

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Maintenance of Way Division

GREEN LINE – LIGHT RAIL TRANSIT

TRACK MAINTENANCE AND SAFETY STANDARDS

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INTRODUCTION

The LRT (Light Rail Transit) Track Maintenance and Safety Standards are published by the Maintenance of Way Division of the MBTA. They are published for the purpose of maintaining the rail facilities of the MBTA to a standard which will ensure the safety of the riding public and of the employees of the MBTA.

These Standards have been revised as noted in the Revision History and are supplemented by previously issued MBTA documents including the M.O.W. Division's Safety Rules, Flagging and Train Protection Policy, Right-of-Way Safety Rules, Power Switching Policy, MBTA General Rules and others.

The Director, Systemwide Maintenance and Improvements is responsible for the development of the Standards. Implementation of the Standards is the responsibility of the Superintendents, Supervisors and Forepersons of the Maintenance of Way Division.

Compliance with the Standards is the responsibility of every member of the M.O.W. Division. All personnel should familiarize themselves with the requirements of the Standards and conduct themselves accordingly.

HNTB
Rail Systems Group

December, 2002

GREEN LINE – LIGHT RAIL TRANSIT

TRACK MAINTENANCE AND SAFETY STANDARDS

REVISION HISTORY

Rev	Date	Details
1	July 1, 2003	In Section LRT213.53, the depth below top of rail plane at which gage (and gage side rail wear) is measured changed from 5/8” to 1/2”; minimum track gage maintenance threshold changed from 56-1/4” to 56-1/8” with the ability to operate trains through gage < 56-1/8” under stipulated supervisory oversight. In Section LRT213.114, the allowable vertical rail wear (treadwear) changed from 7/8” to 1/2”.
2	July 1, 2005	In Section LRT213.55, the maintenance thresholds for deviations from uniform horizontal alignment changed as follows: for 31’ chord measurements only, Green was 5/8” -- now < 5/8”; Yellow was 5/8” – 7/8” resulted in 30 mph speed restriction and 7/8” – 1-1/4” resulted in 20 mph speed restriction -- now 5/8” – 1-1/4” results in speed restriction of 20 miles per hour; Red was 1-1/4” resulted in speed restriction of 10 mph -- now > 1-1/4” results in speed restriction of 10 miles per hour.
3	July 15, 2008	In Section LRT213.2, formerly DTE Regulations changed to DPU Regulations. All other references to DTE within the Standards have been changed to DPU. In Section LRT213.53, the maximum gage limits have been revised as follows: for tangent track the Yellow threshold was 57-1/8”, now 57-1/4”; the Red threshold was 57-3/8”, now 57-1/2”; in curves <1000’ radius, the Yellow threshold was 57-3/8”, now 57-1/2”; the Red threshold was 57-5/8”, now 57-3/4”. Maximum gage limits for special trackwork have been revised correspondingly. The maximum allowable gage transition has been reduced from 5/8” in 31’ to 1/2” in 31’. Speed restrictions for exceptions to the gage transition criteria have been revised to reflect the changes made in Revision 2, 20 mph for >1/2” and 10 mph for >1”. Restricted speed references as Response Actions to Deviations exceeding Maintenance Thresholds for LRT213.63 Track Surface, LRT213.109 Crossties, LRT213.113 Defective Rails, LRT213.114 Rail Wear, LRT213.115 Rail End Mismatch, LRT213.116 Restraining Rail, LRT213.339 Girder Rail Gages and Flangeways and elsewhere have been revised from a percentage of normal operating speed to defined mph designations. In Section LRT213.109 Crossties, the minimum number of non-defective crossties per 39’ of track has been revised to correspond with the DPU Regulations. In Section LRT213.116 Restraining Rail, the Measurement Parameter language has been changed from Consecutive Broken Bolts to Consecutive Broken, Loose or Frozen Bolts. In Section LRT213.143 Frog Guard Check Gage, criteria have been revised to correct a calculation error. In Section LRT213.235 Switch Certification, criteria have been revised to quarterly inspections for revenue track turnouts and 3x/year for yard track turnouts. In Section LRT213.337 Girder Rail Special Trackwork, the distance below top of rail plane at which gage and sidewear measurements are taken was changed from 5/8” to 1/2”. Appendix A, Gage Maintenance Criteria for the Mattapan Line has been added. Appendix B, Commonwealth of Massachusetts Department of Public Utilities regulations CMR 151.11 Track Inspection and CMR 151.12 Track Maintenance, has been added.

MBTA

MAINTENANCE OF WAY DIVISION

LRT Track Safety and Maintenance Standards

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LRT213 – Track Maintenance and Safety Standards

PART A – GENERAL

LRT213.1 Scope.

This section prescribes minimum maintenance and safety requirements for transit railroad track on the MBTA's Green Line. The requirements prescribed in this section apply to specific track conditions existing in isolation. **Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements of this section, may require remedial action to provide for safe operations over the track.**

LRT213.2 DPU Regulations.

Inspection and maintenance of MBTA track is regulated by the Commonwealth of Massachusetts' Department of Public Utilities. The DPU is the designated state oversight agency pursuant to M.G.L. c. 161A 3(i) and 49 C.F.R. Part 659. Track inspection is described at 220 CMR 151.08; Track Inspection and 151.09; Track Maintenance. The DPU regulations will prescribe inspection and maintenance standards except as modified by the MBTA standards. The MBTA Track Maintenance Standards meet or exceed the DPU standards in every respect.

LRT213.3 Application.

The track maintenance and safety standards contained herein are designed to enable the operation of trains at the maximum safe speed for the track over which the trains are operating.

Trains may be operated safely at a lower speed than that posted based upon parameters given within the Standards. Certain track defects are categorized by severity thresholds identified within the Standards. Color-coded maintenance threshold limits are used to govern reaction to detected track defects.

GREEN coded track conditions are not exceptions to the MBTA Track Maintenance Standards and do not necessarily require immediate remedial action. GREEN coded conditions should be monitored for any deterioration which must be communicated to the responsible Section Foreman and/or Supervisor. Remedial action shall be scheduled before conditions can deteriorate further to the next level.

YELLOW coded track conditions have reached or are closely approaching the maintenance limit for train operation at normal posted speed. As such, YELLOW coded conditions are classified as track defects and remedial action should be scheduled for completion within a maximum of 30 days to correct the deficiency. Until such remedial action is taken, this level condition should be monitored on an ongoing basis to prevent deterioration to the next level.

RED coded track conditions are defects which generate speed restrictions (slow orders) and at the most severe level are grounds for removing effected track from service until repairs can be made. Supervisory notification of RED coded defects must be made immediately and remedial action scheduled for completion within 72 hours. These defects are by definition the highest repair priority.

The intent of the Standards is not to establish artificially rigid procedures governing track maintenance but rather to serve as guidelines for prudent track maintenance practice. These guidelines must be used in concert with proper exercise of judgment based upon experience and knowledge of service requirements.

The track maintenance guidelines are intended to apply to normal operating conditions. During maintenance activities or under temporary conditions, interim modifications of the Standards may be required and would be subject to existing site conditions.

LRT213.4 Track Maintenance Strategies

Certain track conditions and maintenance practices which would otherwise be perfectly acceptable should be avoided to the greatest extent possible on the Green Line. These conditions/practices have been implicated in past derailments in which vehicle and/or operator deficiencies were also involved.

A combination of track conditions, especially YELLOW coded conditions, can act in concert with operator error and/or vehicle malfunction to cause a derailment. This is especially true in special trackwork, where the overwhelming majority of derailments occur. Conditions such as negative superelevation, irregular track surface and/or alignment, abrupt gage transitions, non-uniform wheel restraint, poorly finished gage side welds and others which may create a dynamic imbalance in certain operating environments should be closely monitored.

When performing maintenance operations in LRT track, especially LRT track worn close to permissible limits through repeated normal use, a very important principle must be kept in mind. *Adjustments made to, or components replaced on one side of a switch or curve will have a direct and substantial effect on the opposite side of the switch or curve.* Care must be exercised to ensure that existing conditions are not put into an imbalanced state through well intentioned and well executed maintenance work. Imbalance of track conditions through maintenance of only one side of worn track leads to differential distribution of vehicle forces which may result in wheel climb, component failure and derailment.

Under certain circumstances, logistical constraints make it impossible to perform maintenance activities so that track conditions do not become imbalanced. In such circumstances, it is almost always preferable to work on the inside of the switch or curve first. Experience has shown that lateral wheel forces are far more successfully managed by restraint to the back of the inside wheel flange than at the gage corner of the outside wheel. One caution: when renewing rail and re-establishing proper wheel restraint on the inside of curves, be sure that the outside wheel will not be “pulled off” the outside rail. This is particularly true where the outside gage face is worn. The use of test trains and speed restrictions is almost always warranted in cases of unavoidable imbalanced track conditions.

LRT213.5 Responsibility for Compliance with Track Maintenance Standards

Reported defects must receive prompt investigation and corrective action as required. Emergency conditions detected which constitute or should reasonably constitute an immediate safety hazard must be acted upon.

On occasion where the responsible M.O.W. Div. personnel knows or has responsible notice from other sources that a track condition is in violation of the Standards herein and the safe operation of trains is potentially jeopardized, the following steps must be taken:

1. Reduce the operating speed of trains to the level where track conditions are compliant with the Standards (REFER TO SMI SPECIAL ORDER #98-2 (in M.O.W. Division Book of Policies and Standard Operating Procedures) FOR INSTITUTING SPEED RESTRICTIONS AND ENSURE THAT PROPER NOTIFICATION FORM HAS BEEN FILLED OUT AS REQUIRED); or
2. Repair the track to support normal train operation; or
3. Stop train traffic over impacted track.

LRT213.6 Restricted Speed Rules.

Any track condition which may interfere with the safe operation or passage of trains is considered an “obstruction”. Protection shall be provided for any track which is obstructed or not considered safe for the passage of trains at the normal, posted operating speed. Protection shall be provided as outlined in SMI Special Order #98-2. Proper notification must be given using Restricted Operation Notification form found in the M.O.W. Division Book of Policies and Standard Operating Procedures. *It is critical that the M.O.W. person responsible for the placement of a restricted speed order remain at the scene until the appropriate speed signs are in place and/or a Subway Operations official has arrived on the scene to provide relief.*

The limit to which speed should be restricted due to defects and/or abnormal track conditions is indicated within the Standards.

LRT213.7 Designation of Personnel to Supervise Track Maintenance Activities and to Inspect Track.

The minimum qualifications required by Commonwealth of Massachusetts regulations of MoW personnel involved in the supervision of track maintenance activities and track inspections are contained in the DPU regulations under section 151.11 (4).

The MoW Division has its own published qualification standards for the experience, training, certification and periodic re-certification requirements for personnel involved with the inspection of MBTA tracks. Personnel meeting these qualification standards may be referred to within the Track Maintenance Standards as Qualified Persons to inspect track.

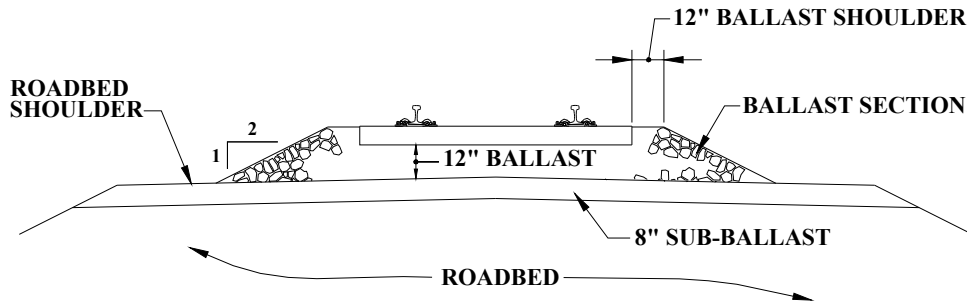
LRT213.13 Measuring Track Not Under Load (Manually).

When unloaded track (static condition) is measured to evaluate compliance with the requirements of these Standards, any apparent rail movement (both vertically and horizontally) must be added to the measurements of the unloaded track. The resulting product (dynamic condition) will be used to determine compliance with the Standards.

PART B – ROADBED

LRT213.31 Scope.

This section prescribes minimum requirements for roadbed and areas immediately adjacent to roadbed. Roadbed consists of the area beneath the track structure which supports the track structure, absorbs loads transmitted from the track structure and is subject to the deteriorating effects of cyclical traffic loads.



Periodic maintenance is required to restore roadbed shoulders to their original configuration to ensure the roadbed drains properly and supports the loads transmitted to it by the track structure. Ditches need to be kept free of vegetation and debris. Unmaintained ditches lead to flooding conditions and destroy the integrity of the track structure.

LRT213.33 Drainage.

Proper drainage from the track structure is critical to the performance of the track structure. Improperly drained track becomes unstable and maintenance-intensive. Maintenance programs should be in place to keep all drainage facilities beneath and adjacent to the track free from obstructions and able to accommodate the expected water flow for the area served by the drainage facilities.

