory upon inspection and

identification. Non-controlled cooled rails (pre-1937) are not to be used in welded strings. When rail cannot be identified because of corrosion, rust scaling or otherwise, assume that the rail is an "A-rail" and inventory as such. Under current policy, no A-rails or non-controlled cooled rails may be purchased. A-rail is limited to secondhad rail relay. Rail manufactures after 1938 identified controlled cooled rail by "CC", "VT" or "OP" on Brand side of rail. * Note: All rail manufactured after 1938 is controlled cooled and is identified by "CC", "VT" or "OP" on the Brand side of the web of the rail.

5.19.5.7 Service Failure/Broken Rail

A service failed broken rail is defined as an unexpected break in the rail, usually in two or more pieces with separation OR rail with a substantial portion of the rail head, web, or base missing.

Using a digital camera, capture pictures of the rail while still in track and pictures of each full rail end. Email photos and CWR Stress Adjustment/Disturbance Report to: TRACK&STRUCTURES@SCRRRA.NET. When sending pictures, include: Fail date, Subdivision, Track, milepost (including decimal) and rail side (Left or Right). Provide a contact with phone number for follow-up questions.

5.20 Remedial Action Required

See Appendix B to determine the required action for rail defects.

5.21 Rail/Flange Lubricators

5.21.1 *Placement*

1. Lubricators, when required, shall be placed on tangent track between curves; at beginning points of spirals of curves 3° and over; and at any location where visible signs of rail wear have occurred. Lubricators shall be installed to provide lubricant to both high and low rails of curve. The length of effective lubrication (lubricant carry) will depend on actual train operations and an accumulation of variables; adjustments in lubricator location may be required.
2. Proper lubrication can be checked by wiping the gage side of the rail with a paper towel to see if lubricant is present.

5.21.2 *Lubricant*

Only use curve lubricant approved by SCRRRA.

5.21.3 *Inspection and Maintenance*

1. All rail flange lubricators shall be inspected by a designated inspector and maintained on a monthly basis. Track Inspectors shall observe lubricators during each inspection to ensure they are working properly. If a lubricator is noted as not working, then immediate repairs shall be made. Lubricators must be adjusted so that excessive lubrication is not placed on the rail surface and so that the gage face of the rail is maintained in a lubricated state.
2. A regular rail lubricator inspection and maintenance schedule shall be established. Scheduling should be based on local train operations, other maintenance considerations and manufacturer's recommendation. Inspection program shall be established by the rail and structures maintenance contractor and approved by SCRRRA. Lubricators shall be inspected monthly, recorded on the Rail Lubricators form in Appendix C, and submitted to TRACK&STRUCTURES@SCRRRA.NET. This program of inspection, refilling, and repair of lubricators is necessary to achieve the nominal service life from the rail and special trackwork.

5.21.4 *Containment of excess lubricant*

Provide a geotextile fabric covering over ties for a distance of 20 feet each side of curve lubricators, on inside and outside of rails. Secure covering with nail in wood ties, secure with adhesive on concrete ties. Replace geotextile periodically and disposing of the soiled covering in accordance with hazardous material regulations.

5.21.5 *Disposal*

Empty lubricant containers shall be disposed of properly at approved facilities. Full or partially full containers shall not be stored on the right-of-way. Excess, dirty, or waste lubricant shall be collected and removed from the right-of-way.

5.22 Rail Grinding

5.22.1 *General*

Rail grinding prolongs rail life by reducing rail surface corrugations, spalling, head checks, surface cracking, and flow. Grinding reshapes the rail head to a profile that provides improved wheel contact. If rail is allowed to deteriorate as corrugations, shelling, and rail batter increase, the following conditions will result:

1. Decreased rail life due to internal rail defects
2. Poor riding surface
3. Spike lift
4. Tie and ballast breakdown
5. Damage to rolling stock
6. Gage widening

5.22.2 *Corrective, Maintenance, and Preventive Grinding*

The three types of rail grinding practices are corrective grinding, maintenance grinding, and preventive grinding.

1. Corrective Grinding: Remove visible rail damage as required by grinding the rail head heavily. This practice usually requires 5 to 7 passes.
2. Maintenance Grinding: Perform scheduled out-of-face grinding at an increased speed on a frequent cycle based on tonnage and track geometry. Maintenance grinding removes surface defects and cracks before they are allowed to propagate. This practice requires 3 to 5 passes.
3. Preventive Grinding: Perform high-speed out-of-face grinding on a regular schedule based on tonnage and curvature. This practice requires 1 to 3 passes.

5.22.3 *When to Grind and Type of Grinding*

Use Section 5.22.2 Corrective, Maintenance, and Preventive Grinding as a guide for type of grinding to use. In addition, the following will also be used as a guide to the type and timing of grinding to be done.

1. Hi-rail inspection by grinding supervisor and/or proper SCRRRA authority.
2. Surface defects, number, length and depth.
3. Quality of detector car tests.
4. New rail will be ground at the first opportunity.
5. Rail defect history.

5.22.4 *Grinding Requirements*

Determine the grinding requirements by measurements taken electronically by a track evaluation car.

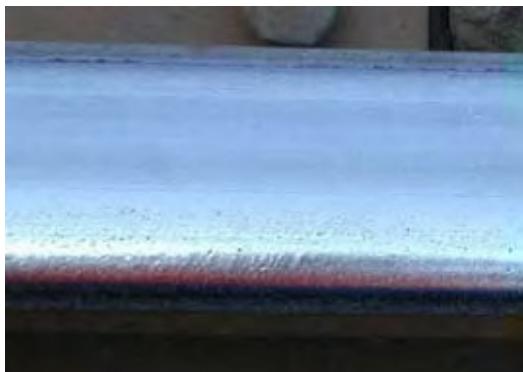
5.22.5 Classification of Rail Condition for Grinding

Rolling Contact Fatigue (RCF)

Visible and undesirable rail surface conditions that require treatment by rail grinding to prevent loss of rail life.

1. Head Checking

Hair line cracks which appear in the gage corner of the rail head, at any angle with the length of the rail. When not readily visible the presence of the checks may often be detected by the raspy feeling of their sharp edges.



Light Checking



Severe Checking with Spalling



Head Checking with Flaking

Figure 5-49

2. Flaking

A surface condition consisting of the gouging of metal on the rail head. It is indicated by small chipping and cavities. It is a progressive horizontal separation on the running surface of rail near the gage 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 usually near the gage corner of the rail and is not as deep as shelling.



Severe Flaking with Head Checking

Close Up of Flaking on Gage

Figure 5-50

3. Shelling

Pieces of rail metal that crack or break away from the gage corner of the rail, due to repeated cycles of high contact stress on the gage corner. This condition consists of progressive subsurface horizontal separations that may crack out on the gage side of the rail head. Shelling normally occurs on the upper gage face of the rail head and extends longitudinally. Shells originate under the surface of the rail head.



Shelling (Light)



Severe Shelling Gage Corner

Figure 5-51

4. Spalling

Cracking and shipping of the rail surface. This condition is a direct result in high horizontal wheel-rail creeping forces, transverse friction forces and extreme wheel-rail contact stresses resulting in micro-cracking, head checking or chipping. Crack progression may be in any plane.



Light Spalling



Mild Spalling



Severe Rail Center Spalling

Figure 5-52

5. Corrugation

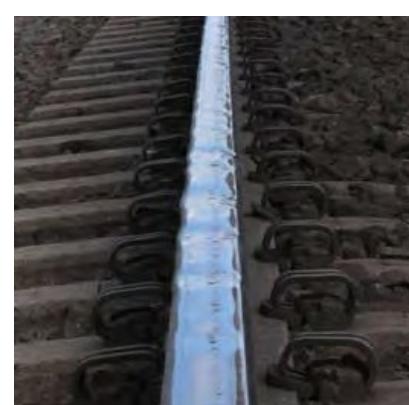
Repetitive longitudinal pattern of shallow wavelike depressions along the rail surface. There is short wave (2 to 3 inches) and long wave (10 to 12 inches or more) corrugation.



Corrugation (Light)



Corrugation – Low Rail (Mild)



Corrugation with Crushing (Severe)

Figure 5-53

6. Mill Scale and Corrosion

Mill scale is an oily scaly layer on the surface of the rail. The purpose of removing mill scale is to enhance shunting capability and prevent corrugations from developing due to the irregular surface. The de-carbonized layer is very soft and may produce surface cracks. Corrosion is disintegration starting at the surface, from chemical decay, mainly oxidation (rusting). As it progresses, it often forms irregular pits, cavities, or develops cracks in the rail web or base.



Figure 5-54

5.22.6 Preparation for Grinding

1. Pre-inspection of subdivision(s) is completed by track supervisor and/or grinding supervisor including all grinding operation details such as metal removal plan, number of passes, can't test locations, and upcoming rail program work.
2. Remove rail lubricators.
3. Inform SCRRRA of the daily/weekly/monthly plan before grinding including grinding train tie up locations.
4. Update any schedule changes immediately to SCRRRA.
5. At all times, and especially in areas where fire risk is high, current instructions for SCRRRA Fire Prevention Plan must be complied with.

5.22.7 Switch Grinder Responsibilities

1. Specialty rail grinding will fill in the areas at switches and road crossings, that the production rail grinder are unable to grind.
2. Curves and mainline rail marked as difficult to test due to rail conditions will be ground if production rail grinder will not be on the subdivision within 3 months, or before next ultrasonic testing is performed.
3. Sidings marked as difficult to test due to rail conditions will be ground if track time allows.
4. An 8-inch radius shall be ground on the running rails of the switch.
5. Remove rail lubricator bars, wheel sensors, and plungers before grinding operations.
6. When grinding turnouts, in heavily used sidings, industrial leads, set out or yard tracks, all areas of turnout will be ground (A-G). For all other turnouts, only section F-G (Switch Point and Stock Rail) will be ground. See Figure 5-55.

Turnout Areas to be Ground

The straight and turnout sides of the switch beginning 100 feet ahead of the switch points and 100 feet behind the frog joint/weld area or to tie into where the production rail grinder ended. On sidings and crossovers, turnout curves will be ground up to 10 feet prior to insulated joint.

Areas to grind will include

1. A – B = Straight side of switch
2. F – C = Turnout side of switch
3. C – D = Turnout curve
4. E = Frog/guard rail area (Do not grind closer than 6 inches either side of frog point)
5. F – G = Switch Point and Stock Rail: 1) Begin grinding switch points when the switch point is $\frac{1}{2}$ the rail head width or when the switch point is higher than the stock rail, 2) Inspect Stock Rail in the wheel transfer area to determine specific grind needed.

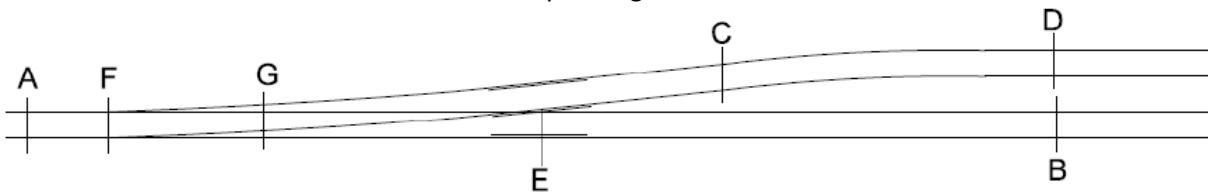


Figure 5-55

Switch Points

When grinding switch points, begin grinding 10 feet ahead of switch points and raise grinding wheels before making contact with switch point tip. Lower grinding wheels when the switch point is $\frac{1}{2}$ the rail head width or when the switch point is higher than the stock rail.

Turnout Stock Rails

When grinding the turnout stock rail, effort must be made to correct surface condition where worn wheels with a false flange ride on the stock rail while making the transfer from switch point to stock rail.

Frogs

1. Rail Bound Manganese: Grind within 6 inches of frog point on either end of frog.
2. Spring Rail: Grind to within 6 inches of frog point on either end of frog.
3. Flange Bearing Frog: This type of frog will not be ground
4. Standard Diamond Crossing: Grind up to 10 feet prior to the insulated joints on either end of the frog
5. One Way Low Speed (OWLS) Diamond Crossing: Grind up to the insulated joints on either end of the frog.

5.22.8 *Grinding on Bridges*

1. Rail on concrete and steel ballast deck bridges in scheduled grinding limits will be ground.
2. Rail on bridges with wood ties on steel girders (and no other wood on bridge except timber guard rails and walkways) and timber ballast deck bridges will be ground when the bridge is part of a curve or tangent scheduled for grinding.
 - 2.1. Grinder will operate all side water sprays and cannons, front and rear.
 - 2.2. Grinder will operate front and rear tie sprays with at least a .03% foam mix. If front tie sprays are not operable, grinder will pre-wet the bridge before grinding, with the remaining tie spray and front and rear water cannons (one time only).
 - 2.3. The rail grinding operation will be followed by a hi-rail water truck which will manually or automatically scan the entire bridge deck, sides, and areas below the bridge with an infra-red heat sensing device to detect any hot spots. The water truck will not leave the bridge area until the entire bridge and surrounding area is shown to be negative with the scanning device.
3. Open deck timber stringer bridges will be ground when falling in the scheduled grinding limits, after the following is completed:
 - 3.1. Grinding Supervisor or SCRRRA determines rail on bridge requires grinding.
 - 3.2. Grinding Supervisor or SCRRRA has contacted the local Bridge forces, notified them of the bridge(s) to be ground on their territory and ascertained from them that they will be on site for the grinding at the time of grinding and will protect the bridge for four hours after the last grinding pass has been made.

5.22.9 *Requirements for Assisting Production Rail Grinding*

Rail Grinding operations requires the support of a pilot, hi-rail water trucks, bridge inspectors, signal maintainers, and right-of-way crews for fire prevention in addition to the fuel servicing of the rail grinding equipment.

Tie up tracks, fueling, and water supply locations shall be identified in advance of the rail grinding operations.

No grinding will take place without completing a fire risk assessment and placing proper fire prevention measures in place during grinding operations.

The use of two hi-rail water trucks is preferred as this will allow for at minimum one truck to provide protection while the other is refilling the water tank.

On track production grinder operators shall be qualified and provide documentation supporting training and compliance with the proper and safe operation of the rail grinding equipment.

Provide a track at least 700' long to tie-up grinder at the end of shift. This track should be at least 25' from the mainline when possible and must have access on one side or the other to have the ability to allow fuel and water tanker to approach the grinder. If at all possible, a fire hydrant should be close to this tie up location. Grinding contractor will provide private locks for locking switches, derails, etc. at tie up locations.

6.0 Turnouts

6.1 Turnout Identification

6.1.1 *General*

Turnouts are identified by their frog number, frog type, diverging track direction, and rail weight. Figure 6-1 shows the turnout terminology. Turnouts for new construction will follow latest SCRRRA Standards. Repair and maintenance of existing turnouts that require more than 50% reconstruction should be considered for upgrade to new standards.

Turnout maintenance shall, at all times, conform to 49 CFR Parts 133-143, 213, 233, and 235 for minimum inspection and maintenance regulations. Place and maintain all switches and frogs in accordance with SCRRRA Standards. Track and signal personnel must inspect each main track turnout jointly each quarter and document using Turnout Inspection Report form in Appendix C.

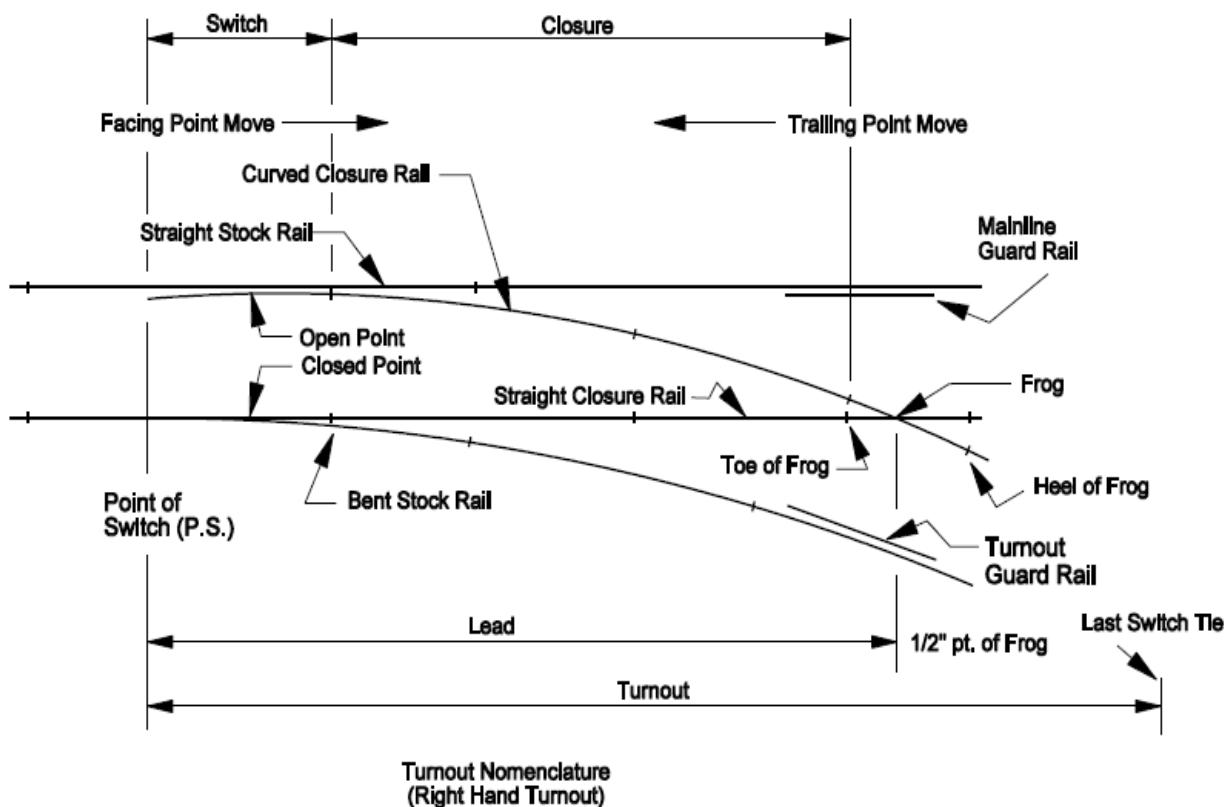


Figure 6-1

Note: On controlled track, notify the SCRRRA Signal Department in advance when: Changing rails, frogs, switch points, or switch stands. Performing work that may compromise the integrity of the signal system.

6.1.2 *Turnout Types*

Standard Wood

Standard wood turnouts have these characteristics:

1. They consist of wood ties, conventional cut spike fasteners, and rolled steel tie plates.
2. The switch and frog portion of the turnout uses plates with elastic fastenings.
3. Switch points and stock rails are Samson design.

Premium Wood

Premium wood turnouts have these characteristics:

1. They consist of hardwood ties, elastic type fasteners, and wood screw lags.
2. Switch points and stock rails are Samson design.

Concrete

Concrete turnouts have these characteristics:

1. They consist of concrete ties, tie pads, elastic type fasteners, and coach screws for special plating.
2. Switch points and stock rails are Samson design.

6.2 Switches

6.2.1 *Switch Types*

1. A hand-throw switch uses a manually operated switch stand to control the movement of the switch points.
2. A switch equipped with an electric lock is a hand-throw switch with an electrically controlled device that mechanically locks the switch. The release of the electric lock is usually controlled by the dispatcher or set on a preset time delay.
3. A Dual Control Switch can be controlled manually by means of a hand throw lever or from a remote location such as from the dispatcher or with local control. See SCRRRA Maintenance-of-Way Operating Rules for instructions on operations.

6.2.2 *Switch Targets*

Use switch targets as follows:

1. Ten-inch-diameter switch targets should be used on low mast stands, and 18-inch-diameter targets should be used on high mast stands.
2. Switch targets should show red or yellow when lined for other than normal movement. Red targets are used on main tracks and all tracks leading to main tracks. Yellow targets are used on other than tracks such as yard and side tracks.
3. Switch targets are not required on dual control switches.
4. SCRRRA Standard ES2703-01, ES2703-02 shows standard target types and applications.

6.2.3 *Switch Stands*

Hand-throw switch stands must meet the following requirements:

1. It should be set tightly against and attached securely to head block ties.
2. Switch stands shall be placed on the turnout side of track, wherever possible.
3. When installing on lead tracks, the stand shall be placed on the straight side of the lead track. Certain crossover applications may require the stand to be on the open point side of the switch.
4. Hand-throw switch stands shall be installed with the handle pointing towards the frog when line for the straight (normal) route Refer to SCRRRA Standard ES2108.

Refer to the Track Standards for the recommended switch stand type and application.

1. SCRRRA Standard ES2701 High star switch stand double crank – double headblock
2. SCRRRA Standard ES2704 Low star switch stand double crank – double headblock
3. SCRRRA Standard ES2707 - 22E Switch stand
4. SCRRRA Standard ES2708 - 36E and 36EH Switch stand
5. SCRRRA Standard ES2709 112E High switch stand
6. See SCRRRA Standard ES2803-36, ES2803-37, ES2803-38, ES2803-39, ES2803-56, and ES2803-57 and Specifications 34 42 43 for electric lock information.
7. The Track Department maintains hand-throw switch stands. The Signal Department maintains dual control switch machines.
8. Switch stand lubrication shall be checked during monthly inspection. Clean and lubricate as needed.

6.2.4 *Switch Stand Adjustment*

1. To adjust switch stands with adjustable crank eyes and connecting rods, refer to Table 6-1 depending on the existing fit of the switch point against the stock rail.

Conditions of points		Action Needed	
Near Point	Far Point	Crank eye on Stand	Clevis on Connecting Rod
Fits properly	Too tight	Screw in	Screw in
Fits properly	Too loose	Screw out	Screw out
Too tight	Fits properly	Screw in	Screw out
Too loose	Fits properly	Screw out	Screw in
Too tight	Too tight	Screw in	None
Too loose	Too loose	Screw out	None
Too tight	Too loose	None	Screw out
Too loose	Too tight	None	Screw in

Table 6-1

Note: One complete turn of the crank eye or clevis adjusts the switch point approximately 1/8 inch.

2. Adjust the lever of a hand-throw switch stand to allow 1-1/2 to 2 inches above the final resting place in the foot latch when the point contacts the stock rail. See Figure 6-2.

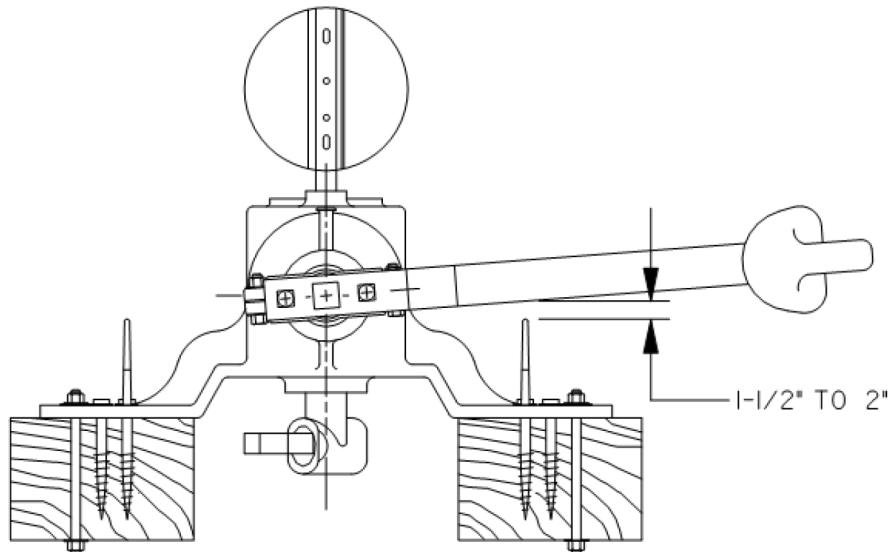


Figure 6-2

3. Keep the hand lever of a High Star or Low Star switch stand 1/4 inch from the locked position when the point contacts the stock rail. See Figure 6-3.

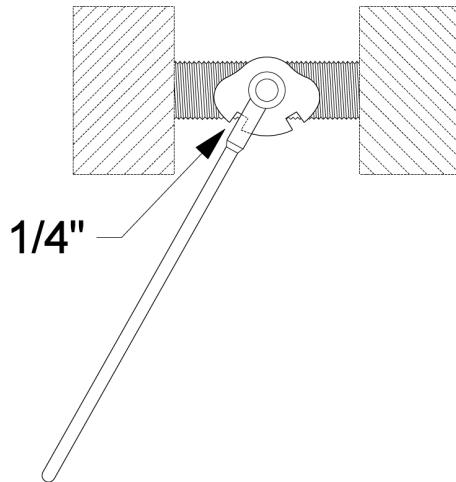


Figure 6-3

4. Do not place high stands closer than 8 feet 6 inches (high stands) or 6'-0 for (Low Stands) from the centerline of any track to any part of the stand or target in its most restrictive position. SCRRRA Standard ES2108.

6.2.5 *Switch Locks*

All switch stands on controlled track shall be equipped with a switch lock.

For locks on derails, see Section 6.6 Turnout Maintenance.

Except for power operated switches, switch locks approved by Director, Engineering and Construction, shall be applied on all main line switches.

Safety switch locks shall be provided for the protection at all main track hand operated switches within 50' of at-grade highway crossings and all other locations designated by SCRRRA.

6.2.6 *Switch Security*

Anytime a main line switch is temporarily disconnected from a switch-stand or a Dual Control Power switch machine, switch must be spiked, clamped, and point protection provided. When a switch cannot be secured in place by the switch stand or switch machine, as well as spiking the closed switch point, use an approved switch point clamp to secure the closed switch point. If a switch point clamp is unavailable, place a 10 MPH speed restriction over the switch and inspect the point after each train move looking for properly secured switch point and that it is up against the stock rail. For more information, see also SCRRRA Signal Maintenance Manual, Section 2.1.2 When Necessary to Disconnect Switch Stand, Controller, etc.

6.2.7 *Switch Point Foot Latch*

1. Except for power operated switches, switch point foot latch approved by SCRRRA, shall be applied on all mainline and controlled siding switches.
2. To operate the switch point foot latch, after removing switch lock, put foot on lever and push down, then operate switch stand in usual manner. The foot pedal shall remain in down position until switch point is closed. When the switch point is closed, the device should snap up and automatically return to its normal or locked position, as the base plate is made of spring steel.
3. Switch locks shall not be inserted in switch point foot latch until switch has been restored to normal position.
4. Do not place or operate the switch point foot latch with your hands.

6.2.8 *Switch Point Clamps*

See SCRRRA Standard ES2354. Switch point clamp to be used only when:

1. No switch stand/machine has been installed (i.e. new construction) with the approval of SCRRRA Signal Department.
2. A main line switch is temporarily disconnected from a switch stand/machine, an interlocked switch machine, or when a switch cannot be secured in place by the switch stand/machine, the switch shall be secured. Securing requires spiking the switch out of service and the use of an approved switch point clamp. If a switch point clamp is unavailable, place a 10 MPH speed restriction and protect the switch until it is properly secured.
3. Maintenance personnel desire to restrict access to a track(s) by making the switch inoperable.

Installation of switch point clamp:

1. Inspect jaws and locking ring of switch point clamp for cracks. If any cracks are found, scrap switch point clamp.
2. Line switch for the intended direction.
3. Install between the point of switch and #2 throw rod.
4. Position switch point clamp in crib and attach one jaw to the base of the switch point and the other jaw to the base of the stock rail on the field side.
5. Turn locking ring clockwise with wrench until tight.
6. Inspect point of switch to ensure no gap exists between switch point and stock rail.
7. Install pad lock to secure lock ring to jaw (only one jaw has hole for pad lock).
8. Place out of service tag on switch stand/machine.

6.2.9 *Switch Point Rollers*

1. Install switch point rollers on all switch points over 16 feet 6 inches long. Install rollers on other points as necessary.
2. Roller designs that reduce turnout throw force are available. In situations where hard to throw switches are an issue, rollers can be utilized. Alternative roller designs are not a replacement for good switch maintenance practices.
3. When utilizing alternative roller designs, care should be taken to limit the amount of lubrication applied to the plates. These rollers are designed to reduce lubrication requirements and excess lubrication can cause them to bind.

6.2.10 Switch Point Guards

1. Use switch point guards only as directed by SCRRRA.
2. Do not use switch point guards on turnouts in main tracks or sidings where track speed is greater than 10 MPH.
3. Use a switch point guard of the correct rail size and brace plate design. Follow the manufacturer's installation instructions.
4. When the distance between the gage line of the running rail and the guarding face of the point guard reaches 4-3/16 inches, adjust or replace the wear bar. See Figure 6-4.
5. Do not build up switch point guards by welding in track.

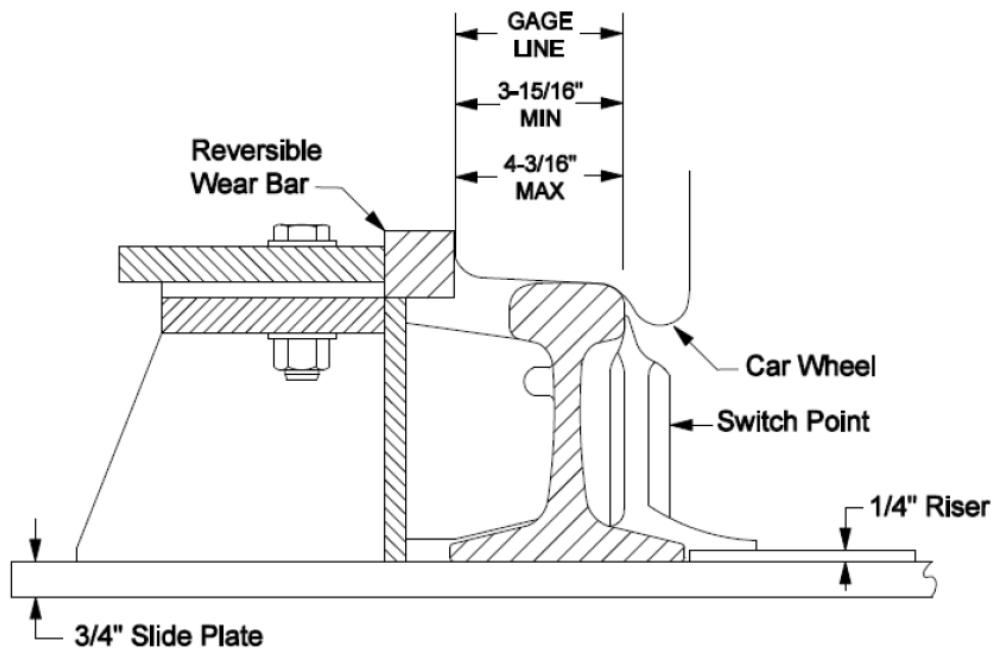


Figure 6-4

6.3 Switch Rods

1. See SCRRRA Standard ES2800 for the corresponding switch size.
2. Switch rods space switch points the proper distance apart to ensure that the switch points fit tightly against the stock rails.
3. Switch rods are identified by rail weight, switch point length, and rod number.
4. Adjust vertical type switch rods to the correct over tee dimensions to ensure proper switch point spacing.

6.3.1 Connecting Rods

The connecting rod connects the switch stand to the head rod or No. 1 rod of the switch.

Do not allow the connecting rod to rub against the head block ties. See SCRRA Standard ES2712 for more information on connecting rod specifications.

6.3.1.1 Connecting Rod Applications

Determine the length of the connecting rod used by considering clearance restrictions or operating conditions and CPUC clearance requirement. In general, use the following connecting rod lengths for the specified applications listed in Table 6-2.

See Connecting Rod SCRRA Standard ES2712.

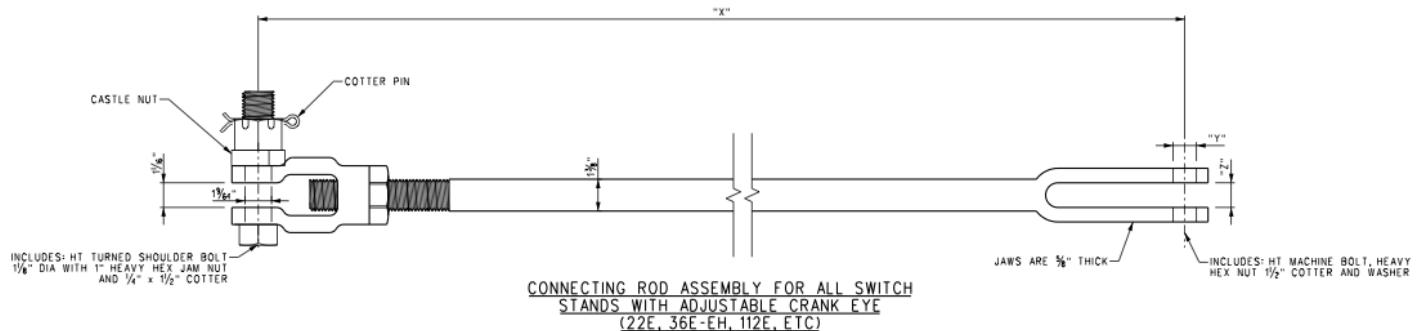


Figure 6-5

Connecting Rod Length	Application
3 feet 4 inches	Between tracks with track centers less than 20 feet.
5 feet	Yard and ladder tracks
6 feet 3/4 inch	Main tracks
13 feet 9 inches	Inside switches on ladder tracks

Table 6-2

Note: Do not use connecting rods shorter than 6 feet with high mast switch stands.

6.3.1.2 Connecting Rod Repairs

Do not repair connecting rods by welding.

6.3.1.3 Connecting Rod Installation

Attach the adjustable end of the connecting rod to the crank eye on switch stands with adjustable cranks.

6.3.2 Connecting Rod Bolts

Insert connecting rod bolts, of the proper dimension, with the head down and secured with a nut and cotter pin on top.

6.4 Switch Points

1. Ensure that switch points are the same rail size as the stock rails they are mated to.
2. Measure switch point length from the tip of the switch point to the heel block assembly of the switch.
3. On extended length type switch points, measure switch point length from the tip of the point to the center of the heel block assembly. Extended switch points are often characterized by heel block length and overall extended length. (Example: 16'6" point extended to 39' can be used in 16'6" switch point applications and can be cropped to the necessary length.)

6.4.1 *Switch Point Use*

1. Knife point switch points are generally used in yard and industry tracks and should not be utilized on mainline applications. Knifepoints should be upgraded to Samson design when replaced. Samson switch points are the current standard and shall be utilized on all mainline applications.
2. Use Standard (knifepoint) design switch points with standard rail section stock rails. See Figure 6-6.

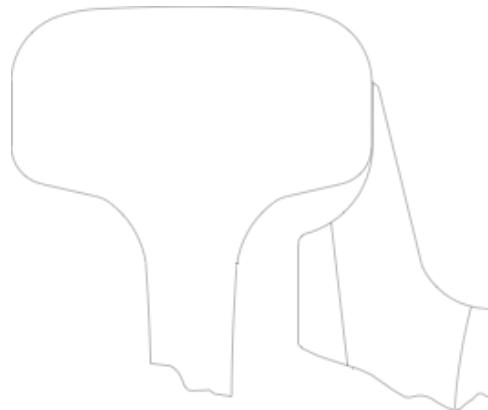
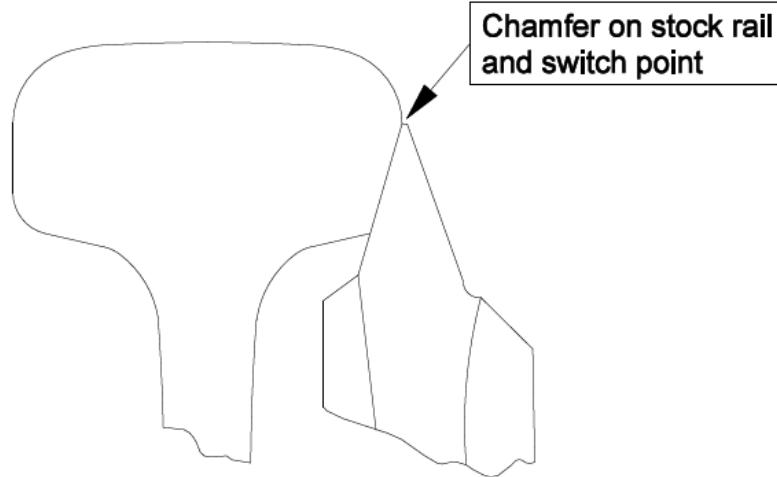


Figure 6-6

- 2.1. Use Samson design switch points only with Samson type stock rails. See Figure 6-7. Conventional bolted heel block Samson points must be upgraded to floating heel block style extended Samson points when replaced in mainline applications. Refer to Section 6.4.3 Heel Blocks.



Samson design switch point and stock rail

Figure 6-7

3. Crop extended length switch points and stock rails during replacement operations to facilitate field welding and future replacements.
4. Change out worn switch points and stock rails together. If changing out a damaged switch point without installing a new stock rail, grind off any overflow on the stock rail and excessive switch point height to prevent tip breakage. See Figure 6-8.

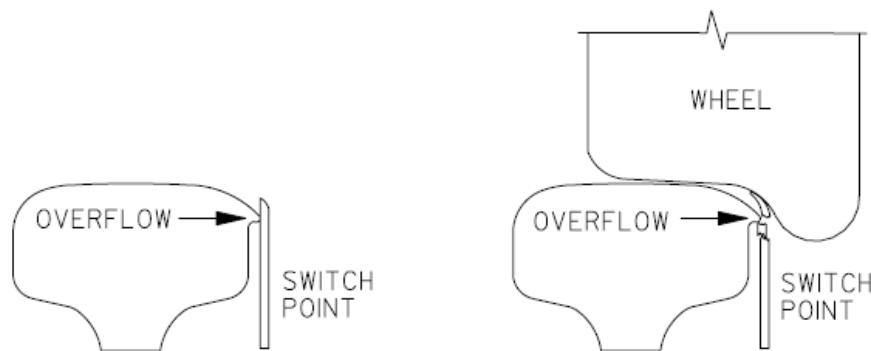


Figure 6-8

6.4.2 Switch Point Maintenance

Repair switch points as follows:

1. Grind off rail flow from the switch point that prevents it from bearing fully against the head of the stock rail. See Figure 6-9.

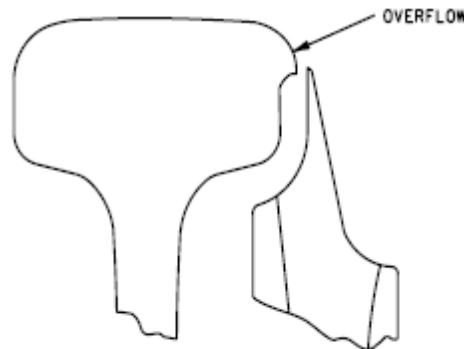


Figure 6-9

2. Grind the flowed metal from the stock rail from 6 inches ahead of the switch point toward the heel to a point where the switch point no longer contacts the stock rail. Grind the edge of the stock rail to a 5/8-inch radius.
3. Do not replace stock rail only. Stock rail and switch point must be changed as a pair.
4. Do not use switch points in main tracks that have been repaired or built up by welding.

6.4.3 Heel Blocks

Heel blocks act as a hinge for the switch point. The following are the different types of heel blocks, See Figure 6-10 for examples:

1. **Conventional bolted heel blocks** have a joint held together by a cast block and bolts as shown in Figure 6-11. These conventional bolted heel blocks are associated with short points.
2. **Floating heel blocks** do not have this joint and use a small block and two bolts. These floating heel blocks are associated with extended switch points.

Note: When conventional bolted heel blocks require replacement, they must be replaced with floating heel block style extended switch points in mainline and siding applications.

Maintain heel blocks properly to ensure that the switch can be operated without using excessive force.

1. Keep spikes or welded stops from preventing the hinging movement of the switch point in the heel area.
2. Lubricate heel joint assemblies with switch plate oil and do not over tighten them so as to bind the switch point.
3. Use effective ties to support the heel and solidly tamp the heel joints.
4. Use the appropriate joint bars as follows:
 - 4.1. For floating heel joint assemblies for 16-foot 6-inch and 24-foot switch points, use 5-hole angle bars.
 - 4.2. For 39-foot switch points, use 6-hole angle bars.
 - 4.3. For extended switch points, no joint bar is required at the heel location.
 - 4.4. For continuous filler block assemblies, use the bent 5-hole bar designed for that purpose. See Figure 6-11.

Use only hardwood ties under the heel block and maintain them so that there is no unusual pumping at this joint or location. In case of bolt failures, check the joint first to determine why bolts are breaking. If unusual stress is causing problems at the joint, correct the problem to ensure the joint and/or rail does not fail.



Figure 6-10

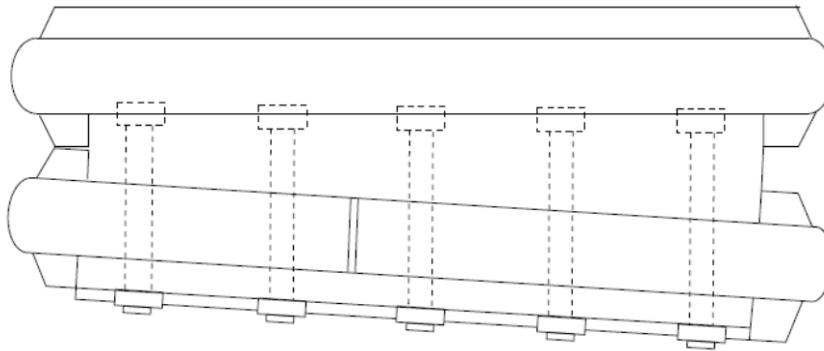


Figure 6-11

6.4.4 Stock Rail Replacement

1. To prevent wheels from striking the tip of the point, replace stock rails that are curve worn more than $3/16$ inch ahead of the switch point.
2. Do not place a new stock rail against a worn switch point.
 - 2.1. The switch point should rise a minimum of $3/16$ inch above the stock rail where the wheel transfers from the switch point to the stock rail. See Figure 6-12.

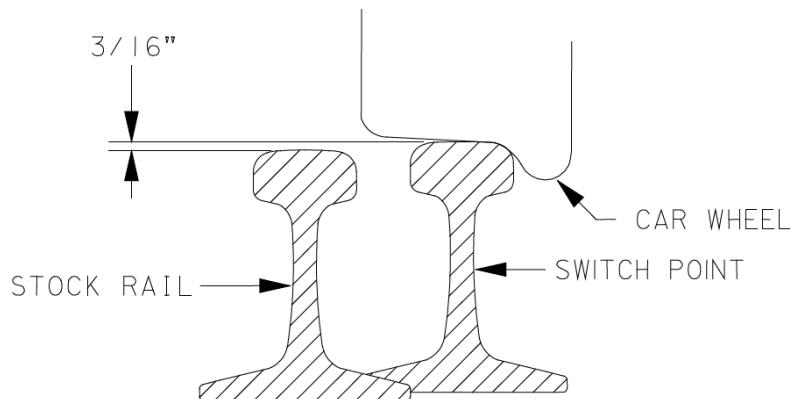


Figure 6-12

- 2.2. The outer edge of the wheel tread must not contact the gage side of the stock rail. See Figure 6-13. When correcting this defect ensure that the switch plates are not worn. Replace if necessary.

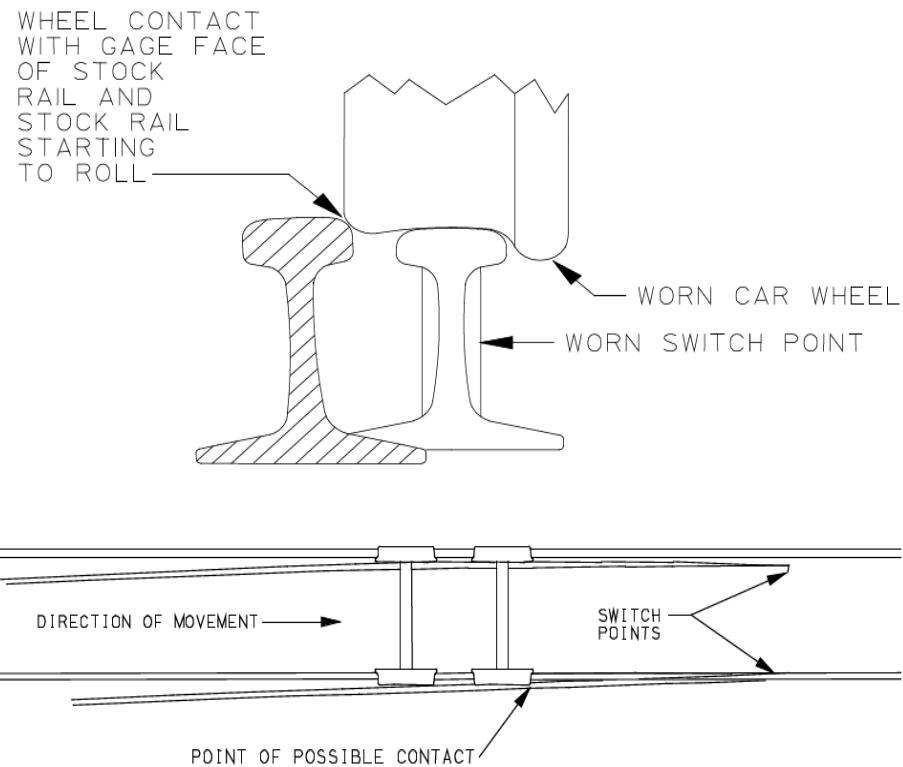


Figure 6-13

3. Keep adjustable brace plates tight to keep the stock rail securely fastened in the riser plates, but do not over tighten them to the point that the stock rail is canted. The stock rail should not move when the switch point is brought up tight against it.

6.4.5 Plating in Turnouts

1. Special trackwork plates are stamped with the plate number and rail size.
2. Fasten plating with round holes to ties with screw spikes. Use the square cut spike holes in these plates for gaging purposes only.
 - 2.1. Fasten plates to ties using two screw spikes per plate end.
 - 2.2. Use the outer two holes unless one of the holes is within 1 inch of the edge of the tie. In this case, use the middle hole. See Figure 6-14.