Within tunnels and/or subway structures, defects which result in water falling onto track components should be repaired as soon as possible. Water must be diverted to a drainage system or the leak sealed.

LRT213.37 Vegetation.

Vegetation on MBTA property which is within or immediately adjacent to the track area must be controlled. Vegetation is a deterrent to drainage and causes a wide range of problems within the right-of-way. Some consequences of failure to control vegetation are:

- (a) Fouled roadbed and ballast sections from roots and vines.
- (b) Fire hazard, especially in dry weather or in the autumn.
- (c) Obstructed visibility with respect to wayside signals, speed signs, etc.
- (d) Safety hazard due to line-of-sight interference for operating personnel.
- (e) Interference to employees performing track, power or signal duties.
- (f) Improper functioning of signal and communication equipment.

PART C – TRACK GEOMETRY

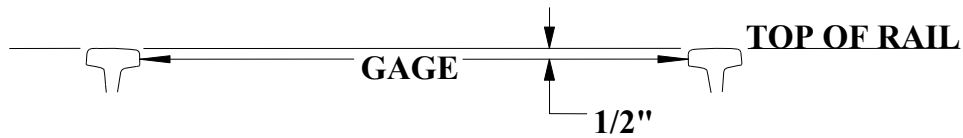
LRT213.51 Scope.

This section prescribes requirements for the maintenance limits for track gage, track alignment, track surface, track crosslevel, spiral track geometry, clearances and speed limitation in curved track.

LRT213.53 Gage.

For Tee Rail Sections Only (85 ASCE and 115 RE)

For LRT track (Green Line), gage is measured between the heads of the rails at right angles to the rails in a plane one half of an inch (1/2") below the tops of the rail heads.



GAGE MEASUREMENT FOR LRT TRACK

When measuring track gage, the gage dimension is the *total* of the actual distance measured plus any apparent rail movement caused by train loading and/or any sidewear to the rail(s). As gage is measured 1/2" below the tops of the rail heads, sidewear to the rails is also measured 1/2" below the tops of the rail heads.

<p>Minimum track gage in LRT track is 56-1/8" (loaded condition). Train operation over track at gage less than 56-1/8" may be manually supervised (walked through) at the discretion of the M.O.W. Line Supervisor or Superintendent on site, based on their observations of train performance and their assessment of operational safety.</p>				
<p>MAXIMUM GAGE LIMITS FOR LRT TEE RAIL TRACK</p> <p>THIS CRITERIA DOES NOT APPLY TO MATTAPAN TROLLEY TRACK (Refer to Appendix A for Gage Maintenance Criteria for Mattapan Line track)</p>				
Track Configuration	Design Gage	Maintenance Threshold Limits		
		Green	Yellow	Red
Tangent and curves greater than or equal to 1000'R	56-1/2"	56-7/8"	57-1/4"	57-1/2"
		Monitor conditions	Restrict speed to 20 mph. Repair within 30 days.	Restrict speed to 6 mph. Repair within 72 hours.
Curves less than 1000'R (excluding switches)	56-7/8"	57-1/8"	57-1/2"	57-3/4"
		Monitor conditions	Restrict speed to 20 mph. Repair within 30 days.	Restrict speed to 6 mph. Repair within 72 hours.

MAXIMUM GAGE LIMITS FOR LRT TEE RAIL TRACK (Continued)
Special Trackwork Criteria
(Minimum gage in LRT switches = 56-1/4" (straight side) and 56-1/2" (curved side))

Track Configuration	Design Gage	Maintenance Threshold Limits Response Actions		
		Green	Yellow	Red
Guarded switches over 100'R	56-7/8" curved side	57-1/8"	57-1/2"	57-3/4"
	56-1/2" straight side	57"	57-1/4"	57-1/2"
Guarded switches 100'R or less	57" curved side	Monitor conditions	Restrict speed to 10 mph. Repair before Red limit is reached.	Supervise Operations Through Switch until repairs completed.
	56-1/2" straight side			

Flangeway at cover guard to be 1-5/8"* (to gage line of double switch point thrown for straight move). Flangeway throughout rest of turnout to be 1-5/8" except one-piece guard rails opposite frogs that have flangeway of 1-3/8". Remedial flangeway work to be initiated at 1-7/8"** in turnouts. Refer to **LRT213.143** for guard check criteria.

* = Flangeway of 1-1/2" in turnouts 100'R or less. Flangeway may be reduced to 1-1/4" in special circumstances where wheel climb at outside switch point is an issue due to geometric design constraints of the turnout.

** = Remedial flangeway work to be initiated at 1-3/4" through cover guard and 1-7/8" throughout rest of turnout in turnouts 100'R or less. Where flangeway opening has been reduced below typical, remedial work is to be initiated at 1/4" greater than original flangeway opening.

Track Configuration	Design Gage	Maintenance Threshold Limits Response Actions		
		Green	Yellow	Red
Rail crossings (Diamonds) with curves equal to or less than 100'R*	56-3/4" curved.	57"	57-1/4"	57-1/2"
	56-1/2" straight	57"	57-1/4"	57-1/2"
Rail crossings (Diamonds) with curves greater than 100'R**	56-7/8" curved	Monitor conditions	Restrict speed to 10 mph. Repair before Red limit is reached.	Supervise operations through crossing until repairs completed
	56-1/2" straight			

* = Flangeways on curved side of crossing to be 1-1/2" throughout, both inside and out; Flangeways on straight side to be 1-3/8" throughout, both inside and out.

** = Flangeways on curved side of crossing to be 1-1/2" through frog castings inside rail, 1-5/8" through frog castings outside rail and 1-5/8" elsewhere, both inside and out.

Flangeways on straight side to be 1-3/8" throughout, both inside and out.

GAGE TRANSITIONS

Track Gage Maintenance

General Notes:

Transitions in track gage are used by design only in special trackwork, entering/leaving curved track with restraining rail and at joints where new rail is connected to old rail. At such joints, the old rail has gage face wear and/or has been ground to a 15° angle from vertical for compatibility with the modified Green Line flange profile. **Transitions in track gage shall be at the rate of 1/2" in no less than 31'**, except in special trackwork and when entering/leaving restrained curves, which shall be as shown in the Design Standards. **Transitions in track gage between 1/2"- 1" shall constitute YELLOW coded track conditions and transitions greater than 1" shall constitute RED coded track conditions.** YELLOW coded gage transitions exceptions shall be restricted at **20 mph** and repaired within 30 days. RED coded gage transition exceptions shall be restricted at **10 mph** and repaired within 72 hours.

Under ordinary conditions it will not be necessary to regage track if it is within limits indicated for the track in question and does not exceed standard for uniformity. Gage conditions exceeding the limits must be corrected immediately. A combination of marginal track conditions may mandate corrective action before the maintenance limit for any individual parameter is reached.

Permanent gage transitions between new and worn/ground rail may be accomplished by grinding the gage face of the new rail. At the joint, the new rail is ground to a 15° angle (from vertical) to match the worn/ground rail profile. The gage face angle should transition smoothly to vertical matching the profile of the new rail at the end of the transition. The gage corner must be rounded to match the profile of the rails and the modified wheel flange geometry. Rail is to be finish ground leaving no striations, burrs or other surface imperfections.

Temporary gage transitions shall be done at the rate of 0.25" per foot (max.). This may be done by welding and grinding the old rail or by grinding the new rail. The angle of the gage face must transition as described for permanent gage transitions. Due to the severity of transition in temporary applications, train speed must be restricted to 5 mph over the transition until a permanent repair is made.

Deteriorating track gage conditions not corrected until maintenance limits are reached will result in increasingly accelerated degradation of the track structure. Attention to deteriorating track gage conditions will result in longer-lived track and will in most cases prevent the need for critical repairs to maintain acceptable gage.

LRT213.54 Flangeway Width.

For Tee Rail Sections Only (85 ASCE and 115 RE)

Standard flangeway width for LRT track is 1-5/8". Flangeway widths in double restrained track are 1-1/2" both inner and outer. Refer to LRT213.53 for flangeway criteria in special trackwork. **Flangeway width opposite the frog on the straight side of tee rail turnouts is 1-3/8", on the curved side 1-5/8"**. Nominal flangeway depth through flange bearing special trackwork is 11/16". Maintenance Threshold Limits for flangeway width are shown below and at LRT213.116 except where modified for special trackwork in LRT213.53.

Flangeway maintenance typically involves adjustment of the flangeway width and/or replacement of broken spacer block assembly components, particularly bolts. **Maintenance Threshold Limits for standard flangeway width are: Green – 1-3/4", Yellow – 1-7/8" and Red – 2-1/8"; for double restrained track: Green – 1-5/8", Yellow – 1-3/4" and Red – 2"; for opposite frogs on the straight side of tee rail turnouts: Green – 1-1/2", Yellow – 1-5/8" and Red – 1-3/4"**. Maintenance Threshold Limits for design flangeway widths within special trackwork are given in LRT213.53. **Response Actions** upon reaching flangeway width Maintenance Threshold Limits are: **Yellow** – schedule work to re-establish proper flangeway width and **Red** – restrict speed to 10 mph, perform required work within 72 hours.

LRT213.55 Horizontal Track Alignment.

Definition: horizontal track alignment consists of a series of tangent (straight) lengths of track connected by curves. Curves are either simple (same radius throughout) or compound (different radii within the same curve). Spiral curves are used to connect simple curves to tangent track or a simple curve to another simple curve. Spiral curves provide a gradual transition between changes in track alignment and accommodate runoff of SE. This is done to allow vehicle (train) trucks (sets of wheels) to gradually rotate entering or leaving curves. Spiral curves both reduce rail/wheel wear and result in a smoother, safer ride.

LIMITS OF DEVIATION FROM UNIFORM HORIZONTAL TRACK ALIGNMENT											
Measurement Parameter for Tangent Track:						Measurement Parameter for Curved Track:					
The deviation at the middle of a						The deviation from the mid-ordinate of a					
31' Chord*			62' Chord*			31' Chord**			62' Chord**		
Maintenance Threshold						Maintenance Threshold					
Green	Yellow	Red	Green	Yellow	Red	Green	Yellow	Red	Green	Yellow	Red
5/8"	5/8" – 1-1/4"	1-1/4"	1"	1-1/2"	2-1/4"	5/8"	5/8"- 1-1/4"	1-1/4"	1"	1-1/2"	2-1/4"

Response Actions for exceptions to color-coded maintenance thresholds for horizontal track alignment:

Green: monitor conditions.

Yellow: restrict speed over track to 30 mph for alignment deviations between 5/8" and 7/8" in 31' chord, to 20 mph for alignment deviations between 7/8" and 1-1/4" in 31' chord and between 1-1/2" and 2-1/4" in 62' chord. Schedule repairs to be done within 30 days.

Red: restrict speed over track to 10 mph for alignment deviations greater than 1-1/4" in 31' chord or greater than 2-1/4" in 62' chord – make repairs within 72 hours.

Note: Train operation through line deviations exceeding the Red maintenance threshold may be manually supervised (walked through) at the discretion of the M.O.W. Line Supervisor or Superintendent on site based on their assessment of track fitness.

*The ends of the 31' and 62' chord shall be at points on the gage side of the line rail, 1/2" below the top of the rail head. Either rail may be used as the line rail provided that the same rail is used for the entire length of the tangent segment of track.

** The ends of the 31' and 62' chords shall be at points on the gage side of the outer rail (line rail on curves), 1/2" below the top of the rail head.

LRT213.57 Curves; Superelevation and Speed Limitations.

Definitions: *superelevation* (or elevation) is the amount the outer rail of a curve is raised above the inner rail. This is known as E_a or actual elevation. Its function is to counteract the effect of centrifugal force. *Equilibrium* (or balanced elevation) is the amount of superelevation in a curve which exactly counterbalances the effect of centrifugal force in that curve for the designated speed in the curve. This is known as E_e or equilibrium elevation. *Unbalanced* elevation is the amount of elevation less than that required to achieve equilibrium in a curve for the designated speed. This is known as E_u or unbalanced elevation. *Overbalanced* elevation is the amount of elevation more than that required to achieve equilibrium in a curve for the designed speed.

Actual elevation equals equilibrium elevation minus unbalanced elevation, if any, or $E_a = E_e - E_u$.

The maximum actual superelevation (Ea) on the outside rail of a curve may not be more than 6-1/2" throughout the system. The amount of unbalanced elevation (Eu) may not be more than 3". The outside rail of a curve may not be lower than the inside except as provided in **LRT213.63**. To calculate equilibrium elevation required for a given curve, use the following formula:

$$E_e = 4.011 \times V^2 / R$$

Where:

Ee = Superelevation (equilibrium elevation) in inches.

V = Speed (velocity) in miles per hour.

R = Radius of curve in feet.

Track surface, including superelevation, shall be maintained so that variations in profile, runoff and crosslevel do not exceed the limits in the table at **LRT213.63**. Immediate speed restriction and corrective action are necessary when the limits are exceeded.

LRT213.59 Elevation of Curved Track; Runoff.