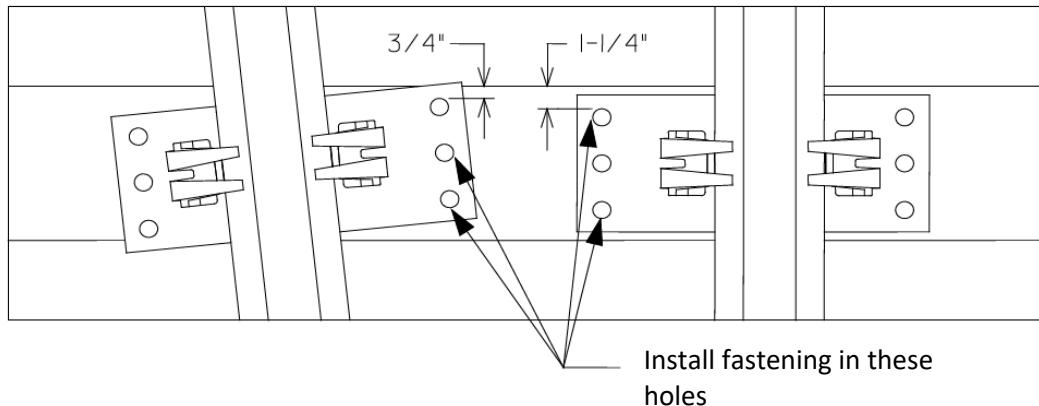


Figure 6-14

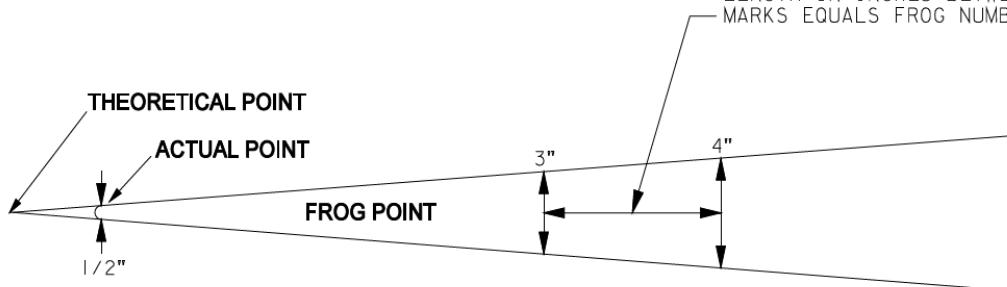
6.5 Frogs

Frogs are furnished in extended lengths to provide clearance for field welding in track and replacement in the field without having to add additional rail. Frogs may need to be cropped before installation in the field.

6.5.1 Identification of Frogs by Number

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

1. With a tape measure, mark a 3-inch width across the top of the frog.
2. Mark a 4-inch width across the top of the frog.
3. Measure between marks. The number of inches measured equals the frog number. See Figure 6-15.



FIELD IDENTIFICATION OF FROG NUMBERS

Figure 6-15

6.5.2 Frog Types

6.5.2.1 Railbound Manganese Frog (RBM)

The RBM frog has a cast manganese body insert for the point section of the frog. See Figure 6-16. RBM Frogs shall not be used on concrete tie turnouts.

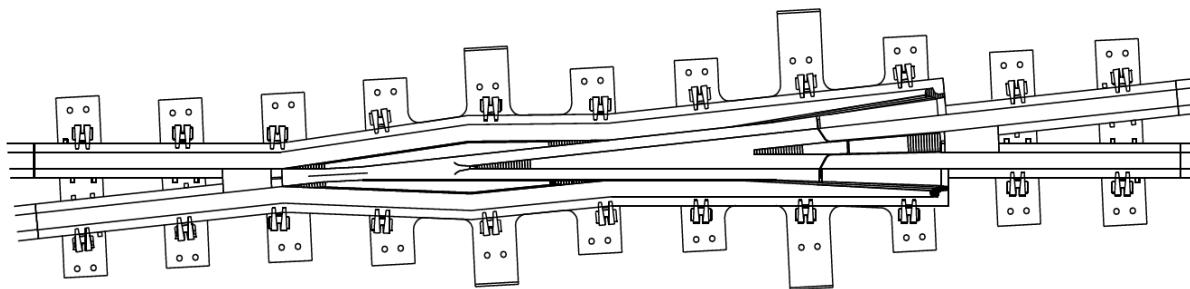


Figure 6-16

6.5.2.2 Rigid Bolted Frog

The rigid bolted frog is similar in design to the RBM frog, except the point section is constructed from rail instead of manganese. Install a frog with the short point on the turnout side. See Figure 6-17.

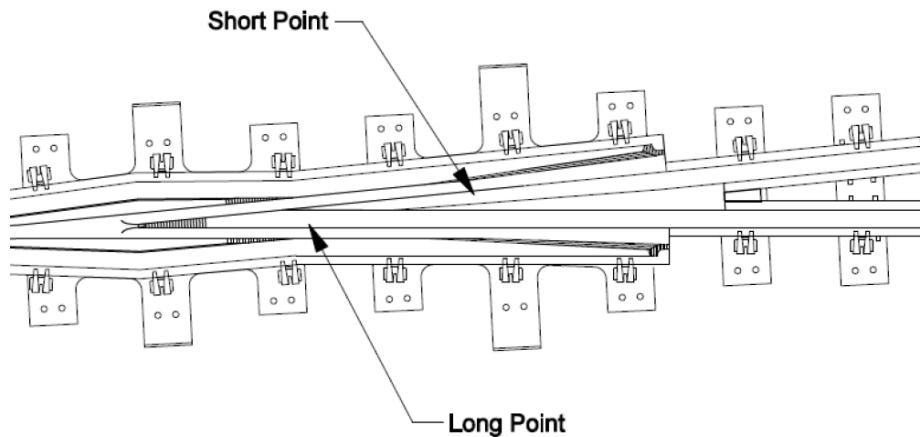


Figure 6-17

6.5.2.3 Spring Frog

1. The spring frog has a movable wing rail that is normally held closed against the body of the frog except when pushed open by a diverging movement. See Figure 6-18.
 - 1.1. Power tampers shall not be allowed to lift spring rail frog wing rails or base plates. If a base plate or wing rail is bent or damaged during installation or tamping, the frog shall be immediately replaced or removed from service on diverging route.
 - 1.2. Maintain each spring rail frog so that the outer edge on the wheel tread cannot touch the gage face of the wing rail. During transport and installation in the track and during installation of panel turnouts, spring rail frogs shall be secured with blocks and clamping bars to prevent horizontal or vertical movement of the wing rail.
 - 1.3. To determine the correct "hand" for spring frogs, stand at the toe of the frog and face the frog point.

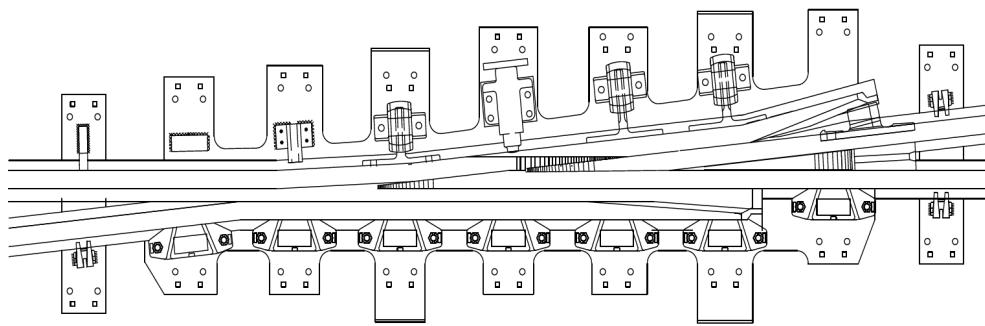


Figure 6-18

- 1.4. If the spring wing is on the left, it is a left-hand frog.
- 1.5. If the spring wing is on the right, it is a right-hand frog.
2. When installing a spring frog without a toe block, align the match marks on the spring wing with those on the frog body. This ensures that the hold downs and horns are centered, and the designed 3/8-inch opening is between the frog point and wing rail.
3. Ensure that the ties under the toe of the frog are in good condition and are solidly tamped.
4. Use wing rail retarders with frogs on dual control and spring-operated switches.
5. A WSM – Welded Spring Manganese frog features three welds between the casting and the rail for a "boltless connection". These frogs are characterized by 2 stainless steel welds at the toe and one at the heel of the casting and no bolted joints.
6. All spring rail frogs, No. 14 or greater, shall be equipped with a hydraulic retarder or controller.
7. No. 10 turnouts shall have spring rail frogs if main track speeds are 20 MPH or greater and turnout side not used for meeting or passing of through trains.
8. Wood tie turnouts with Rail Bound Manganese (RBM) frogs shall have replacement spring rail frogs installed when the RBM frog is deteriorated to the point it must be replaced and the diverging traffic is less than 30 percent of the main line traffic.

6.5.2.4 Self-Guarded Solid Manganese Frog (SGSM)

The SGSM frog has a body cast in one piece from manganese steel. A raised guard cast into the body protects the frog point from passing wheels, making the installation of a guard rail on the opposite rail unnecessary. See Figure 6-19.

SGSM frogs may only be replaced in-kind when track speeds does not exceed 10 MPH, otherwise consider upgrading to an RBM frog with guard rails.

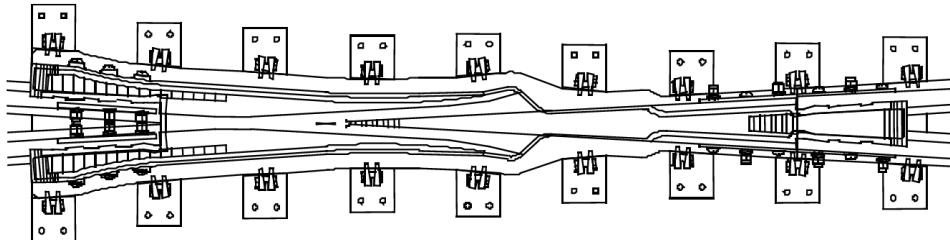


Figure 6-19

If building the frog point under traffic, build the guarding face before the frog point.

Install guard rails as an option in cases where additional guarding may be required, such as curved switches.

6.5.2.5 Movable Point Frog (MPF)

Reserved for future use.

6.5.2.6 Flange Bearing Frog (Also referred to as a lift or jump frog)

The flange bearing frog features a continuous mainline rail and a flange bearing run on the turnout side. This frog can be utilized in situations where traffic through the diverging route is minimal such as maintenance of way tracks or low tonnage industry and branch line tracks. Speed is limited to 10 MPH on the turnout side by the FRA.

When installing a flange bearing frog the mainline guard rail can be removed. Gage plates are required between the frog and the mainline running rail. Do not allow gage through the frog to exceed 57".

The turnout side guard rail must be installed. Guard rail must be upgraded to the latest boltless adjustable style and shimmed upwards at the center per SCRRRA Standard ES2800-50 .

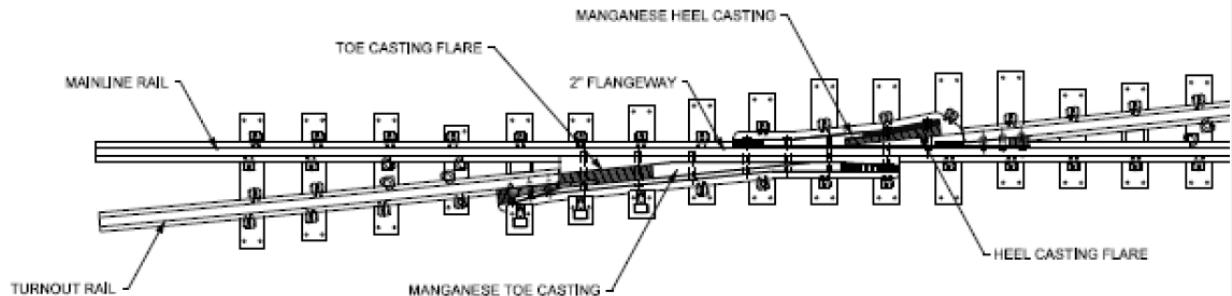


Figure 6-20

6.5.2.7 Diamond Crossing

Diamond crossings allow two tracks to cross over one another at grade. They may be constructed from all rail or with manganese inserts at the locations where the rails cross over each other. Diamond Crossings include many different design angles to meet the needed angles where tracks cross each other.

Note: There are three distinctly different designs of rail crossings that include:

1. Low Angle Reversible – crossing central angle is 16-40 degrees, refer to Figure 6-21.

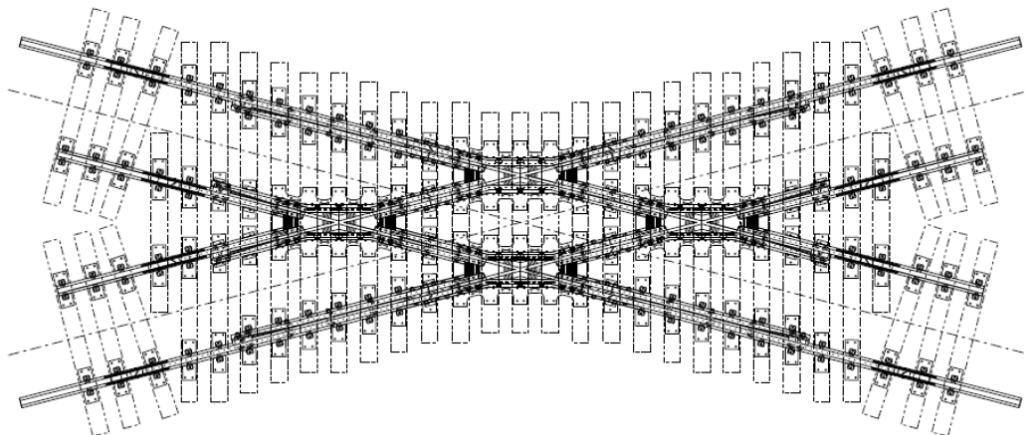


Figure 6-21

2. Straight Rail Reversible – crossing central angle is 41-90 degrees, refer to Figure 6-22

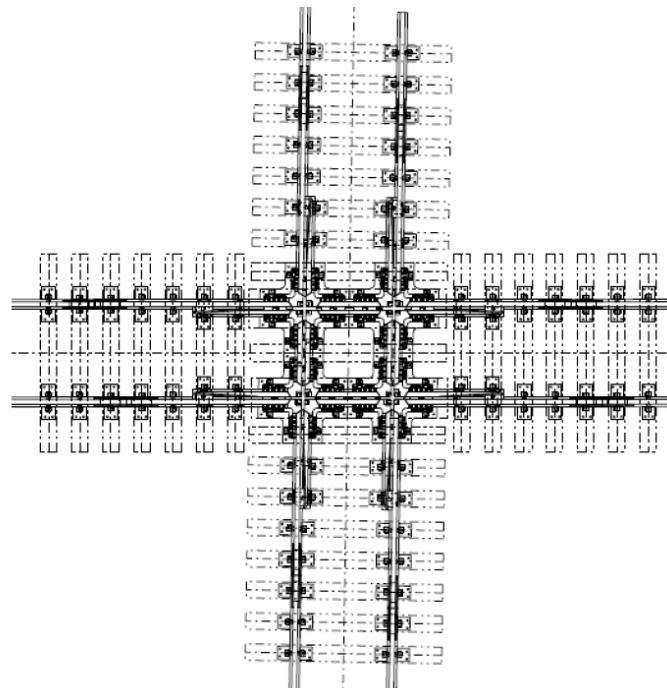


Figure 6-22

3. OWLS (One Way Low Speed) – crossing central angle is 35-90 degrees, refer to Figure 6-23.

OWLS crossings utilize a flange bearing lift on one track that is limited to 10 MPH. The mainline speed can be up to 79 MPH.

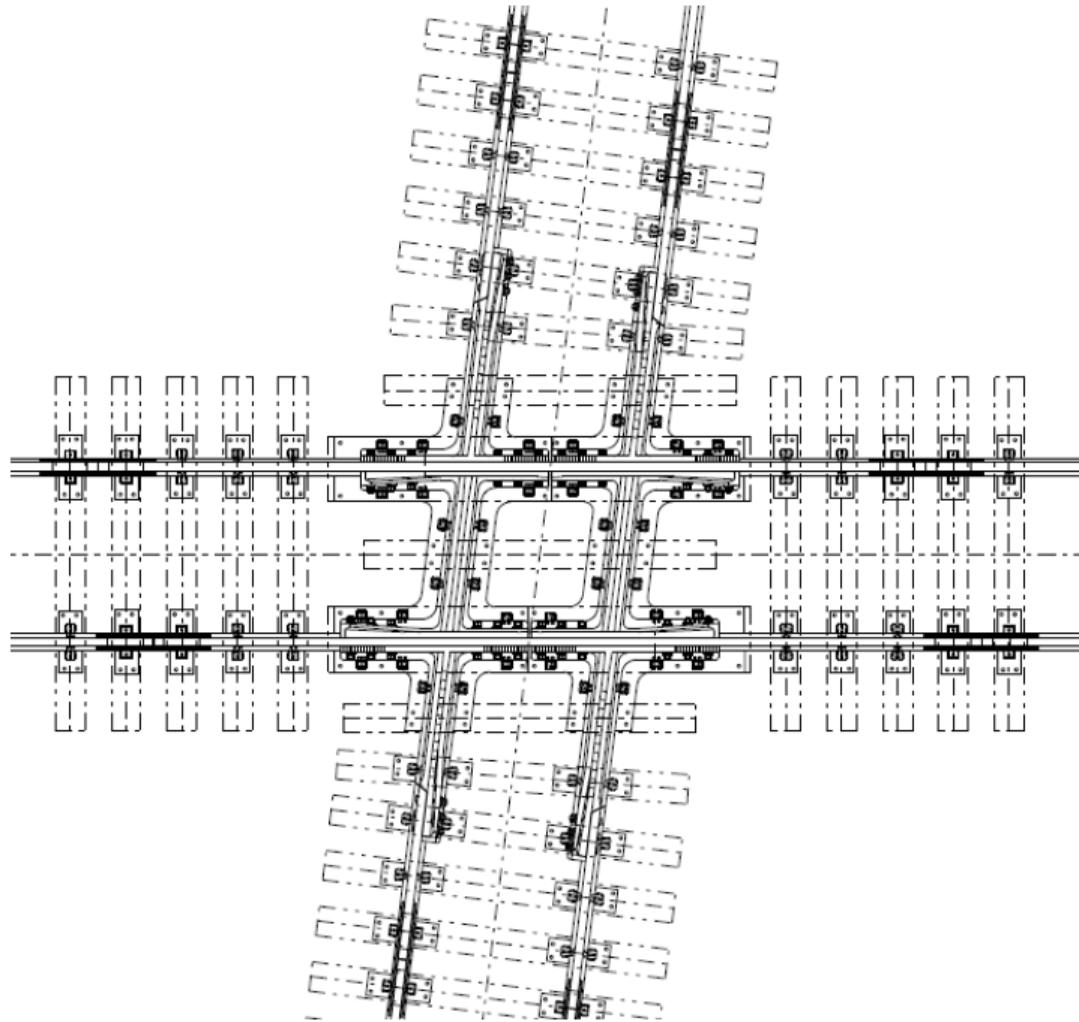


Figure 6-23

4. FBF (Flange Bearing Frog) or Full-Flange Bearing Crossings – crossing central angle is 20-90 degrees.

FBF crossings utilize a flange bearing lift ramp on both tracks.

FBF crossings have long signal “dead zones” that require additional signal work to be performed before installation.

Figure 6-24 contains common nomenclature for rail crossing designs.

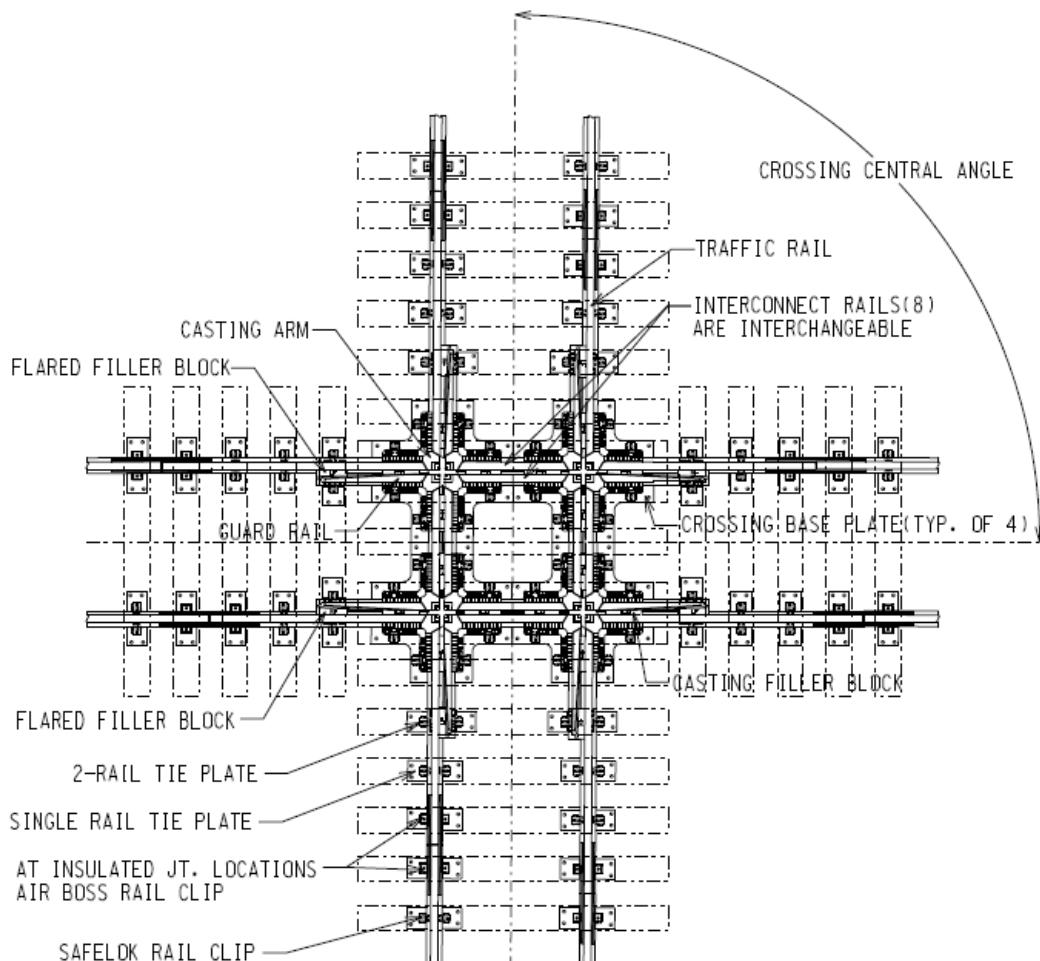


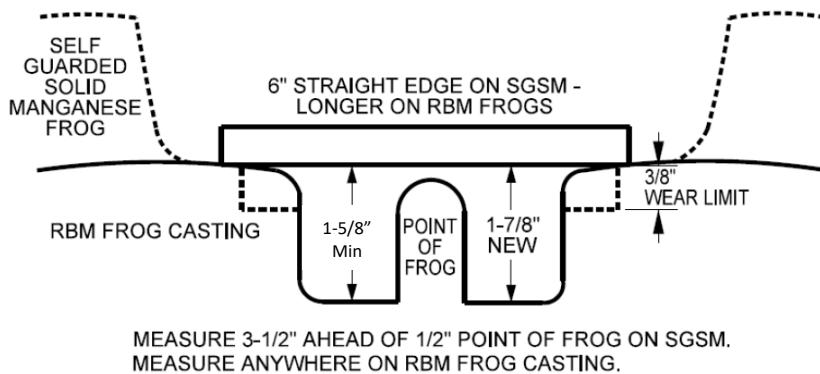
Figure 6-24



6.5.3 Frog Wear Non-Conformal Frogs (RBM, SGSM, Flange Bearing, and Diamonds)

Check frog wear on Non-Conformal Frogs as follows:

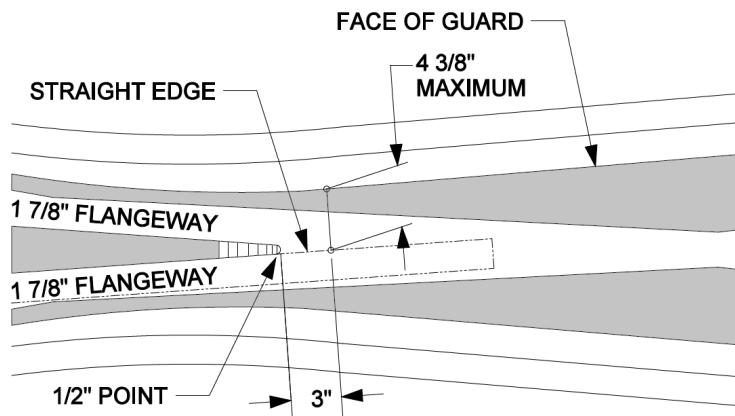
1. Do not allow the frog to wear such that the flangeway is less than 1-9/16 inch deep or less than 1-1/2 inch wide, as shown and measured in Figure 6-25.



VERTICAL WEAR LIMIT ON NON-CONFORMAL FROG FLANGEWAYS

Figure 6-25

2. If the tread portion of a frog casting is worn down more than 3/8 inch below the original contour, restrict the operating speed over that frog to 10 MPH. Wear to be checked using a straight edge.
3. If a frog point is chipped, broken, or worn more than 5/8 inches down and 6 inches back, restrict the operating speed over that the frog to 10 MPH.
4. For self-guarded frogs, ensure that the distance from the gage line of the frog point to the guarding face does not exceed 4-3/8 inches as shown in Figure 6-26.
5. On OWLS crossing diamonds or Flange Bearing Frogs, any gouge made in the mainline running rails by the flange bearing wheels must not exceed 1/2" in depth. If any gouges exceed this the mainline rail must be replaced or restricted to 10 MPH.



Wear Limit for Self-Guarded Frog

Figure 6-26

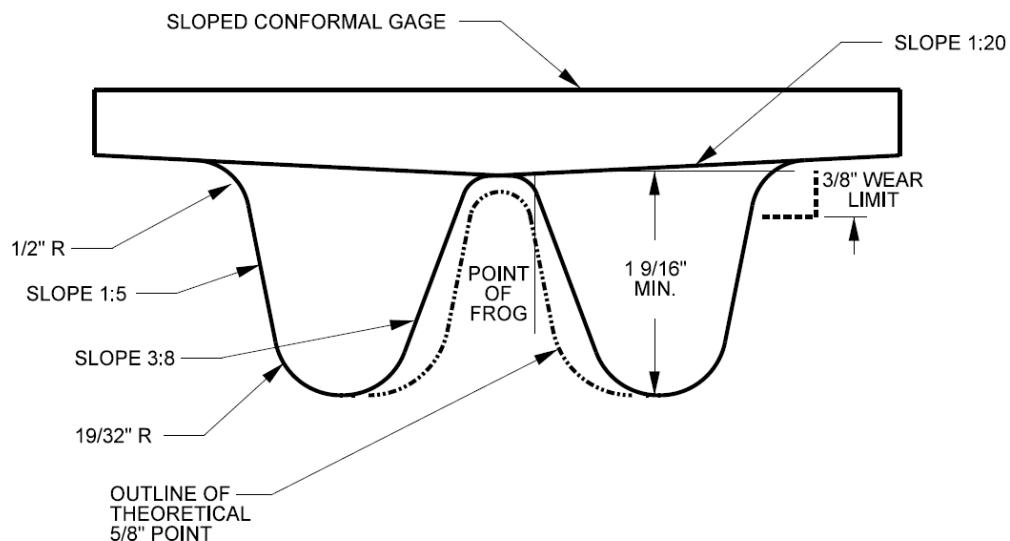
6.5.4 Frog Wear Conformal Frogs (Heavy Point RBM)

The conformal top frog has a 1:20 slope on the tread or “wing” side of the casting that is designed to better fit the profile of the wheel. To identify a conformal top RBM casting lay a straight edge across the frog at the point, if the castings are sloped as shown in Figure 6-27 the frog is conformal.

Figure 6-28 shows a conformal top-heavy point RBM frog. Although it can be difficult to detect visually the slope indicates a conformal top frog. Conformal top frogs will also be stamped Conformal or CF on the castings or will have Conformal indicated on the manufacturers ID tag.

When measuring conformal frogs for wear:

1. Use the special conformal top gages to measure, flange depth and tread wear limits. Gages are sloped to account for the 1:20 casting slope. Not using these gages can result in inaccurate measurements of wear and depth.
2. When rebuilding conformal castings by welding, casting can be repaired back to a flat slope as seen in Figure 6-25. Weld repairing to the flat slope is simpler than trying to restore the 1:20 slope.
3. Conformal gages must also be utilized to check for point wear. Using a straight edge will provide an inaccurate measurement that does not account for slope.
4. At any point on the frog, flangeways must be a minimum of 1-1/2 inches wide and 1- 9/16 inches deep. Tread portion must not have wear in excess of 3/8" below the conformal contour.



VERTICAL WEAR LIMIT ON CONFORMAL FROG FLANGEWAYS

Figure 6-27



Figure 6-28

6.5.5 *Frog Guard Rail Size and Length*

Refer to the appropriate turnout within SCRRRA Standard ES2901 through ES2951 for details on guard rail placement, specifications and settings.

Use guard rail lengths for turnouts as shown in Table 6-3.

Frog Size	Main Track Guard Rail Length (Feet)	Turnout Guard Rail Length (Feet)
No. 7, No. 8, and No. 9	13 feet	13 feet
No. 10 and No. 14	19 feet 6 inches	15 feet
No. 11 and No. 15	19 feet 6 inches	19 feet 6 inches
No. 20 and No. 24	26 feet	26 feet

Table 6-3

Note: If the track speed is greater than 40 MPH, use at minimum a 19'6" guard rail length.

6.5.6 Frog Bolt Sizes and Torque

Determine the frog bolt and washer diameter and torque from Table 6-4.

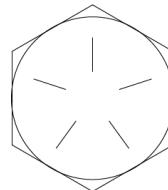
Rail Size	Bolt and Washer Diameter	Torque (lb.)
85 lb. or less	1-1/8"	1,500
90 to 100 lb.	1-1/4"	1,750
110 lb. or more	1-3/8"	2,200

Table 6-4

6.5.7 Frog Bolt Installation

Replace frog bolts that are missing, bent, cracked or worn more than 1/8 inch in diameter, or that cannot be tightened to compress the washer.

Use only frog bolts made from Grade 8 material. Grade 8 bolts can be identified by 5 tick marks on the bolt head. See Figure 6-29.



Grade 8 Bolt Marking

Figure 6-29

Use proper length bolts that do not allow the threaded portion of the bolt to extend more than 1 inch past the nut.

Install frog bolts using a torque wrench as follows: Tighten all bolts to the desired torque. Apply an approved never seize lubricant to the bolt threads and nut threads before tightening. When torque wrench is not available, use one cam washer with a lock nut (Figure 6-30). Tighten all bolts to refusal.

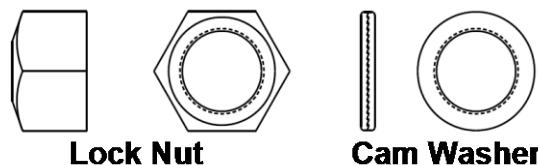


Figure 6-30

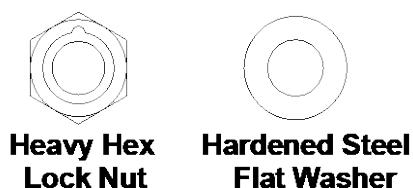


Figure 6-31

6.5.8 Frog Gage Plates

Fit frog gage plates to frog and guard rail plates after properly setting track gage, guard check gage, and guard face gage.

Frog gage plates must be insulated in signalized territories.

When installing a flange bearing frog, gage plates are required between the mainline and frog to prevent excessive flange contact on the raised portions of the castings.

6.5.9 Guard Check Gage

Guard check and Guard Face gage are key players in keeping wheels from excessively contacting frog points. If frog point wear is excessive make sure to check gage to be sure that wheel flanges are not allowed to strike frog points excessively.

Class of Track	Guard Check Gage may not be less than	Guard Face Gage may not be more than
1	54 1/8"	53 1/4"
2	54 1/4"	53 1/8"
3 and 4	54 3/8"	53 1/8"
5	54 1/2"	53"
HEAVY POINT FROG, CLASS 5*	54 3/8"	53 1/8"

Table 6-5

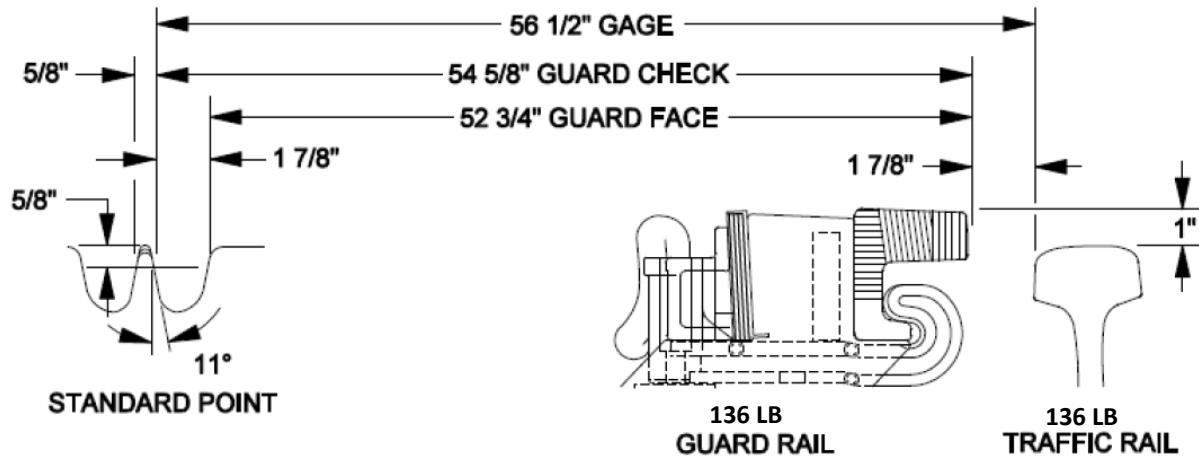


Figure 6-32



6.5.9.1 Gage Settings for Standard Point Frogs

When repairing or installing standard point frogs set Guard Check Gage at 54-5/8 inches and mainline gage at 56 1/2 inches. Maintain guard rail flangeways at 1 – 7/8 inches for standard gage.

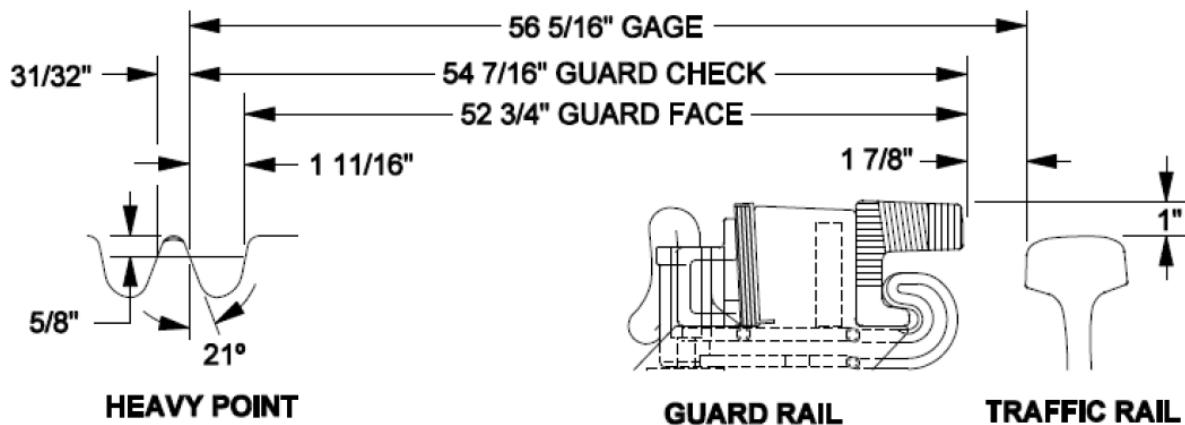


STANDARD POINT FROG AND GUARD RAIL

Figure 6-33

6.5.9.2 Gage Settings for Heavy Point Frogs

When repairing or installing heavy point frogs set Guard Check Gage at 54-7/16 inches and mainline gage at 56 5/16 inches.



HEAVY POINT FROG AND GUARD RAIL

Figure 6-34



Note: Heavy point frogs must have three gage plates (welded) under the frog and guard rails in Class 5 track to allow for Class 4 tolerances. This includes the turnout side. SPRING FROGS MAY ALSO BE CLASSIFIED AS HEAVY POINT FROGS, see Figure 6-32 for identification.

Early wear may be detected on the tip of a heavy point frog, THIS IS NORMAL, this wear is intentional to establish early work hardening. For an example of normal early wear see Figure 6-35.



Figure 6-35

6.5.10 Flange Bearing Frogs (Also referred to as lift or jump frog)

Flange Bearing Frogs can be utilized in locations where the turnout route has a maximum of 65 cars at any one time, and the mainline or siding route is heavy traffic. Flange Bearing Frogs greatly reduce impact loads and can provide a large reduction in maintenance.

Care must be taken to control the mainline and turnout gage to prevent excessive wheel flange contact on raised castings which could lead to a derailment.

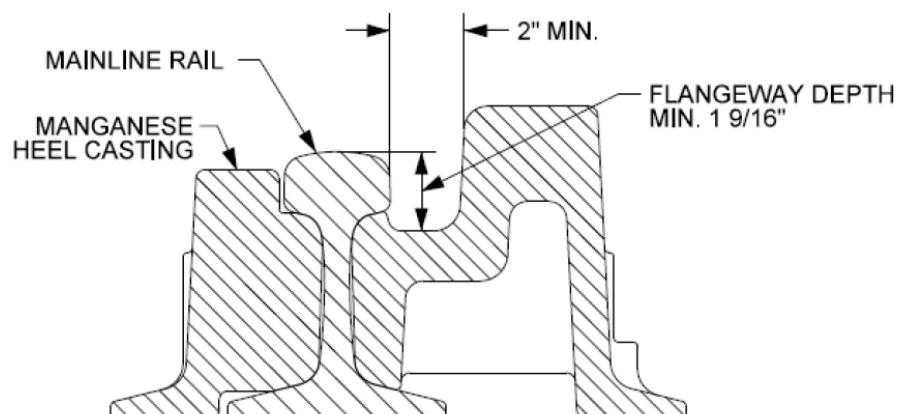
1. Mainline gage through the Flange Bearing Frog must not exceed 57". If 57" is exceeded the frog, place a 25 MPH speed restriction until corrected.
2. Flange Bearing Frogs are limited to 10 MPH turnout side movement.
3. Flange Bearing Frog warning sign must be installed. Care must be taken when hi-railing over Flange Bearing Frogs due to the raised casting potentially contacting the hi-rail wheels.



4. Gage plates must be installed between the mainline rail and the frog itself. Gage plates will help control gage and prevent excessive wheel contact. Figure 6-36.
5. All raised portions of the casting above the mainline rail surface shall be inspected for excessive flange contact during monthly switch inspections. Excessive contact, such as large gouges or extreme amounts of polish, indicate a problem.
6. Shim plates must be installed beneath the turnout side guard rail.
7. Shims help prevent stiff truck derailments of on-track equipment when traversing the turnout side.
8. Gouges in the head of the mainline rail caused by turnout movement flange wear should not exceed 1/2" deep. If 1/2" is exceeded, place a speed restriction of 10 MPH and replace the mainline rail.
9. For Flange Bearing Frogs ensure that mainline rail wear does not allow the flange way depth to be less than 1- 9/16". See Figure 6-37. Measure by using a straight edge on the mainline rail head to simulate the flat tread surface. Do not allow the flange way gap between the mainline rail and casting to be less than 2".



Figure 6-36



MINIMUM ALLOWABLE FLANGEWAY DEPTH ON JUMP FROGS

Figure 6-37

6.5.11 *Spring Rail Frog Inspection and Maintenance Procedure*

Change out rigid or spring rail frogs when headwear on wing rail reaches 1/4 inch.

Power tampers shall not be allowed to lift spring rail frog wing rails or base plates. If a base plate or wing rail is bent or damaged during installation or tamping, the frog shall be immediately replaced or removed from service on diverging route.

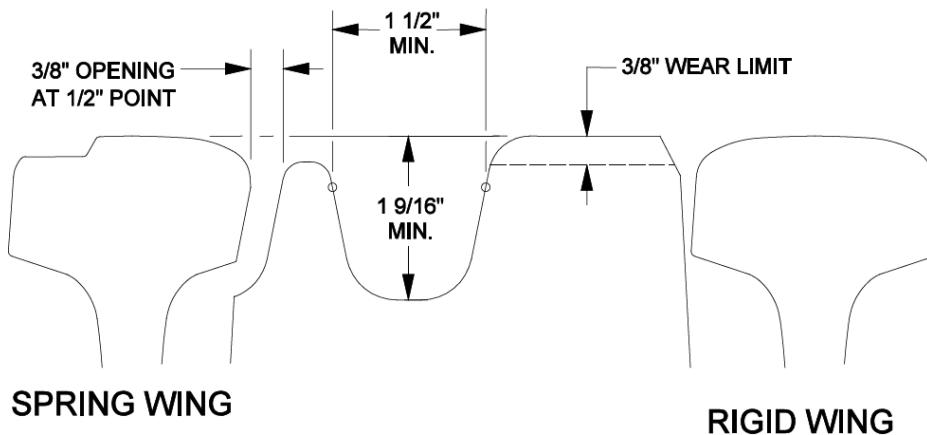
Maintain each spring rail frog so that the outer edge on the wheel tread cannot touch the gage face of the wing rail. During transport and installation in the track and during installation of panel turnouts, spring rail frogs shall be secured with blocks and clamping bars to prevent horizontal or vertical movement of the wing rail.

An inspection and maintenance procedure on frogs are an important part of maintaining good, safe track. Spring Frogs can provide reduced welding maintenance from RBMs if properly maintained. Spring Frogs in Class 2-6 Track are required to have a detailed inspection every 90 days. Due to the moving parts involved with the operation of a spring frog follow these steps to ensure that it is properly maintained.

6.5.11.1 Frog Body

Basic inspection and maintenance items required for all frogs include:

1. Checking for breaks and cracks in the rails and castings.
2. Replacing missing body bolts and keeping bolts torqued to 2000 ft/lbs. A torque wrench can be used, or a standard impact wrench can suffice.
 - 2.1. Thin head body bolts are used along the spring wing on spring frogs. These bolts are not visible in the normal closed position and should be inspected by opening the spring wing with a hydraulic spreader.
 - 2.2. Replacement stud bolts, with a thin jam nut, are available for replacement of these bolts.
 - 2.3. Broken body bolts must be replaced with the thin head variety to ensure that the wing rail will fit properly along the body of the frog.
3. Grinding excess metal flow from the running surfaces to prevent chipping:
 - 3.1. Slot mating surfaces between adjoining rails and castings to a depth of at least 3/16" and slightly beveled at the top.
 - 3.2. Grind gage corners of running surface to a 5/8" radius.
4. Flangeway width not less than 1 1/2".
5. Flangeway depth not less than 1 9/16".
6. Tread wear on casting not worn more than 3/8" as shown in Figure 6-38.



SECTION AT 1/2" POINT

Figure 6-38

7. Excessive wear and breaks on the point within 16" of the 1/2" PF should be repaired. This is the critical area where wheel transition between the point and the wing rail occurs.
8. If the running surface of the frog is worn or broken to the point where there are indications that the outer edge of the wheel is contacting the side of the spring wing rail, the frog must be repaired or replaced.
9. Track gage should not be less than 56 1/4" or more than 56 7/8".
10. Guard check gage should not be less than 54 1/2" on frog with a standard point. A heavy point frog guard check gage is 54 7/16".

6.5.11.2 Handling

1. The spring wing is sensitive to movement. A two or four leg sling should be used during handling to minimize bowing or sagging.
2. If a toe block is not designed into the frog, ensure that the match marks on the wing rail and frog body are lined up when installed. This will ensure that the spring wing is set correctly in relation to the frog body and horns centered in the hold-downs.

6.5.11.3 Surface and Line

1. Good tie condition and surface must be maintained throughout the frog area. Poor surface or cross-level can cause binding of the spring wing and place unnecessary pressure on the spring assembly.
2. Line should be maintained to minimize unequal bearing of the spring wing against the point rail. Unequal bearing and continual slapping of the spring wing can cause point failure and the spring wing to lose its bend set.
3. Tamping with automated equipment can bend the plates and may restrict the opening or closure of the spring wing if precautions are not taken. Auxiliary jacks should be placed under the far rail of the turnout opposite the tamper when surfacing through the frog area to assist in lifting. The rail clamps of the tamper should not be used to grab and lift the wing rail or plating anywhere along the base plate supporting the frog on the spring wing side. See Figure 6-39.

Do not lift frog on the spring wing side in this area with automated tampers

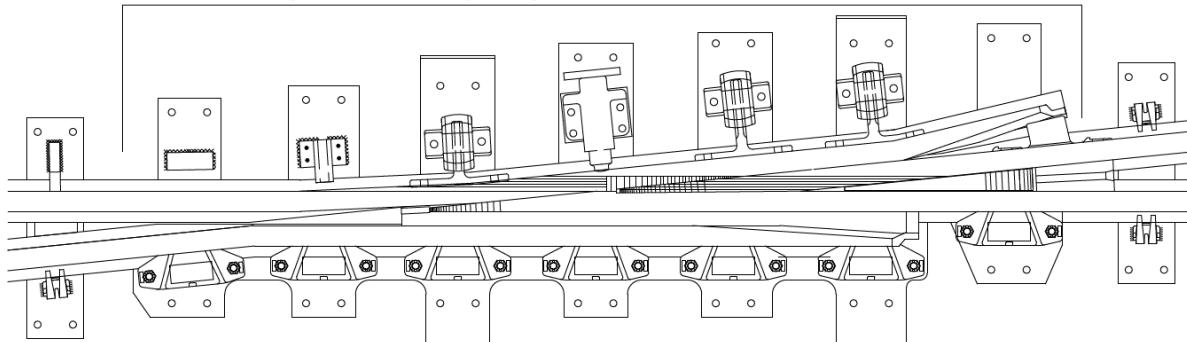


Figure 6-39

4. Inspect base plates for damage after tamping operation if automated equipment is used.
5. Spring frogs should be hand tamped to avoid damage and ensure proper ballast distribution under frog body.

6.5.11.4 Toe Area of Frog

If there is a bolted joint:

1. Make sure all the bolts are in and tight.
2. Check rail ends for chipping or batter. Chips and batter should be repaired promptly and joint slotted with a slotting wheel no thicker than 5/32".
3. Carefully inspect the joint bars for any cracks. A joint bar with any type of crack must be replaced.

If there is a toe block, be sure the bolts are the correct size, in place, and tight. The toe block provides a hinge point and helps to minimize longitudinal movement of the spring wing.

Check the tie condition under the toe to ensure that the ties are in good condition and solidly tamped. This is very important to minimize any vertical movement of the spring wing.

6.5.11.5 Spring Wing

1. Check the gap between the frog point and wing rail in the closed position. The design gap is 3/8 inch. A gap of no more than 3/4 inch should be maintained.
2. Check the alignment of the spring wing along the frog body. The spring wing should fit up against the body of the frog along the entire straight portion of the rail.
3. If the spring wing is not set correctly against the frog body a closer inspection of the situation should be made to determine the cause. Some of the possibilities would include:
 - 3.1. Inadequate anchoring – Inspect the anchor pattern. All switch ties and track for 200' each sides of the turnout should be fully box anchored to the extent possible. Check the anchors to be sure they are the correct size for the rail, and they are up against the sides of the ties.
 - 3.2. Spring box failure – Check that the spring box is in place and springs and spring retaining bolts are in good condition.
 - 3.3. Retarder failure- If the retarder malfunctions it may not slow the wing rail. If there is no retarder, or the retarder is not functioning properly the constant impact of the wing rail against the frog body may cause point or wing rail failure, or the wing rail to lose some of its bend set.

If a retarder fails, limit operating speed to 20 MPH through the turnout and replace or adjust the retarder.

4. A hydraulic spreader jaw should be used to check the maximum wing rail opening width. Place the hydraulic spreader jaw in the throat of the frog just ahead of the point. On manganese insert frogs, the cylinder end of the jaw should be placed on the moveable wing rail so that the tabs of the spreader bracket fit underneath the rail head. This orientation will help anchor the cylinder to prevent it from dislodging. On all rail frogs the cylinder may be used in either orientation.



Insure that the spreader bracket is securely screwed into the cylinder head. If it is loose, there is potential of the bracket head breaking off the cylinder.

Care must be taken when operating the spreader jaw. Do not place yourself in a position directly over the jaw when it is under pressure in the event that it would slip out. Generally, a 1,400 to 2,000 PSI gage reading is all that should be required to open up the wing rail to the fully opened position. If the force is approaching the red area on the gage take pressure off the spring to reduce the force required to open the wing.

Note: Many spring rail testing kits come with a conversion table to convert lbs. to PSI. Make sure to follow this chart to avoid damaging the testing kit.

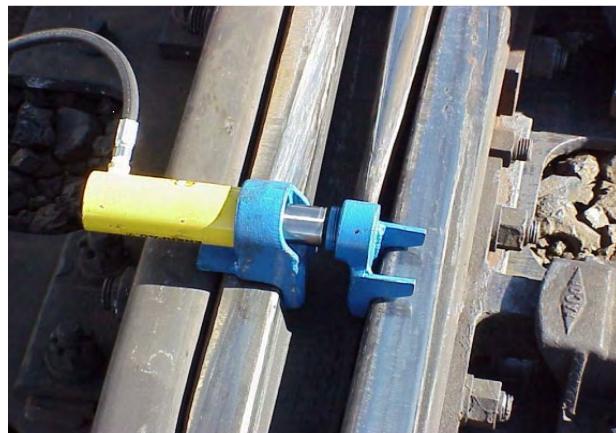


Figure 6-40

5. Begin by loosening the adjustment bolts to relieve spring tension. Reducing the pressure on the spring will prevent excessive pressure being placed on the spreader head. Failure to loosen bolts will put excessive pressure on the spreader and may cause it to crack, by loosening spring tension prior to testing the spreader can more easily spread the wing. Use the jaw to open the wing until it is up against the rail stops. Measure the spring wing flange way opening at the Frog Point. Adjust wing rail stops if flange way opening is more than 2".
6. Inspect the flange way area and the area over which the spring wing travels. This area should be kept clear of sand, dirt, snow, ice, and foreign material. During times when snow and ice can be expected these must be cleaned or a method of heating or de-icing put in place. This must be performed to prevent a build-up of material under the wing rail or in the flange way that would hold the wing rail open or force the wing to rise up off the base plate. With the wing rail in an open position or raised up, a passing wheel with a false flange could get down below the railhead and roll the wing rail causing a derailment.
7. Inspect the wing rail railhead. Check for any indications where the outer edges of the wheel may be contacting the railhead. This can be caused by:
 - 7.1. Excessive tread wear on the frog body. In the case of an all rail frog, the frog should be replaced. In the case of a manganese frog the casting may be repaired by welding if the contact area is resulting from a localized defect.
 - 7.2. Excessive vertical rail movement caused by a buildup under the wing rail, in which case the flange way and base plate area should be cleaned.
 - 7.3. Excessive movements between hold downs and horns, in which case the clearances between these components should be adjusted.

6.5.11.6 Horns and Hold Downs

1. Each horn and hold down should be inspected for breakage or cracks. Damaged or worn horn and hold down assemblies may permit the wing rail to rise sufficiently to allow the outer edge of a wheel to contact the side of the wing rail and roll it out.
2. Forged components may be repaired by welding in the field. If two or more horns or hold down sets have required welding repair within 3 months, the frog should be considered for replacement.
3. Cast components that break or develop cracks should be replaced. Bolt torque securing the horn and hold down assembly should be maintained at 600 ft/lbs.
4. Inspect each horn and hold down for wear. Excessive wear on the top and bottom of the horns and hold downs can be an indication of vertical rail movement. Excessive vertical rail movement can be caused by:
 - 4.1. Poor surface
 - 4.2. Poor ties.
5. Excessive wear on the sides of the horn and hold down can indicate misalignment of the wing rail. Misalignment of the wing rail can be caused by:
 - 5.1. Inadequate anchoring through the turnout (especially on frogs without toe blocks).
 - 5.2. Insecure base plate
 - 5.3. Insecure toe (Broken joint bars. Broken, missing or incorrect size toe block or joint bar bolts)
 - 5.4. Loss of bend set on the wing rail (Missing or inoperative retarder)
6. The horn and hold down area should be lubricated with an approved switch plate lubricant to reduce wear and binding.
7. The clearance between the top of the horn and the hold down should not be more than 3/16". The clearance between the bottom of the horn and the hold down should not be more than 1/4". The clearance between the side of the horn and hold down should be a minimum of 3/16". These measurements should be taken at both the front and rear of the hold down assembly. A tape measure or ruler may be used where the horn can be plainly seen. Where the end of the horn is obscured by the hold down, a taper gage with a range capacity of at least 3/8" should be used. Measurements that do not meet the 3/16" criteria must be corrected:
 - 7.1. A forged hold down may be heated on top and hammered down until the 3/16" clearance requirement is met. (Figure 6-41)

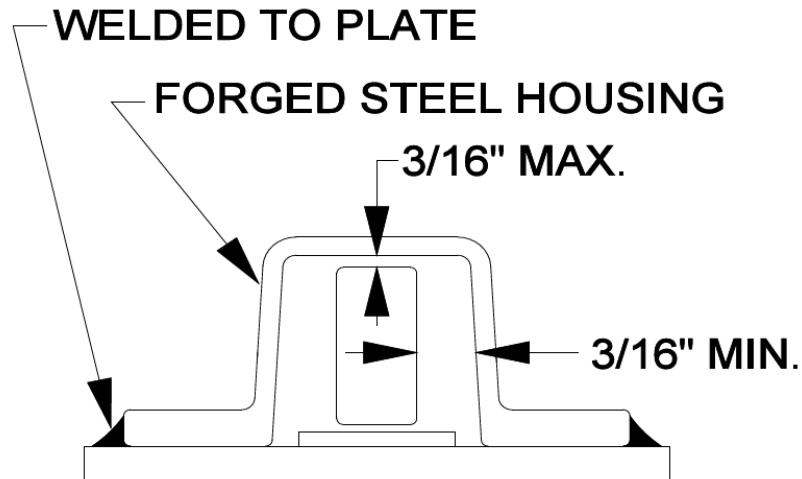


Figure 6-41

- 7.2. With a cast assembly, the horn can be turned over or replaced, the hold down is reversible and replaceable, and the riser pad can be rotated, reversed or replaced. (Figure 6-42)

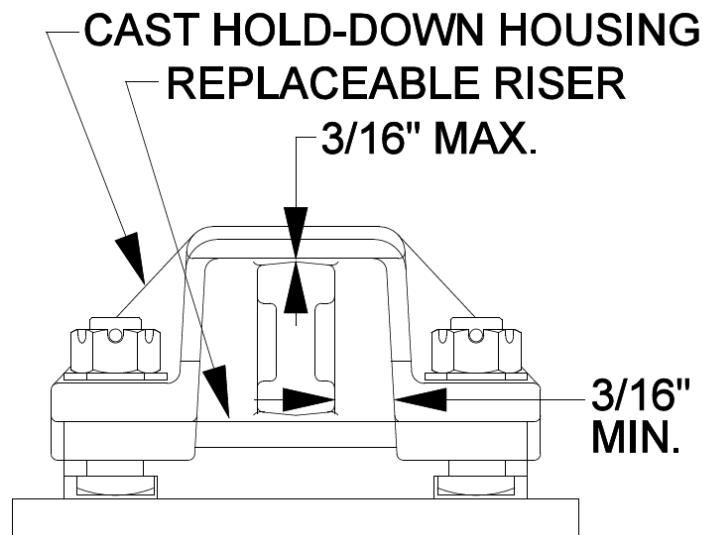


Figure 6-42

6.5.11.7 Spring Box Assembly

1. Inspect the spring box assembly to ensure sufficient pressure is being exerted to overcome the force exerted by the frog retarder and hold the spring wing against the frog body in the closed position. The normal force exerted by the spring box plunger against the rail is approximately 600 lbs.
2. Check the retaining nuts on the back of the spring housing to ensure they are in place.
3. The hydraulic spring testing device should be used to check the force exerted by the plunger against the side of the wing rail.
4. The jaw should be placed over the tapered portion of the spring plunger as shown in Figure 6-43.
5. The hand pump should be operated slowly until the plunger is first seen to move.
6. The reading on the gage should then be noted.
7. Release the pressure and repeat steps a second time.
8. The average of the two readings will give an indication of the force.



Figure 6-43

9. The green area of the gage (4000 – 5200 PSI) shows the acceptable range for the spring force reading. If the spring force gage reading is below 4000 PSI, in the white area of the gage, the spring pressure should be increased by tightening the nuts on the retaining bolts until the force can be brought to this minimum. If the gage reading is in the red area, above 5200 PSI, and there is no hydraulic retarder attached to the wing rail, loosen the retaining nuts until the force can be brought down into the green area, between 4000 and 5200 PSI. Before adjusting the spring force on frogs that have hydraulic retarders attached, check the closing time of the wing rail as described in the section on the hydraulic retarder.

NOTE: PSI will be determined by recommendation of manufacturer

10. A 1/8" of movement of the retainer nuts should equal approximately 500 PSI of force. If force cannot be obtained the springs in the plunger must be replaced.



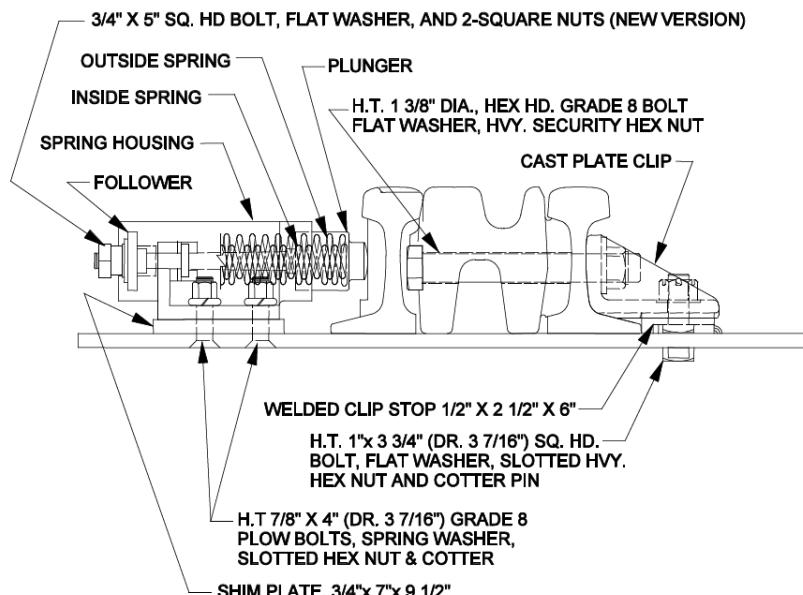
6.5.11.8 Spring Replacement

To replace a broken spring (see Figure 6-44) the nuts on the retaining bolts should be loosened alternately 1/2" at a time until there is no spring pressure felt against the follower backing plate.

1. Remove the retainer bolts and follower plate.
2. Pull out weak or broken springs. Pull plunger out to ensure all the pieces of a broken spring are removed.
3. A coating of lithium or switch plate lubricant should be applied to the inside of the housing to assure that the plunger will continue to slide smoothly in and out.
4. Where a double spring is used in the spring box. Both springs should be replaced at the same time if available.

To re-assemble the spring assembly, follow these steps:

1. Ensure that the wing rail is closed up against the frog body and the spring box plunger is up against the wing rail.
2. Insert the new spring(s) in the spring housing, place the back cover over the retaining bolts and push the springs up against the back of the plunger.
3. Screw the nuts on both retaining bolts up against the backing plate.
4. Mark the bolt with chalk or crayon at the point where the nut is now located.
5. Alternate tightening the nuts on the retaining bolts in 1/2" increments until 1" of travel has been achieved as verified from the mark on the bolt. This will give the 1" pre-load designed into the spring pack to achieve the force from the plunger into the wing rail.
6. Using the hydraulic force gage, verify that manufacturer's recommended PSI force has been attained.
7. If the required force has not been attained adjust the nuts on the retainer bolts.
8. Repeat last 2 steps until the required force is obtained.



SECTION THRU SPRING HOUSING

Figure 6-44

6.5.11.9 Hydraulic Retarder

A hydraulic retarder is used to slow the movement of the wing rail return between passing wheel sets. The amount of time that the retarder allows the wing rail to return to its normal position will vary. A range of between 30 seconds and 3 minutes is acceptable. Retarders should be installed per manufacturer instructions. Ensure that the steel bushing is present in the wing and plate brackets before installing retarder.

1. If the retarder is not operating properly it may fail by:
 - 1.1. Offering too much resistance against the spring box and holding the wing rail open. This allows foreign matter to fill the spring wing flangeway and also causes point wear and added impact loading due to the wheels now having to jump a flangeway gap.
 - 1.2. Offering too little resistance against the spring box allowing the wing rail to quickly close between wheel sets. This can cause premature spring failure, plate wear, bolt and point failure, and added impact loading on the spring wing which can cause it to crack or lose its bend set.
2. Visual inspection of the frog retarder:
 - 2.1. Observe that the unit is not physically damaged or broken.
 - 2.2. Check to make sure the bolts holding the retarder and wing rail bracket are in place and tight.
 - 2.3. Look for any signs of oil leaks on the body of the retarder or on the ballast underneath the unit that might indicate it is failing.
3. To check the retarder mechanically:
 - 3.1. Check the spring box pressure against the wing rail.
 - 3.2. If the spring pressure is within the manufacturer's recommendation on the force gage, then proceed to the next step. If the spring box pressure is not at an acceptable level, see the previous section concerning spring box inspection before proceeding.
 - 3.3. Use the hydraulic wing rail spreader jaw to open the wing rail until it hits the stops that are welded on the frog plates.
 - 3.4. If any foreign material is observed in the flangeway opening use a stick or broom to remove it.
 - 3.5. Release the pressure in the spreader jaw and observe the movement of the wing rail.
 - 3.6. If the wing rail does not close within a 30 second to 3-minute range, use a lining bar near the heel of the wing rail trying to force wing rail toward the frog body.
 - 3.7. If the wing rail now closes on its own, observe if there are any shiny areas on the plate where the wing rail may have been binding. If the plate is bent, it should be heated and straightened. Clean the plate area over which the wing rail travels and apply an approved switch plate lubricant to the base plate area.
 - 3.8. Inspect the horn and hold down assemblies to determine if any binding is occurring in this area. Apply an approved switch plate lubricant to the horns and hold downs.
 - 3.9. Repeat the process.
 - 3.10. If the wing rail still does not close within the specified time, observe the lubricated area and check if there is spot where the wing rail is dragging. Check the surface along the frog. If there is any deviation in uniform surface more than 1/8" it should be corrected.
 - 3.11. Repeat the process.
 - 3.12. If the wing rail still does not close the retarder should be replaced.

6.5.11.10 *Retarder Replacement*

Note: Retarders are shipped from the manufacturer preset with a 20-5/8" length between the mounting brackets. This is done to ease the installation, so a minimum of adjustment is necessary to line up the holes of the frog brackets with those of the retarder brackets. Do not compress the retarder before installing it, as it will be extremely difficult to expand out to reach the frog bracket. If the retarder does become compressed, use the hydraulic wing rail spreader to open the wing rail a sufficient distance to allow the mounting brackets to line up. Be sure to block the wing rail open before attempting to line up the bolt holes.

1. If the retarder has failed holding the wing rail open, place a block in the wing rail flangeway to prevent the wing rail from moving until installation is complete.
2. Remove the old retarder by removing the bolts attaching it to the wing rail and plate brackets.
3. Check the brackets on the wing rail and frog plate to confirm:
 - 3.1. Wing rail bracket is tight
 - 3.2. Rear plate bracket is not bent or twisted
 - 3.3. Hardened steel bushings are in place in bracket bolt holes.
4. If not already performed, check spring pressure against the wing rail in the closed position as described in the Spring Box Assembly section.
5. Attach retarder to brackets according to manufacturer instructions.
6. Apply an approved switch plate lubricant to the base plate over the area where the wing rail will travel and on the horns.
7. Test the retarder operation by opening the wing rail with a hydraulic wing rail spreader tool until a 2" flangeway opening is obtained at the point where the retarder attaches to the wing rail.
8. Release the jack pressure and observe the time it takes for the wing rail to close. A closing time of 30 seconds to 3 minutes is acceptable.
9. If the closing time falls outside the acceptable range. Refer to Section 6.5.11.9 Hydraulic Retarder for Procedural Inspection Process.
10. If adjustments fail to bring the retarder within the specified range, it should be replaced.

6.5.12 Welded Spring Manganese (WSM) Frogs

1. A special stainless-steel weld between the manganese casting of the frog and the running rails is used on these frogs, see Figure 6-45.
2. Fully inspect the area within 6" of either side of the weld for cracking. If any cracks are present, place a 10 MPH speed restriction until frog is replaced.
3. Inspect the outside edges of the manganese casting for signs of cracking. If cracking in the casting base is found place a 40 MPH speed restriction on the frog until replaced. If the cracking extends to within 2" of the top running surface of the casting place a 10 MPH speed restriction on the frog until replaced. For a sample crack see Figure 6-46.



Figure 6-45

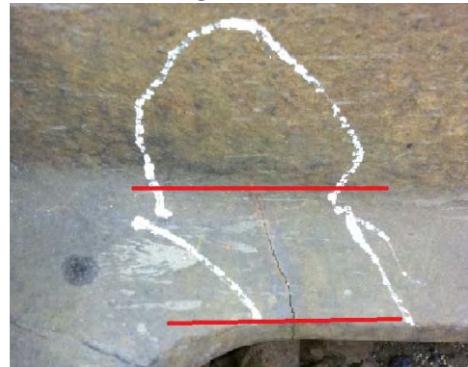


Figure 6-46

6.6 Turnout Maintenance

Turnout maintenance shall, at all times, conform to 49 CFR 213 parts 133- 143, 233, and 235 for minimum inspection and maintenance regulations. Inspect and maintain all switches and frogs in accordance with SCRRRA Standards. Track and signal personnel must inspect each main track turnout jointly each quarter using form in Appendix C. For further details on switch inspection and maintenance, see SCRRRA standards.

Note: On controlled track, notify the Signal Department in advance when: Changing rails, frogs, switch points, or switch stands. Performing work that may compromise the integrity of the signal system.

6.6.1 *Speeds through Turnouts*

Unless otherwise approved by SCRRA, the maximum allowable speeds through the diverging route of a lateral turnout installed in tangent track are shown in Table 6-6 per SCRRA Standard ES2208.

Note: Any conflicting Special Instructions or General Orders will supersede any speed posted in Table 6-6.

PASSENGER						
TURNOUT NO	TANGENTIAL		STANDARD		EQUILATERAL (MPH)	DOUBLE SLIP (MPH)
-	SWITCH LENGTH (POINTS)	MPH	SWITCH LENGTH (POINTS)	MPH	-	-
8	-	-	16' - 6"	12	N / A	12
9	-	-	16' - 6"	12	N / A	N / A
10	21' - 6"	25	16' - 6"	20	N / A	15
11	-	-	19' - 6"	20	N / A	N / A
14	29' - 0"	35	26' - 0"	30	N / A	N / A
15	-	-	26' - 0"	30	N / A	N / A
20	47' - 0"	50	39' - 0"	45	70	N / A
24	61' - 6"	60	39' - 0"	55	85	N / A
30	82' - 0"	75	-	N / A	110	N / A

FREIGHT						
TURNOUT NO	TANGENTIAL		STANDARD		EQUILATERAL (MPH)	DOUBLE SLIP (MPH)
-	SWITCH LENGTH (POINTS)	MPH	SWITCH LENGTH (POINTS)	MPH	-	-
8	-	-	16' - 6"	10	N / A	10
9	-	-	16' - 6"	10	N / A	N / A
10	21' - 6"	15	16' - 6"	15	N / A	10
11	-	-	19' - 6"	15	N / A	N / A
14	29' - 0"	25	26' - 0"	20	N / A	N / A
15	-	-	26' - 0"	20	N / A	N / A
20	47' - 0"	40	39' - 0"	35	50	N / A
24	61' - 6"	50	39' - 0"	40	60	N / A
30	82' - 0"	60	-	N / A	80	N / A

Table 6-6

6.6.2 Switch Rods

1. Repair or replace transit clips, helper rods, connecting rods and switch rods that are bent or broken.
2. Ensure that all bolts are in place. Do not over tighten the bolts connecting the switch rods and transit clips. This connection must be allowed to pivot as the switch is thrown for proper operation.
3. Clean ballast and foreign material out from the connecting rod and switch rod cribs for a distance of 2 inches below the rod, as shown in Figure 6-47.

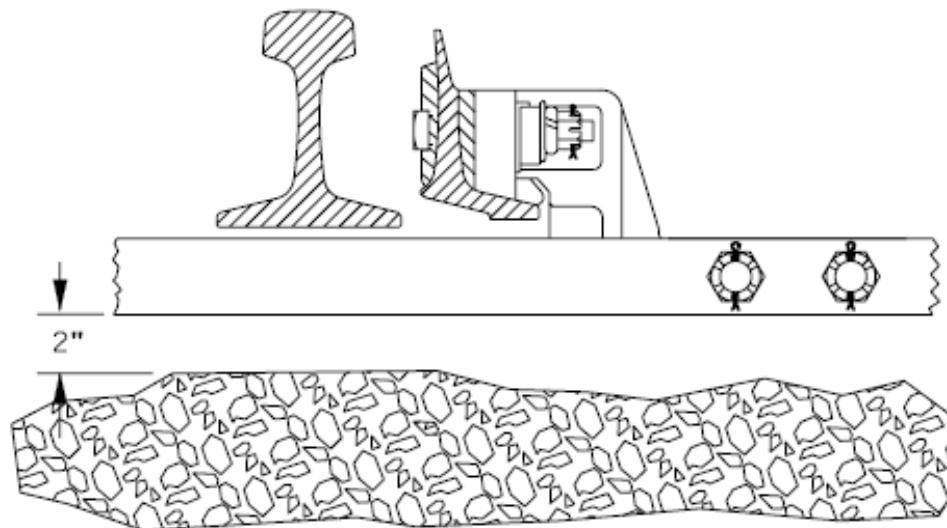


Figure 6-47

6.6.3 Switch Points

1. Paint switch point tips white to show wheel wear and to aid in switch point inspection.
2. Check the condition of the switch point stops and make sure they are intact and tight.
3. Switch point rollers, if installed, should turn easily. Lubricate or replace rollers as needed.

6.6.3.1 Switch Point Throw

Maintain the throw (dimension between the back of the switch point and the gage side of the stock rail) at 4-3/4 inches at the No.1 switch rod at hand-throw switches (and 4-1/2 inches for power-operated switches), as shown in Figure 6-48.

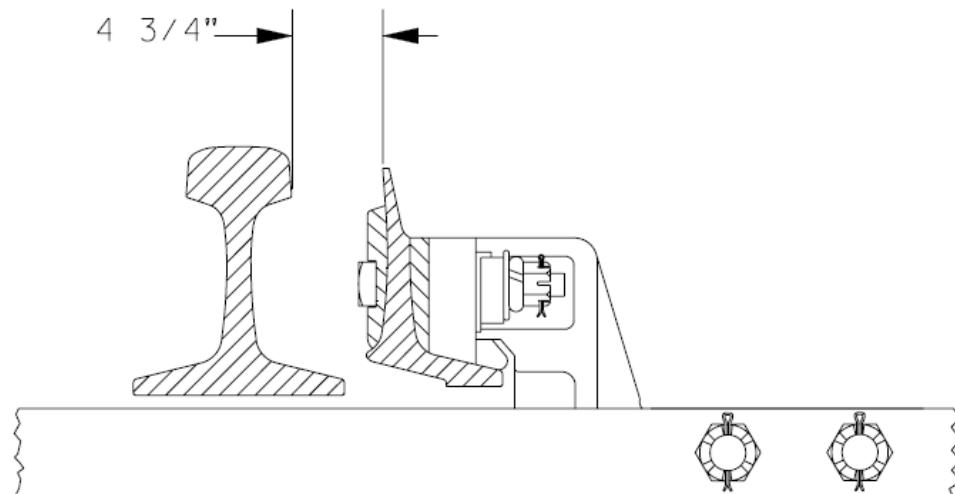


Figure 6-48

EXCEPTION: Tangential design turnouts may have throws up to 7 inches.

6.6.3.2 Switch Point Fit

Grind off metal flow on the stock rail and switch point that prevents the switch point from fitting up flush against the stock rail. Readjust the point for a tight fit. See Figure 6-49.

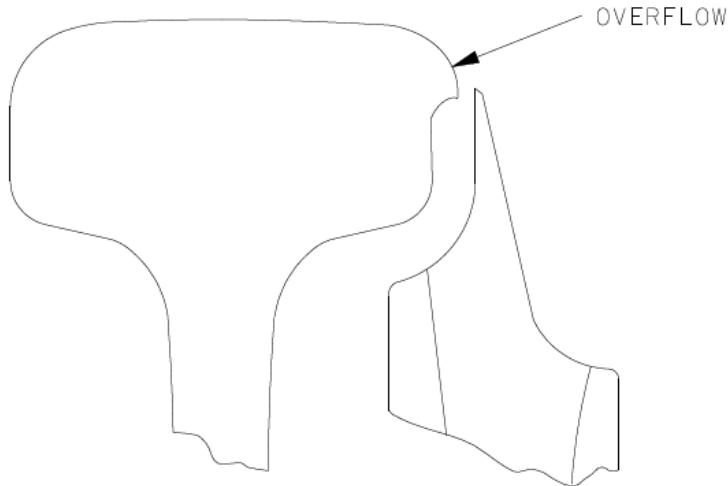


Figure 6-49

Limit switch points to a maximum of 1/2 inch vertical movement at the tip when the switch point is closed against the stock rail. Calculate this measurement by adding the measurement of the clearance between the top of the No. 1 rod and bottom of the stock rail and the measurement between the bottom of the switch point with the top of the base of the stock rail. See Figure 6-50.

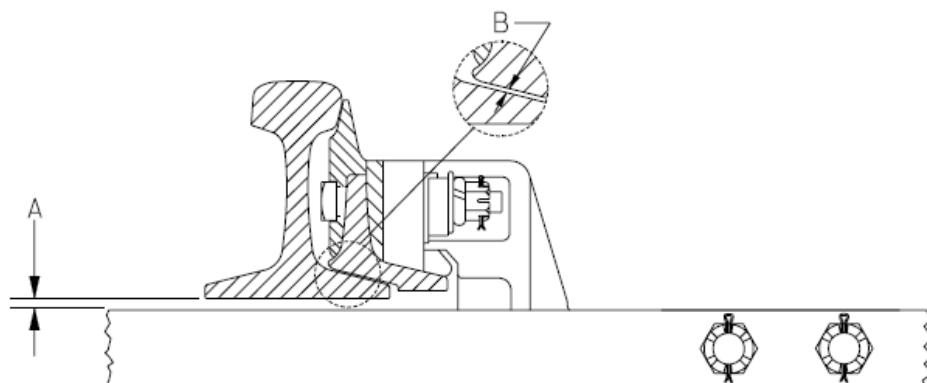


Figure 6-50

6.6.3.3 Switch Point Wear

Repair or replace a switch point that is worn down or chipped so that the top is more than 7/8 inch below the plane across the top of the stock rail. If switch point cannot be replaced prior to train traffic, place a 10MPH speed restriction until replaced. See Figure 6-51 and Table 6-7.

MAIN TRACK SWITCH POINT CONDITIONS REQUIRING CORRECTIVE ACTION

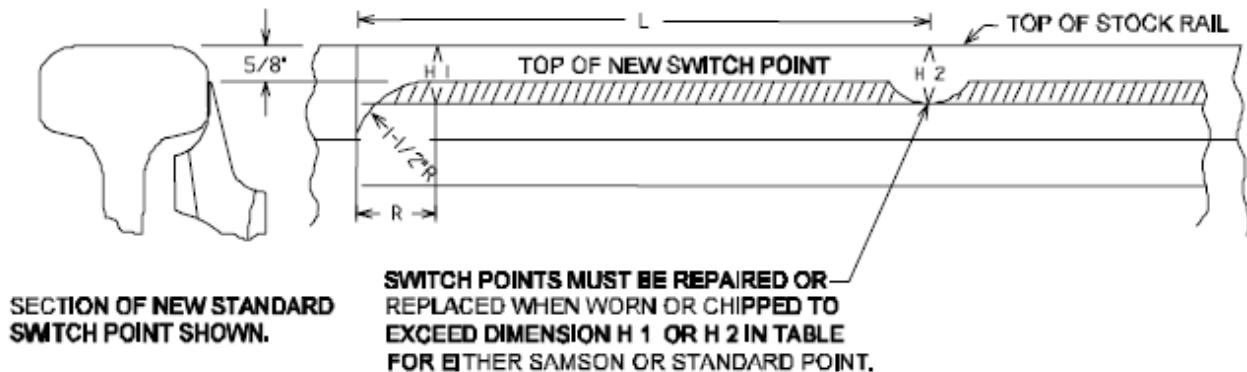


Figure 6-51

Length of Switch Point	Distance			
	R	H1	L	H2
Up to 19'6"	1-1/2"	7/8"	over 10"	3/4"
19'6" or over	1-1/2"	7/8"	over 16"	3/4"

Table 6-7

Repair or replace a switch point that is chipped and has an unprotected vertical surface that is 5/16 inch or wider 3/4 inch below the top of the stock rail as indicated by Figure 6-52.

MAIN TRACK SWITCH POINT CONDITIONS REQUIRING CORRECTIVE ACTION

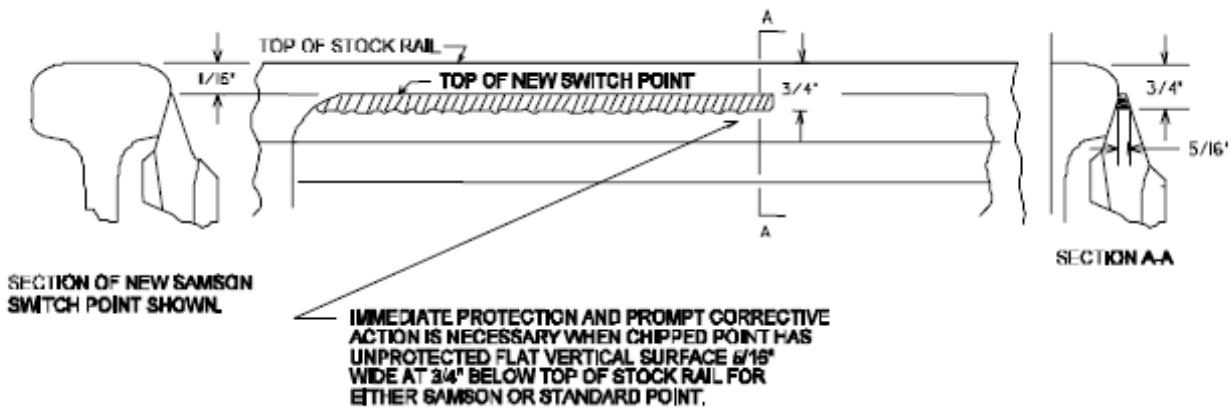


Figure 6-52

Lightly lubricate switch point tips with switch plate oil or lubricant to prevent excessive wear.

Switch points should rise a minimum of 3/16 inch above the stock rail where the wheel transfers from the switch point to the stock rail. This prevents the outer edge of the wheel tread from contacting the gage side of the stock rail. If this measurement falls below the 3/16-inch limit, replace the switch point and stock rail. See Figure 6-53.

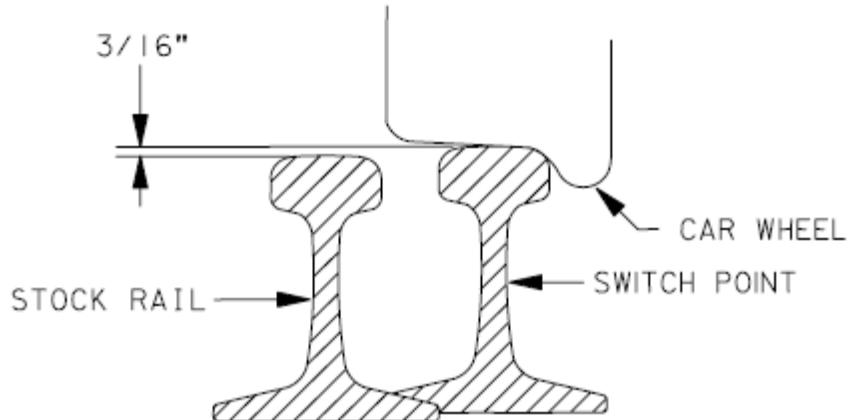


Figure 6-53

6.7 Derails – Permanent and Portable

Install all derails per SCRRRA Standard ES2601.

Derails are required on all tracks where equipment may foul the main line or a controlled siding. All mainline routes require the use of derails on all industrial or auxiliary tracks that connect to the main line or sidings.

Note: Derails shall be located so that they derail equipment in a direction away from the primary track. Derails shall be located beyond the clearance points of converging tracks.

6.7.1 *Derail Types*

There are 3 primary derail types allowed on SCRRRA property:

1. Hinged or Sliding Derails
2. Double Point Derails
3. Portable Derails

For Derail Requirements, refer to SCRRRA Standard ES2601.

Refer SCRRRA Standard ES2613 and ES2614 for Bi-Directional Derail with Crowder which is only allowed if currently installed and not for new installations.

All new installations of derails as outlined above shall be the double switch point type SCRRRA Standard ES2604.

6.7.2 Hinged or Sliding Derail Installation

When using a hinged or sliding derail it is critical to ensure it is the correct size to match the rail height and that it comes fully locked when closed. See SCRRRA Standard ES2613 and ES2614 for detailed installation instructions.

To size the derail, take the measurement from the top of the ties at the installation location to the top of the rail using a straight edge set across the top of rail. This measurement in inches will indicate the size of the derail. For example, 7" will be a size 7 derail. If the measurement is 7.5" then a size 7 derail will be required with a 1/2" shim to bring the height to 7.5". Figure 6-54 shows a correct installation.

If sliding derail does not come down directly on top of the rail (sits above the rail head and will not come down on top) try moving the derail away from the rail slightly. This should allow the derail more room to slide down onto the railhead. If this does not work, go to the next size smaller derail. If the sliding derail is hitting the rail head a size bigger derail or additional shimming is needed. Larger or smaller tie plates can also be used to move the head of the rail up/down.

To secure the rail use a cutoff tie plate that does not protrude beyond the base of the rail on the gage side. Plate can be cut on one end by a welding torch.

Correct Installation



Figure 6-54

1. This derail correctly locked into place. The thrust shaft is barely visible and there is no gap between the thrust shaft and the front seat.
2. This was a size 7 derail installed at a location with a measurement of 7" from the top of the rail to the top of the tie.
3. By visually inspecting the derail looking to make sure this thrust shaft is resting on top of the front seat is a visual indication that the derail is locked into place.

6.7.3 Use of Portable Derails

Portable derails are to be used only for temporary applications where permanent derails cannot be installed. Portable derails must be applied per the procedure below.

Portable derails may not be used to protect tracks with grade greater than 0.25% ascending away (uphill).

Note: Portable derails must be stored inside a locked tool box or storage box on vehicles or inside of a locked storage facility.

Any portable derails that are struck by equipment must be discarded and replaced.

Portable Derail Installation Procedures:

1. Select a location with a solid cross tie to install the derail.
2. Loosen set screw and screw handle of the derail.
3. Determine the direction of traffic to be protected against as it will dictate the required orientation of the derail. Position the derail on the inside of the rail with the graduated teeth section facing away from the direction of traffic.

CAUTION: Ensure the derail is level and parallel to the rail.

4. Position the graduated teeth securely against the corner of a cross tie or tie plate on the inside of the rail.
5. Adjust set screws on the field side of the derail to fit securely under the head of the rail.
6. Hand-tighten the screw handle of the derail to secure derail to rail.
7. Install padlock.
8. Install warning flag 50' in front of derail.

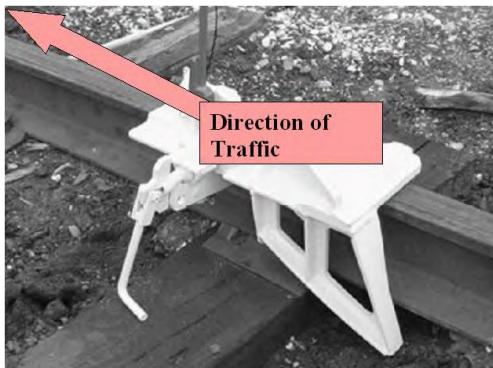


Figure 6-55

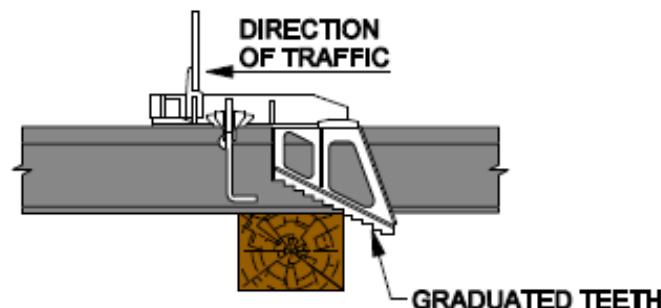


Figure 6-56

6.8 Foul Point

Ensure the foul point on auxiliary and yard lead tracks are clearly marked at 13' clear point with white paint. If paint is faded repaint.

6.9 Frog Grinding and Slotting

1. Grind flowed metal from frogs as needed to maintain a 5/8-inch radius on the gage corners of all castings and/or rail pieces. Grinding is especially important with new installations while the metal is being work hardened.
2. When grinding, do not remove metal below the gage corner in the flangeways except in conjunction with welding repairs. Gages as the one shown in Figure 6-57 can be used to measure proper radius of the gage corners of the casting.

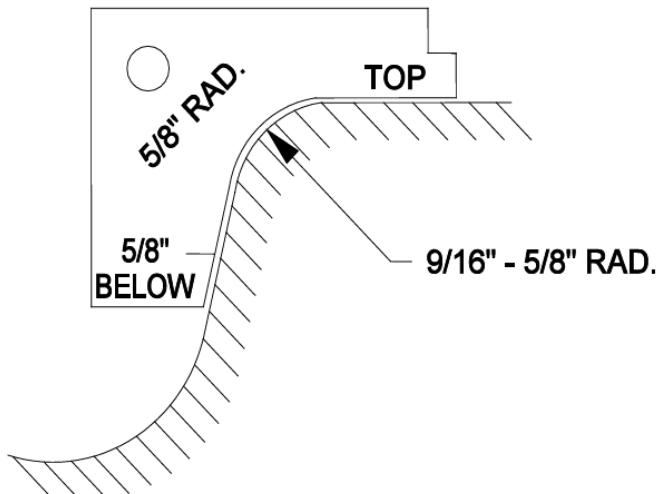


Figure 6-57

3. Use a slotting type grinding wheel to remove flowed metal from all mating or joining surfaces between the frog casting and/or rail pieces. Components should be slotted to a depth of 3/16 inch and slightly beveled at the top.

6.9.1 *Manganese Frogs and Crossings*

1. Grinding: Grinding maintenance shall be performed on all newly installed manganese frogs and diamond crossings to improve quality and to extend the lifecycle of these components. Inspect new manganese turnout frogs and crossing castings or recently welded castings periodically, checking for any metal flow, which might have occurred during the work hardening process of the manganese. Grind off any bead or ridge from the top edges of the casting. Confine grinding to the top edges where the bead or ridge forms. Grind a radius of 3/8 inch to 5/8 inch. Do not leave any sharp edges or square corners. Perform this procedure a number of times until the unit is fully work-hardened.
 - 1.1. Slot grind at regular intervals. Include areas where manganese castings are in rigid contact with binder rails, the mating surface between long and short point rails, the heel of frog castings and rail joints at the ends of crossing and/or turnout frogs.
2. Welding: Manganese turnout frogs and crossings need to be repaired in the following situations:
 - 2.1. Cracks have developed
 - 2.2. Depressions have developed
 - 2.3. Wear exceeds standards
 - 2.4. Spalling, cracking, chipping or casting defects have surfaced
3. Prior to welding, tighten all loose bolts and correct all track conditions such as faulty ties, irregular surface, misaligned track, and incorrect guard rail flangeway width.
4. Remove work hardened surface metal and defective material by grinding or with arc air before welding on casting. Weld using electric arc process only. Use only electrodes or wire feed welding metals designated for repair of manganese steel special trackwork. The temperature of a track casting must not exceed 700 degrees F in any area during a welding operation.
5. Control thermal stress. Weld bead size shall be no more than 5/8 inch in width. Peen weld deposits in severely restricted areas.
6. After completing the weld, check clearance and build up the carbon rail components, as necessary, to match level of the casting on such components as wing rails, long point rails, and short point.

6.9.2 *Welding Carbon Rail Frogs and Crossings*

1. Repair battered or chipped areas of carbon rail frogs or crossings by building up worn or damaged areas to match the contour.
2. Before doing any welding, tighten all loose bolts and check frog or crossing for gage, alignment, surface, and tie irregularities. If unsatisfactory conditions exist, correct them before proceeding.
3. Check for worn or damaged areas with a straight edge to determine area to be built up. Grind to a depth of approximately 1/16 inch in order to remove work-hardened metal. Grind chipped, flaking, or spalled metal until reaching sound metal.
4. Preheat head, web, and base of rail to 600 degrees F in areas to be welded. In point area of the frog, where filler blocks cover the web and the base of rail, pre-heat only the railhead.
5. Grind the welded area (web and base) so that the surface is as level as possible and that it conforms to the contour of the entire unit.

6.9.3 *Approved Welding Procedures*

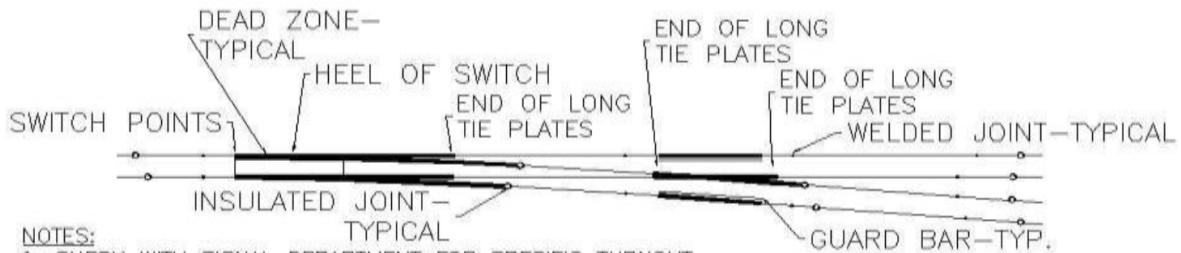
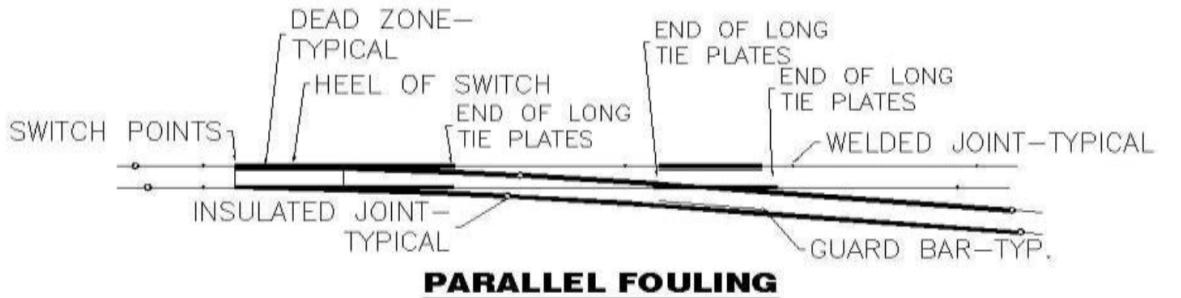
1. Repair of manganese steel track casting (except manganese tip switch points in main track) including cracks, casting defects, and batter or wear.
2. Binder rails on rail bound manganese frogs and diamond crossings (excluding cracked or broken rails).
3. Repair carbon rail frogs and diamond crossings (excluding spring wing rail on spring frogs).
4. Weld "A and B" plate stops on frog gage plates.
5. Weld hold down boxes on spring frogs.

6.10 Dead Zone Locations

A Dead Zone is an undetectable section of track that results from rails not being insulated from each other. Rail in the following locations may be in a Dead Zone.

1. Some locations on turnout ties
2. Ends of sidings from behind turnout up to insulated joint at clearance point
3. Rail crossing diamonds
4. Puzzle switches
5. Road crossings next to flange rails
6. Next to guard rails in advance of switch points
7. Long bond locations
8. Insulated joints from end post to track wire

Locations described above are illustrated in the following diagrams. Figure 6-59 shows the Dead Zones in a normal turnout signaled with a single-battery and a two-battery circuit. Figure 6-60 shows the Dead Zones in a typical crossover (note crossover is broken into two parts). Contact SCRRRA if you have any questions about the actual protection provided in a specific turnout.

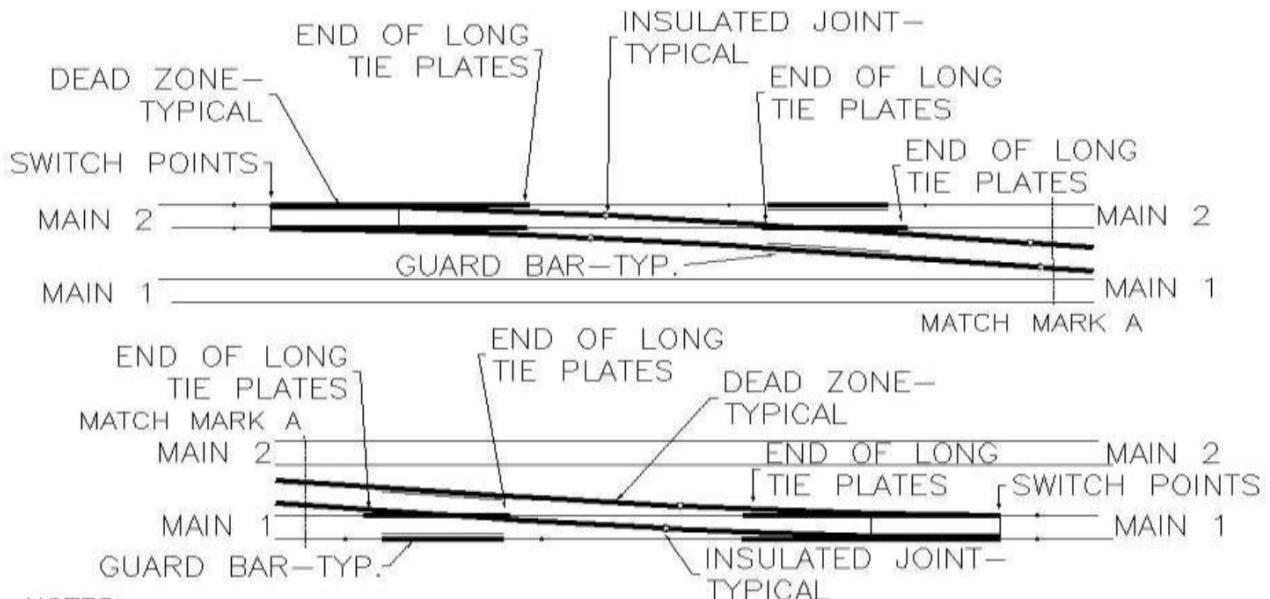


NOTES:

1. CHECK WITH SIGNAL DEPARTMENT FOR SPECIFIC TURNOUT ON YOUR TERRITORY FOR PROPER CIRCUITRY.
2. DEAD ZONES SHOWN AS BOLD LINE.