Elevation occurring in a curve shall be provided uniformly throughout the curve unless physical conditions do not permit. If elevation runoff is required in a curve, the actual minimum elevation shall be used to compute the maximum allowable speed for that curve under **LRT213.57**. Elevation runoff shall be at a uniform rate, within the limits of track surface deviation under **LRT213.63**, and shall extend at least the full length of the spiral(s). If the length of spiral is limited by physical conditions, part of the SE runoff may occur on tangent track up to a limit of 1".

LRT213.63 Track Surface.

LIMITS OF DEVIATION FROM UNIFORM TRACK SURFACE			
Measurement Parameter	Maintenance Threshold		
	Green	Yellow	Red
Runoff in any 31' of rail at the end of a raise.	1-1/4"	1-1/2"	2-1/2"
Deviation from uniform profile on either rail at the mid-ordinate of a 62' chord.	1-5/8"	2"	2-1/2"
Variation in cross-level on spirals in any 31' maximum.	7/8"	1-1/8"	1-1/2"
Deviation from designated elevation on spirals.	7/8"	1"	1-1/4"
Deviation from zero crosslevel at any point on tangents or reverse crosslevel on curves.	1-1/8"	1-1/4"	1-7/8"
Difference in crosslevel between any two points less than 62' apart on tangents and on curves between spirals.	1-5/8"	1-3/4"	2-1/8"
Response Actions to Deviations			
Green	Yellow	Red	
Monitor conditions on an ongoing basis.	Restrict speed to 25 mph. Schedule track surfacing within 30 days.	Restrict speed to 10 mph. Surface track in violation within 72 hours.	

LRT213.65 Clearances.

Specific minimum clearances must be maintained between trains and wayside/overhead structures and facilities. When surfacing and/or lining track or when engaged in out-of-face track reconstruction, attention shall be given to the preservation of existing clearances. Pantograph to catenary relationship must also be carefully considered when horizontal track shifts or changes in superelevation are contemplated. A one inch (1") change in crosslevel can translate into up to five inches (5") of lateral pantograph shift at the catenary.

The preferred minimum horizontal clearance measured from the centerline of track on tangent alignment is 7'-6". An absolute minimum of 6'-0" on tangent alignment may be used in extreme cases where absolutely necessary. In either case, and even more importantly in curved track, consideration of curvature, superelevation, car body roll, car body suspension related lateral displacement and vehicle overhang must be taken when calculating required clearances.

Every effort should be made to preserve existing vertical clearance when planning track maintenance or construction activities. In the event where overhead clearance will be reduced due to proposed track structure changes or for other reasons, a clearance survey of existing conditions should be undertaken using an actual vehicle if possible. This is especially critical in areas of low wire height. Pantograph "lockdown" could result from track lifts in low wire height territory. Potential clearance obstructions should be located relative to vehicle's dynamic clearance envelope on reconfigured track. Under no conditions should any obstruction be allowed to encroach within 3" of the dynamic clearance envelope, a minimum of 6" is preferred.

The preferred minimum horizontal distance between LRT centerlines on tangent alignment is 12'-0". Absolute minimum is 11'-0". In any case, the clearance between dynamic envelopes of vehicles on adjacent tracks shall be no less than 6" after taking all factors (curvature, etc.) into account.

PART D - TRACK STRUCTURE

T213.101 Scope.

This section prescribes minimum requirements for ballast, crossties, fastening assemblies and the physical condition of rails including restraining rail.

T213.103 Ballast.

Unless the track is structurally supported in another fashion (i.e., concrete slab, steel stringer, etc.), it shall be supported by material (crushed granite ballast) which will meet the following requirements:

- a) Transmit and distribute static track loads and loads from passing trains to the subgrade;
- b) Provide lateral, longitudinal and vertical restraint under dynamic loads imposed by passing trains and from thermal stress exerted by the rails during extremes in temperature;
- c) Provide proper drainage of the track structure; and
- d) Facilitate the maintenance of track line, surface and crosslevel.

Ballast used on the Green Line shall be A.R.E.M.A. No. 4 (sieve opening 3/4" to 1-1/2") unless otherwise specified. Ballast received from suppliers that is of inferior quality, the wrong grade or contains dirt or other contaminants (fines) shall be rejected.

Refer to typical track structure cross-section under **LRT213.31 - ROADBED**. A ballast section that provides a ballast shoulder measuring 12" from the end of tie to the top of slope and a ballast slope of 2:1, is highly desirable. Under no circumstances should the ballast shoulder measure less than 6" horizontally. The ballast level in the tie cribs (area between the ties) should be maintained even with the top of ties or no less than 1" below the tops of ties.

Insufficient or improperly sloped ballast shoulders and/or tie cribs not adequately filled with stone make track susceptible to unwanted movement including possible buckling under high stress. Track which is in improper ballast condition (<6" shoulder, more severe than 2:1 shoulder slope and/or cribs lower than 1" from top of tie level) should receive immediate attention and speed should be restricted until repairs can be made.

Track which has been substantially disturbed through lining or especially surfacing or by any other means whereby the adhesion between ties and ballast has been broken, must be inspected prior to the resumption of train operations. The inspection must be conducted by personnel designated as a Qualified Person to inspect track. Speed of trains shall be restricted to 50% of the normal operating speed over the track for a minimum of 24 hours after the completion of work.

LRT213.109 Crossties.

Crossties used on the Green Line shall be 7" x 9" x 8'-6", 100% hardwood and shall conform to the requirements of the AREMA Specifications for Timber Crossties. All crossties shall be equipped with approved anti-splitting devices per the AREMA. Specifications.

All tracks shall have a sufficient number of crossties which in combination provide effective support and shall:

- a) Hold gage within the limits prescribed in **LRT213.53**;
- b) Maintain track surface within the limits prescribed in **LRT213.63**; and
- c) Maintain horizontal alignment within the limits prescribed in **LRT213.55**.

Each 39' section of track shall have the minimum number of non-defective crossties as indicated in the table on the following page. To satisfy the requirements set forth in the table, crossties must not be:

- 1) Broken through - a crosstie with a *vertical* break *completely through* the thickness of the tie;
- 2) Split or otherwise impaired to the extent that ballast from beneath the tie has worked through or spikes may be pulled from the tie easily by hand;
- 3) Deteriorated to the extent that the tie plate or rail base (in the absence of a plate) moves laterally under dynamic loading more than ½" relative to the tie's surface; or
- 4) Cut by the tie plate (or rail base) more than 15% (nominally 1-1/8") of the tie's thickness.
- 5) Incapable of maintaining gage, horizontal and/or vertical alignment as described above.

Response Action to tie maintenance threshold criteria shown below.					
Green		Yellow		Red	
Monitor tie conditions. Notify line supervisory personnel of any deterioration of conditions.		Restrict speed to 25 mph. Schedule tie renewal within 30 days.		Restrict speed to 10 mph. Replace defective ties within 72 hours.	
Measurement Parameter:					
MINIMUM NUMBER OF NON-DEFECTIVE CROSSTIES PER 39' OF TRACK					
Maintenance Thresholds:					
Green		Yellow		Red	
Tangent 9	Curved* 10	Tangent 8	Curved* 9	Tangent 5	Curved* 6
*Indicates curves less than 1000' radius.					
Measurement Parameter:					
MAXIMUM DISTANCE BETWEEN NON-DEFECTIVE TIES (CTR. TO CTR.) BASED ON 24" TIE SPACING					
Maintenance Thresholds:					
Green		Yellow		Red	
Tangent 72"	Curved* 48"	Tangent 96"	Curved* 72"	Tangent 120"	Curved* 96"
*Indicates curves less than 1000' radius.					
Measurement Parameter:					
MAXIMUM NUMBER OF SUCCESSIVE DEFECTIVE TIES (BASED ON 24" TIE SPACING)					
Maintenance Thresholds:					
Green		Yellow		Red	
Tangent 2	Curved* 1	Tangent 3	Curved* 2	Tangent 4	Curved* 3
*Indicates curves less than 1000' radius.					

In jointed track:

To support train speed up to 25 m.p.h., track shall have one non-defective crosstie whose centerline is within 24" of each joint location. To support train speeds up to 50 m.p.h. (system speed limit), track shall have one non-defective crosstie within 18" of each joint location or, two non-defective crossties whose centerlines are within 24" either side of each joint location. Train operation over track not meeting this criteria shall be restricted to 5 mph and manually supervised by personnel designated as a Qualified Person to inspect track.

For track constructed without crossties, such as concrete slab track, track with rails directly connected to bridge structural components or track over inspection/service pits, the track structure shall meet the requirements for gage in **LRT213.53**, track surface in **LRT213.63** and track alignment in **LRT213.55**.

LRT213.113 Defective Rails.

When it is learned, through inspection or by other means, that a rail in track contains any of the defects listed in the table on the following page, M.O.W. personnel designated as a Qualified Person to inspect track shall determine whether trains may continue to operate over the track. If it is determined, after careful inspection, that the track may continue to support train operations, such operations are not permitted until the remedial action prescribed in the following tables is initiated:

DEFECTIVE RAILS AND REMEDIAL ACTION				
Defect	Defect Size (% of rail head cross section)		Until Defective Rail is replaced	
	From	To	Remedial action to be taken	Maximum speed
Detected Transverse Defects in Non-control Cooled Rail and Transverse Fissure or Compound Fissure	0	99	Limit operating speed to –	10 mph
	100%		Visually inspect track after each supervised operation over rail.	5 mph
Detected Transverse Defects in Control Cooled Rail -or- Detail Fracture IMPORTANT (See note below on Detail Fractures) Defective Weld Engine Burn Fracture Broken Rail as a Result of Defects Listed Above	0	19	Apply joint bars to defect within 20 days (omit middle bolt holes) Until joint bars are applied, limit speed to –	25 mph
	20	99	Apply joint bars to defect within 10days (omit middle bolt holes) Until joint bars are applied. limit speed to –	10 mph
	100%		Apply joint bars with two bolts on each side of defect Until bars are installed, supervise train operation and limit speed to –	Normal operating speed 5 mph
Horizontal Split Head Vertical Split Head	0" - 2"		Inspect rail every 90 days for defect propagation	Normal operating speed
	2" - 4"		Inspect rail every 30 days and limit speed to –	25 mph
	Over 4"		Limit speed to –	10 mph
	break-out in rail head		Visually super-vice each operation over rail	Walking speed

Note:

Detail fractures developing from shelling or spalling conditions at gage corner shall be treated as indicated in table above. **DETAIL FRACTURES DEVELOPING IN THE WEB OF RAIL CALL FOR AN IMMEDIATE 10 MPH RESTRICTION TO REMAIN IN PLACE UNTIL THE DEFECTIVE RAIL IS REMOVED FROM TRACK.**

DEFECTIVE RAILS AND REMEDIAL ACTION (Continued)				
Defect	Defect Size		Until Defective Rail is replaced	
	From	To	Remedial action to be taken	Maximum speed
Split Web Piped Rail Head & Web Separation	0"	½"	Inspect rail every 90 days for defect propagation	Normal operating speed
	½"	3"	Inspect rail every 30 days and limit speed to –	25 mph
	over 3"		Limit speed to –	10 mph
	Break-out in rail head		Visually supervise each operation over rail	Walking speed
Bolt Hole Crack	0"	½"	Inspect rail every 90 days for defect propagation	Normal operating speed
	½"	1-1/2"	Inspect rail every 30 days and limit speed to –	25 mph
	over 1-1/2"		Limit speed to –	10 mph
	Break-out in rail head		Visually supervise each operation over rail	Walking speed
Broken Base	0"	6"	Apply joint bars with two bolts on each side of defect and limit speed to	25 mph
	over 6"		Replace rail	–
Ordinary Broken Rail			Apply joint bars with two bolts on each side of break, speed after bars are installed to be	Normal operating speed
			Until joint bars are installed, supervise each train over break and limit speed to	Walking speed
Damaged Rail			Apply joint bars to defect within 20 days, until bars are installed limit speed to –	25 mph
			After installation of bars, limit speed to	Normal operating speed

Notes:

- 1) Inspections called for in Defective Rail tables to be performed by personnel designated as a Qualified Person to inspect track.
- 2) Transverse defects, transverse and/or compound fissures can not be verified until rail is removed from track and fracture faces of the defect examined.
- 3) In temporarily repairing defects through the use of joint bars as prescribed in the Defective Rail tables, 6 hole bars are to be used and the middle 2 holes of the bar are not to be used nor is the rail to be drilled for the middle 2 holes.