SERIES TRACK CIRCUIT
TWO RELAY - SINGLE BATTERY TRACK CIRCUIT
TWO RELAY - TWO BATTERY TRACK CIRCUIT

Figure 6-58



NOTES:

1. CHECK WITH SIGNAL DEPARTMENT FOR SPECIFIC TURNOUT ON YOUR TERRITORY FOR PROPER CIRCUITRY.
2. DEAD ZONES SHOWN AS BOLD LINE.

**CROSSOVER CIRCUIT FOR
 MAINLINE TO MAINLINE**

Figure 6-59

7.0 Right-of-Way and Other Facilities

7.1 Vegetation Control

7.1.1 *General*

Control vegetation so that it does not:

1. Obstruct the view at grade crossings, signals, and signs.
2. Foul the ballast section and toe path. Generally, the toe path is the approximate location where the bottom slope of the ballast section intersects the roadbed. In certain locations the side slope of the ballast section from the clearance point to the roadbed may serve as a toe path.
3. Interfere with employees performing normal trackside duties.
4. Prevent the proper functioning of signal and communication lines.
5. Obstruct drainage in ditches and pipes.

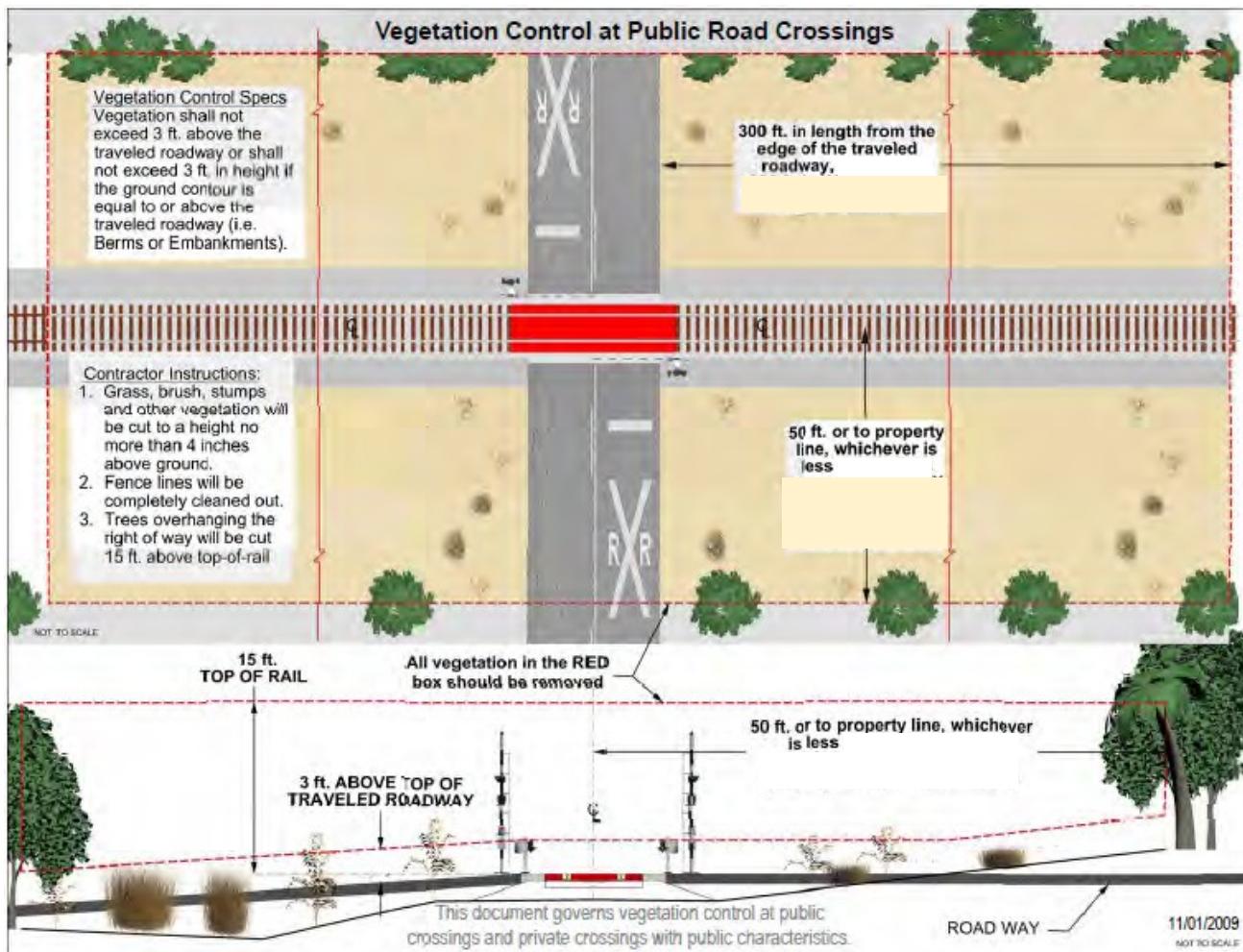
7.1.2 *Chemical Herbicides*

Employees involved in handling and applying any vegetation control chemical must comply with all applicable safety requirements, regulations, and instructions. Use only chemical herbicides approved by SCRRA.

7.1.3 *Clearing for Sight Distances*

Vegetation, maintenance of way equipment, materials, signs, etc. on railroad property that obstructs visibility must be removed for at least:

1. 300 feet each way from public crossings and private crossings that have the characteristics of a public crossing, refer to Figure 7-1.
2. 50 feet or to property line, whichever is less, refer to Figure 7-1.
3. 50 feet around buildings, stations, and platforms.
4. 15 feet around all signs and signals when terrain and conditions allow.

**Figure 7-1**

7.2 Roadway Signs

7.2.1 General

Employees must place and maintain roadway signs where required. Keep roadway signs erect, plumb, and legible. Replace all defaced signs as soon as practicable. Any deviation from the standards must have SCRRRA approval.

7.2.2 Whistle Boards

Whistle boards are used to inform an engineer of an approaching road crossing and are required by Federal law. Federal law requires the engineer to sound a whistle except in Quiet Zones.

Whistle boards shall be installed per SCRRRA Standard ES5216.

7.2.3 *Standard Highway Crossing Signs (Crossbucks)– NO TRESPASSING, MPS SPEED BOARDS, SPOT CAR*

Standard highway crossing signs (crossbucks) must be placed on the right side of each approach of all public road crossings without signalized protection. Place crossbuck signs so that the sign face is perpendicular to the center line of the highway. See SCRRRA Standard ES4310 for additional information.

The placement of traffic signs other than standard highway crossing signs with yield signs (for example, stop signs) is determined by the public authority with responsibility for the roadway, or the state regulatory body, whichever is applicable. SCRRRA maintains/replaces these signs after they are installed.

Refer to SCRRRA Standard ES4310 for design and installation requirements for passive public crossing signage (crossbucks with yield sign, or crossbuck with stop sign).

7.2.4 *Clearance Warning Signs*

Use close or impaired clearance signs at locations with horizontal or vertical clearances that are less than standard.

Mount close clearance signs at each end of the restricted track's entrance so they are clearly visible from the direction of approach.

Mount close clearance signs on posts or structures.

See SCRRRA Standard ES4310 for general placement details. Specific requirements for state or local ordinances may also be required on the sign face.

7.2.5 *Replacing Existing Signs*

For installations where it can be determined that a yield or stop sign was previously installed but is now missing, replace with in-kind size and type of sign. It is imperative to refer to SCRRRA Standard ES4310 and ES4311 prior to replacement of the existing sign.

To determine the current sign type and standard for existing yield or stop sign installations for any particular at-grade crossing location(s), contact SCRRRA.

Contact SCRRRA if there are questions regarding installations at crossings that may be exceptions to SCRRRA Standards.

7.3 Fencing

1. When constructing new fencing refer to SCRRRA Standard ES5106.
2. When constructing right-of-way fence, place it on the boundary or property line of the railroad right-of-way unless otherwise directed.
3. Inspect and repair existing fence as required.
4. Keep all right-of-way gates closed and locked when not in use.

7.4 Graffiti

High priority shall be given to controlling graffiti in the following areas:

1. Signals and Signal Enclosures (by SCRRRA signal forces)
2. Right-of-Way Signs
3. Maintenance vehicles, equipment, and SCRRRA buildings
4. Highway underpasses
5. Locations at or near stations

Graffiti on private property facing the right-of-way is generally the responsibility of the private property owner.

7.5 Trespasser Encampments

Do not engage trespassers directly.

Notify SCRRRA Safety and Security Department when a trespasser encampment is encountered on the right-of-way.

Coordinate with SCRRRA Safety and Security Department before removing trespasser encampments and after trespassers have been removed.

7.6 Bridges and Culverts

When maintaining bridges and culverts:

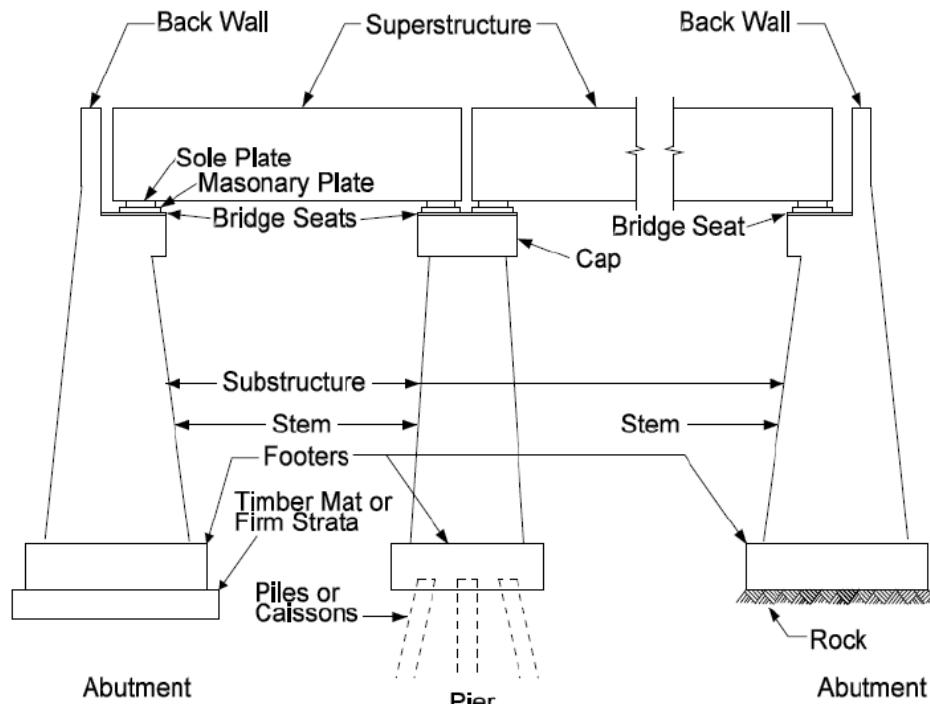
1. When replacing damaged culverts, use a replacement culvert of the same diameter or larger.
2. When installing culverts, place the bottom of the culvert at the flow line.
3. Ensure the cover thickness over the top of a culvert to the bottom of the tie is at least one-half the culvert diameter.
4. Remove weeds, debris, and snow that hinder water flow through culverts.
5. Promptly remove drift that accumulates around bridges. During high water, use a crane and clamshell bucket.

Refer to SCRRRA Standard ES2302 and ES2304 to determine which structures require inside guard rails. These drawings also show construction details.



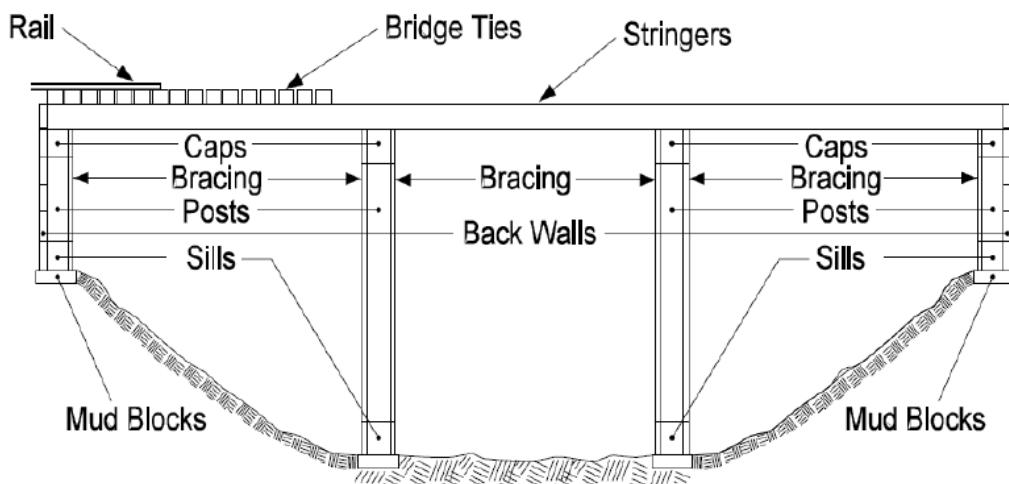
7.6.1 Bridge Identification

The following illustrations in Figure 7-2, Figure 7-3, Figure 7-4 show some basic bridge terminology.



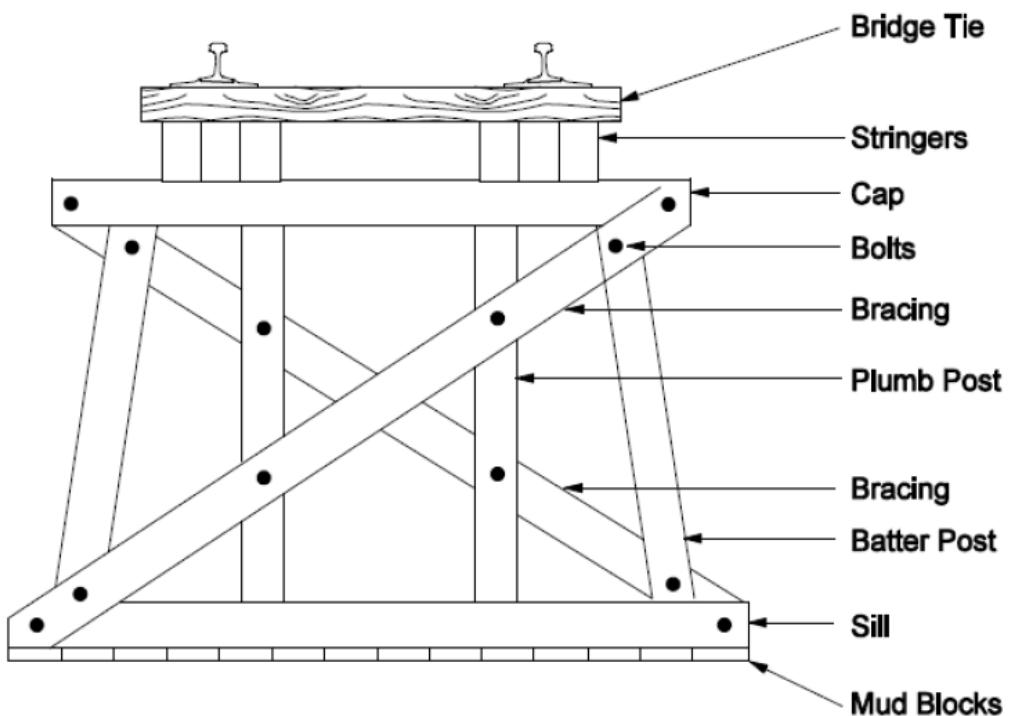
Typical Deck Girder

Figure 7-2



**Typical Framed Timber Trestle
Horizontal View**

Figure 7-3



Timber Frame Trestle Cross-Section

Figure 7-4

8.0 Track Inspection

8.1 Standards and Regulations

Compliance with SCRRRA and FRA standards regarding track safety is mandatory. All 49 CFR 213.7 qualified employees must comply with, and have readily available, the documents in Section 8.6.2 Track Inspector Documents and have readily available.

These requirements include standards, practices, and procedures which MUST be followed to ensure safety and/or to comply with regulations. Track conditions must meet, at a minimum, the FRA Track Safety Standards for the associated class of track.

In addition, inspection frequencies and traversal of all tracks and switches must be performed in accordance with this manual but never less than required by FRA for the class of track.

This requirement applies to all SCRRRA owned and maintained main tracks and sidings, yard tracks, and industry trackage. Unless a prior agreement concerning the maintenance and inspection is in place, privately owned industry tracks and leased trackage do not fall under SCRRRA inspection responsibility. Private tracks should be identified, and inspections must be made up to the clearance point, property line, or gate leading into that industry.

8.2 FRA Qualified Personnel

8.2.1 *FRA 213.7 Qualification (Class of Track 1-5)*

Each employee responsible for the inspection of (213.7 b) and/or repair of track (213.7 a) and/or installation/inspection/repair of CWR (213.7 c) owned and maintained by SCRRRA must be trained and designated as qualified per FRA 213.7. The basis for the qualifications consists of one year's supervisory experience or a combination of work experience and track inspection training. More importantly, managers must ensure that employees know and understand the regulations, are able to identify defects, and can prescribe the appropriate remedial actions before 213.7 designations are made. Employees must demonstrate the ability to make accurate track geometry measurements using the proper measuring devices and determine remedial actions using the FRA Track Safety Standards and SCRRRA Standards.

Track supervisors shall go through an annual training program that will address all track maintenance instructions and standards described in this manual as well as FRA Track Safety Standards including:

1. Track Geometry
2. Rail
 - 2.1. Identification
 - 2.2. Wear limits
 - 2.3. Defects
 - 2.4. Remedial Actions
3. Turnout inspections
4. Ties (condition and assessments)
5. Drainage
6. Ballast
7. Testing and understanding of Standards
8. Understanding and Knowledge to apply remedial actions

All employees responsible for the inspection, installation, adjustment, or maintenance of CWR track must complete training on CWR procedures annually. In addition, they shall be provided a copy of these procedures and accompanying documents. SCRRRA and SCRRRA contractors will maintain lists of those employees qualified to supervise restorations and inspect track in CWR territory. The qualified employee lists will be made available to the FRA upon request.

CWR Training programs will address the following:

1. CWR installation procedures.
2. Rail anchoring requirements when installing CWR.
3. Preventive maintenance on existing CWR track.
4. Monitoring curve movement following track surfacing and lining.
5. Placing temporary speed restrictions account trackwork.
6. Rail joint inspections.
7. Insufficient ballast.
8. Extreme weather inspections.
9. Recordkeeping.

8.3 Safety and Protection during Inspections

Be aware of train movement on or near the tracks being inspected. Comply with operating rules and safety rules and use common sense. If unsafe conditions or deviations that exceed the allowable limits are detected, initiate corrective or remedial action. Carry the proper tools to handle routine track deviations that may be found during the inspection. If conditions cannot be corrected, immediately protect a defect before the next train. The safety of the railroad is the utmost importance and notify the proper authority immediately.

8.4 Compliance

8.4.1 *Qualifications*

Individuals performing track inspections for defects must be designated and qualified as outlined in the FRA Track Safety Standards (49CFR213.7 a, b and c). Qualification includes attending an FRA approved training course, passing all required examinations, demonstrating the ability to detect defects, and annual refresher training thereafter. Only those authorized and on the current list of designated inspectors are fully qualified to inspect track for defects and supervise restorations and renewals of track under traffic conditions.

8.4.2 *Authority and Responsibility*

When an inspector finds conditions that make the track unsafe for trains moving at authorized speed, or finds deviations greater than those permitted by the FRA Track Safety Standards, the employee MUST do one of the following BEFORE the next train:

1. Make repairs to bring the condition into compliance.
2. Place temporary speed restriction, lowering the speed of the trains to the class for which it complies.
3. Remove track from service, if it does not comply with class 1 track.

All deviations found during inspection that cannot be corrected immediately must be properly and safely protected and reported on the appropriate document.

8.4.3 *Supervisors/Managers*

A track inspectors' supervisor/manager or equivalent shall perform track inspector evaluations on a quarterly basis. The supervisor/manager or equivalent shall make a hi-rail inspection over the entire territory with each track inspector on a quarterly basis. On these inspection trips the supervisor will:

1. Audit the quality of the track inspection being done.
2. Audit the track inspection vehicle for housekeeping, material/tool storage, proper tools and measuring devices, and required safety equipment.
3. Audit the track inspector on compliance with and understanding of Maintenance of Way Operating Rules (MOWOR), Maintenance of Way Safety Rules (MOWSR), Timetable, Special Instructions, Roadway Worker Protection, FRA regulations, and this TMM.
4. Audit for proper form and completeness of forms and review all expired and voided track authority documents (T and T, CTC, Form B, etc.) that the track inspector possesses.
5. Review TMM procedures with the Track Inspector that directly pertain to his/her daily responsibilities.
6. Audit the quality of communication between the Track Inspector and other employees, including the dispatcher.
7. Audit work practices and rules compliance of other work groups encountered on the inspection trip.

8.5 Inspection Methods

Perform inspections on foot or by traversing over the track with a hi-rail vehicle at a speed that allows sufficient visual inspection of the track structure at a maximum speed of 15 MPH or less. Turnouts and track crossing diamonds shall be inspected at a speed not exceeding 5 MPH.

Inspection of track reconstruction must be performed on foot by the contractor's supervisor in charge of the work, the contract operator, and SCRRRA representative before returning the track to service or before the next train over the segment of track affected. Inspection must be documented, signed by all parties making inspection and submitted to SCRRRA at TRACK&STRUCTURES@SCRRRA.NET.

Mechanical, electrical, and other approved track inspection devices may be used along with the visual inspection. A tape measure, a track level, straightedge, string line, taper gage, and an infrared (optical) thermometer are all basic tools of an effective track inspector. Safe, efficient inspections require that frequent measurements of track conditions be made.

8.6 Track Inspector Responsibilities

The Track Inspector's primary responsibility and duty is to inspect track for defects and protect all defects found according to SCRRRA and FRA Track Safety Standards.

1. Track Inspectors will perform inspections on foot or by riding in a vehicle that allows visual inspection of the track. Track Inspectors must be allowed to complete inspections of all SCRRRA assigned track and turnouts at track inspections frequencies described in Section 8.6.1 Track Inspection Frequencies and at FRA minimum required frequencies for each calendar month.
2. The Track Inspector has both the authority and responsibility to place a speed restriction for the track or remove tracks from service as conditions warrant.
3. Track Inspectors are also expected to perform minor repairs, but at no time will the scope of running repairs prevent the inspector from completing scheduled inspections.
4. Track Inspectors will complete required inspection reports and submit to TRACK&STRUCTURES@SCRRRA.NET.

8.6.1 *Track Inspection Frequencies*

Main Tracks and Sidings

Inspect all main tracks at least twice weekly with at least 1 calendar day interval between inspections. Each main track must be traversed by the inspection vehicle or inspected on foot at least once every week and documenting how each inspection was completed on the inspection form. Make additional inspections as provided in these instructions and in other sections of this manual as required. Report weekly inspections on the track inspection report form located in Appendix C. Send reports to TRACK&STRUCTURES@SCRRRA.NET.

If a track is not inspected to at least the FRA required frequency, it must be removed from service until inspection is performed.

Turnouts

Inspect each turnout on foot at least monthly. Quarterly inspections conducted jointly with signal department are also required. All turnout inspections must be documented on the Turnout Inspection Form attached in Appendix C. Send reports to TRACK&STRUCTURES@SCRRRA.NET.

Yard tracks and Industry Tracks

Perform a walking inspection of each yard track and industry track at least monthly with at least 20 calendar days interval between inspections according to the inspection requirements of the FRA. Perform additional inspections if substandard track conditions exist that may deteriorate quickly such as gage in high degree curves.

8.6.2 *Track Inspector Documents*

Track Inspectors must carry and be able to produce the latest version of the following documents upon request.

1. FRA 213 Track Safety Standards Subpart A to F, Class of Track 1-5 and Signal Maintenance Instructions/Standard Drawings
2. FRA 213.7 Qualification Card – To be carried by employees who either inspect track or perform repairs that require placing or removing speed restrictions
3. GCOR/MW Rule Book
4. SCRRRA Track Bulletins
5. SCRRRA Current Timetable, Special Instructions, and applicable General Orders
6. SCRRRA Maintenance of Way Operating Rules
7. SCRRRA Maintenance of Way Safety Rules
8. SCRRRA Maintenance of Way General Orders
9. SCRRRA Track Maintenance Manual (TMM)
10. SCRRRA Written CWR Procedures, Chapter 9 herein of this Track Maintenance Manual
11. SCRRRA Track Charts
12. SCRRRA Standards
13. Job Safety Briefing book
14. Lone Worker Job Safety Briefing book
15. On-Track Safety card or sticker
16. Statement of On Track Safety (if using individual Train Detection)
17. Machine operators' inspection log book – Updated and kept in machine
18. Operators Manual (Equipment) – Safe operation instructions
19. Hi-rail Inspection Logbook – Required to be kept in the vehicle and completed on a daily basis
20. CPUC General Orders

8.6.3 *Track Inspector Tools*

Track Inspectors must have access to the following inspecting tools to perform a proper inspection:

1. 25 ft Tape Measure
2. Level Board
3. 62 ft. String Line
4. Taper or Step Gauge
5. 6", 24" and/or 36" straight edge
6. Highly Visible Ribbon (to mark defects)
7. Rail wear gauge
8. Portable Track Loading Fixture (PTLF)
9. Switch Point Wear Measuring Tool
10. Paint Sticks /soapstone/ lumber crayon/White Paint (For switch point markings)
11. Infrared (optical) thermometer
12. Working radio – Must have access when using On-Track Safety

The following is a list of recommended tools to assist Track Inspectors to make quality track inspections:

1. 100ft, 200ft Tape Measure
2. Measuring Wheel
3. Combination Square
4. 2 lb. hammer
5. Counters
6. Engine inspection mirror.
7. Track geometry strip charts
8. Spring frog testing devices

Track Inspectors should also carry the proper tools and materials to make minor repairs.

8.6.4 *Track Inspection FRA Defects Reporting*

All track conditions that do not comply with the FRA 213 Safety standards must be identified and appropriate remedial action taken. Track Inspectors will record defects and the appropriate remedial action for every non-compliant FRA condition, even if it was **repaired immediately**.

8.6.5 *Remedial Action Definitions*

Repaired Before Traffic - Inspectors will use the remedial action of "Repaired before Traffic" when a defect is corrected before the passing of a train.

Speed Restrictions - Inspectors will use speed restrictions to protect locations that do not meet the Class of track standards set forth in 213 Track Safety Standards (TSS). Whenever a speed restriction is placed, inspectors will arrange to place yellow flags in advance of the restriction, unless the inspector knows that the defect will be repaired before the end of that working day.

Schedule for Repair - This remedial action can only be used for non-class specific defects. Once "Schedule for Repair" is used, defects must be repaired as soon as possible, with the understanding that all defects will be repaired within 30 days. All "Schedule for Repair" defects that exceed 30 days are in violation of FRA regulations.

213.9(b) - When a defective condition exists that does not meet the FRA requirements for Class 1 track, inspectors may still allow operation at Class 1 speeds over that defect for a period of not more than 30 days if the inspector determines that operations may safely continue. If the track has not been repaired before the 30-day period has expired the track will be taken out of service.

Out of Service - When Track Inspectors take tracks out of service, no operation is to take place over that track until repairs have been made and the track is restored to service.

Exception: Out of Service Tracks can be operated over only in cases of emergency and only if a qualified person visually supervises each move.

8.7 Track Inspection by Train

At least quarterly, the assigned track inspector shall traverse all main line tracks from the head end of a train over the entire territory. Make notes based on the ride and on the engineer's comments and follow up to inspect and/or correct any conditions noted.

8.8 *Track Inspection*

1. Be familiar with potential problem areas on assigned territory and give them careful attention during inspections.
2. Know the general condition of ditches, drainage facilities, tunnels, bridges, culverts, and other structures in order to react effectively to severe weather and other potentially dangerous conditions.
3. Perform a thorough visual inspection and note the general condition of track, roadbed, and right-of-way to determine the required maintenance.
4. Regularly walk all track especially curved track. This is an important method for detecting defects that cannot be found when hi-railing.
5. Notify SCRRRA at TRACK&STRUCTURES@SCRRRA.NET of any encroachments, development on adjacent land or dumping by outsiders on the right-of-way.
6. Remove small scrap along the right-of-way that can be placed on the tracks if possible or make arrangements to have it picked as soon as possible and disposed of properly.
7. Report scrap material along the right-of-way that presents a hazard belonging to other contractors to the Project Manager or your immediate supervisor. Place track bulletins if required to protect conditions and safety of other employees

8.8.1 *Ballast*

Good ballast and proper drainage are necessary to maintain good surface and line throughout the track structure. Ensure that muddy conditions and standing water in the track structure are reported. Monitor the amount of ballast present off the shoulders and in the cribs, especially when there is potential for tight rail conditions. Ballast defects (insufficient and fouled) are non-class specific. Use and refer to SCRRRA Standards for required ballast sections. Good judgment should be used to insure track is protected for safe passage of trains.

8.8.2 *Drainage*

Drainage is a sometimes neglected yet an important aspect of track inspections. Check for any conditions that prevents water from flowing freely away from the track. Culverts, bridges, and ditches need to be inspected once every year and all obstructions, vegetation, and debris that prevents the free flow of water must be removed before the winter rainy season. Any defects found requiring permitting or the coordination of public agencies must be reported to your immediate supervisor for handling with the proper SCRRRA authority. Note any standing water along the tracks because it may indicate a blocked culvert. Drainage defects are non-class specific.

8.8.3 *Vegetation*

Vegetation must be maintained to prevent obstruction of wayside signs and signals to train crews, to the general public at railroad grade crossings, and/or a hazard to adjacent properties. Right-of-way must be sprayed twice per year to prevent weed and grass growth and kept clear of short brush and grass that may present a fire hazard. The removal of the brush and grass along the right-of-way must be done before it becomes a fire hazard.

8.8.4 *Gage*

Wide gage is responsible for more track caused derailments than any other defect. Inspectors must regularly monitor gage conditions in curves and turnouts and at joint locations. Add lateral under load movements to static measurements to determine remedial actions.

Gage is measured between the heads of the rail at right-angles to the rails 5/8" bellow the top of rail head. Gage shall be within the limits prescribed in the Urgent columns in Table 3-1.

The Portable Track Loading Fixture (PTLF) is a tool that is designed to test track gage, lateral strength of railroad crossties and fastening systems. The PTLF applies 4,000 pounds of lateral force providing the ability to simulate a lateral load on the track to get the full track movement. The PTLF provides the ability and flexibility to find potential gage locations that would not normally be measured with just a track gage.

The PTLF should be used in locations where:

1. Track movement is evident on the fastenings and/or ties, and the need develops to measure the full movement.
2. Static track gage measurements exceed 57-1/4".
3. Light gage trucks find .75" movement.
4. Wide gage has been found behind the Geometry cars.
5. Wide gage has been found behind the Gage Restraint Measurement System (GRMS) vehicle.
6. Ahead of yard and industry switch points checking for any gap that may occur under load.
7. Any location where tie condition is poor.

8.8.5 *Geometry*

Geometry defects include alignment and surface defects such as runoff, profile, cross level, and warp. Geometry defects are class specific. Accurate measurements must be taken and entered into the report. All measurements must include movement under loaded conditions. See Table 3-1.

8.8.6 *Rail Defects*

There are 2 main categories of rail defects: Transverse (percent of railhead) and Longitudinal (length of defect). Transverse defects are usually found by detector cars.

Track Inspectors need to be alert for:

1. Unusual appearances on the rail running surface.
2. Bleeding and discoloration below the rail head.
3. Bolt Hole Breaks, Head Web separations, and Horizontal Split Heads at joint locations.

Note: Notify TRACK&STRUCTURES@SCRRRA.NET immediately of rail defects. Rail defects will be remediated in accordance with FRA requirements. Any rail defect shall be removed from the track as soon as practical.

8.8.7 *Rail End Mismatch*

Mismatch is often found where new rail has been installed against old. Mismatch also is found at loose joints or improperly installed compromise joints. There are two types of mismatch: Tread (top) and Gage (side). Gage mismatch is a serious condition which can lead to a derailment. Make note of any mismatch that exceeds Urgent levels on the track inspection report form. Rail end mismatch will be remediated in accordance with FRA requirements. Any rail end mismatch shall be corrected as soon as practical. See Table 3-1 for critical and urgent conditions.

8.8.8 CWR Rail Joints

Joint bar inspection requirements are class specific. Because of the wide range of defects, care must be used in determining the remedial action shown.

	<i>Freight trains operating over track with an annual tonnage of:</i>			<i>Passenger trains operating over track with an annual tonnage of:</i>	
	<i>Less than 40 mgt</i>	<i>40 to 60 mgt</i>	<i>Greater than 60 mgt</i>	<i>Less than 20 mgt</i>	<i>Greater than or equal to 20 mgt</i>
<i>Class 5 & above</i>	2	3^2	4^2	3^2	3^2
<i>Class 4</i>	2	3^2	4^2	2	3^2
<i>Class 3</i>	1	2	2	2	2
<i>Class 2</i>	0	0	0	1	1
<i>Class 1</i>	0	0	0	0	0
<i>Excepted track</i>	0	0	0	n/a	n/a

4 = Four times per year, with one inspection in each of the following periods: January to March, April to June, July to September, and October to December; and with consecutive inspections separated by at least 60 calendar days.

3 = Three times per calendar year, with one inspection in each of the following periods: January to April, May to August, and September to December; and with consecutive inspections separated by at least 90 calendar days.

2 = Twice per calendar year, with one inspection in each of the following periods: January to June and July to December; and with consecutive inspections separated by at least 120 calendar days.

1 = Once per calendar year, with consecutive inspections separated by at least 180 calendar days.

¹Where a track owner operates both freight and passenger trains over a given segment of track, and there are two different possible inspection interval requirements, the more frequent inspection interval applies.

²When extreme weather conditions prevent a track owner from conducting an inspection of a particular territory within the required interval, the track owner may extend the interval by up to 30 calendar days from the last day that the extreme weather condition prevented the required inspection

Table 8-1

All rail joint bars and insulated joints shall be documented at TRACK&STRUCTURES@SCRRRA.NET per form in Appendix C.

8.8.9 CWR Joint Bar Conditions

Locations of joint bars in CWR territory must be documented per the CWR Plan.

8.8.9.1 Joints added to CWR

Whenever a joint is added to CWR, such as when a defective rail segment has been replaced, the ends must be welded within 30 days. If the joint cannot be welded within 30 days, it must be fully bolted with 6 bolts and fully box anchor every tie for 200'.

8.8.9.2 Remedial Action

1. Any joint bar with a visible center crack must be replaced.
2. If one center cracked or broken bars is found, limit operating speed to not more than 15/10 MPH until replaced.
3. If two center cracked or broken joint bars are found, limit operating speed to 10 MPH over joint and assign a qualified person to visually supervise each train over angle bars, until repaired.
4. If excessive longitudinal rail movement is exhibited at the joint area, rail anchors/clips must be adjusted or rail must be destressed in accordance with the CWR procedures herein.
5. If a CWR joint is gapped open more than Table 5-9, a speed restriction must be placed on the track.

8.8.9.3 Inspection Documentation

Track inspectors will document the inspection finding on the prescribed track inspection form in Appendix C and note any substandard track conditions and any remedial action taken.

Conditions that could contribute to broken joint bars in CWR may need additional inspections.

These include:

1. Loose, missing, or bent bolts - A minimum of 2 bolts per rail must be in place at each joint.
2. Rail end batter - More than 3/8" in depth and more than 6" in length measured with a 24-inch straight-edge.
3. Gap between rail ends.
4. Longitudinal rail movement.
5. Tie(s) not effectively supporting joint.
6. Broken or missing tie plate(s).
7. Joint lateral movement, in a curve or spiral, that reaches $\frac{3}{4}$ inch.
8. Fouled ballast present in conjunction with joint vertical movement (profile) that exceeds 75% of the allowable threshold for the designated class of track.

Joint vertical movement that exceeds 75 percent of the allowable threshold for the designated class of track. Joint lateral and vertical movement is the apparent visible movement measured at the joint.

Use Table 8-2 to determine if action is needed:

Visible Vertical Movement Table	
Class of Track	Measurement
2	1 1/2"
3	1 1/4"
4	1"
5	3/4"

Table 8-2

8.8.10 CWR Joint Inspections at Turnout Locations

Joint bars will be inspected at turnout locations during the monthly switch inspection. Turnout locations are defined as:

1. At Control Points and signalized switches – All joints up to and including the insulated joint for the signal governing movement over the switch. In the event the insulated joint rail is not welded in track, include both joints on each end of the rail.
2. Other turnouts in CWR territory – include all joints 50 feet in front of the switch points and 50 feet behind the heel of frog.
3. At crossovers, all joints in track between switches.

At track crossings:

All joints from the crossing up to and including the insulated joints at the signals governing movement entering and leaving the control point or interlocking.

If there are no signals at the track crossings, include as a minimum all joints that are between or connected to the diamond crossing.

Embedded Joints:

Permanently Embedded Locations:

Where such locations exist, it is not necessary to disassemble or remove the track structure (e.g., remove pavement or crossing pads) to conduct an inspection of CWR joints. Make every effort, to the extent practicable, to inspect the visible portion of joints in these structures.

Temporarily Buried Locations:

Joints may sometimes be temporarily buried (e.g., where ballast or similar material is in the middle of the track and along the track) and therefore unavailable for inspection. Where CWR joints are buried (e.g., by ballast), wait for the completion of the trackwork before conducting joint bar inspections. Make every effort, to the extent practicable, to inspect the visible portion of joints in these structures.

8.8.11 *Insulated Joint Bar Inspections*

When an insulated joint is found to be defective as described in Table 8-3, take the following actions to protect the safety of train operations:

Level	Defective Conditions	Action
3	Insulation/glue stripped out from center of joint past the 2nd bolt hole on the top of the joint bars, evidence of joint slippage at the end of the joint bars or rail ends touching.	Schedule for repair (replacement) within 30 days. If only defect is rail ends touching, remedial action is slotting.
2	Any of the conditions described in level 3 plus any broken bolts.	30 MPH until replaced
1	Insulation/glue stripped out on both top and bottom of bars. The bars will not fit tight and will allow rail movement and bolts to break.	10 MPH until replaced

Table 8-3

Insulated joints must be kept tamped up with good tie support to avoid the conditions described above. Signal maintainer must be immediately notified of any of the conditions noted above so that the Insulated Joint can be tested for compliance with signal standards.

8.8.12 *Torch Cut Rail*

Torch cutting rail ends or bolt holes is prohibited in any track, except in the case when making an emergency repair. Trains must be supervised across rail ends with torch cut bolt holes until the torch cut bolt holes are removed. If torch cut rail ends are found in main track place a 15 MPH Speed restriction and change out rail within 24 hours. ALL train movements must be supervised.

8.8.13 *Tie Plates*

Rail should fit flat into the tie plate with no foreign object between the plate and the base of rail. Plate should be properly sized for the weight of rail and there should not be excessive space between the base of rail and the shoulder of the tie plate that would allow movement.

If condition cannot be corrected immediately, place a 25 MPH speed restriction where spikes or other objects are between the base of rail and the tie plate causing a concentrated load.

8.8.14 *Rail Fastenings*

Rail fastenings are components that maintain gage (spikes, clips, bolts). Where areas of gage widening are found, insufficient or defective fasteners can be considered as a contributing cause. Fastener defects are non-class specific, the remedial action is based on the inspector's judgment regarding the ability of the system to maintain gage.

8.8.15 *Road Crossings*

The condition of all public road crossings must be monitored. Items to monitor include:

1. Signage
2. Crossing surfaces and approach pavement
3. Gates
4. Impaired visibility due to vegetation, OTM, ballast piles, or equipment on the railroad right-of-way

Immediately report any condition that does not comply with SCRRRA Rules and/or Standards. Employees will notify the dispatcher and place the appropriate speed restrictions to protect the affected crossing whenever the following conditions are found.

1. Improper sight clearances to comply with local regulations.
2. Vegetation on the right-of-way that obstructs the view of the crossing.
3. Vegetation that obstructs the view of warning signs or signals on railroad property.
4. Material placed on the right-of-way that obstructs the view of the crossing.
5. Broken crossbuck posts.
6. Missing/damaged crossbuck signs.
7. Missing/wrong multi-track number plates.
8. Missing/damaged stop signs attached to the crossbuck post.
9. Missing/damaged yield signs attached to the crossbuck post.
10. Missing/damaged private crossing sign (other than field to field locations).
11. Missing/damaged stop signs attached to private crossing post.
12. Missing whistle posts (public crossings).

Inspector should observe the crossing during the passing of a train and highway vehicles to determine any excess movement of the crossing panels or rails. Pay attention to any movement of the crossing panels and verify condition of connections between panels and of the end restraints.

Note: Signs are considered damaged if they no longer fulfill their intended function.

8.8.16 *Bridges*

Conditions on bridges that do not comply with Urgent limits require documentation. Refer also to the Bridge, Culvert and Tunnel Safety Management Program manual.

Inspectors should look for and report to TRACK&STRUCTURES@SCRRRA.NET if any of the following conditions are found:

1. Marginal tie conditions that exist at an open deck bridge.
2. Marginal tie conditions on the approach to the bridge.
3. Any geometry condition on a bridge which could be an indicator of a more severe condition.
4. Combustible materials in or around any bridge structure.
5. Any drift built up on the up-stream side of bridge.
6. Excess silting of water channel.
7. Any missing or loose ballast retainers.
8. Any damage seen on the superstructure.
9. Any evidence of scouring of back wall and piers.

If there is any concern as to the safety of train operations place a speed restriction, or if necessary, remove from service.

8.8.17 *Main Line Curves*

Track Inspectors must conduct semi-annual walking inspections of main line and siding curves.

The manager will prioritize curves to be walked by using geometry car reports.

Document the walking of curves on the appropriate form.

Advise the TRACK&STRUCTURES@SCRRRA.NET of all serious track defects requiring prompt corrective action.

Inspect for curve movement periodically, especially during periods of large temperature changes. Where the curve has shifted inward more than an average of 3 inches, the curve must be lined out prior to rail temperatures above or forecasted above designated rail laying temperature. If curve is not lined out or destressed a speed restriction of 25 MPH or less must be placed or track removed from service.

8.9 Turnout Inspection

Inspect turnouts on foot at least monthly.

1. Pay particular attention to the condition of turnouts and insulated joints.
2. Operate main line switches and derails to ensure proper adjustment and fit.
3. Ensure that the switch is returned and locked in the normal position.
4. When inspecting turnouts, measure and record on the Turnout Inspection Report Form (provided in Appendix C) and note any remedial actions taken.

8.9.1 *Switch Stand*

Inspect the following items:

1. Operate the switch to ensure correct tension on the stock rails and that throw forces are not excessive. The connecting rod and switch rods shall not contact switch plates or ties.
2. Check the switch lock or keeper. If a lock is required, ensure that it is present and operates easily. Replace it as necessary.
3. Ensure that the switch latch is fastened down tightly and holds the handle securely in place. The handle should not be able to be raised out of the latch in the locked position. Replace the latch as needed.
4. Check the condition of the head block ties.
5. Check that the stand is securely fastened.
6. Ensure that mast is securely attached to the stand.
7. Ensure the stand displays the proper target aspect.
8. Check the condition of reflectorized targets.
9. Refer to Table 6-1 for adjustment procedures.

8.9.2 *Connecting Rod*

Inspect the following items:

1. Check to see that connecting rod does not contact the head block ties.
2. Inspect the connecting rod for excessive wear of bolts and bolt holes.
3. Ensure that the switch and connecting rod bolts are inserted with the nut on top of the rods with cotter pins in place.
4. Check the condition of the eyebolt, its position in the mast barrel and the condition of the connecting rod and all switch rods.
5. Ensure the jam nut is tight against the clevis.
6. Refer to Section 6.3.1 Connecting Rods for additional information.

8.9.3 *Switch Points*

Inspect the following items:

1. Ensure that points and stock rails are of the same rail section.
2. Check points for chipping at the point end. Unusually chipped or worn switch points must be repaired or replaced.
3. Ensure that rail stops are in place and securely fastened.
4. Points should have full bearing on the switch plates to prevent the points from pumping under train movement.
5. Check that rail braces are tight and well driven, but not overdriven to the extent that rail is canted inward.
6. Check all cotter keys.

A recommended monthly practice to monitor switch point and stock rail fit is to apply white spray paint to the location where the switch point contacts the stock rail. Paint 12 inches of the point and of the stock rail. As trains pass over that location, observe the paint wear locations. If the paint is worn off within the first 1 inch of the point, a thorough inspection of the switch area must be made to determine the necessary maintenance required to correct the condition. After repairs are made, repaint and monitor the switch point.

8.9.4 *Switch Point Throw*

Make sure the switch point throw meets these parameters:

1. Verify the proper switch point throw between the stock rail and the switch point using Table 8-4 for specified switches. Use Standard Drawings to reference other switch lengths.

Proper Switch Point Throw Between Stock Rail and Switch			
	39-foot Switch	30-foot Switch	24-foot Switch
At Point of Switch	4-15/16"	5"	5"
At No. 1 Rod	4-3/4"	4-3/4"	4-3/4"
At No. 2 Rod	4-1/2"	4-1/2"	4-1/2"
At No. 3 Rod	3-7/8"	3-5/8"	3-1/2"
At No. 4 Rod	3-1/6"	2-13/16"	2-3/4"
At No. 5 Rod	2-1/4"	N/A	N/A

Table 8-4

2. On a No. 20 turnout with 39-foot switch points, verify that the switch point fully mates against the stock rail so full head separation occurs approximately 9 inches behind the last switch rod.

8.9.5 *Switch Point Fit*

Inspect the following items:

1. Observe if the points are closing properly. Advise the Signal Department to make any adjustments that are necessary on the power-operated switches.
2. Check to see that switch points are not skewed. They must be installed directly opposite each other.
3. When switch points are thrown ensure that stock rails do not move when the point makes initial contact.
4. Check the throw of the switch points. The correct throw is 4-3/4 inches for hand operated switches and 4-1/2 inches for power-operated switches.

8.9.6 *Switch Point Wear*

Refer to Section 6.6.3.3 Switch Point Wear.

8.9.7 *Switch Point Guards*

Where authorized, measure switch point guards for wear as shown in the standard drawings. If wear is more than the wear limit allowed, the guard can be adjusted or replaced.

8.9.8 *Stock Rails*

Inspect the following items:

1. Check that metal flow on the gage side of stock rails is not more than 1/8 inch.
2. Check that stock rail on the turnout side is properly bent to provide a good fit for the switch point.
3. Ensure that the stock rail is not curve worn more than 3/16 inch anywhere within 24 inches ahead of the point.

8.9.9 Switch Rods

See Section 6.6.2 Switch Rods. Also inspect the following items:

1. Check switch rods for excessive wear in bolt hole areas. Check insulation in insulated rods. Check for excessive wear on rod clips, rod clip bolts and connecting rod bolt.
2. Check clearance to avoid contacting ties or ballast.

8.9.10 Switch Points and Stock Rails

Inspect switch points and stock rails to ensure that the outer edge of the wheel tread does not contact the gage side of the stock rail. This is measured at the point where the gage lines of the stock rail and switch point are $4 \frac{1}{2}$ " apart, as shown in Figure 8-1.

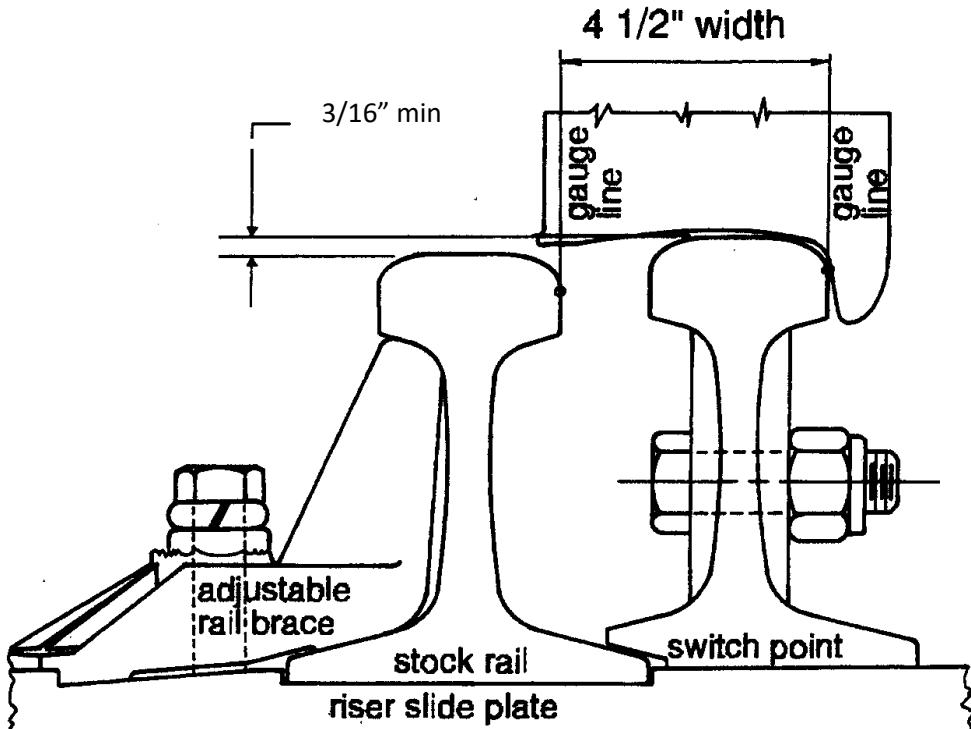


Figure 8-1

To measure a switch point for gage face wear or minor chipping, do the following:

1. Close the switch point against the stock rail and mark a line on the switch point $\frac{5}{8}$ inch below the top of the stock rail.
2. Use a 36-inch straightedge. A 24-inch straightedge can be used, but a 36-inch is preferred.
3. Hold the straightedge with one hand on the side away from the tip end of the switch point.
4. Start $1\frac{1}{2}$ inches from the tip end of the switch point and slide the straightedge on the line marked on the switch point ($\frac{5}{8}$ inch below the top of the stock rail) toward the heel of the switch point until a gap appears between the straight edge and the switch point.

5. Measure the wear offset of the switch point along the gage face over a distance of 24 inches with the following procedure:

When using a 36-inch straightedge, mark the 6-inch, 18-inch, and 30-inch points. Move the 18-inch mark on the straightedge to the largest gap between the gage face and the straight edge. Measure the distance from the gage face to the straight edge at the 6-inch, 18-inch, and 30-inch points. Subtract the smaller of the 6-inch or the 30-inch from the gap at 18 inches.

When using a 24-inch straightedge, place a mark on the straightedge at the 12-inch point. Place the 12-inch point over the center of the largest gap between the straightedge and the gage face. Determine the smallest gap at each end of the straightedge and subtract that gap from the gap at 12 inches.

If the width of this gap differential exceeds dimensions in Table 8-5, repair or replace the switch point as required.

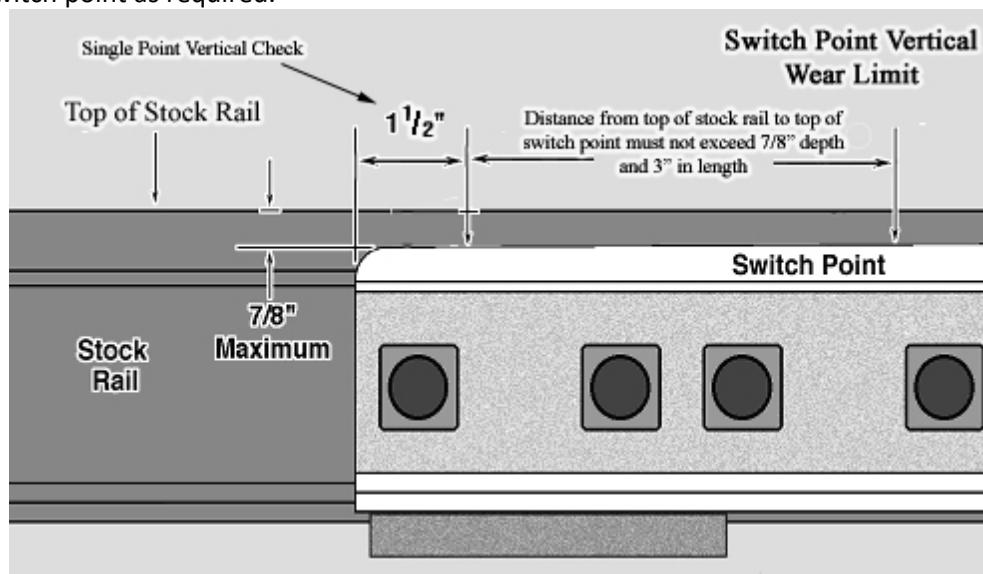


Figure 8-2

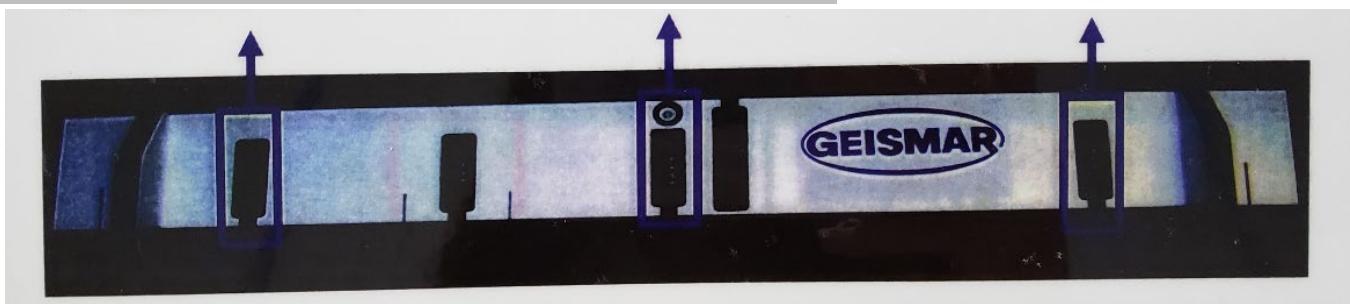
To measure a switch point for gage face wear or minor chipping with a Geismar:

Switch Point Measuring Device

(this device is to measure wear change in switch point)

1. Take all measurements $1\frac{1}{2}''$ * from the tip of the switch point.
2. Place the SPG on top of the stock rail over the closed switch point. Ensure the SPG-G is level.
3. The SPG-G will position three scales $\frac{5}{8}''$ from top of the rail. The scales are located 6", 18" and 30" respectively.
4. Find the widest measurement at the center scale on the SPG.
5. Take measurements from all three scales. ($\frac{5}{8}''$ scales).
6. Subtract the smallest reading from the largest reading. This is the actual wear/Gap differential.
7. Determine the necessary remedial action per Table 8-5.

*Note: For facing point moves.

**Figure 8-3**

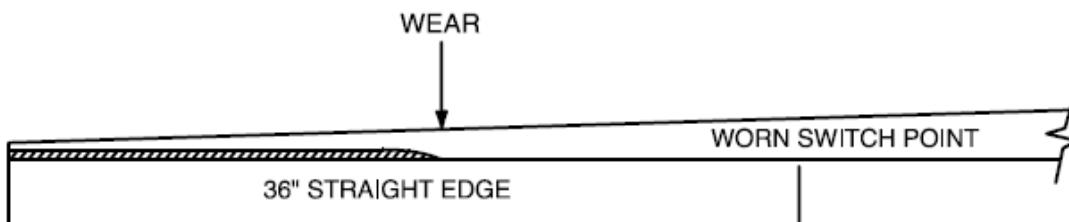
Switch Point Gage Face Wear Limits				
Class of Track	Gap Differential (Inches)	Gap Differential (1000ths of an Inch)	Restrict to 25MPH*	Restrict to 10MPH*
1	1/4	0.250	XXXXX	0.250
2	3/16	0.188	0.188	0.250
3	3/16	0.188	0.188	0.250
4,5	1/8	0.125	0.188	0.250

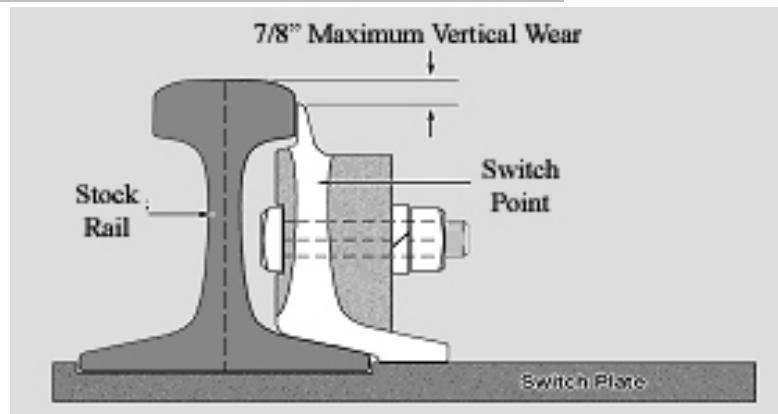
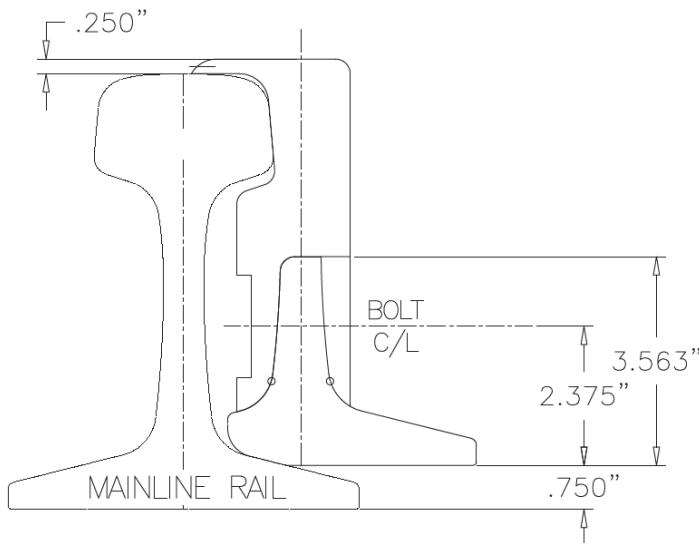
Table 8-5

*Note: For facing point moves.

To measure head wear loss on the switch point, use a 36-inch straightedge and start approximately 3 feet from the tip end of the switch point.

1. Hold the straightedge with one hand on the top of the switch point.
2. Slide the straightedge toward the tip end of the switch point and mark the location where the gap appears.
3. Change out the switch point when the distance from the top of the stock rail to the top of the switch point is greater than $\frac{1}{8}$ inch at any location starting $1\frac{1}{2}$ inches from the tip of the switch point.
4. If chipping, and/or cracking, of the switch point on the gage side is $\frac{1}{8}$ inch or more below the top of the stock rail, and the length of this chipping (and/or cracking) exceeds 3 inches in length, condemn the switch point.

**Figure 8-4**

**Figure 8-5**

**SECTION AT POINT
VERTICAL SWITCH**

Figure 8-6

8.9.11 Causes for unusual switch wear

Address root causes for unusual switch point wear. Unusual wear in a turnout indicates that some portion of the turnout is not in proper condition. Consider the following:

1. Surface
2. Tie condition
3. Gage
4. Alignment
5. Improper (or lack of) maintenance grinding

Lubricate switches regularly with the appropriate switch lubricant. Determine the need for lubrication during the monthly turnout inspection and apply lubricant on an appropriate schedule.

8.9.12 *Switch Plates*

Inspect gage plates, riser slide plates, turnout plates, hook-twin tie-plates, frog plates, guard rail plates and tie plates. Inspect for the following items:

1. Broken, bent or missing plates.
2. Ensure riser plates are securely seated and all braces are tight.
3. Gage plates with defective insulation (must be reported to SCRRRA and the Signal Maintainer).
4. Riser slide plates and spring frog plates for proper lubrication to permit free movement of switch points and spring wing rail.

8.9.13 *Heel Blocks*

Inspect the following items:

1. Ensure that the heel of the switch point is fully tamped and secure.
2. Check the heel block assembly to ensure that the bearing of the switch point is correct in relation to the heel block and to the bent joint bar.
3. Check the block assembly for a broken shoulder bolt. Replace bolts where required and maintain them in a tight condition.

8.9.14 *Frogs*

Inspect the following items:

1. Ensure that all bolts and fastenings are of the proper length and diameter and are kept tight. Check for loose bolts in the frog and in the rail joint connections.
2. Keep each switch, frog, and guard rail free of snow, ice, and other obstructions that may interfere with wheel passage.
3. Keep frog wear within the limits prescribed in Section 6.5.3 Frog Wear Non-Conformal Frogs (RBM, SGSM, Flange Bearing, and Diamonds). Wheel marks in the flangeway indicate a worn frog that needs to be repaired or replaced.
4. Set guard check gage and guard rail settings as shown in Section 6.5.9 Guard Check Gage.
5. Inspect flange depth on frogs. If the tread portion of the frog casting is worn down 3/8 inch or more below the original contour, the frog should be restricted to 10 MPH until repaired. Refer to Figure 6-25.

Note: On spring frogs the stops must be maintained to not allow the wing rail to open more than 2" at the point.

6. Check the frog for alignment and lateral movement and check for signs of wheel flange contact on the point.
7. If a frog point is chipped, broken, or worn more than 5/8" down and 6 inches back, operating speed over the frog shall not be more than 10 MPH.

8.9.15 *Self-Guarded Frog*

Inspect the following items:

Check the wear measurement on raised guards of a self-guarded frog. Urgent limit for this is $4 \frac{1}{4}$ ", Critical is $4 \frac{3}{8}$ ".

See Figure 6-26 for more information.

8.9.16 *Guard Rails*

Inspect the following items:

1. Check to see that guard rails are properly located in their longitudinal position in relation to the frog point as depicted in Figure 8-7. Also check that guard rails are correctly placed in terms of their lateral position in relation to the gage line of the frog per SCRRRA Standards as depicted in Figure 8-8.
2. Guard Check Gage is from the gage of the frog point to the face of the guard rail. Guard face gage is from the face of the wing rail on the frog to the face of the guard rail.
3. Flangeway clearance should not be less than $1 \frac{5}{8}$ inches for class 2-5 track throughout the guard rail.
4. Flangeway clearance should not be less than $1 \frac{1}{2}$ inches for class 1 track throughout the guard rail.
5. Verify that the guard rails are fully and securely spiked or lagged.

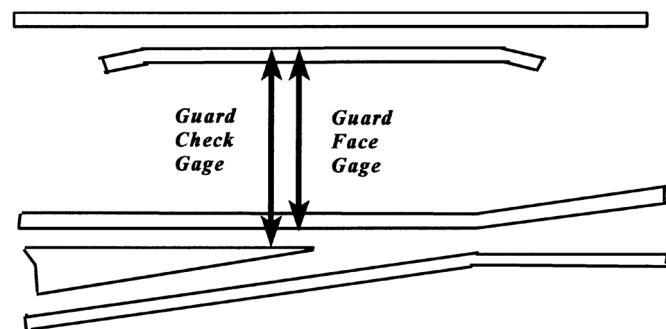


Figure 8-7

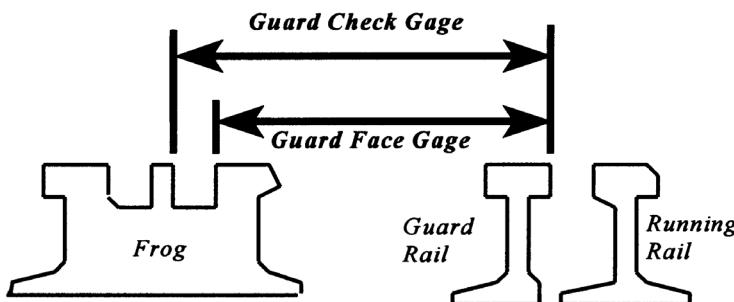


Figure 8-8

Class of Track	Guard Check Gage may not be less than	Guard Face Gage may not be more than
1	54 1/8"	53 1/4"
2	54 1/4"	53 1/8"
3 and 4	54 3/8"	53 1/8"
5	54 1/2"	53"
Heavy Point Frog, Class 5	54 3/8"	53 1/8"

Table 8-6

8.9.17 *Cross Level*

Inspect the following items:

1. Measure cross level throughout the turnout at locations every 4 to 6 ties apart.
2. Check the turnback curve to ensure that the proper elevation is maintained. Do not allow reverse elevation in the turnback curve.

8.9.18 *Alignment*

Inspect the following items:

1. Standing ahead of the switch looking toward the frog, look for alignment deviations.
2. Observe the curved closure rails for uniformity of curvature.
3. Measure defects by stretching a 62-foot cord along the gage side of the outer rail and measuring the offsets at the center of the cord.
4. At spring frogs, line should be maintained to minimize unequal bearing of the spring wing against the point rail. Unequal bearing and continual slapping of the spring wing can cause point failure and the spring wing to lose its bend set.

8.9.19 *Switch Ties*

Inspect switch ties as follows:

1. Check ties, especially head blocks under the switch heel and under the frog, to ensure they are not defective.
2. Good tie condition and surface must be maintained throughout the turnout. Surface should not have a depression or crown. Poor surface or cross-level can cause binding of the switch points causing a switch to be hard to throw. Poor surface can also cause binding of the spring wing of a spring frog and place unnecessary pressure on the spring assembly.
3. Ensure that there are sufficient amounts of non-defective ties.

8.9.20 *Rails*

Inspect the following:

1. Measure rails for gage face and for vertical head wear, in accordance with the current rail wear limit charts. Also, examine rails for surface defects and signs of internal defects especially at guard rails and stock rails.
2. Use an inspection mirror to closer inspect rail in guard rails and tight switch areas.

8.9.21 *Rail Anchors*

Check that track is properly anchored adjacent to and through turnouts. If $\frac{3}{4}$ inch or more movement is evident at the switch point, add more anchors to restrain movement.

8.9.22 *Ballast*

Inspect the following locations of a turnout to ensure that no loose ballast is present to obstruct proper operation of components:

1. Between the point and stock rail up to the heel block.
2. Around connecting rods and switch rods.
3. Spring frog wing rails.
4. Point rails of moveable point frogs.

8.10 Derail Inspection

Switch point derails per Section 6.7 Derails – Permanent and Portable shall be inspected monthly and maintained to function as intended.

Inspect derails while making a switch inspection. If any of the conditions below are substandard, promptly repair, replace, or remove them from service, giving immediate notice to SCRRRA. Inspect derails for the following criteria:

Proper installation - Make sure derail is locked as instructed and that it is not worn to the extent that it moves when it is locked. Properly installed derails have:

1. Proper size.
2. Good quality and securely fastened ties.
3. Derail is not damaged (i.e., exhibiting unusual wear, usage distortion, or fracturing).
4. The sign is legible and visible.

8.11 Return to Service Track Inspection

Inspectors and track foreman inspect the track worked by their crew each day to be certain that the work was performed to standards before returning track to service. When checking the quality of work, inspect for the following:

1. Alignment, gage, and surface meet required class of track
2. Proper ballast section is restored and that the track is properly dressed
3. Ties are up tight against the rail base and fully tamped
4. Tie plates are on and centered on the ties
5. Rail is properly seated in the tie plates
6. Tie fasteners are properly placed
7. Joints tightly bolted with at least two bolts in each rail end
8. Work and materials properly cleaned up
9. Proper speed restriction in place, if required
10. Rail anchors properly placed, installed tight against the ties, and in the prescribed pattern

Non-compliant conditions must be protected by appropriate remedial actions.

Repairs and other events can affect the integrity of the track. Note where the integrity of the track has been or could have been affected by repairs or other events. Pay close attention to these locations during inspections. Additional inspections may be needed in areas where the rail has not been destressed. If rail was added it must be documented and rail adjustment must be made before rail temperatures reach or exceed 40 degrees above laying temperature. Refer to Section 9.10 Placing Temporary Speed Restrictions for Trackwork.

8.12 Special Inspections

8.12.1 *Storms, Floods, Washouts, Mud/Rock Slides*

Violent winds and heavy rains pose a potential hazard to track and structures. When a storm, an indication of a storm, or high water may cause an unsafe condition in and around the right-of-way, the inspector must:

1. Keep informed of current weather forecasts and conditions.
2. Notify the immediate supervisor and Train Dispatcher of actions.
3. Determine approximately how high the water could crest above or below the track and structures in the affected area.
4. Notify the Train Dispatcher and immediate supervisor of potential hazards.
5. Continue performing inspections until the hazard no longer exists.

When conducting a special inspection of track and structures, the inspector will check the following:

1. Alignment, cross level, and profile of the track.
2. Bridge piers, abutments, and bulkheads for signs of scouring.
3. Substructure and superstructure for damage from large objects washed into structures.
4. Piers, bents, and bridge members for missing components.
5. Materials fouling the track, such as trees, pole lines, wires, etc.
6. Volume of excessive drift and debris under bridges and in culverts obstructing water flow.

8.12.2 *Right-of-Way Fires*

When a fire is reported on or near the right of way that may pose a threat to track and structures, the inspector must conduct a special inspection as follows:

1. Obtain the milepost location of the fire from the Train Dispatcher.
2. Determine whether local fire authorities have been notified and are on the scene or are en route.
3. Determine the extent of track and bridge structure involvement in the fire, or risk of involvement if the fire were to spread.
4. Immediately notify the Train Dispatcher and immediate supervisor when track or structures are on fire.

Assess fire damage to track and structures by checking the following:

1. Alignment, cross level, and profile of the track.
2. Cross ties, bridge ties, bridge pier supports, and abutments.
3. Bridge substructure and superstructure.
4. Piers, bents, and bridge members.
5. Signal pole lines.
6. Slide fences (where applicable).

Continue performing inspections and provide frequent status reports to the Train Dispatcher and immediate supervisor until the hazard no longer exists.

8.12.3 *Earthquakes*

When an earthquake occurs, each earthquake's magnitude—or inherent strength—is measured and reported by the SCRRRA's direct link with the California Integrated Seismic Network (CISN) Southern California Earthquake Center management center (Caltech/USGS Pasadena). Per the Dispatch Manual the direct link (CUBE/CISN system) or other available links to the National Earthquake Information Service operated by the U.S. Geological Survey in Golden, Colorado may be used. These Earthquake Early Warning (EEW) sites can be quickly and easily reached through various internet sites and news media. In some case the internet or the site may be overloaded with requests for information so there could be delays in determining the epicenter and magnitude of the earthquake.

The magnitude of the earthquake as determined by the Richter scale gauges the magnitude of energy released by an earthquake, as measured by the ground motion recorded on a seismograph. The magnitude of an earthquake is the same no matter where one is located. The earthquake intensity as measured by the Modified Mercalli Scale (MM)—or the degree to which shaking is felt in a specific location—varies depending on one's distance from the earthquake's epicenter, the detailed characteristics of the earthquake: (bearing, depth) type of earthquake fault movement (strike-slip, thrust, normal) and the site specific ground conditions and built structure subject to the seismic waves generated by the earthquake.

When an earthquake has occurred, the Dispatcher will contact and stop trains based on the Table below. The Dispatch Operations Center (DOC) shall set up a conference call as soon as possible with the key personnel from Operations, Maintenance of Way (track and signal) and Compliance/Safety and the details of the earthquake (epicenter, magnitude and any known intensity information). The location, name and estimated time for key Contractor and SCRRRA personnel (operations, track, signal, building, building compliance) to respond to sites (subdivision) or buildings requiring inspection or trains needing support shall be both coordinated and determined. An **earthquake event coordinator (EEC)** shall be designated (typically a senior SCRRRA Maintenance of Way or Engineering representative) and the EEC shall coordinate the response activities until trains and personnel are in a safe location and passengers and employee safety has been determined. The EEC shall also coordinate communications with the Incident Response Plan (IRP) and ensure that the details of the earthquake are communicated to the key contacts in the Metrolink organization.

After the earthquake is reported and key details determined, the Dispatch Operations Center along with the EEC notifies and coordinates the response of the Maintenance-of-Way (MOW) track, bridge and signal Inspectors/Contractors, as well as SCRRRA MOW and Engineering staff to begin inspections of track, signals, bridges and key buildings within the boundaries of the inspection area per the Tables below. SCRRRA Compliance/Safety is also contacted to meet with the trains that may be stopped and provide assistance on movement of trains and handling of train passengers and assist MOW staff on the earthquake response. Use the criteria in Table 8-7 to determine whether a special inspection is warranted.

Earthquake Response		
Magnitude	Initiate Inspection	Criteria for Response
Unknown	Yes	Field reports ground shaking in a geographic area. Trains stop within 50-mile radius of reported shaking. Seek direction from EEC.
0.0 to 4.9	No	Proceed at normal speed. No inspections are required.
5.0 to 5.49	Yes	All trains within a 30-mile radius must operate at restricted speed until track, structures key buildings and signal system have been inspected at the direction and coordination of the MoW EEC.
5.5 to 5.99	Yes	All trains within a 30-mile radius of known epicenter must operate at restricted speed until track, structures, key buildings and signal system have been inspected at the direction and coordination of the MoW EEC.
6.0 to 6.49	Yes	All trains within a 50-mile radius of known epicenter must STOP* and not proceed until track, structures, key buildings and signal system have been inspected at the direction and coordination of the MoW EEC.
6.5 to 6.99	Yes	All trains within a 70-mile radius of known epicenter must STOP* and not proceed until track, structures, buildings and signal system have been inspected at the direction and coordination of the MoW EEC.
7.0 to 7.49	Yes	All trains within a 100-mile radius of known epicenter must STOP* and not proceed until track, structures, key buildings and signal system have been inspected at the direction and coordination of the MoW EEC.
7.5 and above	Yes	All trains within a 150-mile radius must STOP* until track, structures and signal system have been inspected and the Command Center releases trains. Command Center and MoW EEC may extend the radius dependent on the severity.
<p>*Note: Trains may be moved the minimum distance required not exceeding 5 mph to avoid an emergency situation (i.e.: to clear a bridge, grade crossing, etc.). Upon instruction from the MoW EEC passenger/commuter trains may proceed to the next or station or make a reverse move to a station behind and may not exceed 5 MPH.</p>		

Table 8-7

When notified, inspectors must be prepared to perform special inspections to identify hazards and take precautions to protect the safety of trains operating in the affected areas. When conducting a special inspection, check the following:

1. Materials fouling the track, such as trees, pole lines, wires, etc.
2. Alignment, cross level, and profile of the track especially at bridge approaches.
3. Bridge piers, abutments, and bulkheads for signs of structural damage, shifting and movement.
4. Substructure and superstructure for damage or movement, spalling, cracks, weld or bolt failures.
5. Piers, bents, and bridge members for movement or missing components.
6. Signal outages and malfunctions. Shifted batteries, relays, or damaged signal equipment inside houses and damaged air conditioner units outside.
7. Slide fences, where installed, for rocks and talus or physical damage.
8. Slope movements (rocks, talus, slides).
9. Key Buildings (Dispatch Operations Center, Metrolink Operations Center, Melbourne, Central Maintenance Facility, Eastern Maintenance Facility, Wilshire Grand) - check for gas, water, sewer, power, fire/life safety alarm, telecommunication damage and then structural damage including bent columns, roof damage, broken windows, shifted HVAC units, settlement or shifting.

8.12.4 Temperature Based Inspections

Refer to Section 9.12.3 Placing Temperature Restrictions.

Speed restrictions in accordance with Section 9.12.3 Placing Temperature Restrictions herein and Rule 6.21.6 of the timetable shall be put in place. Level 1 speed restriction shall be placed when ambient temperature rises above 100°F. Level 2 speed restriction shall be placed when ambient temperature rises above 105 °F.

8.12.4.1 Hot Weather

Hot weather inspection reports and temperature recordings shall be documented on the Heat Run/ Unusual Occurrence Report and be kept on file by Contract Operator for one year.

Do NOT allow trains to operate over a track buckle. The train will likely cause more movement.

At locations where rail movement is occurring, and tight rail conditions exist place at least a 25 MPH speed restriction until rail is destressed. If conditions warrant, a more restrictive speed restriction should be placed or track removed from service. Destress rail to the PRLT following the procedures outlined in Section 9.8.1 Destressing Rail Procedure.

Note: Refer to Section 9.12.3 Placing Temperature Restrictions for placing Heat Orders.

When documenting heat inspections, the inspector must write heat inspection in the comments of the inspection report. Refer to Section 8.12.4.1.1 Lateral Rail Movement through Section 8.12.4.1.11 Ballast Conditions for track conditions requiring additional attention.

8.12.4.1.1 Lateral Rail Movement

Lateral movement occurs when rail moves from side to side.

When inspecting for lateral movement look for the following:

1. Tight, wavy, or nervous rail.
2. Clusters of defective ties.
3. Voids between the ballast section and the end of the tie.
4. Rail touching the opposite corners on the shoulder of the plates.

8.12.4.1.2 Vertical Rail Movement

Vertical movement occurs when the rail moves up or down. When inspecting for vertical movement look for the following:

1. Track appearing to have surface irregularities.
2. Ties that have pulled up out of the ballast.
3. Clusters of high spikes.
4. Rail lifting off the plates.
5. Rail that is canted either inward or outward.

8.12.4.1.3 Longitudinal Rail Movement

When the rail is in compression and allowed to move unrestrained longitudinally, the rail can bunch at fixed locations.

When inspecting for longitudinal movement look for the following:

1. Ballast accumulating on one side of the tie. This indicates that the ties are moving with the rail and pushing the ballast. A ridge of ballast forms ahead of one side of the tie and leaves a void on the other.
2. Skewed ties (ties are not at a right angle to both rails).
3. Anchors that are not tight against the tie. This indicates that the anchors have lost their holding strength and are moving with the rail.
4. Shiny marks on the base of the rail. These marks are made from the spike heads, anchors or insulator/clips scraping the rail.
5. Frogs that appear to be out of line or there is tight gage.
6. Improper fit of the switch point to the stock rail.
7. Switch rods are binding on the head block ties.
8. Numerous failed elastic fasteners.

8.12.4.1.4 Rail Conditions

Inspect for corrugated, battered, or engine-burned rail. The presence of these increases the dynamic loading on the track. Sharp curves are especially vulnerable.

8.12.4.1.5 Where Rail Could Have Been Added

Inspect locations where rail may have been added due to repair of service failures, rail defects, pull-aparts, or where field welding has occurred, particularly in cold weather.

8.12.4.1.6 Where Recent Trackwork Had Been Performed

Inspect locations where track maintenance work, such as tie and rail renewals, undercutting, or surfacing and lining was recently performed. Other locations that need to be considered are newly constructed track, derailment sites and washout areas.

8.12.4.1.7 Fixed Track Structures

Inspect fixed structure locations, such as road crossings, diamond crossings, turnouts, bridges, platforms, and concrete-to-wood tie transitions where rail may bunch.

8.12.4.1.8 Where Trains Could Cause Longitudinal Rail Movement

Inspect locations where the braking action of trains can change the longitudinal forces in the track. Areas include the following:

1. Heavy braking areas.
2. On grades, the bottom of grades and vertical curves.
3. In advance of speed restrictions.
4. Horizontal curves; paying special attention to high degree curves.
5. Where train traffic is predominately one direction.

Fixed track structures as noted in Section 8.12.4.1.7 Fixed Track Structures.

8.12.4.1.9 Track Geometry Deviations

When inspecting for substandard track geometry look for the following:

1. Track surface deviation.
2. Deviations in the super-elevation of the curve.
3. Cross-level deviations at joint locations.
4. Weakness in sub-grade that may cause a surface deviation.
5. Deviations in track alignment.
6. Misalignments resulting from curve shifting.

Note: Use care when inspecting curves for line defects. Usually the buckle is towards the high side of the curve, a small buckle in a curve can go unnoticed.

8.12.4.1.10 Insufficient Anchors and Fasteners

When inspecting for insufficient anchors and fasteners look for:

1. Lack of standard box anchoring for 200 feet in both directions at turnout, road crossing, and bridge locations.
2. Missing or inadequate anchors/fasteners at joint locations.
3. Rail moving through anchors or fasteners (shiny mark).

8.12.4.1.11 Ballast Conditions

The standard CWR ballast section for wood tie track is a minimum 9 inches wide and 12 inches wide for concrete tie track with a two-to-one slope. A two-to-one (2:1) slope is defined as two feet of horizontal distance for each foot (12 inches) of drop.

When inspecting the ballast section look for the following:

1. Empty ballast cribs.
2. Insufficient ballast on the shoulders.
3. Fouled ballast.
4. Signs of freshly disturbed track.

8.12.4.2 Cold Weather

On main tracks, cold weather inspections must be performed as directed by SCRRA.

Inspect for:

1. Broken rails
2. Pull-aparts
3. Curve movement
4. Wide gap between rail-ends
5. Bent bolts
6. Cracked or broken joint bars
7. Canted rail

When documenting cold weather inspections, the inspector must write cold inspection in the comments of the inspection report.

8.12.5 *Conditions Reported by Trains*

The DOC shall notify the track inspector whenever an irregular track condition is reported by trains. The track inspector will immediately arrange to have the track inspected and report sent to TRACK&STRUCTURES@SCRRRA.NET. Protect train operations until any necessary repairs are completed.

8.12.6 *Wheel damaged Rails, Ties and OTM*

Inspect for wheel damage as follows:

1. Nicked, gouged, or broken rail
2. Displaced or broken anchors
3. Damaged plates
4. Damaged ties
5. Look for wheel burns
6. Determine the limits of the damage and place the appropriate speed restriction. See Summary of Speed Restrictions for Trackwork in Appendix B.
7. Broken and damaged fasteners
8. Broken fastener housings

8.13 FRA Inspections

A SCRRRA representative shall accompany an FRA Inspector making a track inspection on the territory. When this is not possible, SCRRRA representative may designate another employee.

A copy of the inspection reports from the FRA must be sent to the TRACK&STRUCTURES@SCRRRA.NET no later than the next business day after completion of the inspection.

Note: In this section, "FRA Inspector" refers to federal or state PUC employees legally authorized to make track inspections under FRA rules.

8.14 Required Field Documentation – FRA Compliance

See Section 8.6.2 Track Inspector Documents.

8.15 Placing and Removing Temporary Speed Restrictions

8.15.1 *Responsibility*

Issue a speed restriction for any condition that might prevent trains from operating safely at maximum authorized speed. In addition, SCRRRA staff, SCRRRA consultants, and other authorized contractors may place speed restrictions when necessary.

Temporary speed restrictions protect passengers, crews, trains, freight, and facilities. This section explains how to place and remove temporary speed restrictions under certain conditions. However, this section cannot give safe train speeds for all conditions. Use good judgment when placing speed restrictions for conditions not covered in this section. Consider the following factors:

1. Maximum authorized speed for the track
2. The traffic on the track
3. The severity of the conditions
4. The weather
5. The location, tangent track or curved track

Special care and judgement must be exercised during inspection to be aware of the combination of conditions which, individually, may not exceed the limits for a specific condition but when taken as a group may present a track condition that may best be addressed by reducing track speed.

8.15.2 *Placing Temporary Speed Restrictions-General*

Temporary speed restrictions delay train operations. Place temporary speed restrictions only when railroad safety requires them. At the same time, plan to correct unsafe conditions so that the restrictions can be removed as soon as possible.

When multiple temporary speed restrictions are too close together to permit trains to increase speed between affected areas, establish longer restriction limits to prevent undesirable in-train forces. Before combining multiple restrictions, consider differential train speeds and expected duration of adjacent restrictions.

The temporary speed restriction should be the highest speed at which a train can pass safely through the restricted area.

When placing temporary speed restrictions, refer to the following for maximum speed and minimum duration requirements.

Refer to Summary of Speed Restrictions for Trackwork and Remedial Action for Rail Defects Table in Appendix B for instructions on placing temporary speed restrictions for trackwork.

Procedure for Placing Temporary Speed Restrictions

Notify the train dispatcher as much in advance as possible when planned maintenance activities will result in a temporary speed restriction. Several hours of advance notice of your speed restriction and milepost limits will allow the train dispatcher to issue the restriction to trains in a more desirable non-emergency work mode.

To place a temporary speed restriction:

Contact the dispatcher and identify yourself.

Give the dispatcher the following information:

1. Track or tracks covered by the restriction
2. Specific limits of the restriction using mile posts, hundredths of a mile from mile posts, and stations on each side of the restriction limits
3. Location of flags to be used
4. Speed at which trains may operate
5. Date the restriction will probably be removed
6. Reason for the restriction

Confirm with the dispatcher that the green flag will not interfere with any other speed restrictions and/or work limits.

Confirm with the dispatcher that all trains will be protected by track bulletin or track warrant.

The dispatcher notifies trains passing over restricted track that the temporary speed restriction is in effect.

Placing Track Flags

When placing temporary speed restrictions, place track flags according to the SCRRRA Maintenance of Way Operating Rule 5.4.8 and timetable special instruction.

Whenever practicable, flags should be placed directly opposite of tenth mile markers as stenciled on the rail. Other locations not at tenth mile markers must be approved by the proper SCRRRA authority.

Notification of Speed Restrictions

Notify the appropriate supervisor immediately of any temporary speed restrictions placed on your territory. Give the following information:

1. Location and reason for the restriction
2. Estimated removal date of the temporary speed restriction
3. Estimate of the material, machinery, and labor required to repair the track or structure

Checking Restrictions

Qualified personnel must inspect locations covered by temporary speed restrictions and prescribe and direct the work needed to remove the restrictions as soon as possible.

Periodically check the superelevation of curves within speed restriction limits to detect any increases in superelevation. The weight of trains moving slowly through curves can cause increased superelevation, which can cause wheel climb, especially if track alignment or cross-level is irregular. Recently undercut track is particularly susceptible to these conditions.

Check restrictions daily, if necessary, to ensure that they are at the proper speed.

8.15.3 *Removing Temporary Speed Restrictions*

Temporary speed restrictions can make train handling more difficult. The first priority should be correcting the conditions that require a restriction in an isolated location. Then, correct conditions that require a series of restrictions over a short distance. Before removing any speed restrictions, the abutting rail's anchor pattern, rail end gap, cross level, and rail end mismatch shall be inspected.

Procedure to Remove Temporary Speed Restriction

To remove a temporary speed restriction:

1. Know who placed the original speed restriction and why it was placed. This is especially true if the restriction was placed by someone other than contract operator, such as a contractor, consultant, or SCRRRA staff.
2. Verify that the condition has been repaired or corrected. If the speed restriction was placed by someone other than the contract operator, obtain confirmation in writing that the speed restriction may be removed.
3. Contact the dispatcher and identify yourself.
4. Give the following information:
 - 4.1. Track or tracks covered by the restriction
 - 4.2. Specific limits of the restriction using mile posts, tenths of a mile from mile posts, and stations or control points on each side of the restricted limits
5. Confirm with the dispatcher that removing the green flag will not interfere with any other speed restrictions in the area.
6. Confirm with the dispatcher that the restriction has been removed.
7. If possible, the person who placed the speed restriction should be the one to remove it.
8. The dispatcher stops notifying trains of the restriction after you advise that the restriction is no longer needed.

8.15.4 *Removing Track Flags*

Remove track flags immediately after a speed restriction is removed, starting with the most restrictive flags.

Note: Track flags reduce train speed to 10 MPH for at least 2 miles if they are displayed without a track bulletin.

8.16 Other conditions requiring additional inspections

8.16.1 *Track not Meeting SCRRRA Standards*

Reduce the maximum authorized speed on track that does not meet all SCRRRA track standards. Determine whether to place a temporary speed restriction on other substandard conditions based on inspection, comparing the actual conditions to the standards described in the FRA track safety standards, SCRRRA track standards, and this manual.

Watch for rail movement close to road crossings, bridge ends, turnouts, curves, sags, and areas of substandard ballast. Rail will typically move in the direction of train braking until it is stopped by more solid segment of the track, such as a road crossing or a bridge.

Above all, be concerned about areas of disturbed track, where ballast is loose, or ties have been moved or removed.

The following table provides examples of potential track buckling conditions.

For example, consider placing a temporary speed restriction when	
When ambient temperature is expected to rise over 80 degrees F. Any of the following conditions reduce the track structure's lateral resistance:	
Poor tie condition	Floating or hanging ties
Inadequate ballast section	Sink holes
Rail running through anchors	Churning ballast
Rail base not properly seated	Rail not properly adjusted.
Short flat spots on curves	Line kinks in tangent
Temporary Detours (shooflies)	Temporary realignments

Table 8-8

8.16.2 *Track Replaced or Welded in Cold Weather*

Tight rail and track buckling can appear where rail is replaced or field welded during cool weather. On warm days after the work is completed, inspect these locations closely. If symptoms of tight rail or track buckling appear, place the appropriate temporary speed restriction and have maintenance personnel cut the rail and relieve the stress. Refer to Chapter 9 for CWR procedures.

8.17 Track Under Repair

The employee in charge of the repair work must follow the procedures in the FRA standards, RWP Rules, the timetable, and this manual to place protective speed restrictions during trackwork.

When temperatures are above 80°F ambient temperature, precautions must be taken to prevent track buckles. If conditions warrant, track must be removed from service to perform work. Repairs must be documented on the Return to Service Report found in Appendix C.

8.18 Track Damaged by Derailment or Washout

A train derailment or washout can severely damage the track and roadbed. Remove track from service until it has been inspected and determined that it is safe to operate over. If a speed restriction is necessary, use this manual, the 213 Track Safety Standards, and good judgement to determine the safe speed until the track is safe for the maximum authorized speed.

Be aware that a track on a rebuilt roadbed will take longer to stabilize.

After a derailment, check all track and structure components and verify with other departments that the entire track segment has been inspected and repaired before returning track to service.

8.19 Temporary Speed Restriction Tables

See Appendix B for Speed Restrictions after trackwork.

Note: As used in the table, "trains" refers to a set of at least 5 passenger cars plus locomotive for stabilizing purposes. One tonnage train equals six passenger sets. A tonnage train must have at least 30 cars.

Preference will always be to use the Dynamic Track Stabilizer as the first choice, then a non-revenue passenger set and then a revenue passenger set as a last resort.

Note: When it is shown that speeds may be increased after the passage of a certain number of trains, the track must be inspected by a qualified track inspector and conditions verified that they are safe to increase the speed.

9.0 SCRRRA Procedures for the Installation, Adjustments, Maintenance, and Inspection for Continuous Welded Rail (CWR) as Required by 49 CFR213.119

This chapter details the Southern California Regional Rail Authority's (SCRRRA) policy on installing, adjusting, maintaining and inspecting Continuous Welded Rail (CWR) track. Each section details how SCRRRA applies its standards and procedures to comply with FRA standards. Employees involved in the Adjustment, Maintenance, and Inspection of CWR as required by 49 CFR 213.119 are required to have the most current version of SCRRRA's CWR procedures.

CWR installation and adjustments must be performed or supervised by FRA 213 qualified personnel as designated by SCRRRA.

9.1 Background and Terminology

Adjusted Rail Temperature: The temperature the rail was adjusted to at time of installation.

Annual re-training: Means training every calendar year.

Buckling Incident: The formation of a lateral misalignment sufficient in magnitude to constitute a deviation from the FRA Class 1 alignment requirements specified in 49 CFR 213.55 (Federal Track Safety Standards). These normally occur when rail temperatures are relatively high and are caused by high longitudinal compressive forces.

Continuous Welded Rail (CWR): Rail that has been welded together into lengths exceeding 400 feet. Rail installed as CWR, remains CWR, regardless of whether a joint or plug is installed into the rail at a later time.

Compressive Forces: Push toward each other. They tend to squeeze or compress an object.

Corrective Action: The action specified to address track conditions of actual or potential failure.

Critical Buckling Temperature: The point at which the track buckles without any outside forces. When outside forces are applied, the critical buckling temperature is lowered.

CWR Joint: Any joint directly connected to CWR.

Disturbed Track: The disturbance of the roadbed or ballast section, as a result of track maintenance or any other event, which reduces the lateral or longitudinal resistance of the track or both.

Dynamic Loading of Trains: The forces that are applied to the track structure from wheel and axle loads, braking, acceleration, rocking, truck hunting, flat spots on wheels, and slack action. These vertical, longitudinal, and lateral dynamic forces can contribute to the buckling potential of the rail.

Installation Temperature: The temperature at which the CWR was laid and anchored. It is a key component in understanding the dynamics of track buckling. This is the initial neutral temperature.

Lateral Resistance: The reaction that is presented by the ballast to prevent lateral movement of the rail and ties. As the compressive forces in the rail increase the track structure has a tendency to push outward. The ties and ballast resist this outward movement. This is a key parameter in providing lateral resistance and stability for buckling prevention. Figure 9-1 shows how the ballast resists lateral movement of the track structure.

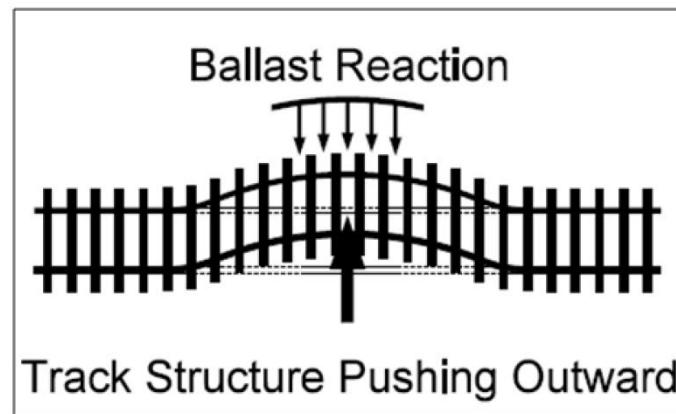


Figure 9-1

Three components make up the lateral resistance of the track structure: friction between the bottom of the tie and the ballast, friction between the side of the tie and the ballast in the crib, and the interaction between the end of the tie and the ballast on the shoulder. See Figure 9-2.