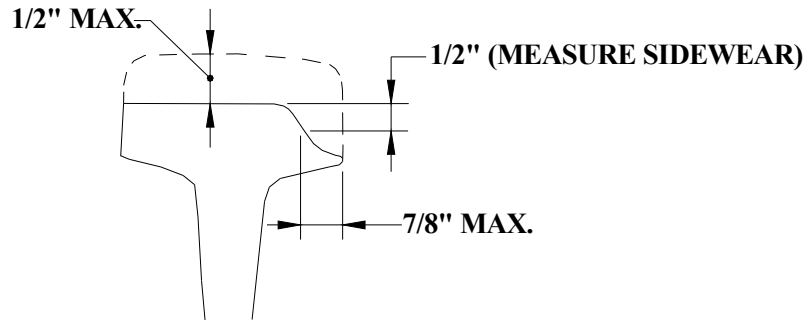
- 4) It may not be possible to use conventional joint bars for temporary repair of a defective weld. The use of “bubble bars” is only permitted when conventional joint bars will not fit the rail web due to uncropped weld material. “Bubble bars” are an emergency repair only and constitute a RED-coded track condition. A speed restriction of 3 mph is required until a permanent repair has been made.
- 5) Defective rails and welds should be cut out of track using a rail saw. Torch cutting should not be done except under emergency circumstances. Torch cut rails should not be operated over at more than 10 mph and must be removed from track within 24 hours when in revenue service track.
- 6) The minimum length rail installed in track should be 18' except in emergency situations. Field welds made in CWR shall be inspected for internal defects by a qualified inspector.

ADDITIONAL DEFECTIVE RAIL CONDITIONS AND REMEDIAL ACTION PRESCRIBED		
Condition	When a determination for replacement is made by personnel designated as a Qualified Person to inspect track:	When a determination is made by personnel designated as a Qualified Person to inspect track that replacement is not required at this time:
Shelly spots Head checks Engine burn (no fracture)	Limit speed to 25 mph and schedule rail replacement.	Inspect rail for internal defect at least once a year.
Flaking Slivered Corrugations Corrosion	Limit speed to 25 mph and schedule rail replacement	Inspect rail for internal defects at least once every 6 months.
For definitions of defect conditions as outlined in LRT213.113 , refer to M.O.W. Division Book of Policies and Standard Operating Procedures.		

LRT213.114 Rail Wear.

For Section 115 RE:

Rail may remain in service until the horizontal head wear limit is reached provided that track gage is within limits described in LRT213.53. **The maximum amount of horizontal head wear (sidewear) allowable is 1/2" if irregular within a 31' distance.** Sidewear would then become subject to limitations under gage variation limit criteria. **The maximum amount of horizontal head wear (sidewear) allowable is 7/8" if uniform throughout a curve.** The maximum amount of vertical rail wear permissible is 1/2".



**Figure LRT 213.114
Rail Wear
Measurements**

LRT213.115 Rail End Mismatch.

Any mismatch of rails at joint locations may not be more than that prescribed in the following table. Mismatches can be due to different railwear levels between two joined pieces of rail, rail-end batter on either or both rails or worn joint bars.

RAIL END MISMATCH MAINTENANCE LIMITS					
Measurement Parameters:					
Vertical mismatch on the tread of the rail ends			Horizontal mismatch on the gage side of the rail ends		
Maintenance Thresholds:					
Green	Yellow	Red	Green	Yellow	Red
1/8"	1/4"	3/8"	1/8"	3/16"	1/4"
Response Actions:					
Green (G): Monitor conditions.					
Yellow(Y): Restrict speed to 25 mph, repairs to be done within thirty (30) days.					
Red(R): Restrict speed to 10 mph, make repairs within seventy two (72) hours.					

LRT213.116 Restraining Rail.

DEFINITION: Head-hardened or fully heat-treated 132 RE rail mechanically fastened (bolted through the web) to the inside running rail of curves.

FUNCTION: Primary - to reduce rail wear to the outside rail of curves; secondary - to reduce the chance of wheel climb up the gage face and over the outside rail of curves.

Restraining rail is installed with a specified flangeway clearance (refer to LRT213.54) to the gage side of the inside running rail. The restraining face of the restraining rail is toward the gage side of the inside running rail and, when properly adjusted, maintains constant contact with the back of vehicle flange as trains travel through curves.

Restraining rail maintenance typically involves adjustment of the flangeway width and/or replacement of broken spacer block assembly components, particularly bolts. **Maintenance threshold limits for standard LRT flangeway width are: Green - 1-3/4", Yellow - 1-7/8" and Red - 2"**. Details of other flangeway criteria are given at **LRT213.53** and **LRT213.54**. Maintenance threshold limits for restraining rail bolt breakage are shown in the following table.

MAINTENANCE THRESHOLD LIMITS RESTRAINING RAIL BOLTS					
Measurement Parameters:					
Consecutive Broken /Loose or Frozen Bolts			Total Broken Bolts in any 39' of Track		
Maintenance Thresholds:					
Green	Yellow	Red	Green	Yellow	Red
2	3	4	5	6	7
Response Actions:					
Green: Monitor conditions, replace broken bolts before condition deteriorates.					
Yellow: Restrict speed to 25 mph if immediate repairs cannot be made, advise supervisory personnel; execute spot bolt replacement within 72 hours to upgrade speed, schedule wholesale bolt re-torquing/replacement in curve to be done within 30 days.					
Red: Restrict speed to 10 mph until emergency bolt replacement is accomplished to upgrade speed; notify supervisory personnel, schedule wholesale bolt re-torquing/replacement in curve to be done within 72 hours.					

LRT213.119 Continuous Welded Rail (CWR).

Continuous welded rail is designated by the initials CWR in this section. CWR is defined as a group of 39' (usually) or 78' rails welded together to form a rail "string". By definition, a rail "string" of at least 400' in length is CWR. Track constructed with CWR strings is called "CWR track".

CWR must be installed and adjusted in accordance with the Authority's "*CWR Installation Guide and Track Buckling Countermeasures Policy*". (Refer to M.O.W. Division Book of Policies and Standard Operating Procedures.) After installation of CWR, disturbance of the track structure should not take place at rail temperatures higher than the CWR installation or adjusted (de-stressed) installation temperature, except as provided in the aforementioned "*CWR Installation Guide and Track Buckling Countermeasures Policy*".

LRT213.121 Rail Joints.

Bolted rail joints provide structural continuity by transferring lateral and vertical wheel loads between adjacent rails with no relative movement of abutting rail ends. Properly functioning joints permit longitudinal movement within the joint bars to accommodate expansion and contraction of rails due to thermal and/or mechanical stresses.

- a) Each rail joint, insulated joint and compromise joint shall be of a structurally sound design and dimensions for the rail section on which it is used.
- b) If a joint bar is cracked, broken or because of wear allows vertical movement of either rail independent of the other when all bolts are tight, it must be replaced.
- c) If a joint bar is cracked or broken between the middle two bolt holes, it must be replaced.
- d) If both bars of a joint are cracked or broken between the middle two bolt holes or one of the bars is found to be broken completely through, a 10 mph speed restriction must be placed on the track until the bar(s) can be replaced.

e) If both bars are found to be broken completely through between the middle two bolt holes, trains may operate over the joint only under the visual supervision of a person designated under **LRT213.7** until the bars are replaced.

f) In conventional jointed revenue service track, each rail must be bolted with at least 2 bolts at each joint. Yard track joints must be bolted with at least one bolt on each rail.

g) In CWR track, each rail must be bolted with at least 2 bolts at each joint used to connect CWR strings or to connect CWR to conventional rail.

h) When any of the conditions in f) or g) are not met, a speed restriction must be put in place until the condition is corrected.

i) Each joint bar must be held in position by track bolts sized appropriately for the rail drilling – 1" bolts in 1-1/16" holes and 7/8" bolts in 15/16" holes. Bolts must be tightened sufficiently to provide adequate support for abutting rail ends and to allow longitudinal movement of rails within the joint to accommodate expansion and contraction due to mechanical and thermal stresses.

j) No rail or joint bar having a torch cut hole should be used in revenue service track. If, under emergency circumstances, it becomes necessary to burn a bolt hole in rail or reconfigure a joint bar by torch cutting (slotted holes), speed over the track must be restricted to 10 mph and the rail and/or joint bar removed from track within 72 hours.

Appropriate speed restrictions for the conditions indicated in d), f) and g) are as follows: d) = 10 mph; for pull-aparts 2" or less associated with f) and g), the restriction shall be a maximum of 25 mph or less at the discretion of the Inspector (Qualified Person to inspect track); for pull-aparts in excess of 2" associated with f) and g), the restriction shall be 10 mph and revenue service train operation only under the constant supervision of a Qualified Person to inspect track. Should the Inspector determine that the track is unsafe for passage of trains at any speed, the track should be taken out-of-service until repairs are made.

LRT213.122 Torch Cut Rail.

Except as a temporary repair in emergency situations, no rail having a torch cut end shall be permitted in revenue service track. When such a repair is necessary, speed over that track should be restricted to 10 mph and the torch cut rail removed from track within 24 hours. Torch cut rail in non-revenue service track should be inspected on a regular basis and removed from track within 30 days.

LRT213.123 Tie Plates.

Where timber crossties are used there shall be tie plates under the running rails on at least 9 out of any 10 consecutive ties.

LRT213.125 Rail Anchoring.

Longitudinal rail movement must be effectively controlled. Rail anchors (or elastic spring clip fasteners exerting a minimum nominal vertical force of 2000 lbs. each) must be applied to CWR track as outlined in **Appendix G**, Blue, Orange and Red Lines Track Standards.

In jointed track, effective rail anchoring is provided by spring clip anchors in "Pandrol" type track construction. In track-spike type track construction, the recommended application of anchors is 8 anchors per 39' rail to resist longitudinal movement in the normal direction of traffic. Sufficient "backup" anchors should be provided to protect against reverse running traffic, normal temperature effects in the reverse direction and excessive joint pull apart in the event of a broken rail or failed joint.

LRT213.127 Rail Fastening Systems.

Rails shall be fastened by a system of components which effectively maintains gage within the limits prescribed by **LRT213.53**. Crossties, the minimum number of which is stipulated under **LRT213.109**, must have effective rail fasteners on both the gage and field sides of both rails. There shall not be more than 2 consecutive ties which do not have effective rail fasteners on both sides of both rails.

Where elastic/resilient rail fasteners are used, they must meet the requirements for effective rail anchors *and* for effective track fasteners.

In slab track or in directly fixated track, at least 12 track fastener assemblies in curved track (<1000' R) and at least 9 track fastener assemblies on tangent track, in any 39' of track must have effective rail fasteners on both sides of both rails. There shall be no more than 2 consecutive track fastener assemblies which do not have effective rail fasteners on both sides of both rails.

LRT213.129 Rail Shims.

If track geometry is out of compliance with the requirements set forth under Part C herein and the working of ballast is not possible due to weather or other natural conditions, rail shims may be used to temporarily correct the deficiencies. The shims must be removed, track resurfaced and the ties tamped to a solid bearing as soon as weather permits.

Shims must be installed directly beneath the tie plates on top of the ties. Tie plates should never be removed from ties as a means of adjusting the surface or cross level of track. The proper length track spike shall be used with shims corresponding with the shim thickness (6" up to 1" shim, 8" over 1" up to 2" shim). Special considerations, including restricted speed, must be made for shims over 2".

Shimmed track must be inspected on a greater frequency than that required for regular track. Special attention must be given to the gage holding and surface maintaining capabilities of the shims.

LRT213.133 Turnouts and Track Crossings.

a) Fastenings in turnouts and track crossings must be kept tight and adjusted to keep track components securely in place and functional. All turnout components must be kept free of obstructions which might interfere with the passage of train wheels.

b) Rail anchors (or elastic spring clip fasteners) must be installed through turnouts and crossovers and on each side of track crossings, switches, frogs and guard rails to restrain movement of rails which may affect the position of switch points and/or frogs.

c) Flangeways through turnouts and track crossings must be a minimum of 1-1/4".

LRT213.135 Switches.

a) Stock rails must be properly and securely seated within switch plates. Care must be exercised not to overdrive adjustable rail braces which will unseat the rail base, affect gage and cant the rail.

b) Switch points must fit against stock rails properly with the switch thrown in either direction. Train wheels must be able to pass through switches without contacting the tip of switch points. Lateral and/or vertical movement of a stock rail within switch plates or of a switch plate on a tie must not adversely affect the fit of a point to a stock rail. Nor shall such movement adversely affect the locking capability of the switch machine. Prompt corrective action is required in such eventualities.

c) The heel of each switch point must be secure, loose bolts tightened and missing or broken bolts promptly replaced.

d) Unusually or excessively chipped/worn switch points should be repaired or replaced. Metal flow must be removed to ensure proper closure. Gage criteria at **LRT213.53** should be used to determine wear limits of switch points. Actual gage = static gage measurement including switch point sidewear, measured 1/2" below the top of point, plus any dynamic movement of track due to lateral loading.

SCHEDULE OF SWITCH POINT MAINTENANCE CRITERIA

Immediately repair/replace a switch point and/or stock rail when:

- a. The switch point is chipped or worn 5/8" down from top of stock rail for a distance of 6" or more
- b. The switch point has an unprotected flat horizontal surface of 1/4" or more due to wear or fracturing
- c. There is a 1/8" or greater gap at the point of switch when the switch is fully thrown (closed)
- d. There is a gap between the switch point and stock rail greater than 3/8" at the #2, #3 or #4 rods
- e. There is 1/2" or more gage face wear on the stock rail within 5' of the point of switch

When a condition is discovered corresponding with a. through e. above, the switch shall be removed from service for facing point turnout moves until repairs are made or trains may be manually supervised ("walked through") at the discretion of the MoW Line Supervisor or Superintendent on site, based on their observations of train performance and their assessment of operational safety.