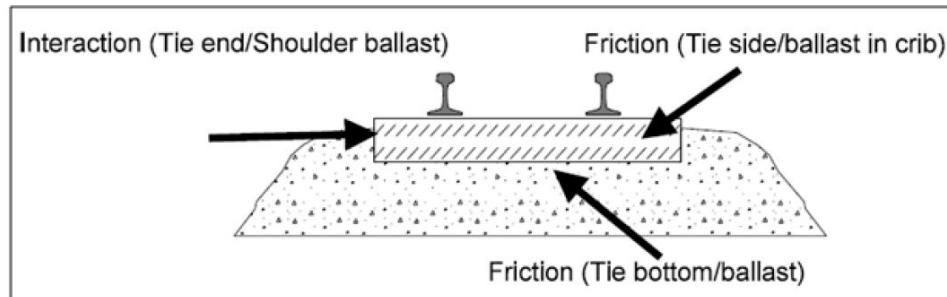


Figure 9-2

For wood ties, the percentage of contribution is: bottom of tie (40%), side of tie (35%) and end of tie (25%). For concrete ties, the percentage of contribution is: bottom of tie (40%), side of tie (30%) and end of tie (30%). The amount of resistance that the ties provide depends on the spacing, dimensions, mass, and geometry. The ballast resistance depends on the type and size of the tie and the profile, density, and consolidation of the ballast.

Longitudinal Forces: Compressive or tensile forces affecting the length of the rail.

Mechanical Stabilization: A type of procedure used to restore track resistance to disturbed track following maintenance operations. The procedure incorporates dynamic track stabilizers or ballast consolidators, which are units of work equipment that are used as a substitute for stabilization action provided by the passage of trains.

Preferred Rail Laying Temperature (PRLT): 110 degrees Fahrenheit. The temperature that the rail is to be installed at, or adjusted to, in order to balance the thermal expansion and contraction forces for optimum track maintenance practices. The PRLT is the designated rail installation temperature.

Pull-Apart or Stripped Joint: A condition when no bolts are mounted through a joint on the rail end, rendering the joint bar ineffective due to excessive expansive or contractive forces. The condition may result from excessive contraction when cold causes rupture of all bolts in the joint.

Pull-Apart Prone Condition: A condition when the actual rail temperature is significantly below the RNT at or near a joint where longitudinal forces may affect fastenings resulting in stripped joints.

Rail Anchors: Those devices which are attached to the rail and bear against the side of the crosstie to control longitudinal rail movement. Certain types of elastic rail fasteners also act as rail anchors and control longitudinal rail movement by exerting a downward clamping force on the upper surface of the rail base.

Rail Neutral Temperature (RNT)/Force Free Temperature: The temperature at which the rail is neither in compression nor tension. The temperature at which there are no longitudinal forces in the rail. The rail is said to be in a state of equilibrium or balance, which means there are no pushing or pulling (compressive or tensile) forces. The rail neutral temperature is equal to the installation temperature, at which the CWR is laid and anchored, if no other rail related activities have occurred.

Remedial Actions: An action to correct or protect defects that compromise the track structure.

Temperature Differential: The difference between the PRLT and the actual rail temperature taken at the time of installation is called the temperature differential.

Tensile Forces: Pull away from each other. These forces tend to stretch an object.

Thermal Expansion of Rail: Occurs when a section of continuous welded rail (CWR) expands in length due to rail temperature increase.

Tight Rail: CWR which exhibits alignment irregularities which indicate that the rail is in a considerable amount of compression.

Track Longitudinal Resistance: The resistance provided by the rail anchors/rail fasteners and the ballast section to the rail/crosstie structure against longitudinal displacements.

9.2 Causes of Track Buckling

A track buckle is a lateral misalignment caused by one or more of the following:

1. Variation in the PRLT, which equates to the longitudinal force in the rail. When the rail's neutral temperature is reduced, the longitudinal force in the rail increases causing a reduction in the track's critical buckling temperature.
2. A weakened track structure or subgrade due to reduced lateral track resistance. The lateral resistance is reduced after the track structure or subgrade has been disturbed.
3. Dynamic loading of trains, such as dynamic uplift, high axle loads (lateral/vertical), braking, and traction loads.
4. Lateral track alignment deviations.
5. Curvature

9.2.1 *Maintenance Activities and Conditions That Impact Track Buckles*

Controlling Rail Neutral Temperature (RNT) is a critical component in the maintenance process. There are several maintenance processes that are performed that can impact the rail neutral temperature and allow for a condition that is prone to a buckle. Maintenance activities and conditions that impact buckles are:

1. Lowered Rail Neutral Temperature - When maintenance is performed on the track where rail is added, the rail's neutral temperature is lowered. If this reduction in neutral temperature reaches the critical buckling point, the track structure can no longer resist the stress created by elevated temperatures and train induced forces, and a track may buckle.
2. Addition of Rail and Field Welds - Rail can be added when repairing service failures, rail defects, or pull-aparts. When work is performed to correct surface or line deviations, the rail will straighten out and can grow in length. There may be too much rail in the track. This increase in length decreases the neutral temperature.
3. Loss of Longitudinal Resistance – Missing anchors, insufficient anchors, and/or a lack of resistance from the fastening system can allow rail to move longitudinally. At the location(s) where the rail stops moving longitudinally, rail may bunch causing a buildup in compressive forces which is susceptible to track buckles.
4. Reduced Lateral Resistance - Lateral resistance holds the track structure in place. When the rail is in compression, the track tries to push outward. Maintenance activities such as tie renewals, undercutting, and/or surfacing and lining can significantly reduce the lateral resistance of the track structure. As the forces increase in the rail, the track structure may release the built-up stress and the location of the weakened track structure is vulnerable to a buckle.
5. Maintenance on Curves - When maintenance is performed on a curve the track could shift inward. As the curve is lined in, the length of the curve is reduced thus creating excess rail. The result of this lowers the rail's neutral temperature.
6. Surface and Alignment Deviations - Poor surface and alignment conditions severely lower the track structure's lateral resistance. Minor surface and alignment defects coupled with lowered neutral temperatures can lead to progressive buckling.
7. Dynamic Train Forces - Dynamic forces significantly increase the potential for track buckling. This is due to the uplift of the track in front of the train, between the front and rear trucks of a car, and the rear of the train. In the uplift area, the lateral resistance is reduced. This magnifies the importance of the lateral resistance between the shoulder ballast and the end of the tie.
8. Poor Train Handling - Poor train handling where trackwork was recently performed may greatly increase the probability of a track buckle, especially on grades or curves.

9.2.2 *Track Buckle Occurrences*

It is important to understand when track buckles occur. Based on an eleven-year study, 75 percent of track buckles occur in the hottest months of the year, which tend to be June, July, and August for SCRRRA. 88 percent of the track buckle incidents occur on hot sunny afternoons between 2 p.m. and 6 p.m. 49 percent of track buckles occur when ambient temperatures are between 90 and 100 degrees Fahrenheit.

9.3 Track Buckling Preventive Maintenance

Track Buckling Prevention is an on-going process. Performing track buckling preventive maintenance throughout the year can reduce the risk of track buckles. Track buckling prevention is achieved through proper management of CWR:

1. Adjust Rail (CWR) - Destress rail when maintenance work requires the adjustment.
2. Adjust Anchors - Maintain a standard anchor pattern. This provides the resistance necessary to keep the track from moving longitudinally. In locations where the standard pattern is not sufficient, or where longitudinal movement is evident, additional anchors shall be applied. The best time to perform this work is when the rail is in tension.
3. Place Ballast - A full ballast section is required to provide the lateral resistance necessary to hold the track in place.
4. Adjust Spiking Pattern - Adjustment of the spiking pattern. The standard spiking pattern helps resist the lateral forces.
5. Line Out Curves - Line out any curve that has inward movement of 3 inches or more prior to rail temperatures above or forecasted above the designated rail laying temperature. See Section 9.9 Monitoring Curve Movement Following Track Surfacing and Lining for more information on this.

Note: Excessive thermal forces in curves can be temporarily relieved by lining the track outward, but without knowledge of the pre-existing RNT of both rails, the amount of adjustment made by lining the track will be unknown. Therefore, a traditional adjustment would be required to properly adjust the location back to within the designated rail installation safe range (PRLT +/- 5°F). Over elevating the RNT in the curve will only exacerbate the cording problem during the next cold weather event.

9.4 Tie Installation

Tie Installation significantly disturbs the track and reduces its lateral resistance. Follow the speed restrictions listed in Section 9.10.4 Speed Restrictions for Trackwork to protect tie installations.

Do not replace more than 50 percent of the cross or switch ties in any 39-foot section of track or more than three consecutive cross or switch ties. Make additional passes if necessary.

When making additional passes to install ties ensure that all ties installed in the first pass have been fully spiked and anchored and ballast is placed to maintain surface and alignment.

Tamp all new ties, and any other ties that are hanging, or have been obviously disturbed. Regardless of rail temperature, ensure that shoulder and crib ballast is placed to maintain surface and alignment. In addition, ensure that spikes and anchors are installed to allow for safe train operations.

All cribs must be completely filled, shoulders restored, and all newly installed ties must have all anchors applied and spikes driven prior to the passage of trains at speeds above 30/20 MPH.

These tie replacement requirements do not apply when installing ties at the following locations:

1. Road crossings.
2. Open deck bridges.
3. Station platforms (with destressing).
4. Confined track areas.
5. Undercutting operation.

Note: When there is evidence of lateral, vertical, or longitudinal rail movement due to tie renewal or surfacing operations, the rail must be destressed.

9.5 Surfacing Operations

Surfacing operations include out-of-face surfacing that is equal to or greater than 19 feet 6 inches and does not involve any tie installation.

General Requirements

When performing surfacing ensure there is sufficient ballast to fill all ballast cribs and establish the required shoulder. When surfacing across ballast deck bridges, do not shift the track from the center of the deck. Shifting track too far to one side of a ballast deck bridge can create excessive loading to one stringer resulting in premature fatigue to the structure.

Follow the speed restrictions listed in Section 9.10.4 Speed Restrictions for Trackwork to protect track following surfacing work.

When performing surfacing, more restrictive speed restrictions may be required for these conditions, regardless of the temperature:

1. Tight rail.
2. Insufficient ballast.
3. Unstable sub-grade.

9.6 CWR Installation Procedures

Rail welded into lengths of 400 feet or more is considered CWR and remains CWR regardless of whether a joint or plug rail is installed into the rail at a later time. These procedures apply to all installations of rail in CWR territory whether a weld, 20 foot plug rail, or 1600 foot string of rail is installed. Temperature variations affect rail length. Rail expands (lengthens) when heated and contracts (shortens) when cooled.

9.6.1 *Preferred Rail Laying Temperature*

The Rail Neutral Temperature (RNT) is the temperature at which a rail is neither in tension nor compression. The Preferred Rail Laying Temperature (PRLT) is the designated temperature that the rail is to be installed at, or adjusted to, in order to balance the thermal expansion and contraction forces to prevent track buckling and for optimum track maintenance practices. When laying or adjusting CWR, adjust rail to the PRLT as outlined below:

1. 110° F on all tracks on all subdivisions with the exception of tunnels.
2. 70° F inside tunnels. See Table 9-1 for SCRRRA tunnel locations.

The designated rail neutral temperature safe range is from -5 to +5 degrees F from the PRLT. If rail is found to be in an adjusted temperature or PRLT more than 5 degrees F below the PRLT, it shall be adjusted. If rail is installed more than 5 degrees F above the PRLT, it must be documented on the CWR Disturbance Report and these locations must be monitored for curve movement and pull-aparts in cold weather. If rail is not adjusted to the PRLT before forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25MPH must be placed.

SCRRRA Tunnel Locations				
Subdivision	Milepost	to	Milepost	Tunnel #
Valley	26.63	to	27.95	25
Valley	44.98	to	45.05	19
Valley	45.42	to	45.47	18
Ventura	441.20	to	442.59	26
Ventura	442.89	to	443.08	27
Ventura	443.88	to	443.98	28

Table 9-1

9.6.2 *Temperature Differential*

The difference between the Preferred Rail Laying Temperature (PRLT) and the actual Rail Temperature (RT) taken at the time of installation is called the temperature differential. CWR laying and adjusting procedures have been established in Section 9.6.3 Maintaining PRLT in CWR Track and Section 9.8 Track Buckling Prevention to compensate for this temperature difference.

9.6.3 Maintaining PRLT in CWR Track

9.6.3.1 Methods for Determining PRLT Adjustment

There are two methods for determining rail re-adjustment:

1. Use of the thermal expansion formula:

G = Growth in rail

L = Length of adjusted rail

T = Temperature differential

E = Thermal expansion coefficient (0.0000067 inch, per inch of rail, for every degree Fahrenheit or 0.0000804 inch, per foot of rail, for every degree Fahrenheit)

$$G = L \times T \times E$$

Example: A 1,440-foot string of rail was laid at 60 degrees Fahrenheit. The rail was not anchored or restrained at either end. If the rail temperature is increased to 120 degrees Fahrenheit, the rail will expand approximately 6.95 inches in length.

2. Use of Table 9-2:

Thermal expansion is linear, and therefore interpolation can be used for Table 9-2. When adjusting rail, determine the temperature differential and length of unrestrained rail. Using these values in Table 9-2 determine the amount of rail expansion needed to achieve PRLT.

CWR Movement Chart - Inches									
Temp. Diff. In Deg. F	CWR Movement Chart - Inches Length of Unrestrained Rail								
	200 ft	400 ft	600 ft	800 ft	1000 ft	1200 ft	1400 ft	1500 ft	1600 ft
5°	1/16	1/8	1/4	3/8	3/8	1/2	5/8	5/8	5/8
10°	1/8	3/8	1/2	5/8	3/4	1	1-1/8	1-1/4	1-1/4
15°	1/4	1/2	3/4	1	1-1/4	1-1/2	1-3/4	1-3/4	1-7/8
20°	3/8	5/8	1	1-1/4	1-5/8	1-7/8	2-1/4	2-3/8	2-5/8
25°	3/8	3/4	1-1/4	1-5/8	2	2-3/8	2-7/8	3	3-1/4
30°	1/2	1	1-1/2	1-7/8	2-3/8	2-7/8	3-3/8	3-5/8	3-7/8
35°	5/8	1-1/8	1-3/4	2-1/4	2-7/8	3-3/8	4	4-1/4	4-1/2
40°	5/8	1-1/4	1-7/8	2-5/8	3-1/4	3-7/8	4-1/2	4-7/8	5-1/8
45°	3/4	1-1/2	2-1/8	2-7/8	3-5/8	4-3/8	5-1/8	5-3/8	5-3/4
50°	3/4	1-5/8	2-3/8	3-1/4	4	4-7/8	5-5/8	6	6-3/8
55°	7/8	1-3/4	2-5/8	3-1/2	4-3/8	5-1/4	6-1/4	6-5/8	7-1/8
60°	1	1-7/8	2-7/8	3-7/8	4-7/8	5-3/4	6-3/4	7-1/4	7-3/4
65°	1-1/16	2-1/8	3-1/8	4-1/8	5-1/4	6-1/4	7-3/8	7-7/8	8-3/8
70°	1-1/8	2-1/4	3-3/8	4-1/2	5-5/8	6-3/4	7-7/8	8-1/2	9
75°	1-1/4	2-3/8	3-5/8	4-7/8	6	7-1/4	8-1/2	9	9-5/8
80°	1-1/4	2-5/8	3-7/8	5-1/8	6-3/8	7-3/4	9	9-5/8	10-1/4
85°	1-3/8	2-3/4	4-1/8	5-1/2	6-7/8	8-1/4	9-5/8	10-1/4	10-7/8
90°	1-1/2	2-7/8	4-3/8	5-3/4	7-1/4	8-5/8	10-1/8	10-7/8	11-5/8
95°	1-1/2	3	4-5/8	6-1/8	7-5/8	9-1/8	10-3/4	11-1/2	12-1/4
100°	1-5/8	3-1/4	4-7/8	6-3/8	8	9-5/8	11-1/4	12	12-7/8

Table 9-2

9.6.3.2 *Installing CWR*

A record of rail temperatures of installed rail will be maintained by SCRRRA. When installing CWR, follow all rail installation requirements and document the required information on the CWR Stress Adjustment/Disturbance Report found in the Appendix and submit to TRACK&STRUCTURES@SCRRA.NET.

1. Refer to Section 9.6.1 Preferred Rail Laying Temperature for the PRLT used for CWR installation on SCRRRA property.
2. Take the Rail Temperature (refer to Section 9.6.3.3 Instructions for Taking Rail Temperature (RT)) and calculate the expansion required before making adjustments.
3. Record the rail laying temperature and rail expansion once installation is complete.
4. Rail temperature adjustment is not required when the actual rail temperature is plus or minus 5 degrees of the PRLT.
5. Rail heaters, rail expanders, or in-track welders may be used to adjust the rail to the correct PRLT.
6. If rail is installed at a temperature below the PRLT, the RNT must be adjusted to the PRLT.
7. A speed restriction must be placed in accordance with the instructions found in Section 9.10.4 Speed Restrictions for Trackwork prior to any rail traffic.

NOTE: If rail is not adjusted to the PRLT before forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25MPH must be placed. Rail laid during the cold months of the year must be carefully monitored the following summer. Particular attention shall be paid to defective rail change out locations that are made during the cold months.

9.6.3.3 *Instructions for Taking Rail Temperature (RT)*

1. Measure rail temperature on the web of the shady side of the rail. Take an average of a minimum of four readings: One at each end with two equally spaced in the middle. Each new string of rail requires its own average temperature on documentation. Record rail temperature notes and installation temperatures on the Record of Rail Installation Temperatures form and submit to TRACK&STRUCTURES@SCRRA.NET.
2. If infrared (optical) thermometers are used, verify calibration by taking 2 readings adjacent to each other. If they vary by more than 3 degrees, a different device must be used and repeat this step.
3. If magnetic thermometers are used, they must be left on the rail for five minutes to ensure that they have equalized to the rail temperature before recording the temperature.

9.6.3.4 Monitor Rail Movement

When installing CWR, monitor rail movement as follows:

1. Do not remove anchors or fasteners prior to making cuts to CWR. Once CWR is cut, it shall be considered disturbed and will require adjustment 400 feet in each direction from any cut. Make necessary cuts to rail.
2. Remove anchors or fasteners for 400 feet on rail to remain in place. Calculate rail expansion necessary to reach the PRLT at each match mark location and place match marks on all rail to be destressed (including the new rail plus 400 feet in each direction). Use a paint stick to record the distance and the expansion required on the web of the rail at each match mark location (refer to Figure 9-10).

Match Marks are to be divided into four marks indicating the required expansion at each location, making the first mark at 100 feet and then the last three equally spaced to the end of the rail using the chart in Table 9-2 or the rail expansion formula in Section 9.6.3.1 Methods for Determining PRLT Adjustment (refer to Figure 9-3). For rail lengths less than 400 feet, match marks are only required at 100 feet increments up to the end of the rail.

Exception: When installing continuous strings of CWR and tying into previously newly installed CWR, only 200 feet of the existing rail must be re-destressed. Remove anchors or fasteners for 200 feet on rail to remain in place. Calculate rail expansion necessary to reach the PRLT at each match mark location on all rail to be destressed (including the new rail plus 200 feet).

Match Marks Prior To Rail Expansion

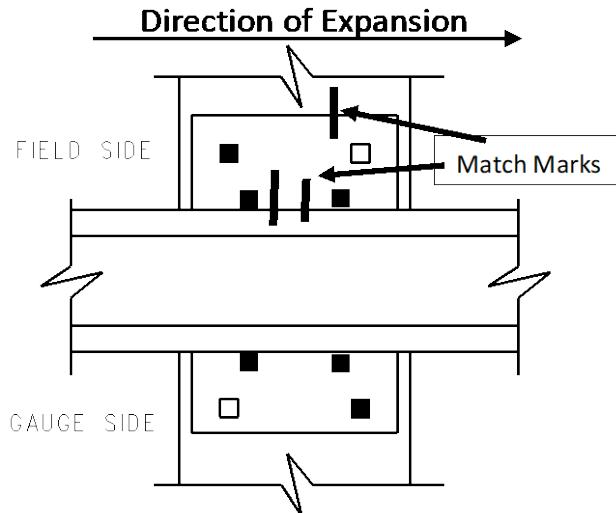


Figure 9-3

When destressing new rail and existing rail simultaneously (free weld or joint created at intersection) include the existing rail length in the calculation for the required rail expansion.

Example 1 (Figure 9-4): Installing 360 feet of rail. Existing rail must be adjusted 400 feet in each direction. Make marks at 100 feet, 320 feet, 540 feet, and 760 feet. Additional marks are required at 100-foot increments on the opposite existing rail.



Figure 9-4

Example 2 (Figure 9-5): Installing a 30-foot plug rail. Existing rail must be adjusted 400 feet in each direction. Make marks at 100 feet, 210 feet, 320 feet and 430 feet. Additional marks are required at 100-foot increments on the opposite existing rail.

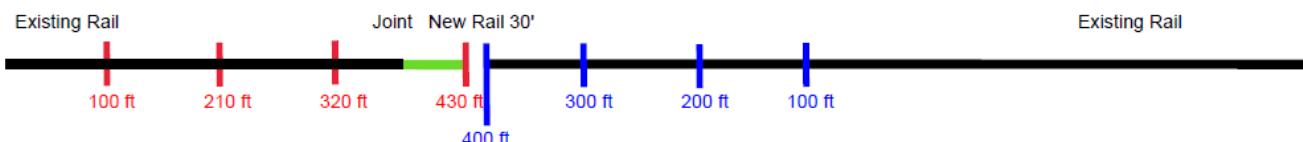


Figure 9-5

Example 3 (Figure 9-6): Installing 1400 feet of rail, during a continuous CWR relay project and when tying into previously newly installed CWR that has been destressed. Make marks at 100 feet, 600 feet, 1100 feet, and 1600 feet. Additional marks are required at 100-foot increments on the opposite existing rail.



Figure 9-6

3. Place spanning reference marks at destress location according to instructions outlined in Section 9.6.3.6 Marking Joints and Field Welds.
4. Heat or pull rail to the PRLT, ensure the required rail expansion is attained at each match mark location (refer to Figure 9-7). The anchors or fasteners shall be applied once match marks align. The rail shall be considered destressed once all anchors or fasteners are applied and joint bars or permanent weld is installed. The procedure shall be documented by the foreman in charge of maintenance or by the construction inspector providing project oversight.

Note: When welding rail ends together, the required weld gap or rail consumption (Flash-Butt Welding) must be taken into consideration when determining the amount of rail adjustment.

Match Marks After Expansion

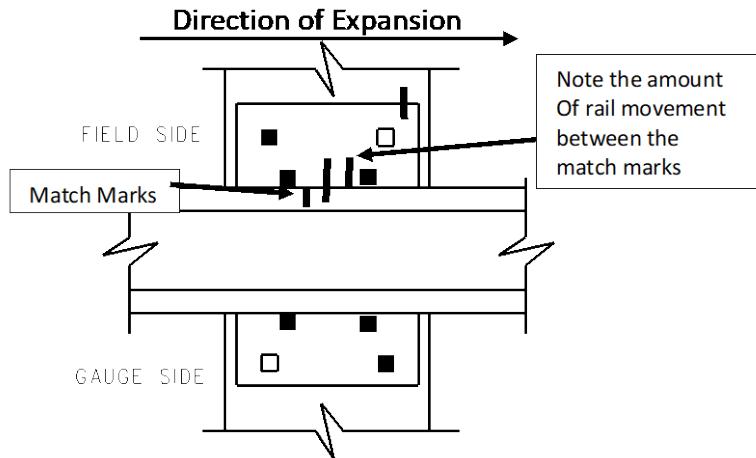


Figure 9-7

9.6.3.5 Heating Rail

Use the following guidelines when heating rail:

1. Use the minimum amount of heat required in order to avoid overheating the rail or damaging fastening system.
2. Position rail crucibles to concentrate heat on the web of the rail.
3. Do not heat across open deck bridges.
4. While heating, vibrate rail to encourage movement through the tie plates.
5. Tap tie plates with a sledgehammer to free rail movement. Do not strike the rail.
6. If the required rail expansion is not accomplished during the first pass with the rail heater, make additional passes.
7. Do not leave gaps between strings of CWR unless the joint will be immediately field welded and if so, do not leave more than what is required for the field weld.
8. On concrete tie track, care must be taken to avoid excessive heat damage to the plastic fastening components.

9.6.3.6 Marking Joints and Field Welds

Each destress thermite weld or joint location must be marked with a 72" spanning reference mark on the web of the rail **BEFORE** any adjustment to the PRLT is made either by heating the rail or using a rail puller. The 72" spanning reference marks **MUST** span the gap between rail ends prior to adjusting rail. Upon completion of a destress thermite weld or joint, the reduction of the distance between the original 72" spanning reference mark shall illustrate the total amount of rail expansion achieved. See Figure 9-8 and Figure 9-9 for examples of spanning reference marks before and after destressing activities.

Spanning Reference Marks Before Adjustment:

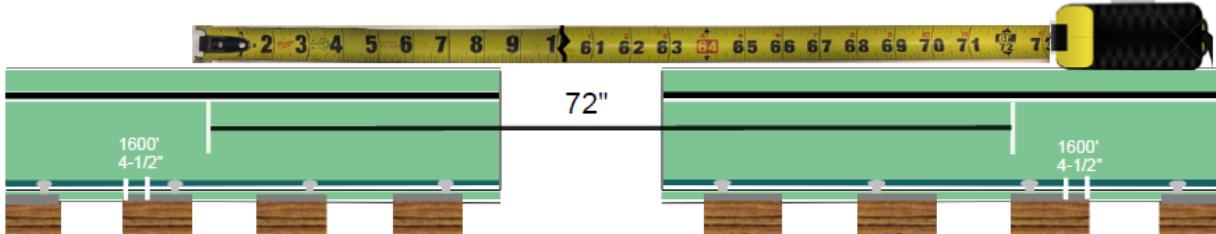


Figure 9-8

Spanning Reference Marks After Adjustment:

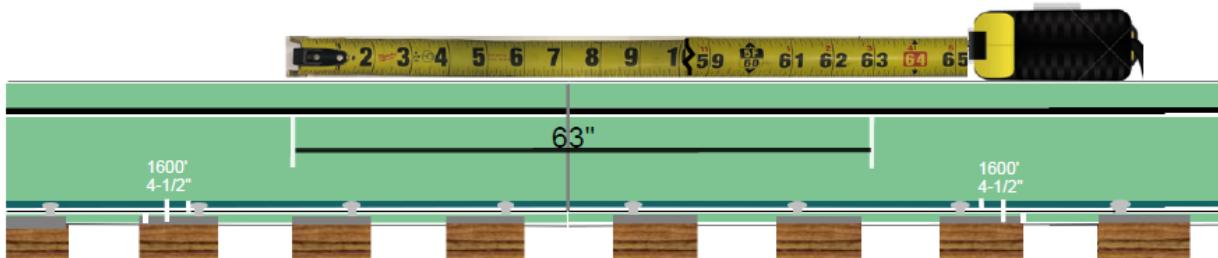


Figure 9-9

Upon completion of a destress thermite weld or joint, in addition to the spanning reference marks, the welder shall use a paint stick to mark the weld with the following, as shown in Figure 9-10:

1. Date
2. The Adjusted Rail Temperature (ART)
3. Rail Temperature (RT)
4. Total amount of rail expansion achieved (in inches)

NOTE: Total amount of rail expansion includes expansion from both sides of the weld or joint measured between the spanning reference marks.

5. The word "Destress"
6. Total length of rail adjusted (in feet)
7. The welder's initials

Example: In this example, both rails were an equal length and adjusted at the same time resulting in equal amount of rail expansion from each rail at this joint.

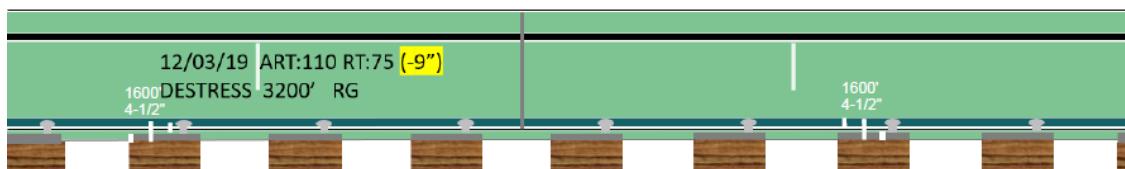


Figure 9-10

When multiple strings of rail are relayed continuously, where one rail is destressed and not welded immediately, the welder shall mark rail as shown in Figure 9-11:

1. Date
2. The Adjusted Rail Temperature (ART)
3. Rail Temperature (RT)
4. Total amount of rail expansion achieved (in inches)
5. The word "Destress"
6. Total length of rail adjusted (in feet)
7. The welder's initials
8. The word "NO WELD"

Example: In this example, the rail on the right was relayed at a later date and adjusted after the rail on the left was installed and adjusted. If the rail on the right is not replaced it would need to be unrestrained and adjusted as described in Section 9.6.3.4 Monitor Rail Movement.

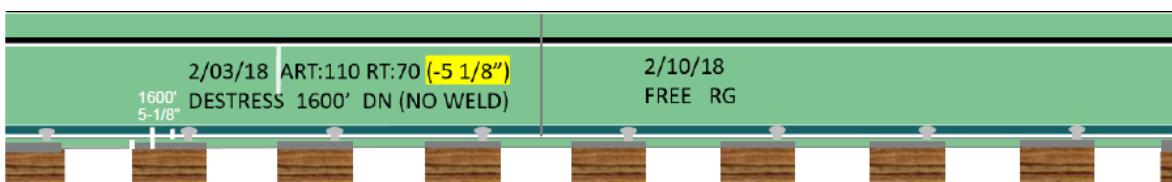


Figure 9-11

If the field weld is made with one free end, the welder shall mark on the web of the rail the date, the word "FREE," and the welder's initials shall be placed. This may occur if a track or switch panel is constructed outside the track or for the first weld of a piece of rail cut into the track.

Note: All field weld marks shall be placed on the field side of the rail and marked within 2 feet of the weld.

If a field weld is made within the destressing range (where rail anchors or clips are removed for destressing) of an older field weld, the welder shall write "OLD" on the web of the rail next to the information on the older weld and put the new date and an arrow towards the new weld. This tells the track inspector that the rail temperature information is no longer valid and where to look for the most recent rail temperature adjustment.

9.7 Rail Anchoring Requirements

Existing anchor patterns (Legacy Patterns) on CWR installations completed before September 21, 1998, may remain in place until a rail relay is performed. Pre-existing railroad standard anchor patterns may remain if rail is restrained to prevent track buckles, but rail must be adjusted (by increasing or decreasing the length of rail or by lining of curves) or anchors added to rail if restraint is not sufficient. Where the anchoring function is otherwise provided by an elastic fastening system, rail anchors may be omitted. Anchors may not be applied where they will interfere with signal or other track appliances, or on rail opposite a joint.

9.7.1 *Anchor Pattern after Repair*

When repairs result in a joint being added to CWR, the anchor pattern shall match the existing pattern in track. At least every other tie will be box anchored for a distance of 200 feet in each direction unless anchoring is otherwise provided. When repairs are made to a stripped joint or failed joint bar, the adjustment or addition of anchors will be as prescribed in Table 9-3. The adjustment or remedial action must be documented and retained.

Condition	Action
Bolted joint in CWR experiencing service failure (stripped joint) or failed bar(s) with gap* present *Gap exists if it cannot be closed by drift pin	Weld joint, OR Remediate joint conditions (per Table 9-7), replace bolts (new, in-kind or stronger), and weld joint within 30 days, OR Replace failed bar(s), install 2 additional bolts and adjust anchors, OR Replace failed bars, bolts (if broken or missing) and anchor every tie for 200' in both directions, OR Add rail, documenting provisions for later adjustments (if applicable) and reapply anchors.

Table 9-3

9.7.2 *Standard Box Pattern*

When laying CWR, box anchor every other tie except as outlined in Section 9.7.3 Solid Box Pattern. Anchor pattern may be varied as reasonable to avoid placing anchors against deteriorated ties but must be restored when ties are replaced.

9.7.3 *Solid Box Pattern*

When laying CWR, box anchor every sound (effective) tie at specific locations listed in Table 9-4 to provide additional restraint against rail movement. Where the anchoring function is otherwise provided by an elastic fastening system, rail anchors may be omitted.

Location	Rail Type	Requirement
Turnouts	CWR or Jointed	All switch ties and 200 feet in both directions
Diamond Crossings	CWR or Jointed	200 feet in both directions
Hot Box / Dragging Equipment Detectors	CWR or Jointed	200 feet in both directions
All Permanent and Insulated Joints	CWR	200 feet in both directions
Expansion Joints	CWR or Jointed	200 feet in both directions
Open-Deck Bridges	CWR or Jointed	Box anchor ties that are anchored to substructure only and 200' in both directions from end of bridge
Road Crossings	CWR or Jointed	200 ft in both directions

Table 9-4

9.8 Track Buckling Prevention

Destressing is a procedure that is used to reduce high longitudinal stress in CWR which readjusts the neutral temperature to the specified value. This procedure is followed when high compressive forces (as exhibited by tight, wavy, or running rail conditions) exist, or as a preventative measure. This procedure involves cutting rail out, destressing the rail a minimum of 400 feet in each direction, refastening and welding. When destressing rail at any location, both rails should be destressed unless one of the rails is located at a fixed location such as at a turnout.

At locations where rail movement is occurring, and tight rail conditions exist place at least a 25 MPH speed restriction until rail is destressed. If conditions warrant, a more restrictive speed restriction should be placed or track removed from service. Destress rail to the PRLT following the procedures outlined in Section 9.8.1 Destressing Rail Procedure.

9.8.1 Destressing Rail Procedure

Place match marks as outlined in Section 9.6.3 Maintaining PRLT in CWR Track which outlines how to monitor rail movement to ensure proper PRLT adjustment. If rail temperature is above the PRLT, place spanning reference marks as described in Section 9.6.3.6 Marking Joints and Field Welds on both sides of the intended cut **PRIOR TO CUTTING THE RAIL** to allow for the monitoring of rail removal due to the rail being in compression. Refer to Figure 9-12 and Figure 9-13 for proper spanning marks results showing before destressing and after destressing.

1. Cut rail to be destressed.
2. Remove or reposition anchors or fasteners for a minimum of 400 feet in each direction for a total of 800 feet from the cut or up to a restriction that prevents rail movement.
3. Wait until the rails stop moving. The rail ends may need to be trimmed more than one time to allow for expansion.
4. Allow rail to expand and take the rail temperature. Refer to Section 9.6.3.3 Instructions for Taking Rail Temperature (RT).
5. Refer to Section 9.6.1 Preferred Rail Laying Temperature to compare the rail temperature with the PRLT and obtain the temperature differential.
6. If the actual rail temperature is lower than the PRLT, use procedures outlined in Section 9.6.3 Maintaining PRLT in CWR Track to adjust the rail to the PRLT.
7. If rail is within PRLT safe range, no additional adjustments are needed. If rail is more than 5 degrees above PRLT, document in report, and plan on adjusting rail before cold weather months.
8. Rail will be anchored or fastened at PRLT. Replace any worn or ineffective rail anchors or fasteners with new anchors or fasteners.
9. Weld the joint or apply joint bars.
10. Fill out a CWR Stress Adjustment/Disturbance Report found in the Appendix and submit the completed report to TRACK&STRUCTURES@SCRRRA.NET.

Figure 9-12 below shows you the spanning mark before destressing.

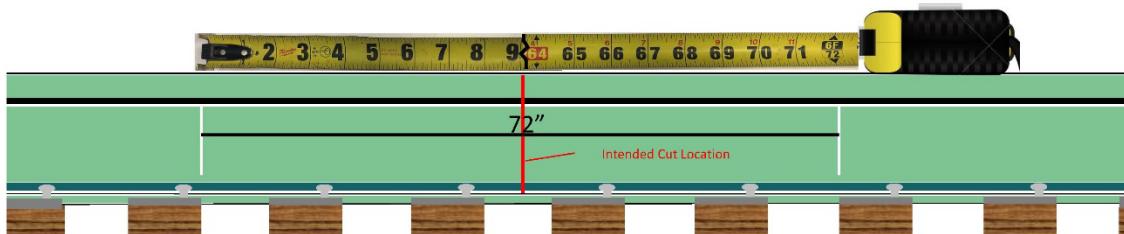


Figure 9-12

Figure 9-13 below shows you the spanning mark after destressing.

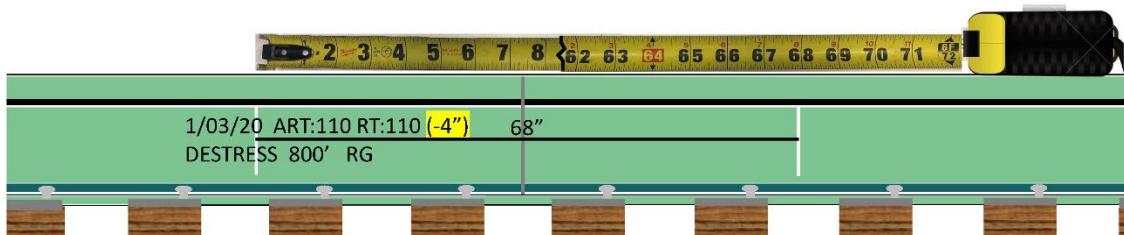


Figure 9-13

9.8.2 *Maintaining Desired Rail Installation Temperature Range*

This section addresses repairs for broken or defective rail, joint elimination through field or in-track welding, and corrections made for tight rail, track buckle, or pull-apart where rail is not adjusted to the PRLT.

NOTE: When performing this work, care must be taken not to add rail to the track reducing the RNT below the PRLT.

If rail is installed below the PRLT safe range for any reason, such as repairing a pull-apart, making emergency repairs, etc., the RNT at this disturbance location is now the rail installation temperature. Permanent repairs MUST be made per the requirements outlined in Section 9.6.3 Maintaining PRLT in CWR Track adjusting rail 400 feet in each direction.

Measure and record the amount of rail added. This measurement can be made in a variety of ways, including but not limited to:

For Pull-aparts and Broken Rails:

1. Measuring the amount of rail removed from the track and subtracting that amount from the length of rail installed.
2. Measuring the gap between rail ends as a result of a pull-apart or broken rail.

For Field Weld or Plug Rail Installation:

3. Make marks that span the length of rail, or weld to be installed, a minimum of 6 feet beyond the intended rail cut(s) and calculate the change in rail length between the marks before and after the repair.

Using the methods described above record the date, rail temperature, amount of rail added, and initials of the employee in charge of the repair on the web of the rail and the CWR Stress Adjustment/Disturbance Report in the Appendix.

A speed restriction must be placed in accordance with the instructions found in Section 9.10.4 Speed Restrictions for Trackwork prior to any rail traffic and shall remain in place until rail is restored to the PRLT. When the rail temperature is expected or forecasted to be 40 degrees above rail installation temperature, protect track by placing a 25MPH speed restriction over the segment of track until rail is destressed to PRLT.

9.8.3 Destressing CWR After a Track Buckle

When track buckles occur, cut the rail at least 100 feet from the buckled area. Do not attempt to work directly on the track buckle until rail is cut and destressed; there are large forces in the rails which, if the rail is cut, will result in violent movement of the rail. If rail temperature is above the PRLT, place spanning reference marks as described in Section 9.6.3.6 Marking Joints and Field Welds on both sides of the intended cut **PRIOR TO CUTTING THE RAIL**, to allow for the monitoring of rail removal due to the rail being in compression (refer to Figure 9-12 and Figure 9-13).

1. Do not remove anchors and spikes before the cut is made.
2. Using a torch, first cut out approximately 4 inches of the head of the rail, and then cut out the same amount of the base, leaving only the web.
3. Cut slices through the web, letting the rail expand as the web is removed. Repeat this process until there is a gap.
4. Begin removing anchors or elastic fasteners and lining in the buckle, while continuing to remove the end of the rails to maintain the gap. Anchors shall be removed for a minimum of 200 feet in each direction.
5. Line the track and pull spikes to enable one of the rail ends to be lined towards the center and allow for the rail ends to pass each other.
6. Remove all anchors both ways from the rail cut for a minimum of 400 feet in each direction for a total distance of not less than 800 feet.
7. Cut excess from end of rail, which had been lined toward center of track with rail saw. Employees/contractors shall walk along unanchored rails striking plates or otherwise relieving binding points allowing rail to run freely. Exercise care to avoid damaging head or base of rail.
8. Replace rail, which had been lined out back into plates.
9. Check temperature of rail with rail thermometer, refer to Section 9.6.3.3 Instructions for Taking Rail Temperature (RT). Follow procedures in Section 9.6.3 Maintaining PRLT in CWR Track to adjust the rail to the PRLT.
10. Surface and line track and place appropriate speed restriction in accordance with Section 9.10.4 Speed Restrictions for Trackwork.
11. Fill out a CWR Stress Adjustment/Disturbance Report found in the Appendix and submit the completed report to TRACK&STRUCTURES@SCRRRA.NET.

9.9 Monitoring Curve Movement Following Track Surfacing and Lining

9.9.1 *Staking Curves*

Before surfacing and lining a curve on main tracks class 2 and above, stake curve if the degree of curvature is more than 3° and the rail temperature is more than 50°F below the designated rail laying temperature (or is expected to be in the next 24 hours).

To stake a curve prior to surfacing and lining, place at least 3 reference stakes uniformly spaced around the curve with the middle stake located near the middle of the curve.

Additional stakes may be used due to the overall length of the curve.

9.9.2 *Inspecting for Curve Movement*

Inspect for curve movement periodically after the work, especially during periods of large temperature changes. Where curve has been staked, per Section 9.9.1 Staking Curves, and full body of the curve has shifted inward more than 3 inches, the curve must be lined out prior to rail temperature reaching the PRLT. If curve is not lined out or destressed, a speed restriction of 40 MPH or less for passenger and freight trains must be placed. When tight rail conditions exist, refer to Section 9.12.1 Heat Inspections.

9.10 Placing Temporary Speed Restrictions for Trackwork

A temporary speed restriction should be placed anytime the roadbed or ballast section is disturbed as required in Section 9.10.4 Speed Restrictions for Trackwork, except where the maximum authorized speed of the track is equal to or less than the required restriction.

9.10.1 *General Requirements*

Speed restrictions ensure safe train operations until the affected track stabilizes. Restrictions need to stay in place to allow the ballast to consolidate, rail compressive forces to equalize, and the subgrade to compact. Take more restrictive measures when conditions warrant. Use of Dynamic Track Stabilizers accelerate the consolidation of ballast after disturbance.

9.10.1.1 *Ambient temperature 80 degrees F or Above or Rail Temperature Above Preferred Rail Laying Temperature*

Avoid disturbing the track when ambient temperature is above or forecasted to be above 80 degrees F. Tracks are more prone to buckling when higher temperatures are present. When it is necessary to disturb the ballast or any component of track structure (including surfacing, tie replacement and ballast cleaning) and the ambient temperature is above or forecasted to be above 80 degrees F or rail temperature is above the PRLT, refer to Section 9.10.4 Speed Restrictions for Trackwork for proper speed restriction and duration.

9.10.2 *Speed Restriction Length*

To minimize running rail and other dynamic forces, trains must have time to brake and adjust slack before entering the disturbed track. To ensure trains reach the desired speed before entering the affected track, place speed restrictions at least 1/4 mile in each direction from the outside limits of the affected track. For heavy grades, sharp curves, or substandard track conditions, extend speed restrictions farther from the work limits if needed.

9.10.3 *Responsibility for Placing Speed Restrictions*

During the work or before returning the track to service, the supervisor or foreman in charge must ensure the following:

1. Proper gage, surface, and alignment have been established for the class of track.
2. Cribs are filled to the top of tie with ballast and ballast shoulders are a minimum 9 inches wide for wood tie track and 12 inches wide for concrete tie track.
3. The rail is anchored per Section 9.7 Rail Anchoring Requirements.
4. Place the appropriate speed restriction per Section 9.10.4 Speed Restrictions for Trackwork.

If performing more than one type of work on the same segment of track, place the most restrictive speed on the track. For example, if the same segment of track is being protected for rail relays (40 MPH maximum speed) and surfacing (30 MPH maximum speed); restrict the speed to 30 MPH on the track.

9.10.4 Speed Restrictions for Trackwork

SOUTHERN CALIFORNIA REGIONAL RAIL AUTHORITY

SUMMARY OF SPEED RESTRICTIONS FOR TRACKWORK

	Type of work preformed	First train	Minimum of 24 Hours & 16 Trains ¹	After 24 hours
	Maximum speed	Pass/Frt	Pass/Frt	Pass/Frt
SPECIAL TRACKWORK	Newly installed switches, turnouts, crossings, track or track panels- not surfaced and not destressed.	10/10 mph	10/10 mph	Not Applicable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced, destressed and not stabilized	10/10 mph	30/20 mph	Timetable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced, stabilized, and destressed.	10/10 mph	40/30 mph	Timetable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced and stabilized – not destressed ⁴	10/10 mph	30/20 mph	40/30 mph
ALL TIE INSTALLATION	Tie Installation – surfaced, with or without stabilizing - above or forecasted to be above 80 degrees F or Rail temp above the PRLT	15/10 mph	15/10 mph	30/20 mph ³
	Tie Installation - surfaced and not stabilized - below 80 degrees F ambient	15/10 mph	30/20 mph	Timetable
	Tie Installation – surfaced and stabilized -below 80 degrees F ambient	30/20 mph	Timetable	Timetable
CWR INSTALLATION	CWR Installation, surfaced, destressed, not stabilized	10/10 mph	30/20 mph	Timetable
	CWR Installation, surfaced, destressed, and stabilized	10/10 mph	40/30 mph	Timetable
	CWR Installation, destressed and no surfacing required	10/10 mph	40/30 mph	Timetable
	CWR Installation, not destressed - (surfaced or not) ⁴	10/10 mph	30/20 mph	40/30 mph

	Type of work preformed	First train	Minimum of 24 Hours & 16 Trains ¹	After 24 hours
	Maximum speed	Pass/Frt	Pass/Frt	Pass/Frt
SURFACING	Track Surfacing without stabilizing ²	15/10 mph	30/20 mph	Timetable
	Track Surfacing with dynamic stabilizing ²	50/40 mph	Timetable	Timetable
	Track Surfacing with or without stabilizing - above or forecasted to be above 80 degrees F ambient or Rail temp above the PRLT ²	15/10 mph	15/10 mph	30/20 mph ³
	<p>After the passage of the first train, the track shall be inspected and then, under the authority of the qualified person-in-charge (qualified under CFR 49Part 213.7), the speed may increase per the table above, for a minimum of 24 hours with a minimum of 16 trains. The speed may then be restored to Timetable Speed after another track inspection.</p> <p>¹ Speed restrictions must remain in place for a minimum of 24 hours in addition to the passage of a minimum of 16 trains (Pass/Frt). Prior to removing restriction, verify that the 16-train requirement was met through train dispatcher and/or timetable.</p> <p>² Track surfacing with up to a maximum of 2 inches of track raise. If track is raised more than 2 inches use Special Trackwork Speed Restrictions.</p> <p>³ Due to the nature of the sub-grade disturbance, an additional 24 hours is required to allow track to consolidate. Track must be inspected prior to removal of speed restriction.</p> <p>⁴ If rail is not adjusted to the PRLT before forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25MPH must be placed.</p>			

Table 9-5

9.11 Rail Joint Inspection

All joints in CWR track must be inspected on foot and must be recorded on the prescribed form. Refer to Section 9.11.6 Report On-Foot Periodic and Follow-up Inspections.

9.11.1 Frequency of Inspection

CWR joints shall be inspected on foot at the frequencies in Table 9-6.

Minimum Number of Inspections Per Calendar Year ¹					
	Freight Trains operating over an annual tonnage of:			Passenger Trains operating over track with an annual tonnage of:	
	Less than 40 million gross tons	40 to 60 million gross tons	Greater than 60 million gross tons	Less than 20 million gross tons	Greater than or equal to 20 million gross tons
Class 5	2x	3x ²	4x ²	3x ²	3x ²
Class 4	2x	3x ²	4x ²	2x	3x ²
Class 3	1x	2x	2x	2x	2x
Class 2	0	0	0	1x	1x
Class 1	0	0	0	0	0
Excepted Track	0	0	0	n/a	n/a

4x = Four times per calendar year, with one inspection in each of the following periods: January to March April to June, July to September, and October to December; and with consecutive inspections separated by at least 60 calendar days.

3x = Three times per calendar year, with one inspection in each of the following periods: January to April, May to August, and September to December; and with consecutive inspections separated by at least 90 calendar days

2x = Twice per calendar year, with one inspection in each of the following periods: January to June and July to December; and with consecutive inspections separated by at least 120 calendar days.

1x = Once per calendar year, with consecutive inspections separated by at least 180 calendar days.

Table 9-6

¹ Where a track owner operates both freight and passenger trains over a given segment of track, and there are two different possible inspection interval requirements, the more frequent inspection interval applies.

² When extreme weather conditions prevent a track owner from conducting an inspection of a particular territory within the required interval, the track owner may extend the interval by up to 30 calendar days from the last day that the extreme weather condition prevented the required inspection.

9.11.1.1 Switches and Track Crossings

Joints within or adjacent to switches and track crossings are exempt from the periodic joint inspection requirements provided they are inspected monthly during the required monthly walking inspection of these devices.

Inspect these locations on a minimum monthly basis and include in the inspection report. Document the following in the inspection report:

At switches:

- All joints, from and including, the insulated joints at the signals governing movement entering and leaving the control point or interlocking.
- If there are no signals at the switch location, include as a minimum all joints from the point of the switch to the heel of the frog.

At crossovers:

- All joints in track between switches.

At track crossings:

- All joints from and including the insulated joints at the signals governing movement entering and leaving the control point or interlocking. If there are no signals at the track crossings, include as a minimum all joints that are between or connected to the crossing frogs.

9.11.2 Identification of Joints

Each rail joint requiring remedial action as outlined in Table 9-7 shall be identified in the field with a highly visible marking. In addition, such joints shall also be identified as to location by specifying the subdivision, milepost location to the nearest 100th, track number and rail (north, south, etc.).

9.11.3 Rail Joint Conditions

When inspecting joints in CWR track, inspectors must watch for, but not be limited to, the rail joint conditions outlined in Table 9-7. When such conditions are found, the appropriate remedial action as outlined in Table 9-7 must be taken.

Each inspection shall be documented by noting the following information:

1. Date
2. Mileage limits of the inspection
3. Location and nature of rail joint conditions specified in this Section
4. Remedial action taken (use Table 9-7)
5. Name of inspector
6. Condition.

Rail Joint Condition	Remedial Action ¹
Visible cracks in joint bar	Replace bar
Loose bolt	Tighten bolt
Bent bolt	Replace bolt Or Inspect weekly
Missing bolt ²	Replace bolt
Tie(s) not effectively supporting joint	Tamp tie(s) Replace or repair tie(s) Or Conduct follow-up inspections every other week until repaired/removed
Broken or missing tie plate(s)	Replace tie plate(s) Or Conduct follow-up inspections every other week until repaired/removed
Deteriorated insulated joint	Replace/repair joint Or Conduct follow-up inspections every other week until repaired/removed
Rail end batter (More than 3/8" in depth and more than 6" in length measured with a 24" straight-edge	Repair by welding joint or removing rail Or Inspect weekly
Rail end mismatch exceeding 1/8"	Weld or grind
Longitudinal rail movement greater than 2.5"	Add or adjust rail anchors, tighten bolts, add or remove rail at appropriate time Or Inspect weekly
Wide rail gap greater than 1"	Adjust rail gap and secure joint Or Inspect weekly
Joint vertical movement (profile) that exceeds 75% of the allowable threshold for the designated class of track ³	Surface joint Or Conduct follow-up inspections every other week until repaired/removed
Joint lateral movement (in a curve or spiral) that reaches 3/4" ³	Correct lateral movement Or Conduct follow-up inspections every other week until repaired/removed

Table 9-7

¹ Remedial action may also consist of placing a speed restriction or removing the track from service.

² Minimum of 2 bolts per rail must be in place.

³ Joint lateral and vertical movement is the apparent visible movement measured at the joint.

9.11.3.1 Pull-Aparts

Pull-aparts are a result of bolt failure in a joint bar and subsequent excessive gap between rail ends.

1. If a pull-apart is 4 inches or less and the rail ends are not damaged, close the pull-apart by using a hydraulic rail expander or by applying heat.
2. If unable to close rail ends using heat or hydraulic rail expander, or a pull-apart is more than 4 inches, or rail end damage is apparent, install a rail that is 19'6" or longer using match marks and record the rail adjustment. Refer to Section 9.6 CWR Installation Procedures.
3. When repairing pull-aparts, visually inspect each joint bar, install all new bolts and adjust rail anchors tightly against the ties per CWR adjustment requirements.

9.11.4 Joints Added to CWR

Whenever a joint is added to CWR, such as when a defective rail segment has been replaced, the ends must be welded within 30 days. If the joint cannot be welded within 30 days, it must be fully bolted with 6 bolts and fully box anchor every tie for 200 feet.

9.11.5 Embedded Joints

Permanently Embedded Locations:

Where such locations exist, it is not necessary to disassemble or remove the track structure (e.g., remove pavement or crossing pads) to conduct an inspection of CWR joints. Make every effort, to the extent practicable, to inspect the visible portion of joints in these structures.

Temporarily Buried Locations:

Joints may sometimes be temporarily buried (e.g., where ballast or similar material is in the middle of the track and along the track) and therefore unavailable for inspection. Where CWR joints are buried (e.g., by ballast), wait for the completion of the trackwork before conducting joint bar inspections. Make every effort, to the extent practicable, to inspect the visible portion of joints in these structures.

9.11.6 Report On-Foot Periodic and Follow-up Inspections

Document each on-foot periodic and follow-up inspection on the date of the inspection by noting the following information:

1. Date
2. Limits of the inspection
3. Location and nature of CWR joint conditions
4. Corrective or remedial action taken by the person making the inspection
5. Name and signature of inspector on the prescribed form.

Track subject to inspections under 49 CFR § 213.119, must comply with:

1. Track Inspections (49 CFR § 213.233),
2. Inspections of switches, turnouts, track crossings, lift rail assemblies or other transition devices on moveable bridges (49 CFR § 213.235), if applicable,
3. Periodic and follow-up CWR Joint Inspections (49 CFR § 213.119 (g)).

9.12 Extreme Weather Inspections

For purposes of forecasting or initiating extreme weather inspections and conversions of rail temperature in relation to ambient temperatures, use the following conversions:

- In sunny weather, rail temperature is approximately the ambient temperature plus 30°F.
- In overcast weather or at night, rail temperature is approximately the ambient temperature.

9.12.1 *Heat Inspections*

On all main tracks and sidings, heat inspections must be performed when the temperature is forecasted to exceed these thresholds:

1. When ambient temperature is, or is forecast to be, over 100 degrees F.
2. When rail temperature is above 130°F.
3. When ambient temperature is, or is forecast to be, over 90 degrees F for the first time in 60 or more days. (This is to cover the first hot days of summer.)
4. When rail temperature is above 120 degrees F for the first time in 60 days.

Continuous inspections should be performed during the heat of the day - primarily between 11:00 AM and 7:00 PM until the rail temperature cools below 130 degrees F. Inspectors should watch for signs of tight rail conditions, including:

1. Tight, wavy, or nervous rail.
2. Rail canting or lifting out of tie plates.
3. Shiny marks on the base of the rail indicating that the rail is running through anchors and fasteners.
4. Gaps in ballast at the ends of ties.
5. Churning ballast in tie cribs.

Inspectors should pay special attention to:

1. Recently disturbed track.
2. On grades, at the bottom of grades and vertical curves.
3. Locations where heavy braking occurs.
4. Fixed track structures, such as turnouts, bridges, and road crossings.
5. Horizontal Curves; paying special attention to high degree curves.
6. Where train traffic is predominately one direction.
7. In advance of speed restrictions.
8. Locations where rail has been repaired or welds installed.

At locations where rail movement is occurring, and tight rail conditions exist place at least a 25 MPH speed restriction until rail is destressed. If conditions warrant, a more restrictive speed restriction should be placed or track removed from service. Destress rail to the PRLT following the procedures outlined in Section 9.8.1 Destressing Rail Procedure.

When documenting heat inspections, the inspector must write heat inspection in the comments of the inspection report.

9.12.2 *Cold Weather Inspections*

On main tracks, cold weather inspections must be performed when the ambient temperature is forecasted to be 32 degrees F or lower. Look for pull-aparts and shifting of curve alignment.

On main tracks, cold weather inspections must be performed as directed by SCRRA.

Inspect for:

1. Broken rails
2. Pull-aparts
3. Curve movement
4. Wide gap between rail-ends
5. Bent bolts
6. Cracked or broken joint bars
7. Canted rail

When documenting cold weather inspections, the inspector must write cold inspection in the comments of the inspection report.

9.12.3 *Placing Temperature Restrictions*

When temperatures exceed the upper or lower thresholds place temporary speed restrictions as outlined below.

9.12.3.1 *Blanket Heat Restrictions*

Blanket hot weather restrictions are established to provide system requirements for placing track speed restrictions, when there are high compressive forces in the rail generated from extreme hot temperatures.

These speed restrictions will be put out as a Form C bulletin. They may be placed during various times of the day, but not less than 12 hours increments. An example would be "in effect from 10:00 AM until 10:00 PM."

The removal time for a blanket heat restriction is 10:00 PM. However, if the ambient temperature cools below the temperature threshold before 10:00 PM, the blanket heat restriction can be removed earlier.

Hot weather mainline speed restrictions will be issued by the Track Supervisor, per instructions in Section 9.12.3.1.1 Level 1 Heat Restrictions and Section 9.12.3.1.2 Level 2 Heat Restrictions.

9.12.3.1.1 *Level 1 Heat Restrictions*

"Level One" restriction as shown in Table 9-8 is required when:

1. Ambient temperature is to be over 90 degrees F for the first time in 60 or more days.
2. Rail temperature is above 130 degrees F.
3. Ambient temperature is to be over 100 degrees F.

9.12.3.1.2 Level 2 Heat Restrictions

"Level Two" restriction as shown in Table 9-8 is required when:

1. Ambient temperature is to be over 100 degrees F for the first time in 60 or more days.
2. Rail temperature is above 140 degrees F.
3. Ambient temperature is to be over 110 degrees F.

Note: The inspector may place a "Level Two" restriction at any time conditions warrant a greater level of caution, as with higher temperatures.

Heat Level	Speed Application	Passenger Speed	Freight Speed
1	Do Not Exceed	No Reduction	50 MPH
	Speed on Curves	No Reduction	No Reduction
	Speed Through Turnouts	No Reduction	No Reduction
2	Do Not Exceed	50 MPH	40 MPH
	Speed on Curves	10 MPH Reduction	5 MPH Reduction
	Speed Through Turnouts	5 MPH Reduction	5 MPH Reduction

Table 9-8

9.13 Training

All employees responsible for the inspection, installation, adjustment, or maintenance of CWR track must complete training on CWR procedures every calendar year. In addition, they shall be provided a copy of these procedures and accompanying documents. SCRRRA, SCRRRA representatives, and SCRRRA contractors will maintain lists of those employees qualified to supervise restorations and inspect track in CWR territory. The qualified employee lists will be made available to the FRA upon request.

CWR Training programs will address the following:

1. CWR installation procedures.
2. Rail anchoring requirements when installing CWR.
3. Preventive maintenance on existing CWR track.
4. Monitoring curve movement following track surfacing and lining.
5. Placing temporary speed restrictions account trackwork.
6. Rail joint inspections.
7. Insufficient ballast.
8. Extreme weather inspections.
9. Recordkeeping.

9.14 Recordkeeping

9.14.1 *Report of CWR Installations*

Records necessary to provide an adequate history of installing and achieving rail neutral temperatures using this procedure will be maintained for at least one year. These records will include the date of installation, location, rail and length, initial rail temperature, designated RNT, expansion, and adjusted RNT and must be recorded on the prescribed forms Record of Rail Installation Temperatures and the CWR Stress Adjustment/Disturbance Report in the Appendix and submitted to TRACK&STRUCTURES@SCRRRA.NET by the qualified person-in-charge. These forms must be retained for at least one year after installation and will be provided by SCRRRA upon request.

9.14.2 *Report Maintenance Work in CWR*

A CWR Stress Adjustment/Disturbance Report in the Appendix shall be filled out by the qualified person-in-charge when work is performed and has the potential for disturbing the preferred rail temperature or the lateral resistance of the track. These reports are required by FRA Track Safety Standards. These reports are for situations that may either raise or lower the rail neutral temperature and are required for both maintenance and construction activities.

The qualified person-in-charge of work being performed on the track shall retain original of report and shall forward a copy to SCRRRA at TRACK&STRUCTURES@SCRRRA.NET. If box marked "Corrective Action Required" is checked, a second report shall be submitted to TRACK&STRUCTURES@SCRRRA.NET within 30 days to indicate the corrective action and shall refer to the original report by date and milepost location.

Reports will be reviewed and compiled by SCRRRA, or a SCRRRA representative. They will be filed in milepost order, by Subdivision, in the same file as the rail installation reports. If a report overlaps a previous report of rail installation temperatures at the same location, the old report will be retained with a notation that it has been superseded by the new report. SCRRRA will examine these reports quarterly to confirm that corrective actions have been accomplished.

Because track maintenance can disturb the lateral and longitudinal resistance of the track, records of the following must be kept until corrections or adjustments are made:

1. Record of each designated cut or break location on the CWR Stress Adjustment/Disturbance Report in the Appendix and submit to TRACK&STRUCTURES@SCRRRA.NET. In areas where rail was added, the RNT must be adjusted and documented, per Section 9.6 CWR Installation Procedures and Section 9.8 Track Buckling Prevention, within 30 days. Records must be retained for 365 days after final corrections are made.

Examples of work requiring submittal of CWR Stress Adjustment/Disturbance Report found in the Appendix includes the following:

1. Additions/changes of rail:
 - 1.1. Installation of repair rail
 - 1.2. Installation/replacement of bonded insulated joint
 - 1.3. Field weld of bolted joint
 - 1.4. Removal/Replacement of Track Panel:
 - 1.4.1.Road Crossing
 - 1.4.2.Bridge Deck
 - 1.4.3.Derailment/Washout
 - 1.4.4.Turnout
 - 1.5. Realignment of Curved Track
 - 1.6. Destressing
 - 1.7. Repair of Track Buckle
 - 1.8. Repair of Pull-Apart
2. Changes to track strength:
 - 2.1. Surfacing
 - 2.2. Loss of ballast due to construction activities
 - 2.3. Installation of ties:
 - 2.3.1.Spot tie or production wood tie replacement
 - 2.3.2.Change-out of wood to concrete ties
 - 2.3.3.Subgrade subsidence repair/surfacing
2. Where curve has been staked and inward lateral curve movement exceeds a maximum of 3 inches.
3. CWR installation or maintenance work that does not conform to these written procedures.

Any of the conditions above must be recorded on a CWR Stress Adjustment/Disturbance Report found in the Appendix and must be filled out by a qualified person-in-charge and submitted to TRACK&STRUCTURES@SCRRRA.NET. SCRRRA must monitor these records to ensure necessary corrections and adjustments are made. If rail is not adjusted to the PRLT before forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25 MPH must be placed.



Appendix to CWR Procedures

*(For fillable PDF forms, click the paperclip/attachment icon within
Adobe/Bluebeam)*

CWR Stress Adjustment / Disturbance Report

Record of Rail Installation Temperatures



METROLINK

CWR Stress Adjustment/Disturbance Report

Report Date:		
Reported By:		
Subdivision:		
Date of Disturbance:		
Corrective Action Required?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Location:

Milepost:		to	
Track No.			
Rail:	<input type="checkbox"/> North	or	<input type="checkbox"/> South

Temperatures:

Air Temperature (AT):		Rail Temperature (RT):	
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Type of Adjustment/Disturbance:

<input type="checkbox"/>	Rail Installed:	Length(ft):		<input type="checkbox"/>	Ties Installed
<input type="checkbox"/>	Destressing Performed:	Length(ft):		<input type="checkbox"/>	Realignment of Curve
<input type="checkbox"/>	Track Panel(s) Installed:	Length(ft):		<input type="checkbox"/>	Undercutting
<input type="checkbox"/>	Road Crossing Installed:	Length(ft):		<input type="checkbox"/>	Washout
<input type="checkbox"/>	Surfacing of Track:	Inches of Lift:		<input type="checkbox"/>	Buckled Track
<input type="checkbox"/>	Turnout Installed			<input type="checkbox"/>	Pull-Apart
<input type="checkbox"/>	Other:				

Corrective Action:

Rail Temperature (RT):		Distance between Spanning Marks Before Adjustment (in):	
Adjusted Rail Temperature (ART):			
Amount of Rail Expansion (in):		Distance between Spanning Marks After Adjustment (in):	

Description:

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RECORD OF RAIL INSTALLATION TEMPERATURES

Date	Mile Post	Sub-division	Track No.	Rail N/S	String No. & Length	Air Temp.	Rail Temp.	Adjusted Rail Temp.	Weather / Time	Calculated Expansion	Actual Expansion

Submitted by: _____

Description: _____

Instructions:

Date: Date when rail was laid.

Rail – N/S: North or South rail, as defined by the timetable direction.

String No.: Number the strings beginning with #1 and continuing in succession with each string laid in the course of a day. Each day the crew should start the numbering with #1. Indicate length of each string.

Air Temp.: Air temperature in degrees Fahrenheit taken at the same time the rail temperature is taken.

Rail Temp.: Actual rail temperature in degrees Fahrenheit taken prior to heating.

Adjusted Rail Temp.: The temperature the rail was adjusted to at time of installation.

Weather/Time: Weather conditions and time when the air temperature and rail temperature are taken.

Calculated Expansion: Expansion required to adjust rail to the PRLT, obtained from the thermal expansion formula or CWR Movement Chart.

Actual Expansion: Actual expansion achieved for rail installed.

Description: Notes about special items (i.e. weather, mile post locations, etc.)

Distribution: Deliver completed forms to SCRRRA for filing by milepost order for each subdivision.

Appendix A

Definitions

DEFINITIONS

This section includes definitions of terms relating to trackwork, switches, frogs, guard rails, crossings, and turnouts.

Abutment: A substructure composed of stone, concrete, brick, or timber supporting the end of a span.

Adjustable Separator: A metal block or two or more parts acting as a filler between the running rail and the guard rail and designed to provide varying widths of flangeway.

Alignment: The horizontal location of a railroad as described by curves and tangents.

Alloy Steel: Steel to which has been added silicon, manganese, nickel, or other elements to give greater strength, or impart other desirable properties for a particular use.

Angle Bar: One of two bars used to join two rail ends together to form continuous track.

Auxiliary Track: Any track not otherwise specified that directly connects to any main track, siding or industrial lead where cars or locomotives are left standing.

Ballast: Material selected for placement on the roadbed for the purpose of holding the track in line and at surface.

Ballast Section: A vertical cross section of the track from the subballast up, including ballast.

Bolted Rigid Frog: A frog built essentially of rolled rails, with fillers between the rails, and held together with bolts.

Branch Line: The secondary line or lines of a railway.

Buckled Track: A major irregularity in track alignment caused by excessive compression in the rails. See also Thermal Misalignment.

Cant: The tilt or inclination on a surface.

Center Frogs: The two frogs at the opposite ends of the short diagonal of a crossing.

Clearance Point: The location behind a turnout where track centers reach 13 feet 6 inches.

Closure Rails: The rails located between the parts of any special trackwork layout, as the rails between the switch and the frog in a turnout (sometimes called the lead rails or connecting rails); also, the rails connecting the frogs of a crossing or adjacent crossings.

Company Material: Material transported by a particular railroad such as rail, cross ties, ballast, fuel oil, etc., used in connection with its operations.

Compound Curve: A continuous curve composed of two or more different curves put together with no tangent in between them, curving in the same direction.

Compromise Joint (Trackwork): A rail joint between rails of different height and section, or rails of the same section but of different joint drillings.

Compromise Rail: A relatively short section of rail where one end is forged to a different section of rail.

Conformal Frog: A frog with a 1:20 sloped running surface designed to better fit the profile of wheels.

Connecting Rod: The rod that connects the switch stand and switch rod.

Connecting Track: A track defined as such in EFMS and the Track Inspection System, usually a track or a wye that connects two subdivisions or railroads.

Continuous Welded Rail (CWR): Rail length that is 400 feet or longer.

Controlled Siding: A siding within CTC or Interlocking limits where a signal indication authorizes the siding's use.

Creosote: A tar distillate produced by high-temperature carbonization of bituminous coal and used in wood treatment.

Crib: The lateral space between two railroad ties.

Cross Level: The difference in elevations one rail is above or below another. This should not be confused with superelevation on curves.

Cross Tie: The transverse member of the track structure to which the rails are spiked or otherwise fastened to provide proper gage and to cushion, distribute, and transmit the stresses of traffic through the ballast to the roadbed.

Crossing (Rail) (Diamond Crossing): A structure, used where one track crosses another at grade, consisting of four connected frogs.

Crossover: A combination of two switches that connect two adjacent tracks.

Crossover, Double: Two crossovers that intersect between the connected tracks.

Crossover, Universal: Two crossovers in opposite directions.

Curve, Compound: A continuous change in direction of alignment by means of two or more contiguous simple curves of different degrees having a common tangent at their junction points.

Curve, Degree of: The angle subtended at the center of a simple curve by 100 ft. chord.

Curve, Reverse: Two contiguous simple curves in opposite directions, with a common tangent at their junction point.

Curve, Simple: A continuous change in direction of alignment by means of an arc of a single radius.

Curve, Vertical: A transition in the track to connect two intersecting grade lines.

Curved Closure Rail: The rail between the switch point and frog on the diverging side of a turnout.

Curved Lead: The distance between the actual point of the switch and the half-inch point of the frog, measured on the outside gage line of the turnout.

Derail: A safety device, attached to one rail of a siding or storage track that will cause a car to be derailed in the event it rolls free towards a main track where it could cause a major accident.

Derailment: Anytime the wheels of a car or engine come off the head of the rail.

Drift Pin: A special railroad tool of round steel tapered for insertion to align holes by striking the large end.

Drill Track: A track connecting with the ladder track, over which locomotives and cars move back and forth in switching.

Dutchman: Short piece of rail that can be used to reduce the gap between rails ends. Used to make emergency or temporary movement of trains over a wide joint gap. Must be used within the limits of joint bars.

Elevation (of Curves) Superelevation: The vertical distance that the outer rail is above the inner rail.

End Frogs: The two frogs at the opposite ends of the long diagonal of a crossing.

Expansion Shim: Spacer inserted between ends of abutting rails while track is being laid to provide allowance for expansion of steel when temperature changes.

Facing Point Switch: A track switch, the points of which face traffic approaching in the direction for which the track is signaled.

Fastenings: Joint bars, bolts, clips, lag screws, and spikes.

Fastenings, Auxiliary: Locknuts, spring washers, tie plates, rail braces, cotter pins, and anti-creeping devices.

Federal Railroad Administration (FRA): An agency of the U.S. Department of Transportation with jurisdiction over matters of railroad safety.

Fiber Optics: Light transmission through very fine flexible glass rods.

Field Side: The side of a rail opposite the gage side.

Field Weld: A weld joining two rails together after rails are installed in track.

Filler Block (Trackwork): A steel block molded and designed to keep uniform the angle spread between lead and turnout rails and frogs, etc.

Flange Lubricator: A device by which either grease or oil can be applied to the flanges of a locomotive driving wheel for the purpose of preventing flange wear and cutting. Rail lubricators mounted along the rail in high curvature territory are also used to apply lubricant to passing flanges to reduce both wheel and rail wear.

Flangeway: The open way through a track structure that provides a passageway for wheel flanges.

Flangeway Depth: The depth of the wheel flange passageway.

Flangeway Width: The distance between the gage line and the guard line of a track structure, which provides a passageway for wheel flanges.

Flare: A tapered widening of the flangeway at the end of the guard line of a track structure, as at the end of a guard rail or at the end of a frog or a crossing wing rail.

Flare Opening: The distance between the gage line and the guard line of a track structure at the wider end of the flare.

Foot Guard: A filler for the space between converging rails to prevent human feet from becoming accidentally wedged between the rails.

Fouling Point: See clearance point.

Frog: A track structure used at the intersection of two running rails to provide support for wheels and passageways for their flanges, thus permitting wheels on either rail to cross the other.

Frog Angle: The angle formed by the intersecting gage lines of a frog.

Frog Heel: The end of a frog furthest from the switch, or opposite the point end.

Frog Number: The ratio of the spread to the length of the frog.

Frog Plates: Any specially designed plate used between the toe and heel of a frog.

Frog Point: The part of a frog lying between the gage lines extending from their intersection toward the heel end.

(a) Theoretical Point: The point of intersection of the gage lines of a frog.

(b) Half-Inch Point: A point located at a distance from the theoretical point towards the heel equal in inches to one-half the frog number, and at which the spread between the gage lines is one-half inch. It is the origin from which measurements are made.

(c) Actual Point: The physical location of the point of frog. This is called the 5/8" point.

Frog, Throat: The point at which the converging wings of a frog are closest together.

Frog, Toe: The end of a frog nearest the switch.

Fusee: A warning device consisting of a cardboard tube filled with a combustible mixture of chemicals that burns brightly when ignited and remains burning for varying lengths of time. Fusees are ignited and dropped on the right-of-way to indicate to a following train the presence of stopped or slow-moving equipment ahead.

Gage (Track): See Standard Gage.

Gage Line: A line 5/8 in. below the top of the center line of head of running rail along the side nearer the center of the track.

Gage Plate: A metal plate, extending from rail to rail, used to maintain gage of track.

Gage Rod: A device for holding track to correct gage, generally consisting of 1-1/4-in. rod with a forged jaw on one end and a malleable jaw on the other end, adjustable through a lock nut.

Geotextile: A material designed to permit the passage of water through it, but not particles of soil or dirt carried by the water. Used under ballast to function as a subballast. Also used to wrap corrugated or loose-jointed pipe and to line drainage trenches or French drains. Also called "filter fabric" or "engineering fabric."

Grade (Degree Of): As used in connection with railway line, the rise or fall in a track expressed as a ratio to 100 feet of horizontal track.

Grade Crossing: An intersection of a highway with a railroad at the same level.

Guard Check Gage: The distance between guard line and gage line, measured across the track at right angles to the gage lines.

Guard Face Gage: The distance between guard lines, measured across the track at right angles to the gage lines.

Guard Line: A line along the side of the flangeway that is nearer the center of the track and at the same elevation as the gage line.

Guard Rail: A rail or other structure laid parallel with the running rails of a track to prevent wheels from being derailed; or to hold wheels in correct alignment to prevent their flanges from striking the points of turnout or diamond crossing or the points of switches. A rail or other structure laid parallel with the running rails of a track to keep derailed wheels adjacent to running rails.

Guard Rail (Frog): A rail or other device to guide the wheel flange so that it is kept clear of the point of the frog.

Guard Rail (Switch): A rail or other track structure laid parallel with the running rail ahead of a split switch and forming a flangeway with the running rail, to hold the wheels of rolling stock in correct alignment when approaching the switch.

Guard Rail Brace: A metal shape designed to fit the contour of the side of the guard rail and extend over the tie, with provision for fastening thereto, to restrain the moving or tilting of the guard rail away from the running rail.

Guard Rail Brace, Adjustable: A guard rail brace, which may be adjustable laterally with respect to the rail, to vary the distance between the guard rail and the running rail.

Guard Rail Clamp: A device consisting of a yoke and fastenings designed to engage the running rail and the guard rail and hold them in correct relation to each other.

Guard Rail, One-Piece: A guard rail consisting of a single complete unit, either fabricated or cast, designed so that no auxiliary parts or fastenings other than spikes are required for its installation.

Head Rod: A rod connecting the points of a switch or movable point frog, by means of which the relative location of the points is maintained and to which the operating rod is attached.

Head Separation: The point on a switch rail where the head of the rail attains its full width.

Head Block Ties: The ties to which a switch stand is attached.

Heel (of Frog): The end of the frog farthest from the switch.

Heel Block: A steel block, through which bolt holes are drilled, that is placed between the heel of a switch point and its stock rail.

Heel Length: The distance between the heel end and the half-inch point of a frog, measured along the gage line.

Heel Spread: The distance, at the heel, between the gage line of a switch rail and the gage line of its stock rail. (This has been standardized at 6-1/4 in. for AREMA style switches.)

Industrial Track: A switching track serving industries, such as mines, mills, smelters, and factories.

Insulated Rail Joint: A joint in which electrical insulation is provided between adjoining rails.

Insulated Switch: A switch in which the fixtures, principally the gage plates and the switch rods, connecting or reaching from one rail to the opposite rail, are provided with insulation so that the electric track circuit will not be shunted.

Insulation: A device or material that prevents the flow of electric current in a track circuit from passing from one rail to the other or through switches and other track structures.

Joint Bar: A steel bar commonly used in pairs for joining rail ends in railroad track.

Joint Gap: The distance between the ends of rails joined by joint bars.

Joint Rail Drilling: The spacing of holes in the ends of rails or other track structures to receive the bolts for fastening joint bars.

Joint, Permanent: A rail joint that will remain in track.

Joint, Rail: The area of fastenings and rail where rail ends meet.

Joint, Supported: A rail joint that sits directly on top of a tie.

Joint, Suspended: A rail joint that sits between two consecutive ties.

Knuckle Rail: A bent rail, or equivalent structure, forming the obtuse point against which the movable center points, of a movable point crossing or slip switch, rest when set for traffic.

Lead (Actual): The length between the actual point of the switch and the half-inch point of the frog measured on the line of the main track.

Lead (Theoretical): The distance from the theoretical point of switch to the theoretical point of the frog, measured on the line of the main track.

Lead Track: An extended track connecting to a series of yard tracks.

Line: The condition of the track with regard to uniformity in direction over short distances on tangents, or uniformity of curvature over short distances on curves.

Lock Nut: A special type of nut with a feature that prevents the nut from turning off the bolt once it is secured. Lock nuts are not reusable since removing them generally destroys the locking feature.

Lock Rod: A rod, attached to the front rod or lug of a switch, movable point frog, or derail, through which a locking plunger may extend when the switch points or derail are in the normal or reverse position.

Lock Washer: A washer designed to prevent undesired loosening of a nut after it has been tightened.

Main Track (Line): A track extending through yards and between stations that must not be occupied without authority or protection. (General Code)

Manganese Steel: Steel containing a high percent of manganese; an alloy of steel to increase hardness and wear resistance.

Manganese Steel Insert Crossing: A crossing in which a manganese steel casting is inserted at each of the four intersections, being fitted into rolled rails and forming the points and wings of the diamond crossings.

Manganese Tipped Switch: A split switch in which the head of one or both of the switch rails is cut away in the point portion and manganese steel insert is fastened to the rail to form the point.

Monday Maul: Sledge hammer.

Movable Center Point: One of the movable tapered rails of a movable point crossing or slip switch.

Movable Point Frog: A frog equipped with points that are movable in the same manner as the points on a switch.

Movable Point Crossing: A crossing of small angle in which each of the two center frogs consists essentially of a knuckle rail and two opposed movable center points with the necessary fixtures.

Passing Track: A track to the main track for meeting or passing trains. Today this is called a siding.

Planing, Bottom: The cut planed at an angle on the bottom of the base of the switch rail from the point and towards the heel to allow the switch rail to rest on the top of the base of the stock rail when the switch rail is closed.

Planing, Chamfer Cut: The vertical beveling of the gage side of the switch point to produce a sharp edge that prevents wheel flanges from striking the point.

Planing, Side: The cuts made on the sides of the head of the switch rail to form the taper.

Planing, Top: The cut made on the top of the head of the switch rail from the point and to approximately the head separation.

Point of Switch (Actual): The end of the switch rail farther from the frog; the point where the spread between the gage lines of the stock rail and the switch rail is sufficient for a switch point.

Point of Switch (Theoretical) of Vertex: The point where the gage line of the switch rail, if extended, would intersect the gage line of the stock rail.

Point Rail, Switch Rail, or Switch Point: The tapered rail of a split switch.

Pull-Apart: A condition that exists at a rail joint when all the bolts in one rail end are missing and the two rail ends have gapped.

Rail: In track, a rolled steel shape, commonly a T-section, designed to be laid end to end in two parallel lines on cross ties or other suitable supports to form a track for railway rolling stock.

Rail Anchor: A device attached to the base of a rail bearing against a cross tie to prevent the rail from moving longitudinally under traffic.

Rail Bond: A short metal cable attached to adjacent rails at the joints to ensure proper electrical continuity across the joint.

Rail Brace: A bracing device used at switches, movable point frogs, etc., in combination with switch, tie, or gage plates for holding the rail from lateral roll.

Rail Brace (Switch): A metal shape designed to fit the contour of the side of the stock rail and extend over the switch plate, with provision for fastening through the plate to the tie, to restrain the lateral roll of the stock rail.

Rail Brace, Adjustable (Switch): A rail brace that may be adjusted laterally with respect to the stock rail, to compensate for variations in the dimensions of the rail and to permit adjusting for wear.

Rail Creep: Longitudinal sliding of rails in track under traffic or because of temperature changes.

Rail Joint: A fastening designed to unite the abutting ends of contiguous rails.

Rail Lubricator (Flange): A device designed to apply grease to the gage side of the rail head at the beginning of a curve, to minimize wear of the rail and wheel flange or to eliminate noise.

Rail Lubricator (Top of Rail): A device designed to apply lubrication to the top of the rail head to minimize wear of the rail and reduce lateral forces, or to eliminate noise.

Railbound Manganese Steel Frog: A frog consisting essentially of a manganese steel body casting fitted into and between rolled rails and held together with bolts.

Relay Rails: Rails taken up from tracks where formerly used, suitable for relaying in other tracks.

Retarder: A braking device, usually power operated, built into a railway track to reduce the speed of cars by means of brake-shoes which, when set in braking position, press against the sides of the lower portions of the wheels.

Reverse Elevation: In curved track, when the outer rail is lower than the inner rail.

Right-of-Way: The strip of land on which a railroad track is built.

Rip Track: A car repair facility with one or more tracks.

Roadbed: The foundation upon which the ballast, ties and rails of a railroad are laid.

Running Rail:

a.) The rail or surface on which the tread of the wheel bears.

b.) Longitudinal movement of rail caused by an insufficient fastening system.

Running Track: A track reserved for movement through a yard.

Screw Spike: A cylindrical threaded spike, designed to be turned with a special wrench into holes bored in ties, to secure rails or to act as a tie plate holder.

Self-Guarded Frog (Flange Frog): A frog provided with guides or flanges, above its running surface, which contact the tread rims of wheels for the purpose of safely guiding their flanges through the frog.

Side Track: An auxiliary track to the main track.

Siding: A track connected to the main track and used for meeting or passing trains. Locations of sidings are shown in the timetable. (General Code)

Slide Fence: A fence interconnected to the signal system placed at the bottom of a cut to warn trains of rock slides by the use of signal indication.

Slip Switch, Double: A combination of a rail crossing and two turnouts interconnected into one assembly.

Slip Switch, Single: A combination of a rail crossing and one turnout interconnected into one assembly.

Solid Manganese Steel Frog: A frog consisting entirely of a single manganese steel casting.

Special Trackwork: Any trackwork consisting of more than two rails and ties. Examples are turnouts, switches and diamond crossings.

Specification: A set of instructions that provide the requirements of a material to be manufactured or constructed.

Spike: A long steel square nail with a cutting edge used to fasten track components in place.

Spiked Switch: A switch whose points are held in fixed position by a spike to prevent the switch from being thrown or to prevent trains from using track that has been taken out of service.

Spiral: The gradual and uniform increase and decrease of curvature between the tangent and the full curve.

Split Switch: A track structure consisting of two movable point rails and necessary fixtures used to divert rolling stock from one track to another.

Spring Rail Frog: A frog with a movable wing rail that is held against the point rail by springs, thus making an unbroken running surface for wheels using one track, whereas the flanges of wheels on the other track force the movable wing rail away from the point rail to provide a passageway.

Spring Rail Frog, Right-Hand and Left-Hand: Standing at the toe end of a spring rail frog and looking toward its point, a right-hand frog has the movable wing rail located on the right-hand side, and a left-hand frog has the movable wing rail located on the left-hand side.

Spring Switch: A switch with a spring mechanism that returns the switch points to the original position after they are trailed through.

Spring Washer: A component designed to apply compressive force to prevent reverse movement of a nut.

Spur: A single-ended track diverging from a main or other track.

Standard Gage: The standard distance between rails of North American railroads: 4 ft. 8-1/2 in. measured between the inside faces of the rail heads 5/8 in. below the top of the rail.

Stock Rail: The rail against which the point of a switch or derail fits.

Stock Rail Bend: The bend placed in the stock rail at or near the switch point to match the switch rail angle.

Storage Track: A track on which cars are placed when awaiting disposition or when not in service.

Straight Closure Rail: The rail between the switch point and frog on the straight side of a turnout.

String Lining:

a.) A method to determine the alignment of a curve by measuring offset from a string line to the gage side of the high rail.

b.) When a train pulls its consist off the low side of a curve.

Stripped Joint: See Pull-Apart.

Subballast: Any material spread on the finished subgrade of the roadbed below the ballast to provide better drainage, prevent upheaval by frost, and better distribute the load over the roadbed.

Subgrade: The finished surface of the roadbed below the ballast and track.

Sun Kink: See *Thermal Misalignment*.

Switch: A track structure with movable rails to divert rolling stock from one track to another.

Switch Angle: *The angle included between the gage lines of the switch rail at its point and the stock rail.*

Switch Circuit Controller: A device connected at the point to switch, derail, or moveable point frog which will electrically indicate an open switch condition when the switch point is open 1/4" or more.

Switch Heater: A device that will heat the area around a switch to melt snow and ice.

Switch Heel: The designated location on the switch point where the heel block is located.

Switch Machine: A machine used to throw track switches. Switch machines can be powered operated or used manually.

Switch Plate: Any specially designed tie plate for use in the switch area of a turnout.

Switch Point: A machined rail with a sharp end mated against a stock rail used to divert rolling stock from one track to another.

Switch Point Derail: A device consisting of at least one switch point for the intended purpose of derailing rolling stock.

Switch Point Protector: A device that diverts a rolling wheel away from the switch point.

Switch Rail Brace: A brace placed against a running rail to dissipate lateral force thus preventing rail turnover.

Switch Rod: A rod connecting the two points of a switch which maintains the proper distance between the points.

Switch Stand: A device for the manual operation of a switch.

Switch Tie: Ties made of various lengths used in a switch, turnout or special trackwork.

Tangent: A section of track that connects two curves.

Thermal Misalignment: An irregularity in track alignment caused by excessive compressive forces in the rail.

Thermite Weld: A weld, made by pouring molten materials into the gap between rail ends, that fuses the rail ends together.

Throat of Frog: The location ahead of the point at which the wing rails of a frog are closest together.

Throw of Switch: The distance between the back of the open switch point and gage line of the stock rail measured along the center line of the No. 1 switch rod. (This distance is standardized at 4-3/4 in.)

Tie Pad: A dampening device located between the rail and the tie.

Tie Plate: A steel plate between a rail and a tie.

Tie Plug: A wood or composite material used to fill holes in ties from which spikes have been removed.

Toe (of Frog): End of a frog nearest the switch.

Toe Length: The distance between the toe end of the frog and the half-inch point of the frog, measured along the gage line.

Track: An assembly of rails, ties, ballast and fastenings over which cars, locomotives, and trains are moved.

Track Bolt: A bolt with a button head and oval, or elliptical neck, and a threaded nut designed to fasten rails and joint bars.

Track Crossing (slang; Diamond): A track component consisting of four connected frogs that permits one track to cross another at grade.

Track Shims: Flat wood boards of length and width similar to tie plates. They are placed between the ties and the tie plates when the ballast is frozen to correct surface irregularities.

Transition Rail (Trackwork): A manufactured rail using the same rail section that is machined to compensate for various amounts of rail head loss.

Tread:

- a.) The top surface of the rail that contacts the wheel.
- b.) The portion of the wheel that contacts the top of the rail.

Turnback Curve: The curve(s) directly behind the diverging side of a turnout.

Turnout: A section of trackwork that allows rolling stock to be diverted from one track to another.

Turnout, Panel: A pre-assembled turnout complete or in sections.

Turnout Plates: Any specially designed tie plate used between the heel of the switch point and toe of the frog.

Turnout Number (Size): The number corresponding to the size of the frog used in the turnout.

Washout: An erosion of the permanent roadbed by storm or flood.

Wheel Flange: The portion of the wheel that protrudes down from the wheel tread to guide rolling stock along the track.

Wide Gage: Any gage wider than standard gage caused by track deterioration or improper installation.

Wye: A track arrangement shaped like the letter Y but with a connecting segment between the two upper legs to enable the turning of equipment.

Yard: A system of tracks, other than main tracks and sidings, used for making up trains, storing cars, and other purposes.