LRT213.136 Switch Cover Guards and Guarded Switch Points.

Cover guards (sometimes called "housetops") and guarded, double switch points are designed to minimize wear to the curved, single switch points and to discourage wheel climb by a train making a turnout move. Cover guards are cast manganese steel while guarded, double switch points are rolled, heat-treated carbon steel.

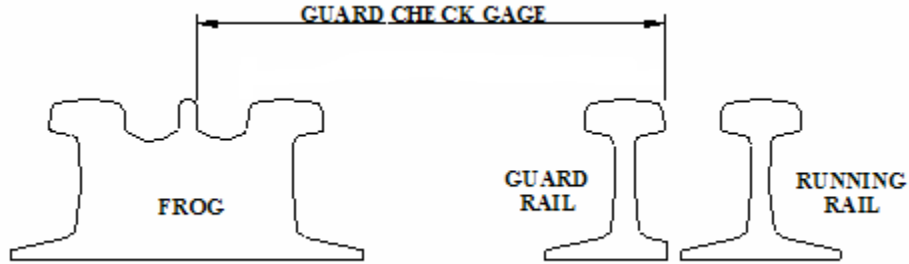
- a) Cover guards must be kept securely fastened to the chairs upon which they rest. Loose cover guard bolts should be tightened and missing or broken bolts replaced. Care must be taken to use the proper bolt length, bolts protruding more than minimally below the bottom of the cover guard may contact the switch point and prevent its proper throw.
- b) Cover guard chairs must be kept securely fastened to the plates/ties upon which they sit. A "plow" bolt design of attaching the chair to plate has become the MBTA standard. It has replaced the previous designs in which 1) screw spikes fasten the chairs to plates and ties or 2) "through" bolts are used. Through bolts are connected to small bearing plates at the bottom of the tie. After a period of use, the older designs fail and the function of the cover guard is defeated. The cover guard lifts under the application of lateral loading imparted by train wheels and "rolls" away from the load. Switches with older design cover guard systems should be retrofit with the "plow" bolt design whenever it becomes necessary to perform any cover guard maintenance.
- c) The contact face of cover guards should be restored to its original configuration by welding when it has worn 1/4". Care should be exercised in ensuring that the contact face of the cover guard matches well in a vertical plane to the restraining face of the attached 132# restraining rail. The rail may need to be welded and ground to achieve this match. Any weld should be "run out" in a minimum of 6" to provide a smooth transition. The nominal flangeway width between cover guard and gage line of stock rail is 1-5/8" (except in special cases as outlined in **LRT213.53 and LRT213.54**).
- d) Double switch points are comprised of a length of 132# restraining rail and a length of 115# running rail. Both rails are milled and planed and then bolted together. **The design switch throw for LRT switches is 3-1/2"**. This dimension is critical with respect to the restraining capability of the double switch point. The dimension should be regularly checked at each switch and adjusted as necessary.
- e) Double switch points are braced against lateral loading by switch stops. These stops are connected to switch plates in the same fashion as cover guard chairs. The plow bolt design should be used whenever possible. The restraining ability of the double switch is reduced with wear to the 132# side of the point. The point should be replaced when the wear exceeds 1/4". Replacement of the double point is generally necessary every other time the single, curved point is replaced.

LRT213.137 Frogs.

- a) All frogs in LRT track are flange-bearing. The flangeway depth of frogs, measured from a plane across the wheel-bearing area (straightedge on point and both wings), is designed to be 11/16". Refer to **LRT213.337** for maintenance limits for depth of grooves in the floor of flange-bearing frogs.
- b) Any frog point chipped, broken or worn 5/8" deep from the plane measured in **LRT213.137 a)** and within 6" of the tip of the frog point calls for a speed restriction of 5 mph max. over that frog and immediate replacement.
- c) If the tread portion (wings) of a frog casting is worn down more than 3/8" below the original contour, operating speed over that frog is limited to 10 mph.
- d) Grinding of "flowed metal" on frog points and wings at impact areas should be done *before* cracking occurs. This practice will prolong the life of frogs and help prevent breakouts. Battered frog points should be built up by welding *before* wings begin to show signs of batter.
- e) Loose frog bolts should be tightened and missing/broken bolts replaced as a matter of routine maintenance. Frog fasteners should be maintained and plates should be checked during Switch Certification for signs of movement.

LRT213.143 Frog Guard Check Gage.

The diagram below illustrates the "guard check gage" dimension at the point of frog. The guard check measurement is taken on a plane 1/2" below the *running* surface of the frog and of the *running* rail opposite the frog. The use of the standard Roadmaster gage will be ineffective within the flange bearing area due to the shallow depth of the flangeway. Measurements must be taken at the bottom of the flange bearing ramps where the flangeway is at least 1" deep.



Green Line Guard Check Gage	
Maintenance Threshold	Response Action
Green 55 1/8" - 55 1/2"	No action required.
Red <55 1/8" and > 55 1/2"	Restrict @ 5mph, repair immediately.

PART E – TRACK APPLIANCES

LRT213.201 Scope.

This part prescribes minimum requirements for certain track appliances.

LRT213.204 WEZE (Impedance) Bonds and Cable Leads.

In the course of routine track inspection, it is important that the condition of WEZE bonds and the associated cable connections to the running rails are checked.

Although the bonds are the responsibility of the Signal Division, damage from hanging train equipment or track maintenance should be brought to the attention of supervisory personnel. Special attention should be given to the cable leads. If the insulation on the cables is damaged or the cable appears to be crushed or broken, it should be noted. Most importantly, cable connections to the running rail web should be inspected. The Cadwelded connection at this location is a common site of rail defects which typically develop internally. As such, they are not detectable by eye. However, often the defects develop into cracks in the web which, if not detected, can become broken rails. Generally the break happens suddenly when the rail is subjected to a concentrated impact load such as from a flat wheel. Any unusual condition should be brought to the attention of supervisory personnel. The location of disconnected leads should be noted on the track inspection report.

LRT213.205 Derails.

Each derail in LRT track must be kept clearly visible at all times, must be locked when not in use and must be maintained to prevent it from being operated without removing the lock. Derails found unlocked must be reported to the GL Dispatcher immediately.

PART F – INSPECTION

LRT213.231 Scope.

This section prescribes MBTA requirements for the frequency and nature of LRT track inspection. Track inspection at the MBTA is regulated by the Commonwealth of Massachusetts' Department of Public Utilities. DPU regulations can be found in the M.O.W. Division Book of Policies and Standard Operating Procedures.

LRT213.233 Track Inspections.

1) Frequency:

- a) All LRT track must be inspected a minimum of three times per week, yard track included, with at least one calendar day interval between inspections.
- b) Any LRT track undergoing or awaiting repair upon which a speed restriction is assigned shall be inspected at a frequency which will ensure safe operations at all times.
- c) Each switch, turnout and track crossing must be inspected on foot at least weekly. In the case of track which is used less than once a month, each switch, turnout and track crossing must be inspected before it is used.
- d) In the event of fire, flood, severe storm or other occurrence which might have damaged the track structure, a special inspection must be made of the track involved as soon as possible after the occurrence.
- e) The DPU may require inspections at more frequent intervals in areas of dense traffic, high operating speeds or questionable physical conditions.

2) Qualifications: the MBTA shall designate qualified persons to inspect track for defects. Each person so designated must have:

A) Experience/Education –

- a) At least one year experience in track inspection, or
- b) A combination of experience in track inspection and training from a course in track inspection or from a college level educational program related to track inspection.

B) Ability to –

- a) Understand inspection requirements;
- b) Detect deviations from the inspection requirements;
- c) Prescribe appropriate remedial action to correct or safely compensate for deviations; and
- d) Procure written authorization from the MBTA to prescribe remedial actions to correct or safely compensate for any deviations from the inspection requirements pending review by a qualified person designated under DPU regulations 220 C.M.R. 151.08(4)(a).

3) Inspections: each inspection must be made on foot or riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with the DPU regulations and the Standards set forth herein. Mechanical, electrical and other track inspection devices may be used to supplement visual inspection. If a vehicle is used for visual inspection, the speed of the vehicle may not be more than 5 mph when passing over grade crossings or special trackwork.

LRT213.235 Switch Certification.

In addition to the inspection schedule outlined in **LRT213.233(1)**, all turnouts at the MBTA are subject to inspection under the System Certification process. This process directs that all revenue service turnouts are thoroughly inspected on a quarterly basis. Non-revenue turnouts are subject to System Certification inspection on a four-month cycle. During the System Certification inspection, a series of specific measurements is taken and recorded to ensure that the turnout is in compliance with the Standards. Records of System Certification are maintained at Line headquarters.

LRT213.237 Inspection of Rail.

In addition to the inspection schedule outlined in **LRT213.233(1)**, the DPU requires that at least once a year a continuous search for internal rail defects (ultrasonic and/or induction testing) must be made of all rail in revenue track.

Inspection equipment must be capable of detecting defects between the joint bars in the area of the rail enclosed by joint bars.

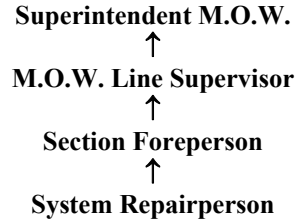
Each defective rail must be marked with highly visible marking on both sides of the web and base.

LRT213.241 Inspection Records.

A written record of each track and/or rail inspection required to be performed shall be kept on file. The MBTA is required by the DPU to designate a location where the original record of each track inspection shall be maintained for at least one year after the date of the inspection. Original records of inspections for internal rail defects must be retained for at least two years after the date of the inspection and for one additional year after remedial action is taken. Complete details of inspection requirements can be found in the DPU regulations under Section 151.08(5)

LRT213.243 Duties and Responsibilities of Supervisors, Section Foremen and System Repairpersons.

The organizational reporting structure of the M.O.W. Division is as shown below:



The *Superintendent M.O.W.* oversees the activities of a Supervisor or Supervisors. The Superintendent is responsible for planning and policy making decisions.

The *M.O.W. Line Supervisor* generally is assigned to one of the four transit lines (Blue, Orange, Red or Green) and is responsible for all track/M.O.W.-related issues on that line. From an inspectional standpoint, the Supv. monitors and maintains records of daily, monthly and bi-annual track and turnout inspections. The Supervisor must personally inspect every turnout and special trackwork location in his/her territory twice a year. Records of these inspections shall be maintained under **LRT213.241 and/or LRT213.241**.

Section Forepersons are assigned a territory for which they assume responsibility for the activities of all System Repairpersons (track inspectors) in that territory. The System Certification process is the direct responsibility of the Section Foreperson. The Section Foreperson must ensure that all track inspection and System Certification documentation is correctly completed in a timely fashion. The Section Foreperson is responsible for bringing to the attention of the Line Supervisor track deficiencies noted on daily inspectional reports or discovered by him/her during System Certification.

System Repairpersons or Track Inspectors are the individuals who perform vital inspectional functions on a daily basis. System Repairpersons should not just walk track, but must be able to recognize exceptions to the Track Maintenance Standards. System Repairpersons are responsible for daily track inspection forms and must communicate any abnormalities or exceptions to the Track Maintenance Standards to their Section Foreperson and/or Supervisor. System Repairpersons must be qualified per DPU regulations under Section 151.08(4)(b).

LRT213.245 Ancillary Responsibilities.

All employees, while on track, must be aware of and report any potentially dangerous or hazardous condition. Examples of such conditions are: fallen or loose materials from structures or buildings, downed or damaged R.O.W. fencing, washouts, catenary problems, graffiti, damaged or obstructed wayside signals or signs, etc.

Any condition, which in the estimation of an individual qualified under **LRT213.7**, could cause damage to a train, its occupants or other personnel on track, must be addressed immediately. Response includes notification of the Green Line Dispatcher, the Maintenance Control Center and a Green Line M.O.W. supervisory person. The individual discovering the problem must remain on scene directing trains past the problem (if passage is possible) until relieved or until the problem is corrected.

PART G – GIRDER RAIL TRACKWORK

LRT213.331 Scope.

This part prescribes recommended maintenance guidelines and maintenance threshold limits for girder rail trackwork.

LRT213.334 Track in Pavement.

Inspection of paved track, with the exception of the running surface of the rail, cannot be performed because the track structure is embedded in asphalt or concrete pavement. Track inspectors should take note of any signs of lateral or vertical movement of the rails which is evidence of underlying problems. Rail movement is detectable through failure of the paving material adjacent to the rails and is indicative of subsurface track structure deterioration.

LRT213.337 Girder Rail Special Trackwork – Maintenance Threshold Limits.

This part identifies maintenance threshold limits for tongue switch, point mate and frog components. The limits shown in the following tables apply to specific conditions which exist in isolation for the component listed. Combinations of marginally defective conditions must be evaluated collectively.

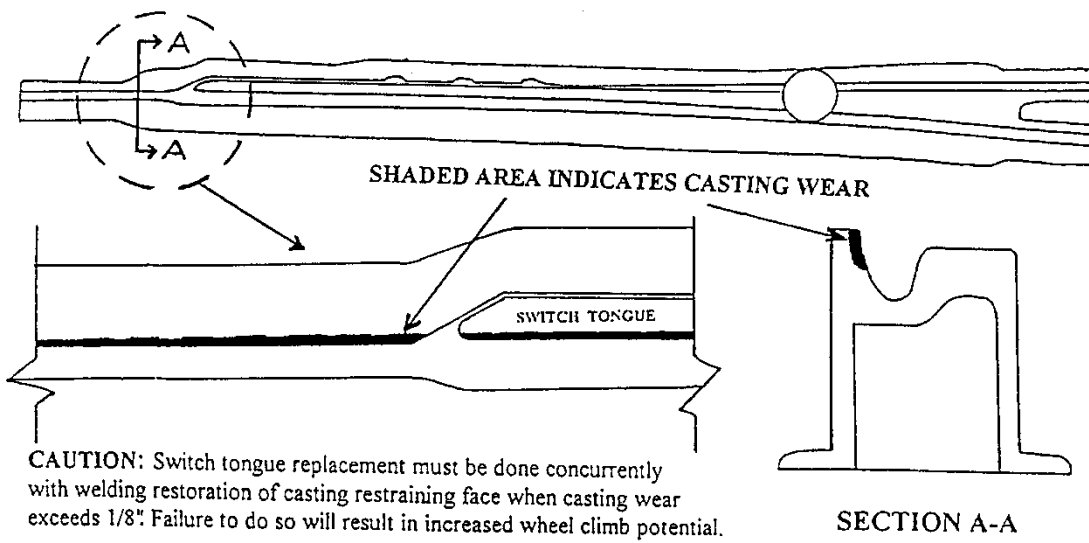
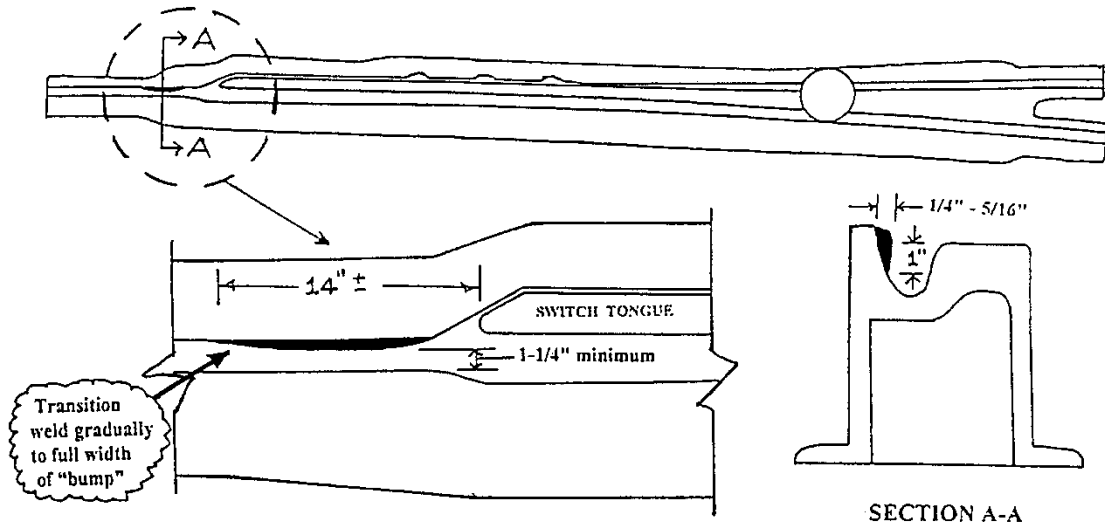
Special attention needs to be given to YELLOW coded track conditions. Such conditions, technically qualifying as track defects but not necessarily requiring immediate attention, could contribute to train derailment or component failure when combined with other marginal track conditions, operator error and/or vehicle malfunction. Particular notice should be taken, especially when evaluating tongue switch condition, of track surface and crosslevel conditions in the immediate vicinity of the switch. Slightly abnormal weight distribution of a light rail vehicle due to marginally imperfect vertical track alignment, in combination with a YELLOW coded tongue switch anomaly, for example, can contribute to derailment cause. Refer to **LRT213.4** for further details.

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LRT213.337 – Girder Rail Special Trackwork -- Maintenance Threshold Limits

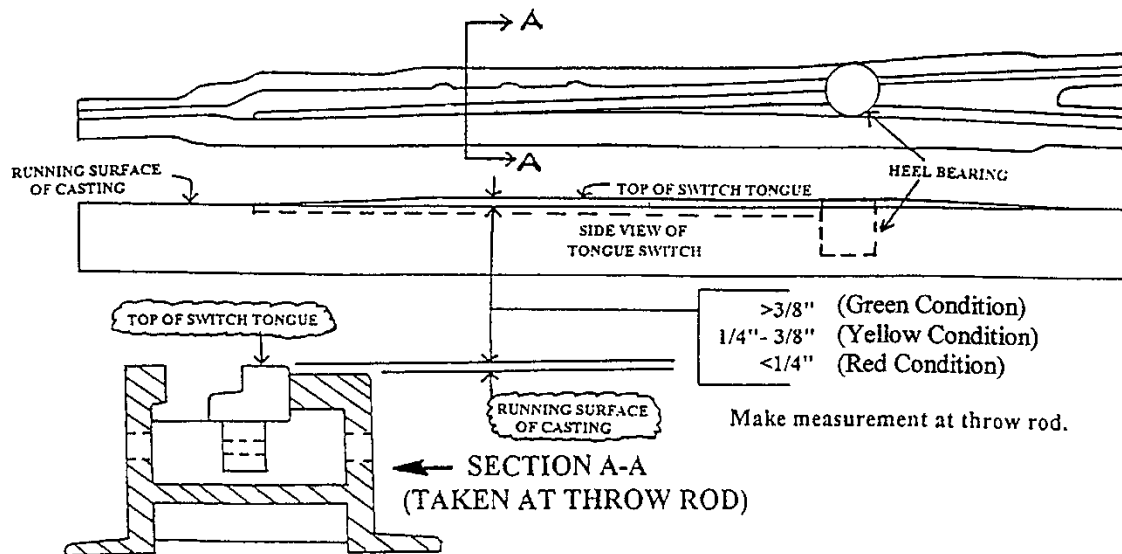
Component		Tongue Switch Casting	Switch Tongue
Defect Description		Corrosion, broken/ missing plate, fastener failure, hanging tie, etc.	Loss of rounded edge at restraining face corner
Effect on Component		Lateral - vertical movement	Increased wheel climb potential
Measurement Parameter		Amount of deflection	
<u>Maintenance Limits</u>	Green	1/4"	This condition only applies to new casting or tongue installations until the restraining face angle has worn to five degrees or greater. Until restraining face wear has developed, "touch-up" sharp edge at restraining face corner with straight grinder. Exercise care as to not remove any more steel than is necessary to relieve sharp edge and discourage wheel climb on tongue.
	Yellow	1/2"	
	Red	3/4"	
<u>Response Action</u>	Green	Monitor condition	
	Yellow	Repair within 14 days	
	Red	Repair within 48 hours	

Component		Tongue Switch	Tongue Switch
Defect Description		Worn casting restraining face weld *	Worn casting restraining face ahead of tongue **
Effect on Component		Increased wheel-to-tongue "angle of attack"	Increased wheel climb potential
Measurement Parameter		Original weld profile	Original casting profile
<u>Maintenance Limits</u>	Green	1/8"	1/8"
	Yellow	3/16"	1/4"
	Red	1/4"	1/2"
<u>Response Action</u>	Green	Monitor- note on report.	Monitor- note on report.
	Yellow	Schedule repair before Red limit is reached.	Schedule repair before Red limit is reached.
	Red	Restrict vs. turnout moves, Re-weld within 24 hrs <i>* Only applies where weld has been added to casting restraining face. (Refer to sketch on next page for details of weld)</i>	Restrict vs. turnout moves. Weld within 24 hrs. <i>** Switch tongue must be replaced in conjunction with weld repair of restraining face over 1/8". (Refer to next page for details)</i>



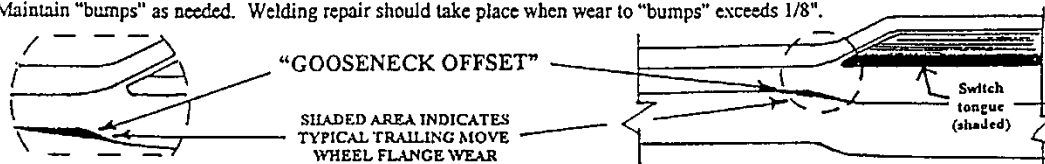
LRT213.337 -- Girder Rail Special Trackwork –Maintenance Threshold Limits

Component		Tongue Switch	
Defect Description		Tread-worn (straight moves)	
Effect on Component		Loss of lateral wheel restraint - increased climb potential	
Measurement Parameter		Top of tongue to top of cast- casting body running surface. Measure at throw rod.	
Maintenance Limits	Green	>3/8"	
	Yellow	1/4" to 3/8"	
	Red	<1/4"	
Response Action	Green	----	
	Yellow	Schedule repair before Red limit is reached.	Repair by grinding casting body running surface or by replacing tongue to achieve minimum of 3/8" restraint at throw rod as indicated in sketch below.
	Red	Restrict against turnout moves. Repair within 24 hours.	

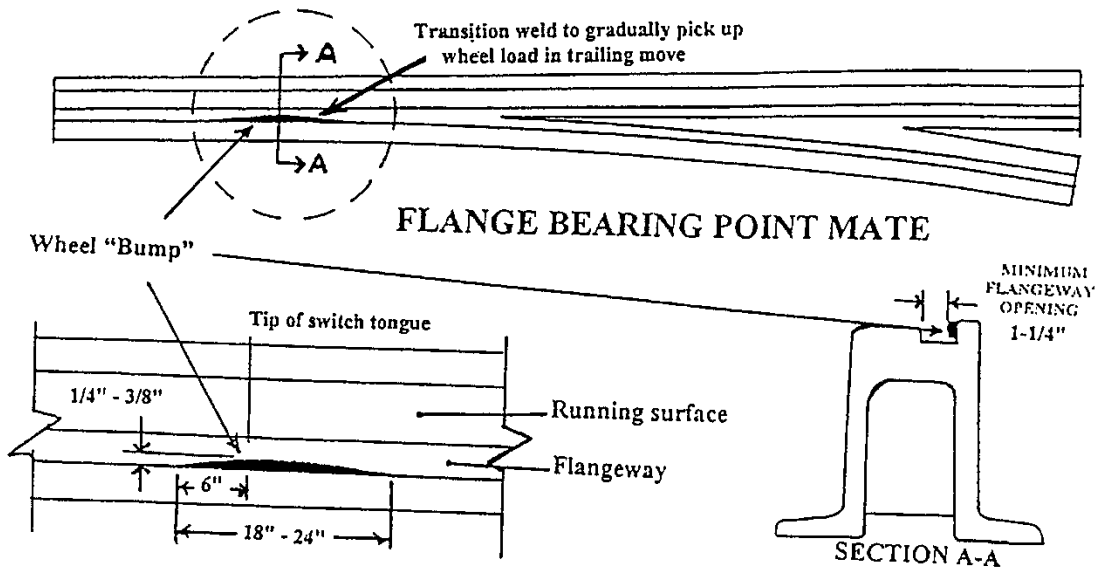


POINT MATE WELDED "BUMPS"

Use welded "bump" on point mates as indicated by details on following page. "Bumps" typically are only needed in switches 75' radius or less where required to prevent wheel of trailing axle of each truck during trailing move through switch from "clipping" gooseneck offset of tongue switch casting as shown below. Install "bumps" when wheel flange contact of tongue switch gooseneck offset is present in switches which are gaged in accordance with the criteria given in LRT213.339. Size (thickness) of "bumps" will vary according to switch manufacturer and radius. Test trains with typical wheel sets and wear should be used during "bump" installation to optimize performance of weld. "Bumps" should be no larger than what is minimally required to avoid tongue switch gooseneck offset wear. Maintain "bumps" as needed. Welding repair should take place when wear to "bumps" exceeds 1/8".