Appendix B

Tables

Summary of Speed Restrictions for Trackwork

Summary of Remedial Action for FRA Rail Defects

**SOUTHERN CALIFORNIA REGIONAL RAIL AUTHORITY
SUMMARY OF SPEED RESTRICTIONS FOR TRACKWORK**

	Type of work preformed	First train	Minimum of 24 Hours & 16 Trains ¹	After 24 hours
	Maximum speed	Pass/Frt	Pass/Frt	Pass/Frt
SPECIAL TRACKWORK	Newly installed switches, turnouts, crossings, track or track panels- not surfaced and not destressed.	10/10 mph	10/10 mph	Not Applicable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced, destressed and not stabilized	10/10 mph	30/20 mph	Timetable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced, stabilized, and destressed.	10/10 mph	40/30 mph	Timetable
	Newly installed switches, turnouts, crossing, track or track panels - surfaced and stabilized – not destressed ⁴	10/10 mph	30/20 mph	40/30 mph
ALL TIE INSTALLATION	Tie Installation – surfaced, with or without stabilizing - above or forecasted to be above 80 degrees F or Rail temp above the PRLT	15/10 mph	15/10 mph	30/20 mph ³
	Tie Installation - surfaced and not stabilized - below 80 degrees F ambient	15/10 mph	30/20 mph	Timetable
	Tie Installation – surfaced and stabilized -below 80 degrees F ambient	30/20 mph	Timetable	Timetable
CWR INSTALLATION	CWR Installation, surfaced, destressed, not stabilized	10/10 mph	30/20 mph	Timetable
	CWR Installation, surfaced, destressed, and stabilized	10/10 mph	40/30 mph	Timetable
	CWR Installation, destressed and no surfacing required	10/10 mph	40/30 mph	Timetable
	CWR Installation, not destressed – (surfaced or not) ⁴	10/10 mph	30/20 mph	40/30 mph

	Type of work preformed	First train	Minimum of 24 Hours & 16 Trains ¹	After 24 hours
	Maximum speed	Pass/Frt	Pass/Frt	Pass/Frt
SURFACING	Track Surfacing without stabilizing ²	15/10 mph	30/20 mph	Timetable
	Track Surfacing with dynamic stabilizing ²	50/40 mph	Timetable	Timetable
	Track Surfacing with or without stabilizing - above or forecasted to be above 80 degrees F ambient or Rail temp above the PRLT ²	15/10 mph	15/10 mph	30/20 mph ³
	<p>After the passage of the first train, the track shall be inspected and then, under the authority of the qualified person-in-charge (qualified under CFR 49Part 213.7), the speed may increase per the table above, for a minimum of 24 hours with a minimum of 16 trains. The speed may then be restored to Timetable Speed after another track inspection.</p> <p>¹ Speed restrictions must remain in place for a minimum of 24 hours in addition to the passage of a minimum of 16 trains (Pass/Frt). Prior to removing restriction, verify that the 16-train requirement was met through train dispatcher and/or timetable.</p> <p>² Track surfacing with up to a maximum of 2 inches of track raise. If track is raised more than 2 inches use Special Trackwork Speed Restrictions.</p> <p>³ Due to the nature of the sub-grade disturbance, an additional 24 hours is required to allow track to consolidate. Track must be inspected prior to removal of speed restriction.</p> <p>⁴ If rail is not adjusted to the PRLT before forecasted temperatures would cause the rail to reach 40 degrees above the rail installation temperature, a speed restriction of 25MPH must be placed.</p>			

Remedial Action for Rail Defects

Defect Type	Applies to Main Tracks and Siding Tracks			Applies to All Other Tracks Tested			Minimum Remedial Code, When not removed ahead of trains
	Percent of existing rail head cross-sectional area weakened by defect		Required Action	Percent of existing rail head cross-sectional area weakened by defect		Required Action	
	Less Than	But Not Less Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	Less Than	But Not Less Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	
Compound fissure (CF) & (CF-G)	25%	1%	Limit operating speed over defect to 30 MPH. Apply joint bars within 48 hours.	70%	1%	Limit operating speed, not to exceed 30 MPH over defect. Apply joint bars within 10 days in class 1 & higher.	B
	70%	25%	Limit operating speed over defect to 10 MPH until joint bars are applied, thereafter 30 MPH. Apply joint bars within 48 hours.				
	100%	70%	After visual inspection, limit operating speed over defect to 10 MPH or less. If not replaced the same day, apply joint bars. Replace or repair rail within 24 hours.	100%	70%	After visual inspection, limit operating speed, not to exceed 10 MPH over defect. Visually inspect within each 24 hour period or replace rail. Apply joint bars within 5 days in class 3 & higher and within 7 days in class 1 & 2 track.	A2
		100% (CO)	Visually supervise each movement over defective rail not to exceed 10 MPH. Replace or repair rail within 24 hours.		100% (CO)	Visually supervise each movement over defective rail, not to exceed 10 MPH. Apply joint bars within 5 days in class 3 & higher and within 7 days in class 1 & 2 track.	A
(CO) "Crack Out" is a visual crack in rail head							

Remedial Action for Rail Defects

Defect Type	Applies to Main Tracks and Siding Tracks			Applies to All Other Tracks Tested			Minimum Remedial Code, When not removed ahead of trains
	Percent of existing rail head cross-sectional area weakened by defect		Required Action	Percent of existing rail head cross-sectional area weakened by defect		Required Action	
	Less Than	But Not Less Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	Less Than	But Not Less Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	
Transverse Fissure (TF) Detail Fracture (DF) & (DF-G)	25%	1%	Limit operating speed to 50 MPH and replace or repair rail within 4 days. If rail not replaced or repaired, restrict to 30 MPH until joint bars are applied and 50 MPH thereafter. Apply bars within 10 days in class 1 & higher. When joint bars have not been applied within 10 days, limit operating speed to 10 MPH	25%	1%	Limit operating speed to 50 MPH and replace rail within 4 days. If rail not replaced, restrict to 30 MPH until bars are applied and 50 MPH thereafter. Apply joint bars within 10 days in class 1 & higher. When joint bars have not been applied within 10 days, limit operating speed to 10 MPH	C
	60%	25%	Limit operating speed over defect to 30 MPH until joint bars are applied, thereafter 50 MPH. Joint bars must be applied within 5 days in class 1 & higher. When joint bars have not been applied within 7 days, limit operating speed to 10 MPH	60%	25%	Limit operating speed over defect to 30 MPH until joint bars are applied, there after 50 MPH. Apply joint bars within 5 days in class 3 & higher and within 7 days in class 1 & 2 track. When joint bars have not been applied within 7 days, limit operating speed to 10 MPH	D
	100%	60%	After visual inspection, limit operating speed over defect to 10 MPH joint bars are applied, thereafter limit operating speed to 50 MPH. Apply joint bars within 24 hours. Make a Visual inspection within each 24 hours until joint bars are applied; rail is replaced or repaired.	100%	60%	After visual inspection, limit operating speed, not to exceed 10 MPH and make a visual inspection within each 24 hours period OR apply joint bars, thereafter limit operating speed to 50 MPH. Apply joint bars within 5 days in class 3 & higher and within 7 days in class 1 & 2 track.	A2 or (E and H)
			Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH until joint bars are applied, thereafter limit operating speed to 50 MPH. Apply joint bars within 24 hours.		100% (CO)	Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH. OR apply joint bars and limit operating speed to 50 MPH. Apply joint bars within 5 days in class 3 & higher and within 7 days in class 1 & 2 track.	A or (E and H)
	See "Repair" definition.		(CO) "Crack Out" is a visual crack in rail head				

Remedial Action for Rail Defects

Defect Type	Applies to Main Tracks and Siding Tracks			Applies to All Other Tracks Tested			Minimum Remedial Code, When not removed ahead of trains
			Required Action			Required Action	
	Length of Defect			Length of Defect			
	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	
Horizontal Split Head (HSH)	0"	1"	Replace rail within 14 days.	0"	1"	No Requirement	NRA
Vertical Split Head (VSH)	1"	2"	Limit operating speed over defect to 50 MPH & Replace rail within 14 days.	1"	2"	Limit operating speed to 50 MPH or maximum allowable speed for class of track. If rail not replaced, inspect rail (Note 3) in 90 days.	H and F
Split Web (SW)	2"	4"	Limit operating speed over defect to 30 MPH & Replace rail within 14 days.	2"	4"	Limit operating speed, not to exceed 30 MPH over defect. If rail not replaced, inspect rail (Note 3) in 30 days.	I and G
Signal Bond (SBT, SBE & SBD) in web or rail	4"		Visually inspect and determine if safe to continue operation over the defect & limit operating speed over defect to 30 MPH. Replace Rail within 24-hours.	4"		Limit operating speed, not to exceed 30 MPH over defect. If rail not replaced, inspect rail (Note 3) in 15 days.	B
Pipe Rail (PR)							
Head & Web Separation (HW)	Break out in rail head		Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH until rail is replaced.	Break out in rail head		Visually supervise each movement over defective rail, not to exceed 10 MPH.	A
<u>Additional Required Actions</u> HW within Joint Area	1/2"	1"	Replace rail within 48 hrs.	1/2"	1"	Replace rail within 14 days	NRA
	1"		Replace rail within 24 hours.	1"		Replace rail within 7 days	Use above sizes for remedial
HW in Spring rail frog	0"	NA	Replace per FRA Track Safety Standards Part 213.139 (c)	0"	NA	Replace per FRA Track Safety Standards Part 213.139 (c)	213

Remedial Action for Rail Defects

Defect Type	Applies to Main Tracks and Siding Tracks			Applies to All Other Tracks Tested			Minimum Remedial Code, When not removed ahead of trains
	Length of Defect		Required Action	Length of Defect		Required Action	
	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	
Bolt Hole Crack (BH) Note: BH defect found in spring rail frog See below	*0"	1/2"	Replace rail within 30 days.	0"	1/2"	No Requirement	NRA
	1/2"	1"	Limit operating speed over defect to 30 MPH & Replace rail within 7 Days	1/2"	1"	Limit operating speed, not to exceed 50 MPH over defect. If rail not replaced, inspect rail (Note 3) in 90 days.	H and F
	1"	1 1/2"	Limit operating speed over defect to 30 MPH & Replace rail within 7 Days	1"	1 1/2"	Limit operating speed, not to exceed 50 MPH over defect. If rail not replaced, inspect rail (Note 3) in 30 days.	H and G
	1-1/2"		Limit operating speed over defect to 10 MPH & Replace rail within 14 Days.	1-1/2"		Limit operating speed, not to exceed 30 MPH over defect.	B
	Break out in rail head		Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH until rail is replaced.	Break out in rail head		Visually supervise each movement over defective rail, not to exceed 10 MPH.	A
BH in Spring rail frog	0"	N/A	Replace per FRA Track Safety Standards Part 213.139 (c)	0"	N/A	Replace per FRA Track Safety Standards Part 213.139 (c)	213
	*No remedial action is required for Bolt Hole defects under the following conditions. > Defects less than 1/4" in size that cannot be visually verified after bars are removed.						
	Note: BH defect found in spring rail frog shall be replaced regardless of size - Reference FRA. Track Safety Standards Part 213.139 (c)						
Broken Base (BB) ---- Signal Bond (SBT, SBC & SBD) attached to base of rail	0"	2"	Limit operating speed over defect to 30 MPH until joint bars are applied, there after 50 MPH. Replace Rail within 48 hours.	0"	6"	Limit operating speed over defect to 30 MPH until joint bars are applied, thereafter 50 MPH. Apply joint bars within 5 days in class 3 & higher and within 10 days in class 1 & 2 track.	D
	2"		After visual inspection and determined safe to continue in operation, limit operating speed to 10 MPH and supervise each movement over defect until joint bars are applied, thereafter 30 MPH. Replace Rail within 48 hours	6"		Visually supervise each movement over defective rail, not to exceed 10 MPH or apply joint bars, thereafter limit operating speed to 30 MPH. Apply joint bars within 5 days in class 3 & higher and within 10 days in class 1 & 2 track	A or (E and I)

Remedial Action for Rail Defects

Defect Type	Applies to Main Tracks and Siding Tracks			Applies to All Other Tracks Tested			Minimum Remedial Code, When not removed ahead of trains
	Length of Defect		Required Action	Length of Defect		Required Action	
	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	More Than	But Not More Than	If defective rail is not replaced or repaired, take the remedial action prescribed in note	
Ordinary Break	N/A		Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH or less, until application of joint bars. Apply joint bars within 24 hours.	N/A		Visually supervise each operation over the defect & limit operating speed over defect to 10 MPH or less, until application of joint bars. Apply joint bars within 24 hours.	A or E
Shell, Sliver, Corrugation (SSC) & (SSC-W)*	N/A		Replace rail or repair within required days per SSC Route Class Remediation Table below. (Note 2) Maintenance officer designated under FRA 213.9 is required to visually inspect within 7-days. (Note 4)	N/A		Replace rail or repair within required days per SSC Route Class Remediation Table below. (Note 2) Maintenance officer designated under FRA 213.9 is required to visually inspect within 14-days. (Note 4)	NRA
	On or within 500 feet of bridge (Note 5)		Limit operating speed to 30 MPH (Note 2). Replace rail within 30 days. Maintenance officer designated under FRA 213.9 is required to visually inspect within 7-days (Note 4)	On or within 500 feet of bridge		Limit operating speed to 30 MPH. Replace rail within 30 days. (Note 2) Maintenance officer designated under FRA 213.9 is required to visually inspect within 7-days. (Note 4)	NRA
Flattened Rail (FR) - Crushed Head (CH)	Depth $\geq 3/8"$ and length $\geq 8"$ or deformation under the rail head		Replace rail or repair within required days per SSC Route Class Remediation Table below. (Note 2) Maintenance officer designated under FRA 213.9 is required to visually inspect within 7-days. (Note 4)	Depth $\geq 3/8"$ and length $\geq 8"$ or deformation under the rail head		Replace rail or repair within required days per SSC Route Class Remediation Table below. (Note 2) Maintenance officer designated under FRA 213.9 is required to visually inspect within 7-days. (Note 4)	H
Damaged Rail (DMG-R)	N/A		Limit operating speed over defect to 30 MPH until joint bars are applied, there after 50 MPH. Apply joint bars within 5 days	N/A		Limit operating speed over defect to 30 MPH until joint bars are applied, there after 50 MPH. Apply joint bars within 5 days in class 3 & higher and within 10 days in class 1 & 2 track	C
All Inspections, restrictions or remedial actions will be performed by Supervisor/person qualified & designated under U.S. DOT Track Safety Standards 213.7(a) in Track Class 1-5. Supervisor may apply more restrictive remedial action to insure safe train operation over defect.							

Remedial Action for Rail Defects

SSC Remediation Action Table		
Defect Type	Length of Defect	Number of Days SSC Defect May Remain in Track Before Remedial Action Must Be Taken:
Shell, Sliver, Corrugation (SSC) & (SSC-W)*	Less than 3 feet	35 Days
	3 to 10 feet	30 Days
	Greater than 10 feet	20 Days
Flattened Rail (FR)	When defect is not corrected within the day requirement above, limit operating speed over defect to 40 MPH for Passenger trains or 30 MPH for Freight trains. (Note 2)	
Crushed Head (CH)	On or within 500 feet of bridge (Note 5)	Limit operating speed to 30 MPH. Replace rail within 30 days. (Note 2)

Definitions and Notes
*Definition: Shell, Silver, Corrugation are locations where rail defects may originate or be hidden under surface conditions. These defects are at risk of not being detected by ultrasonic test systems. SSC defects are usually localized surface conditions between 8 inches and one rail length. SSC-W (Battered Welds SSC) defects usually begin with 6" welds.
Note 1: Thermite Field Weld Defects - Standard joint bars may not be applied without excessive grinding and risk of failure. For these reasons, weld or rail must be replaced prior to expiration of days required by SCRRRA and FRA TSS § 213.113 or § 213.337 to apply joint bars.
Note 2: If not removed or repaired within the days required, a variance must be requested and given by SCRRRA.
Clarification: Note 2 above applies to ALL defects not removed or repaired within the required days.
Note 3: "Inspect Rail" means: Inspect rail within "required" days after it is determined to continue the track in use. If the rail remains in track and is not replaced or repaired, the reinspection cycle starts over with each successive reinspection unless the reinspection reveals the rail defect to have increased in size and has therefore become subject to a more restrictive remedial action. This process continues indefinitely until the rail is removed from track or repaired. If not inspected within "required" days, limit speed to Class 2 or maximum allowable speed under 213.9 for the class of track concerned, whichever is lower, until inspected.
Note 4: Maintenance inspection will be performed by a qualified track inspector under FRA § 213.7. This is an on the ground, visual inspection of the rail to determine if track is to remain in service and/or determine if a more restrictive speed is needed.
Note 5: Bridge means: Any structure with a deck or undergrade structure with spans 10 feet or greater in length, which supports one or more railroad tracks.
"Repair" means Remove Entire Defect or Defective Weld as marked, adjust as required and Apply joint bars or Weld rail.
Application of joint bars associated with remediation of CF and CF-G defects are SCRRRA requirements to reduce risk until defect is repaired or rail is replaced. Remediation requires removing the entire defect in all FRA Track Classes.
Apply joint bars, means: Drill the outermost four holes, two on either side of defect and securely bolt a joint bar to each side of rail. Rail weights greater than 112 LB require 36" or larger joint bars.
Limiting Operating Speed, means the same as "Speed is Not to Exceed"
Defect Classifications : Signal Bond (SBT, SBE, and SBD) are defects originating in signal bond process or application. SBT = Signal Bond Thermite (CAD WELD), SBE = Signal Bond Electric, and SBD = Signal Bond Drilled. Defective Slot Weld (DSW) is a defect originating from slot welding process used to repair some head defects. DF-G = Detail Fracture found with D-car gage ultrasonic wheel. CF-G = Compound Fracture found with D-car gage ultrasonic wheel.
Longitudinal Defects found in Welds - Apply Remediation per Split Web (SW) accordingly to length of defect. When there is any transverse component to the defect, apply the most restrictive weld defect remediation.

Appendix C

Forms

(For fillable PDF forms and Post-Derailment excel file, click the paperclip/attachment icon within Adobe/Bluebeam)

CWR Stress Adjustment / Disturbance Report

CWR Joint Bar Fracture Report

CWR Joint Inventory Report

Record of Rail Installation Temperatures

Semi-Annual Curve Inspection Report

Return to Service Report

Turnout Inspection Report Form

Quarterly Turnout and Derail Inspection Report

Track and Signal Joint Switch Inspection

Frog Welding Repair Report

Thermite Weld Information Report

FRA Track Inspection Report (Critical Conditions)

Urgent Defects Report (Scheduled for Maintenance)

Monthly Yard Track Inspection Form

Hi-Rail Inspection Checklist

Rail Lubricator Inspection Form

Geometry Car Critical (Red Tag) Corrective Action Form

Geometry Car Urgent (Yellow Tag) Corrective Action Form

Heat Run/ Unusual Occurrence Report



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CWR Stress Adjustment/Disturbance Report

Report Date:		
Reported By:		
Subdivision:		
Date of Disturbance:		
Corrective Action Required?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Location:

Milepost:		to	
Track No.			
Rail:	<input type="checkbox"/> North	or	<input type="checkbox"/> South

Temperatures:

Air Temperature (AT):		Rail Temperature (RT):	
-----------------------	--	------------------------	--

Type of Adjustment/Disturbance:

<input type="checkbox"/>	Rail Installed:	Length(ft):		<input type="checkbox"/>	Ties Installed
<input type="checkbox"/>	Destressing Performed:	Length(ft):		<input type="checkbox"/>	Realignment of Curve
<input type="checkbox"/>	Track Panel(s) Installed:	Length(ft):		<input type="checkbox"/>	Undercutting
<input type="checkbox"/>	Road Crossing Installed:	Length(ft):		<input type="checkbox"/>	Washout
<input type="checkbox"/>	Surfacing of Track:	Inches of Lift:		<input type="checkbox"/>	Buckled Track
<input type="checkbox"/>	Turnout Installed			<input type="checkbox"/>	Pull-Apart
<input type="checkbox"/>	Other:				

Corrective Action:

Rail Temperature (RT):		Distance between Spanning Marks Before Adjustment (in):	
Adjusted Rail Temperature (ART):			
Amount of Rail Expansion (in):		Distance between Spanning Marks After Adjustment (in):	

Description:

--

CWR Joint Bar Fracture Report								
 METROLINK		Type of Inspection						
		<input type="checkbox"/>	Periodic Joint Inspection (213.233)[g][5][i]					
		<input type="checkbox"/>	Track Inspection (213.33)					
		<input type="checkbox"/>	Turnout Inspection (213.235)					
		<input type="checkbox"/>	Other Inspection:					
Railroad:	SCRRRA	Subdivision:			Milepost:			
Date Found:		Annual MGT:		Track #		Track Class:		
<input type="checkbox"/>	Tangent		Rail Section(s):	/				
<input type="checkbox"/>	Curve/Spiral	Curve:	Low/Inner	Degree:		High/Outer Rail		
Annual Joint Inspection Frequency For This Segment:			1x,2x,3x,4x	Other:				
Bar Type:		Number of Holes:		Date of Last Joint Inspection:				
Field Side Bar				Gage Side Bar				
Broken Through				Broken Through				
Location of Break:		Location of Break:						
Other:				Other:				
Cracked: Check Location(s) and Record Length(s)				Cracked: (Check Location(s) and Record Length(s))				
<input type="checkbox"/>	Top Center		inches	<input type="checkbox"/>	Top Center		inches	
<input type="checkbox"/>	Bottom Center		inches	<input type="checkbox"/>	Bottom Center		inches	
<input type="checkbox"/>	Inner Bolt Hole		inches	<input type="checkbox"/>	Inner Bolt Hole		inches	
<input type="checkbox"/>	Other:		inches	<input type="checkbox"/>	Other		inches	
	Defect	Rail	Rail End					
<input type="checkbox"/>	Rail End Batter	N/S	E/W		inches high		inches long	
<input type="checkbox"/>	Ramp	N/S	E/W		inches out		inches long	
Gap Between Rail Ends:		inches						
Tread Mismatch		inches		Joint Vertical Movement		inches		
If Joint is in Curve or Spiral:								
Gage Ramp:		inches out				inches long		
Gage Mismatch:		inches						
Joint Lateral Movement:		inches						
Other Comments								



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CWR Joint Inventory Report

Reported By:	
Report Date:	

Location:

Subdivision:			
Milepost:		to	

Inventory List

RECORD OF RAIL INSTALLATION TEMPERATURES

Date	Mile Post	Sub-division	Track No.	Rail N/S	String No. & Length	Air Temp.	Rail Temp.	Adjusted Rail Temp.	Weather / Time	Calculated Expansion	Actual Expansion

Submitted by: _____

Description: _____

Instructions:

Date: Date when rail was laid.

Rail – N/S: North or South rail, as defined by the timetable direction.

String No.: Number the strings beginning with #1 and continuing in succession with each string laid in the course of a day. Each day the crew should start the numbering with #1. Indicate length of each string.

Air Temp.: Air temperature in degrees Fahrenheit taken at the same time the rail temperature is taken.

Rail Temp.: Actual rail temperature in degrees Fahrenheit taken prior to heating.

Adjusted Rail Temp.: The temperature the rail was adjusted to at time of installation.

Weather/Time: Weather conditions and time when the air temperature and rail temperature are taken.

Calculated Expansion: Expansion required to adjust rail to the PRLT, obtained from the thermal expansion formula or CWR Movement Chart.

Actual Expansion: Actual expansion achieved for rail installed.

Description: Notes about special items (i.e. weather, mile post locations, etc.)

Distribution: Deliver completed forms to SCRRRA for filing by milepost order for each subdivision.



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Semi-Annual Curve Inspection Report

Date:	
PLAN Date	

For the		Curve Program
Subdivision:		

**METROLINK®****RETURN TO SERVICE REPORT**

Inspection is required to restore track to service following any significant work/outage. All involved parties (Contractor, SCRRA, Inspector, Signal) shall inspect and verify conditions. Inspectors shall be trained and qualified under applicable SCRRA rules and regulations and shall be familiar with the scope and progress of the work involved.

Reason for Outage					
Description of Work					
Date/Time:			Weather/Temperature:		
Location (Station & Milepost)	Track Number/Name		Timetable Speed	Current Speed	
Condition/Remarks	Corrective Action Taken				
Track is acceptable for return to service	Yes	No	N/A	Print Name & Date	Signature
Employee in Charge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Contractor (Track)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
SCRRA (Track)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Inspector (Track)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Contractor (Signal)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
SCRRA (Signal)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Inspector (Signal)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

Track Conditions			Corridor Conditions		Stations	Bridges
Rail	Ties	Fasteners	Excavation	Signals	Crossings	Piles/Caps
Alignment	Gauge	Turnouts	Shoring	Crossings	Platforms	Substructure
Surface	Anchors	Crossings	Footing	Clearance	Walkways	Superstructure
Joints	Spikes	Bolts	Falsework	Drainage	Clearance	Ballast Retainers



METROLINK®

Turnout Inspection Report Form

(SCRRA Copy)

Subdivision		Size			
Mile Post		Weight		Year	
Track		Hand or Power			
Class		LH or RH			



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Quarterly Turnout and Derail Inspection Report

**Inspector's Signature
(Name and Date)**



METROLINK.

Southern California Regional Rail Authority
Track and Signal Joint Switch Inspection

Date:

Location:

Subdivision:	
Milepost:	
Track No.	

Inspection(s) Performed:

<input type="checkbox"/> Monthly Signal Inspection	<input type="checkbox"/> Cross-level / Track Gage
<input type="checkbox"/> Monthly Track Inspection	<input type="checkbox"/> Track Surface (Is Switch Pumping)
<input type="checkbox"/> Inspect Insulated Joints	<input type="checkbox"/> Hand Throw Operation
<input type="checkbox"/> Inspect rods and Insulation on rods	<input type="checkbox"/> Inspect Switch Machine Housing and Wedges
<input type="checkbox"/> Universal Plate	<input type="checkbox"/> Check Switch Locks
<input type="checkbox"/> Adjustments - Check	<input type="checkbox"/> Cotter Pins Nut, bolts and keepers
<input type="checkbox"/> Rollers	<input type="checkbox"/> Inspect Ties
<input type="checkbox"/> Points and Point Fit	<input type="checkbox"/> Inspect Cranks and Helper Rods
<input type="checkbox"/> Bonding / Fouling	<input type="checkbox"/> Lubrication

Comments:

--

Track Representative

Signal Representative

Title

Title

METROLINK



FROG WELDING REPAIR REPORT

Date: _____

Welder's Name: _____

Print

Subdivision: _____

Mile Post: _____

Control Point: _____

Track Designation: _____

Frog Size: _____

Frog Type: _____

Frog Year: _____

Rail Weight: _____

Direction (RH, LH, EH): _____

Date of Repair: _____

Type of Weld Repair: _____

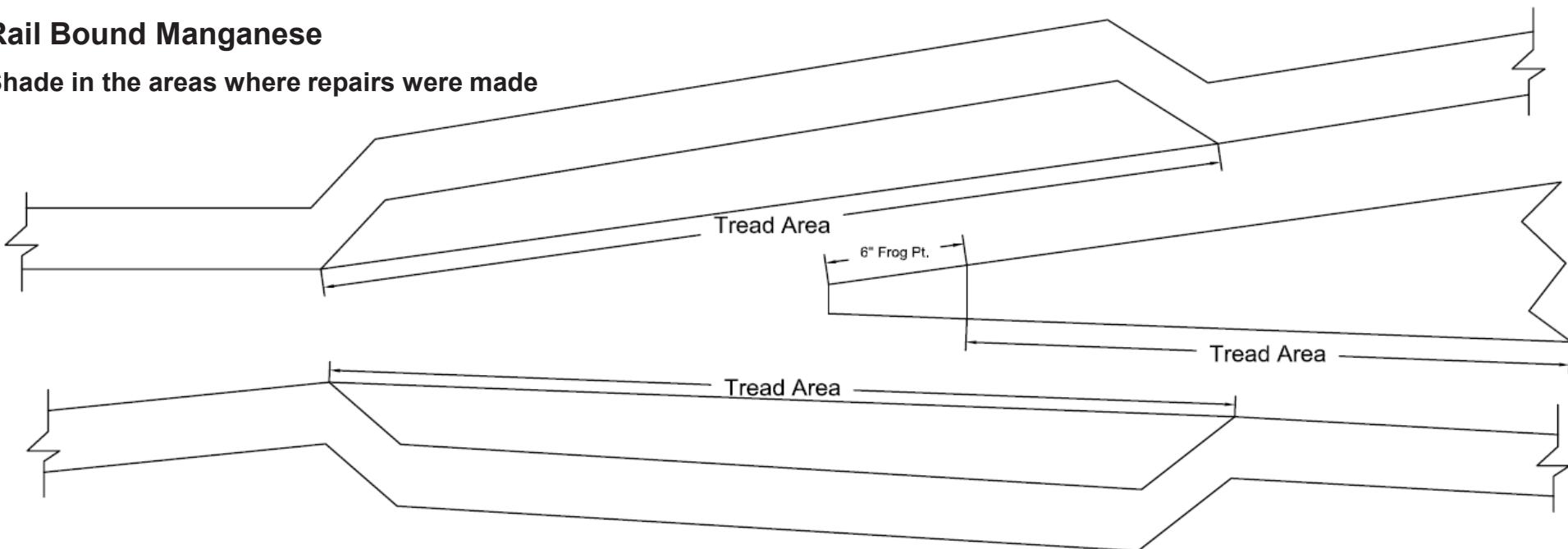
Guard Check: _____

Guard Face: _____

Comments: _____

Rail Bound Manganese

Shade in the areas where repairs were made



Welder's Signature: _____

Sign

Note: Frog Welding Repair Reports **MUST** be turned in DAILY



THERMITE WELD INFORMATION REPORT

	1	2	3	4	5
SUBDIVISION					
MILE POST					
WELD NUMBER					
DATE (MM/DD/YR)	/ /	/ /	/ /	/ /	/ /
TIME WELD WAS MADE					
TRACK ID. #1,#2, OTHER					
TRACK SIDE (NORTH/SOUTH)					
RAIL SIZE					
WELD MANUFACTURER	ORGOTHERMIT	ORGOTHERMIT	ORGOTHERMIT	ORGOTHERMIT	ORGOTHERMIT
PRE-HEAT TYPE (OXY/AIR)					
WELD GAP					
TAP TIME					
AIR AND RAIL TEMPERATURE					
WELDERS					
1 PLACE WELD CHARGE STICKER HERE-	2 PLACE WELD CHARGE STICKER HERE				
3 PLACE WELD CHARGE STICKER HERE	4 PLACE WELD CHARGE STICKER HERE				
5 PLACE WELD CHARGE STICKER HERE	COMMENTS _____ _____ _____ _____				

Welder: _____

Turn the original Thermite Weld Information Report into the Office daily and retain a copy for your records.



FRA TRACK INSPECTION REPORT (CRITICAL CONDITIONS)

SYSTEM	SUBDIVISION	TRACK DESIGNATION	DATE
SCRAA			
TRAVELING DIRECTION	CLASS	STARTING M.P.	ENDING M.P.

NOTES:

INSPECTED BY:

TITLE:

SIGNATURE:



URGENT DEFECTS REPORT(SCHEDULED FOR MAINTENANCE)

METROLINK

SYSTEM	SUBDIVISION	TRACK DESIGNATION	DATE
SCRRA			
TRAVELING DIRECTION	CLASS	STARTING M.P.	ENDING M.P.

NOTES:

INSPECTED BY:

TITLE:

SIGNATURE:



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Note: Use different sheet for each Subdivision

Monthly Yard Track Inspection Form

Subdivision	Track Name	Date Inspected	Defect(s) Found	MP	Remedial Action	Comments

Inspected By: _____ Print Name _____

Inspected By

Title:



Hi-Rail Inspection Checklist

Year		Month		Vehicle No.		Driver		Subdivision	
Date	Vehicle Mileage	Daily Vehicle Inspections				Daily Hi-Rail Inspections			
		Engine/Transmission		Vehicle		Inspection Details		Inspection Details	
		Oil Added or Changed	Coolant Added or Changed	Transmission Oil Added or Changed		Inspect Overall Condition of Vehicle	Inspect Tires for Changes in Inflation, Cupping or Any Physical Damage	Verify Equal Side-to-Side Loading of Tools & Equipment in Passenger & Cargo Area	Inspect Overall Condition of Hi-Rail Gear, Brackets, Weldments, Lock Pins, etc.
1		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31		Y / N	Y / N	Y / N		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Notes:

1. If deviations exist from above guidelines, refer to the Operators Manual for corrective action.
2. Vehicle alignment recommended every 6 months
3. Assure the hi-rail operator, maintenance, and parts manual is in the vehicle at all time for reference information.



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Rail Lubricator Inspection Form



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Geometry Car Critical (Red Tag) Corrective Action Form

Subdivision: _____

Track Inspector: _____

Date Of Test: _____

Test Car: _____

RED TAGS MUST BE INSPECTED WITHIN 24 HOURS OF DISCOVERY

NO.	RED TAG NUMBER	TRACK	MILE POST / LOCATION	DEFECT TYPE	REMEDIAL ACTION	ACTUAL FIELD MEASUREMENTS	CORRECTIVE ACTION DATE	INITIALS OF PERSON PERFORMING CORRECTIONS
1								
	CORRECTIVE ACTION PERFORMED:							
2								
	CORRECTIVE ACTION PERFORMED:							
3								
	CORRECTIVE ACTION PERFORMED:							
4								
	CORRECTIVE ACTION PERFORMED:							
5								
	CORRECTIVE ACTION PERFORMED:							

GEOMETRY CAR OPERATION: The Track Geometry Car shall produce on-car printouts of exceptions found with priority designations. Critical defects shall be checked as soon as possible, not to exceed 24 hours, and immediate action taken to repair or protect with appropriate slow order. After correction is made, report shall be submitted to the Manager, Track and Structures Maintenance. The office of the Manager, Track and Structures Maintenance, will update the computer log of Critical repairs. On Class 4 track and above.

INSPECTORS SIGNATURE _____

NOTE: Geometry Car Critical (Red Tag) Corrective Action Form **Must** Be Turn In Together with the Geometry Car Exception Report Immediately Upon Completion Of All Corrective Actions Performed.



METROLINK

Geometry Car Urgent (Yellow Tag) Corrective Action Form

Subdivision: _____

Track Inspector: _____

Date Of Test: _____

Test Car: _____

YELLOW TAGS DEFECTS SHALL BE CHECKED AS SOON AS POSSIBLE NOT TO EXCEED 7 DAYS

NO.	RED TAG NUMBER	TRACK	MILE POST / LOCATION	DEFECT TYPE	REMEDIAL ACTION	ACTUAL FIELD MEASUREMENTS	CORRECTIVE ACTION DATE	INITIALS OF PERSON PERFORMING CORRECTIONS
1								
CORRECTIVE ACTION PERFORMED:								
2								
CORRECTIVE ACTION PERFORMED:								
3								
CORRECTIVE ACTION PERFORMED:								
4								
CORRECTIVE ACTION PERFORMED:								
5								
CORRECTIVE ACTION PERFORMED:								

GEOMETRY CAR OPERATION: Urgent (Yellow Tag) defects trackage shall be checked as soon as possible, not to exceed seven days, and repairs shall be completed within 90 days. Provide continued spot inspections until repaired or provide slow order protection. All other priority items shall be repaired on a timely basis. The Track Geometry Car data should be utilized as a guide for planning corrective maintenance programs.

INSPECTORS SIGNATURE _____

NOTE: Geometry Car Urgent (Yellow Tag) Corrective Action Form **Must** Be Turn In Together with the Geometry Car Exception Report Immediately Upon Completion Of All Corrective Actions Performed.



METROLINK®

HEAT RUN/ UNUSUAL OCCURRENCE REPORT

Forward Reports to: track&structures@scrra.net

Inspector:				Date:			Time:			
Subdivision:				Temperature:			Weather Conditions:			
Milepost:		to		Notified By:			Time:			
Inspection Type (Mark All That Apply):										
	Bridge		Structure		Hot Weather		Earthquake		Accident:	
	Culvert		Rail Defect		Storm		Tsunami		Other:	

Description: _____

Inspector Signature:

Date and Time Inspection Completed:

Appendix D

Derailment Response and Analysis – Track Inspection Team



Derailment Response and Analysis – Track Inspection Team

1.0 Introduction

This procedure provides guidance to respond to and perform an investigation of the track conditions after a derailment. This will assist investigators in establishing the cause(s) of derailments on the Metrolink system.

The requirements for overall site management, incident coordination, site safety, environmental management, safe working and matters relating to emergency services are not addressed in this section.

Safety will be the primary concern when managing a derailment scene while root cause and rerailed procedures are in progress. A major component of creating a safe working environment is establishing effective communication between department entities.

2.0 Coordination

The Employee in Charge must coordinate track releases with the Railroad Incident Commander (RR-IC). The RR-IC will handle all communications with civil authorities, the track department, mechanical personnel, operations managers and train crew members involved in an incident response and investigation.

At the completion of site restoration, coordinate with all departments on Post Incident Review and Root Cause. The goal is to find root cause based off the facts of the derailment and evidence collected on scene.

3.0 Instructions for Derailment Investigation and Post Derailment Track Geometry Measurement

Use the following procedures for investigating and documenting derailments.

It is important to remember that a derailment under investigation is not complete until it is officially closed out. Avoid rushing to judgements / conclusions about the derailment.

Service failed tools or material associated with the derailment cause is to be safeguarded and preserved for potential analysis.

Advanced Preparation

The following list of items will help document derailment information:

1. Paper/pad & pencil/pen to document site information, perform site sketch, and document other information
2. Digital Camera. Detailed photographs of post-derailment site layout, cars / car numbers, marks on rail, marks on wheels, etc.
3. Hand held GPS unit
4. Measurement tape (25', 50-100') & Measuring wheel
5. Metal marker or lumber crayon
6. Level board & String line
7. Small brass brush
8. Flash light or lantern
9. Rail profile gauge
10. Track measurement form and instructions

Paperwork to assist in the investigation

1. Timetable
2. Track charts
3. Track maintenance manual
4. FRA – TSS Part 213
5. Derailment cause finding & prevention participation book
6. Last geometry car defect and movement report
7. Last ultrasonic detector car defect and movement report
8. Recent track inspection reports
9. Recent track maintenance reports

Arrival at Derailment Site

1. Get a Job Briefing (or conduct one) – Know the On Track Safety, including Time, Limits, and EIC.
2. Is the site secure? Is the track officially out of service with the dispatcher or inaccessible (uncontrolled)
3. Identify risks: HAZ mat (hazardous or flammable material), shifting cars, loads, rail movement (especially when cut or under tension); moving equipment, derailment contractor operations, adjacent tracks, water ways or other environmentally sensitive areas, elevated structures, public, wildlife, etc.
4. Document list of on-site personnel and establish communication procedures with the EIC
5. Identify who the point of contact is for official updates and establish check in schedules for re-briefings
6. Copy train information and details, obtain copy of train manifest, document symbol, direction, speed, braking, etc
7. Interview the crew
8. Work with operating managers to secure TIR from locomotives potentially involved in the derailment and any locomotives which may have passed adjacent to the derailed train prior or during derailment.
9. Find and document location (GPS) and mark rail where lead locomotive stopped. Wheel off distance from that location to any reference distance from the TIR (point train went into emergency, etc)
10. Take photos and sketch the scene, including mileposts, GPS, identifiable features such as road crossings, switches, position of cars with car numbers
11. Depending on the severity of the derailment, consider deploying a UAV to gather photographs and video footage of the derailment site.
12. Document all track information. Speed, curve characteristics, grade, etc
13. Find and document the rail information; weight, alloy, manufacturer, date of rail fabrication, date rail was laid, etc
14. Note any thermite welds, in-track welds and any special track work
15. Locate and document fixed structures including MPs, GPS, and points of reference
16. Identify who will perform track measurements as well as car measurements

Inspection

1. Before inspecting the train, ensure that the train and cars are properly secured. Start with locomotives and cars that are still on the rail. Inspect both sides of the train prior to moving the cars that are not derailed.
2. Inspect wheels for wear (broken or cracked wheels, hollow treads, tread buildup, sharp flanges, flat spots, etc)
3. Are there marks on the wheels ahead of the POD towards the front of the train? Look for marks on the flanges and / or wheel tread. Document and photograph any such marks. Marks which are angular or transverse to tread could indicate that the wheels impacted something on the rail or traversed a gap or broken rail. Other marks could indicate wheels derailed, then re-railed at some point
4. When there are marks, how far do they extend towards the front of the train?
5. Which side or sides?
6. Are the marks on the gage or field side?
7. How are the cars positioned? Are they accordion-style? Is there evidence of string line? Are they piled up in a catastrophic manner? Such may indicate a broken rail or broken wheel.

Inspect locomotives and cars

1. Car end: Couplers, draft sills, coupler carriers, draft gears (knuckle and draw bar area), truck alignment, center bowls, hoses and brake rigging
2. Truck: Side frames, bolsters, springs, side bearings (roller / constant contact), wedges
3. Center sill, side sills, doors, and top cords
4. Copy down information on the first derailed car: Car number, car end, wheel set, car side, MP and GPS



Track Inspection

1. Inspect track ahead of train, looking for any evidence the previous train damaged the track
2. Inspect track between derailed equipment and equipment still on the rail
3. Look for damage to rail(s), ties, broken or marked bolts and fasteners, or broken welds or rail
(When these are present, it may be an indication of cars down or buckled; dragging equipment, or damage from a previous train). Observe ties, spikes and fasteners before and after POD
4. What does the track and surface look like? Look for obvious locations where there may be gage and surface issues. Photograph conditions whether there are signs of such deviations or not.
5. Observe rail surface (crushed heads, head checking, shelling, etc) or worn rail
6. When track is still intact, walk towards the rear and inspect all track
7. Identify the first POD
8. Ensure track measurements are taken and documented, both loaded and unloaded
9. When “wheel climb” over rail is found, take photos of location where wheel went down
10. Then document where the wheel first climbed, measure and photograph distance / marks in between
11. Which direction did the wheel climb off referencing the direction of travel?
12. Are impacts or shiny marks present before the POD?
 - 12.1. Nicks, dents, or rail bent? Is a detector car needed?
13. Marks on the rail base?
14. Are marks on top of the rail, plates, ties? Distance between marks?
 - 14.1. Are marks indicative of impact like a broken wheel?
 - 14.2. Are marks indicative of sliding or equipment dragging?
 - 14.3. Marks parallel or perpendicular to the track?
15. Is there a broken rail?
 - 15.1. Take pictures of every fracture face (use a brass brush to clean rail ends of dirt and debris)
 - 15.2. Safeguard and label all pieces of the broken rail
 - 15.3. Just because there is a broken rail does not mean that the broken rail is the cause of the derailment. Likewise, presence of broken wheel does not necessarily indicate a definitive cause
 - 15.4. Is there leaving or receiving end batter or both on the broken rail?
 - 15.5. Document distance from the broken rail to any identifiable landmarks (field welds, road crossings, switch points, MP stenciling etc.)
 - 15.6. Are there any visible rail defects?
 - 15.7. Be prepared to have a detector car professional review the last DC car tapes
16. Are there broken joint bars?
17. Did the wheel climb or fall in?
18. Reference most recent geometry car defect reports, detector car defect reports and track inspection defect reports
19. Reference recent maintenance activity
20. Evidence of track buckle?
21. Any ballast or subgrade issues?



POD and Track Measurement Procedures

POD – What is the Point of Derailment (POD)? This is the location where the rail / wheel interface was first interrupted. In other words, this is the location where the wheels first left contact with the rail. There may be marks on top of the rail where the wheel tread traveled back and forth between both rails and marks on top of the rail where the wheel flange rolled over the rail towards the field side. Another indication of where wheels hit the ground is: marks on spikes, plates, fasteners, or ties. This location is critical and must be documented

- After identifying the Point of Derailment (POD), track measurements should be taken in conjunction with all mainline and siding geometry, Lateral over Vertical forces L/V or unknown caused derailments as part of the investigation process.
- Measurements taken must indicate the condition of the track prior to repairs being made.
- All references made to left or right rail are determined by facing in the direction the derailed train was traveling.
- Record all measurements in inches to the nearest 1/16".
- All evident lateral and vertical rail movement is to be added to all measurements taken on unloaded track.
- Record crosslevel in respect to the amount the left hand rail is above (+) or below (-) the right hand rail.
- Record crosslevel measurements under load of engine or other equipment when swinging or improperly tamped ties are noted within the limits where measurements are taken.
- Pictures shall be taken at each station in the direction of movement and included with the Derailment Investigation Report. Label each picture by the station name and direction taken.



Derailment Data Checklist

Item Number	Data Information Description		Comments
1	Location:		
	Track Number:		
2	Last Inspection Date:		
3	Inspection Frequency:		
4	Defects noted during the Inspection:		
5	Inspector's Name:		
6	Inspector's years of Inspection Experience:		
7	Last D-Car Date:		
	Type of Defects		
8	Last Geo Car/Truck Date:		
	Type of Defects:		
9	Curve / Tangent / Turnout:	Curve/Tangent/Turnout	
10	Rail Size:		
	Rail Condition:		
11	Tie Condition:		
12	Ballast Condition:		
13	Turnout Size:		
14	Turnout involved Knife or Undercut Switch Points:		
15	Turnout Switch Point Condition and Wear Measurements:		
16	Last Work Performed in the Area:		
17	Signs of a Pre-Existing Condition:	<input type="checkbox"/>	
18	Track Measurement Notes:	<input type="checkbox"/>	
19	Pictures of POD:	<input type="checkbox"/>	
Inspector Signature:			

 METROLINK.	
Instructions for Post Derailment Track Geometry Measurement	
Completion of Post Derailment Track Geometry Measurement	
Column 1:	Mark 15 stations at 15.5' intervals for 232.5' prior to point of derailment (POD). Mark 5 stations at 15.5' intervals for 77.5' behind the point of derailment.
Column 2:	References the accumulative distance in feet at each station prior to and behind the point of derailment
Column 3:	When a joint exists on the left rail between stations, record the number of feet the joint is away from the lowest numbered station it falls between. Leave blank if no joint exists.
Column 4:	When a joint exists on the right rail between stations, record the number of feet the joint is away from the lowest numbered station it falls between. Leave blank if no joint exists.
Column 5:	Record track alignment measurements at the midordinate offset of a 62' chord at each station, e.g. (1"= 1 degree).
Column 6:	Record track gage at the station. If joint exists exactly at the station, leave blank and record measurement in column 7 or 8 as applicable, on the same row as the station number.
Column 7:	Record track gage at the joint location denoted in column 3. If joint exists on the left rail exactly at the station, record the measurement in column 7, on the same row as the station number. Leave blank if no joint exists.
Column 8:	Record track gage at the joint location denoted in column 4. If joint exists on the right rail exactly at the station, record the measurement in column 8, on the same row as the station number. Leave blank if no joint exists.
Column 9:	Record unloaded crosslevel at the station. If joint exists exactly at the station, leave blank and record the measurement in column 16 or 11 as applicable, on the same row as the station number.
Column 10:	Record unloaded crosslevel at the joint location denoted in column 3. If joint exists on the left rail exactly at the station, record the measurement in column 10, on the same row as the station number. Leave blank if no joint exists.
Column 11:	Record unloaded crosslevel at the joint location denoted in column 4. If joint exists on the right rail exactly at the station, record the measurement in column 11, on the same row as the station number. Leave blank if no joint exists.
Column 12:	Record loaded crosslevel at the station. If joint exists exactly at the station, leave blank and record the measurement in column 13 or 14 as applicable, on the same row as the station number.
Column 13:	Record loaded crosslevel at the joint location denoted in column 3. If joint exists on the left rail exactly at the station, record the measurement in column 13, on the same row as the station number. Leave blank if no joint exists.
Column 14:	Record loaded crosslevel at the joint location denoted in column 4. If joint exists on the right rail exactly at the station, record the measurement in column 14, on the same row as the station number. Leave blank if no joint exists.
Column 15:	Record the profile on the left rail, which is the deviation from uniform profile at the mid ordinate of a 62' chord. Note: To only be used when there is profile present.
Column 16:	Record the profile on the right rail, which is the deviation from uniform profile at the mid ordinate of a 62' chord. Note: To only be used when there is profile present.
Column 17:	Automatically calculates the loaded 62' Warp. Note: This is the difference in crosslevel between any two points less than 62' apart.
Column 18:	Automatically calculates the loaded 31' Twist (Spirals only).
Column 19:	Record descriptive characteristics of track that are present at locations where measurements are recorded, e.g. turnouts, road crossings, insulated joints, spirals, full body, etc.

Derailment Form Example

Incident Date	Time	Train Symbol	Lead Unit No.	Nearest Station	Milepost	Subdivision	Posted Speed	Rail Weight	Rail Type	Measurements taken by (Name and Title)									
1/8/2004	9:45 PM	MWCFW06	UP 4156	Aledo, TX	263.7	Baird	60 (S/O 40)	115	X jointed	Date	A. B. Smith-MTM								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Station		*Plus Feet To	*Plus Feet to	Alignment		Track Gage Measured at				Unloaded Crosslevel Measured at				Loaded Crosslevel Measured at		Loaded Profile		Calculated	
No.	Feet from POD	Joint (left rail)	Joint(right rail)	Midordinate at 62'	Chord	Station	*Joint (left rail)	*Joint (right rail)	Station	*Joint (left rail)	*Joint (right rail)	Station	*Joint (left rail)	*Joint (right rail)	left rail profile	right rail profile	Loaded Warp 62'	Calculated	
5	15	232.5		- 1/8	56 1/4				- 1/16			0			0	1/4	1/4	1/4	Comments
14	217			1/16	56 3/8				0			0			- 1/8	- 1/4	1/4	1/4	
13	201.5			0	56 1/4				- 1/8			- 1/4			0	0	1/4	3/16	
12	186			0	56 3/8				0			- 1/16			0	0	1/4	1/8	
11	170.5			0	56 3/8				- 1/8			- 1/8			0	0	3/16	3/16	
10	155			0	56 3/8				0			3/16			- 1/8	- 1/4	1/4	3/16	
9	139.5			0	56 3/8				- 1/8			0			0	1/4	1/4	1/4	
8	124			0	56 7/16				- 1/8			- 1/8			- 1/8	0	3/8	3/16	
7	108.5			0	56 7/16				- 7/16			- 1/4			0	0	1/2	3/8	
6	93			1/8	56 7/16				- 1/16			- 1/16			0	0	1/2	5/16	
5	77.5			- 1/2	56 1/2				0			1/8			0	0	5/16	1/4	
4	62			0	56 5/8				3/8			1/4			- 1/8	0	1	5/16	
3	46.5			1/8	56 1/2				- 1/8			0			4	0	1 7/16	1	
2	31			1/8	56 9/16				1/8			- 1/16			- 1/8	0	1 7/16	1 7/16	
	7			56 1/2					1/2			3/4							
1	15.5			5/8	56 5/8				3/4			15/16			0	0	1 7/16	7/16	
POD	0			5/8	56 1/4				1 3/8			1 3/8			- 1/8	- 1/4	1 3/4	1 3/8	
1	15.5			0	56 1/2				1 1/8			15/16			0	0	1 3/4	1 5/16	
2	31			0	56 1/2				- 1/8			0			0	0	1 5/16	3/8	
3	46.5			1/8	56 1/2				- 5/16			- 3/8			1/8	1/4	3/8	3/8	
4	62			- 1/4	56 1/2				0			0			0	- 1/4	3/8	1/8	
5	77.5			- 1/4	56 1/2				- 1/4			- 1/8			0	1/4	1/8	0	

Railroad Post Derailment Track Geometry Measurements

Incident Date	Time	Train Symbol	Lead Unit No.	Nearest Station	Milepost	Subdivision	Actual Train Speed	Rail Weight	Rail Type cwr jointed	Date	Measurements taken by (Name and Title)								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Station	Feet	*Plus Feet To	*Plus Feet to	Alignment	Track Gage Measured at			Unloaded Crosslevel Measured at			Loaded Crosslevel Measured at			Loaded Profile		Calculated	Calculated		
No.	from POD	Joint (left rail)	Joint(right rail)	Midordinate at 62' Chord	Station	*Joint (left rail)	*Joint (right rail)	Station	*Joint (left rail)	*Joint (right rail)	Station	*Joint (left rail)	*joint (right rail)	left rail profile	right rail profile	Loaded Warp 62'	Loaded 31' Twist (Spiral Only)	Comments	
15	232.5															0	0		
14	217															0	0		
13	201.5															0	0		
12	186															0	0		
11	170.5															0	0		
10	155															0	0		
9	139.5															0	0		
8	124															0	0		
7	108.5															0	0		
6	93															0	0		
5	77.5															0	0		
4	62															0	0		
3	46.5															0	0		
2	31															0	0		
1	15.5															0	0		
POD	0															0	0		
1	15.5															0	0		
2	31															0	0		
3	46.5															0	0		
4	62															0	0		
5	77.5															0	0		