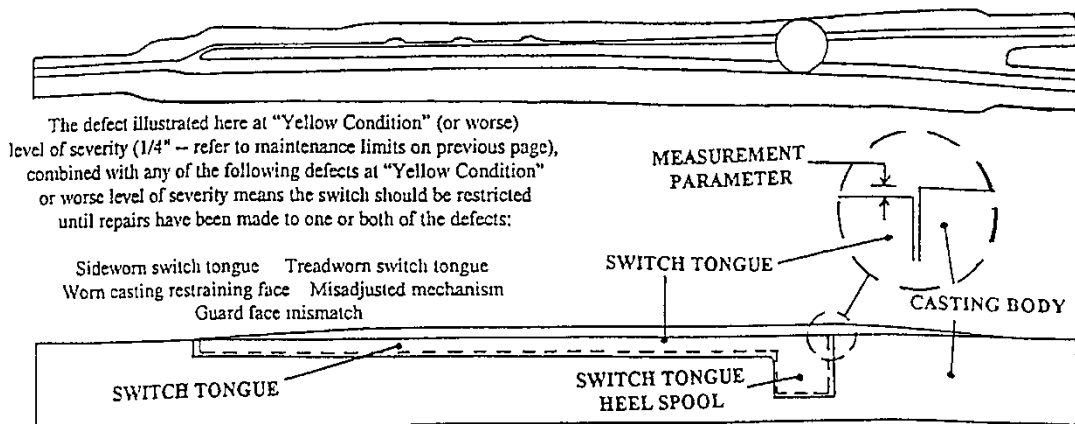


IMPORTANT: Never make a weld repair to the gooseneck offset without restoring the point mate "bump" *at the same time*. To do so will create a wheel climb situation at the offset by the trail axle in trailing point moves. Always check for proper gage.



LRT213.337 -- Girder Rail Special Trackwork Maintenance Threshold Limits

Component		Switch Tongue	Refer to sketch and table below for illustration of condition and defect severity threshold at which switch must be restricted.
Defect Description		Bottom of heel spool worn and/or floor of casting cavity worn	
Effect on Component		Tongue rocks in casting body under load	
Measurement Parameter		Running surface of tongue on spool to adjacent casting body running surface	
Maintenance Limits	Green	1/8"	
	Yellow	1/4"	
	Red	3/8"	
Response Action	Green	Monitor- note on report.	
	Yellow	Schedule for welding.	
	Red	Repair within 72 hours. Restrict if combined with other Yellow level defects as indicated.	



LRT213.337 -- Girder Rail Special Trackwork Maintenance Threshold Limits

Component		Switch Mechanism	Tongue Switch
Defect Description		Worn, damaged or missing parts	Loose, bent, stripped threads
Effect on Component		Lack of proper switch performance. (Poor spring tension)	Sloppy switch performance; inability to throw switch.
Measurement Parameter		Tongue to casting body relationship.	Tongue to casting body relationship.
<u>Maintenance Limits</u>	Green	-----	-----
	Yellow	1/8"	1/8"
	Red	1/4"	1/4"
<u>Response Action</u>	Green	-----	-----
	Yellow	Adjust within 48 hours.	Repair within 24 hours. Restrict switch at 3 mph
	Red	Repair immediately. Supervise all trains through switch.	Repair immediately. Supervise all trains through switch.

LRT213.337 -- Girder Rail Special Trackwork Maintenance Threshold Limits

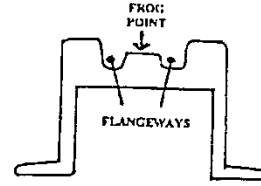
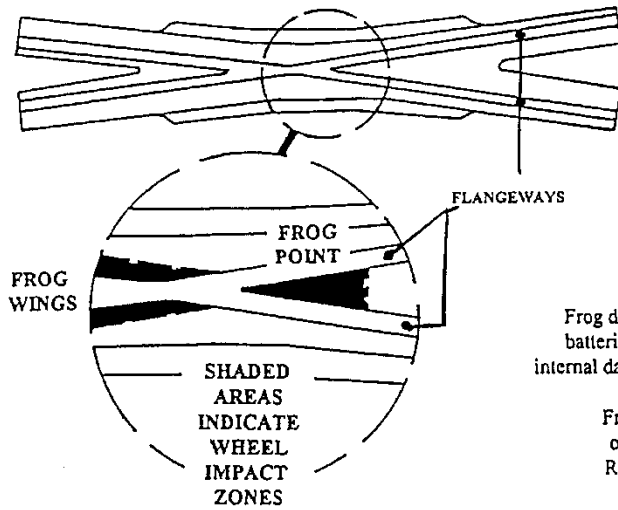
Component		Point Mate and/or flange-bearing frogs	Girder Rail				
Defect Description		Grooves in casting floor	Sidewear (gage corner) and treadwear (running surface)				
Effect on Component		Possible misdirection of train wheels – may contribute to wheel climb in combination with other factors.	Loss of rail head and gage widening (from sidewear)				
Measurement Parameter		Depth of grooves in flange-bearing area of casting floor	Original rail profile (Note: gage measurement – 1/2" down)				
<u>Maintenance Limits</u>	Green	1/8"	<u>Sidewear*</u>	1/4"	<u>Treadwear</u>	1/4"	<i>*Limited by gage maintenance criteria at LRT213.339</i>
	Yellow	1/4"		3/8"		3/8"	
	Red	>1/4"		5/8"		1/2"	
<u>Response Action</u>	Green	Monitor	Monitor				
	Yellow	Schedule for welding within 7 days.	Schedule rail change before Red limit is reached.				
	Red	Repair within 72 hours.	Rail is condemnable Remove from track.				

LRT213.337 -- Girder Rail Special Trackwork Maintenance Threshold Limits

Component		Girder Rail (also any connections to castings)	Girder Rail (also any connections)			
Defect Description		Vertical rail end mismatch	Guard face mismatch			
Effect on Component		Wheel and rail batter	Potential of wheel climb			
Measurement Parameter		Extent of wear relative to original rail profile	Actual mismatch			
<u>Maintenance Limits</u>	Green	1/8"	1/8"	** Tangent track **	1/16"	** Curved track **
	Yellow	3/16"	1/4"		1/8"	
	Red	1/4"	>1/4"		>1/8"	
<u>Response Action</u>	Green	Monitor	Monitor		Monitor	
	Yellow	Restrict speed to 10 mph. Repair within 7 days.	Restrict 10 mph. Repair within 14 days.		Restrict 10 mph . Repair within 48 hours.	
	Red	Restrict speed to 5 mph and repair within 24 hours	Restrict 5 mph. Repair within 72 hours..		Restrict 5 mph. Repair immediately.	

LRT213.337 -- Girder Rail Special Trackwork Maintenance Threshold Limits

Component		Frog	Frog	<i>Refer to sketches on following page for frog illustration.</i>
Defect Description		Battered, worn or otherwise damaged point	Breakout – Piece(s) of steel detached from frog point	
Effect on Component		Higher than normal wheel impact, damage to frog casting	Life of casting cut short – Derailment risk increased	
Measurement Parameter		Extent of wear from original frog point profile	Size and location of breakout relative to frog point	
<u>Maintenance Limits</u>	Green	1/8"	<u>Green</u> – surface cracking	
	Yellow	1/4"	<u>Yellow</u> – chipping of frog point or flangeway walls	
	Red	3/8"	<u>Red</u> – chipped back 6" or 3/8" deep	
<u>Response Action</u>	Green	Monitor, note in report.	<u>Green</u> – monitor progress of defect of defect and note in report	
	Yellow	Schedule for repair before Red limit is reached.	<u>Yellow</u> – schedule for welding or replacement	
	Red	Repair or replace within 72 hours.	<u>Red</u> – restrict speed to 6 mph and repair or replace within 24 hrs.	



SECTION THROUGH
POINT OF FROG

FROG DEFECTS

Frog defects come in the form of wear to the point and wings; battering of the point and wings leading to surface cracks and internal damage; and lipping of the gage corners into the flangeways.

Frog defects also include "break outs" or detachment of pieces of the casting steel in the point and wings. Refer to the previous page for maintenance threshold limits governing all conditions.

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LRT213.339 Girder Rail Gages and Flangeways.

Minimum gage for conventional girder rail track is 56-1/8" for tangent alignment and in curves greater than 100'R; 56-3/4" in curves <100'R. (See Pages 39 and 40 for special trackwork criteria.)

MAXIMUM TRACK GAGE LIMITS FOR CONVENTIONAL GIRDER RAIL TRACK (SEE LIMITS FOR SPECIAL TRACKWORK ON PAGES 39 and 40)				
For 149 RE7A Section Girder Guard (Flangeway = 1-3/4"):				
Track Configuration.	Design Gage	Maintenance Threshold Limits Response Actions		
		Green	Yellow	Red
Tangent and curves greater than 1000'R	56-1/2"	57" Monitor conditions.	57-1/4" Restrict speed to 15 mph. Repair within 30 days.	57-1/2" Restrict speed to 5 mph. Repair within 72 hours.
Curves 100'R –1000'R (149# rail both in & out)	57"	57-1/4" Monitor conditions.	57-1/2" Restrict speed to 15 mph. Repair within 30 days.	>57-5/8" Restrict speed to 5 mph. Repair within 72 hours.
Curves 100' R-1000' R (149# in- side, 115 or 128# outside)	56-7/8"	57-1/8"	57-3/8"	57-5/8"
		Same response actions as for curves with 149# both inner and outer rails.		
Curves less than 100'R	57-1/8"	57-1/4" Monitor conditions.	57-1/2" Restrict speed to 15 mph. Repair within 30 days.	>57-5/8" Restrict speed to 5 mph. Repair within 72 hours.

**MAXIMUM TRACK GAGE LIMITS FOR CONVENTIONAL GIRDER RAIL TRACK (SEE
LIMITS FOR SPECIAL TRACKWORK ON PAGES 39 and 40)**

For 118 GGR Section Girder Guard (Flangeway = 1-1/2"):

Track Configuration	Design Gage	Maintenance Threshold Limits Response Actions		
		Green	Yellow	Red
Tangent and curves >1000'R	56-1/2"	57" Monitor conditions.	57-1/4" Restrict speed to 15 mph. Repair within 30 days.	57-1/2" Restrict speed to 5 mph. Repair within 72 hours.
Curves 100'R – 1000'R (GGR 118 both rails)	56-3/4"	57" Monitor conditions.	57-1/4" Restrict speed to 15 mph. Repair within 30 days.	57-1/2" Restrict speed to 5 mph. Repair within 72 hours.
Curves 100'R – 1000'R (118 inside, 115 outside)	56-7/8"	57-1/8"	57-3/8"	57-5/8"
		Same response actions as for curves with GGR 118 both inner and outer rails.		
Curves less than 100'R	57"	57-1/4" Monitor conditions.	57-1/2" Restrict speed to 5 mph. Repair within 72 hours.	57-3/4" Supervise all train moves over track until repaired.

GAGE AND FLANGEWAY CRITERIA FOR 149# AND 118# GIRDER RAIL SPECIAL TRACKWORK

Within turnouts of all radii:

Rail Type	Track Location	Design Gage	Min. Gage	Maximum Gage Limits		
				Green	Yellow	Red
149 118	Entering Switch	56-5/8"	56-3/8"	56-3/4"	56-7/8"	>57"
149	Leaving Switch	57" cvd. 56-3/4" str.	56-3/4" 56-3/4"	57-1/8" 57"	57-1/4" 57-1/4"	57-3/8" 57-3/8"
118	Leaving Switch	56-5/8" cvd. 56-5/8" str.	56-5/8" 56-5/8"	57" 57"	57-1/4" 57-1/4"	57-3/8" 57-3/8"
149	Opposite Frog point	57" cvd. 57" str.	56-7/8" 56-7/8"	57-1/8" 57-1/8"	57-1/4" 57-1/4"	57-1/2" 57-1/2"
118	Opposite Frog point	56-3/4" cvd. 56-3/4" str.	56-5/8" 56-5/8"	57" 57"	57-1/8" 57-1/8"	57-3/8" 57-3/8"

Within Diamond crossings:

Rail Type	Track Location	Gage Design	Min. Gage	Maximum Gage Limits		
				Green	Yellow	Red
149	Through frog castings	56-3/4" cvd. 56-1/2" str.	56-1/2" 56-1/4"	56-7/8" 56-3/4"	57-1/8" 57"	57-3/8" 57-1/4"
149	Everywhere else	57" cvd. 56-1/2" str.	56-3/4" 56-1/4"	57-1/4" 56-3/4"	57-1/2" 57"	57-5/8" 57-1/4"
118	Throughout crossing	56-3/4" cvd. 56-1/2" str.	56-1/2" 56-1/4"	56-7/8" 56-3/4"	57-1/8" 57"	57-3/8" 57-1/4"

Response Actions for color-coded maintenance threshold exceptions in girder rail special trackwork:

Green: monitor conditions – make note of condition on track inspection report.

Yellow: restrict speed through switch or crossing to 10 mph (for radii over 100') or 5 mph (for radii 100' or less); schedule repairs to be done within 72 hours.

Red: supervise all train moves through switch or crossing until remedial measures have been taken.

Flangeway Design Criteria for Girder Rail Special Trackwork

Through diamond crossings (within frog castings) for both 149# and 118# rail:

Curved road – 1-1/2" inner and outer
Straight road– 1-3/8" both sides

Through 149# switches:

Curved road – 1-3/4" inner and outer
Straight road– 1-3/4" both sides

Through 118 # switches:

Curved road – 1-1/2" inner and outer
Straight road– 1-1/2" both sides

Flangeway maintenance threshold limits for both diamond crossings and turnouts are governed by Guard Check criteria at **LRT213.143**.

Actual flangeway width of 149# rail is 1-7/8" and of 118# rail is 1-5/8". Due to configuration of gage corners and faces of restraining (or guard) components, flangeway widths are represented as 1-3/4" for 149# rail and 1-1/2" for 118# rail for the purposes of establishing maintenance criteria.

Appendix A

Gage Maintenance Criteria for Mattapan Line.

For Tee Rail Sections Only (85 ASCE and 115 RE)

For track on the Mattapan Line and also on the Green Line, gage is measured between the heads of the rails at right angles to the rails in a plane one half of an inch (1/2") below the tops of the railheads.



GAGE MEASUREMENT FOR MATTAPAN LINE TRACK

When measuring track gage, the gage dimension is the *total* of the actual distance measured plus any apparent rail movement caused by train loading and/or any sidewear to the rail(s). As gage is measured 1/2" below the tops of the railheads, sidewear to the rails is also measured 1/2" below the tops of the railheads.

<p>Minimum track gage in Mattapan Line track is 56-1/8" (loaded condition). Train operation over track at gage less than 56-1/8" may be manually supervised (walked through) at the discretion of the M.O.W. Line Supervisor or Superintendent on site, based on their observations of train performance and their assessment of operational safety.</p>		
<p>MAXIMUM GAGE LIMITS FOR MATTAPAN LINE TEE RAIL TRACK</p>		
Track Configuration	Design Gage	Maintenance Threshold Limits Response Actions
Tangent and curves greater than or equal to 1000' Radius	56-1/2"	<p>Yellow = 57-1/8" – Restrict speed to 20 mph. Repair within 30 days.</p> <p>Red = 57-3/8" – Restrict speed to 6 mph. Repair within 72 hours.</p>
Curves less than 1000' Radius (excluding switches)	56-7/8"	<p>Yellow = 57-3/8" – Restrict speed to 20 mph. Repair within 30 days.</p> <p>Red = 57-5/8" – Restrict speed to 6 mph. Repair within 72 hours.</p>

MAXIMUM GAGE LIMITS FOR MATTAPAN LINE TEE RAIL TRACK (Continued)			
<u>Special Trackwork Criteria</u>			
Track Configuration	Design Gage	Maintenance Threshold Limits	Response Actions
Guarded switches over 100' Radius	56-7/8" curved side 56-1/2" straight side	Yellow = 57-3/8" - Red = 57-5/8" Yellow = 57-1/4" - Red = 57-1/2"	Yellow – Restrict speed to 10 mph. Repair before Red limit is reached.
Guarded switches 100' Radius or less	57" curved side 56-1/2" straight side	Yellow = 57-1/2" - Red = 57-3/4" Yellow = 57-1/4" - Red = 57-1/2"	Red – Supervise operations through switch until repairs are completed.
<p>Flangeway at cover guard to be 1-5/8"* (to gage line of double switch point thrown for straight move). Flangeway throughout rest of turnout to be 1-5/8" except one-piece guard rails opposite frogs that have flangeway of 1-3/8". Remedial flangeway work to be initiated at 1-7/8"* in turnouts. Refer to LRT213.143 for guard check criteria.</p> <p>* = Flangeway of 1-1/2" in turnouts 100'R or less. Flangeway may be reduced to 1-1/4" in special circumstances where wheel climb at outside switch point is an issue due to geometric design constraints of the turnout.</p> <p>** = Remedial flangeway work to be initiated at 1-3/4" through cover guard and 1-7/8" throughout rest of turnout in turnouts 100'R or less. Where flangeway opening has been reduced below typical, remedial work is to be initiated at 1/4" greater than original flangeway opening.</p>			
Track Configuration	Design Gage	Maintenance Threshold Limits and Response Actions	
Rail crossings (diamonds) with curves equal to or less than 100' Radius*	56-3/4" curved 56-1/2" straight	Yellow = 57-1/4" – Restrict speed to 10 mph. Repair before Red limit is reached. Red = 57-1/2" – Supervise operations through crossing until repairs have been completed.	
Rail crossings (diamonds) with curves greater than 100' Radius**	56-7/8" curved 56-1/2" straight	Yellow = 57-1/4" – Restrict speed to 10 mph. Repair before Red limit is reached. Red = 57-1/2" – Supervise operations through crossing until repairs have been completed.	
<p>* = Flangeways on curved side of crossing to be 1-1/2" throughout, both inside and out; flangeways on straight side to be 1-3/8" throughout, both inside and out.</p> <p>** = Flangeways on curved side of crossing to be 1-1/2" through frog castings inside rail, 1-5/8" through frog castings outside rail and 1-5/8" elsewhere, both inside and out. Flangeways on straight side to be 1-3/8" throughout, both inside and out.</p>			

Appendix B

Commonwealth of Massachusetts Regulations

CMR 151.11 Track Inspection

CMR 151.12 Track Maintenance

(Pages 44 through 48)

151.11: Track Inspection.

(1) Inspections.

(a) All inspections must be made according to the schedule set out in 220 CMR 151.11(2), by a person designated under 220 CMR 151.11(4).

(b) Each inspection must be made on foot or by riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with 220 CMR 151.00. However, mechanical, electrical and other track inspection devices may be used to supplement visual inspection. If a vehicle is used for visual inspection, the speed of the vehicle may not be more than five miles per hour when passing over track crossings, highway crossings or turnouts.

(c) If the person making the inspection finds a deviation from the inspection requirements the inspector shall immediately initiate remedial action.

(2) Schedule for Track Inspection.

(a) Each track inspection must be made according to the following schedule:

TYPE OF TRACK	REQUIRED FREQUENCY
Light Rail Passenger-service Track	Three times per week with at least one calendar day interval between inspections
Light Rail Yard and Storage Track Heavy Rail Yard and Storage Track	Weekly with at least three calendar days interval between inspections, or before use, if track is used less than once a week.
Heavy Rail Passenger-service Track	Twice weekly with at least one calendar day interval between inspections.

(b) In addition to 220 CMR 151.11(2)(a), any track undergoing or awaiting repair that has a speed restriction placed on it shall be inspected at a frequency that will insure safe operations at all times.

(c) Each switch, turnout, and track crossing must be inspected on foot at least weekly. In the case of track that is used less than once a week, each switch, turnout and track crossing must be inspected before it is used.

(d) In the event of fire, flood, severe storm, or other occurrence which might have damaged track structure, a special inspection must be made of the track involved as soon as possible after the occurrence.

(e) The Department of Telecommunications and Energy may require inspections at more frequent intervals in areas of dense traffic, high operating speed or questionable physical conditions.

(3) Schedule for Rail Inspection.

- (a) In addition to 220 CMR 151.11(2)(a), at least once a year a continuous search for internal rail defects must be made of all rail in all passenger-service track.
- (b) Inspection equipment, including ultrasonic rail testing equipment, must be capable of detecting defects between joint bars, in the area enclosed by joint bars.
- (c) Each defective rail must be marked with highly visible marking on both sides of the web and base.

(4) Personnel.

- (a) The Transportation Authority shall designate qualified persons to supervise restorations and renewals of track under traffic conditions. Each person designated must have:
 - 1. Experience/Education
 - a. One year of supervisory experience in railroad track maintenance, or
 - b. A combination of supervisory experience in track maintenance and training from a course in track maintenance, or
 - c. A college level educational program related to track maintenance.
 - 2. Ability to:
 - a. Understand inspection requirements
 - b. Detect deviations from the inspection requirements
 - c. Prescribe appropriate remedial action to correct or safely compensate for deviations
 - d. Procure written authorization from the Transportation Authority to prescribe remedial actions to correct or safely compensate for any deviations from the inspection requirements.
- (b) The Transportation Authority shall designate qualified persons to inspect track for defects. Each person designated must have:
 - 1. Experience/Education
 - a. At least one year of experience in track inspection, or
 - b. A combination of experience in track inspection and in-house training from a course in track inspection.
 - 2. Ability to:
 - a. Understand inspection requirements
 - b. Detect deviations from the inspection requirements
 - c. Prescribe appropriate remedial action to correct or safely compensate for deviations
 - d. Procure written authorization from the Transportation Authority to prescribe remedial actions to correct or safely compensate for any deviations from the inspection requirements pending review by a qualified person designated under 220 CMR 151.11(4)(a).
- (c) Personnel Records of designees under 220 CMR151.11(4)(a) and (b)

shall show:

1. The basis for each designation
 2. Records must be kept available for inspection or copying by the Department of Telecommunications and Energy.
- (5) Records/Reports.
- (a) The Transportation Authority shall keep a record of each track and rail inspection required to be performed; and such record shall identify the designee who performed the inspection.
 - (b) The Transportation Authority shall designate a location where each original record shall be maintained for at least one year after the track inspection covered by the track inspection record. The Transportation Authority shall retain a rail inspection record for at least two years after the rail inspection and for one additional year after remedial action is taken.
 - (c) Track Inspection Records and Rail Inspection Records shall be:
 1. Prepared on the day the inspection is made
 2. Signed by the person making the inspection.
 - (d) Inspection Records must specify:
 1. The track or rail inspected
 2. The date of inspection
 3. Location of any deviation
 4. Nature of any deviation from the established track standards
 5. Remedial action taken by the person making the inspection.
 - (e) Records must be kept available for inspection or copying by the Department of Telecommunications and Energy.

151.12: Track Maintenance.

- (1) Unless otherwise structurally supported, all track must be supported by ballast material which will:
 - (a) Transmit and distribute the load of the track and railroad rolling equipment to the subgrade
 - (b) Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails
 - (c) Provide adequate drainage for the track
 - (d) Maintain proper track crosslevel, surface, and alignment.
- (2) Crossties shall be made of a material to which rail can be securely fastened.
 - (a) Each 39-foot segment of track shall have a sufficient number of crossties which in combination provide effective support that will maintain gage, surface, and alignment.
 - (b) The minimum number and type of crossties specified in 220 CMR 151.12(3) effectively distributed to support the entire segment; and at least one crosstie of the type specified in 220 CMR 151.12(3) that is located at a joint

location.

- (3) Each 39-foot segment of track shall have the minimum number and type of crossties as indicated in the following table:

MAXIMUM TRACK SPEED	MINIMUM NUMBER OF TIES	
	Tangent Track*	Curved Track**
15 miles per hour	5	6
25 miles per hour	8	9
60 miles per hour	8	10

* Track that is straight or has a radius curve greater than 1000 feet.
 ** Track having a radius curve measuring less than 1000 feet.

Crossties required shall be of the type which are not:

- (a) Broken through
- (b) Split or otherwise impaired to the extent the crossties will allow the ballast to work through, or will not hold spikes or rail fasteners
- (c) So deteriorated that the tie plate or base of rail can move laterally two inches relative to the crossties, or
- (d) Cut by the tie plate (or rail base) through more than 15% (nominally 1 1/8") of a tie's thickness.
- (e) For track constructed without crossties, such as slab track, track connected directly to bridge structural components and track over servicing pits, the track structure must meet the requirements of 220 CMR 151.12(3) in regards to gage restraint, rail support, surface and alignment.

- (4) Gage is measured between the heads of the rails at right-angles to the rails in a plane 5/8 of an inch below the top of the rail head.

- (5) Gage must be within the limits prescribed in the following table:

MAXIMUM TRACK SPEED	MINIMUM TRACK GAGE	MAXIMUM TRACK GAGE
10 miles per hour	56"	58"
60 miles per hour	56"	57 3/4"

- (6) Each rail joint, insulated joint, and compromise joint must be of the proper design and dimensions for the rail on which it is applied.
- (7) If a joint bar is cracked, broken, or because of wear allows excessive vertical movement of either rail when all the bolts are tight, it must be replaced.
- (8) If a joint bar is cracked or broken between the middle two bolt holes it must be replaced.

(9) In the case of conventional jointed rail in passenger-service track, each rail must be bolted with at least two bolts at each joint. Yard and storage track joints must be bolted with at least one bolt on each rail.

(10) In the case of continuous welded rail (CWR) track, each rail must be bolted with at least two bolts at each joint used to connect CWR strings or to connect CWR to conventional rail.

(11) Each joint bar must be held in position by track bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations.

(12) When any condition in 220 CMR 151.12(9) and (10) is not satisfied, an operating restriction must be put in place immediately until the condition is satisfied. The Transportation Authority shall notify the Director of the Transportation Division of the Department of Telecommunications and Energy of the imposition or removal of an operating restriction within 48 hours of said action.

REGULATORY AUTHORITY

220 CMR 151.00: 49 U.S.C. 5330, 49 C.F.R. 659, M.G.L. c. 161A, § 3(i).

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