Metrolinx Track Standards – Heavy Rail

(Formerly: GO Transit Track Standards)

RC-0506-02 TRK

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Metrolinx Track Standards - Heavy Rail

RC-0506-02TRK

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Preface

This is the first edition of the Metrolinx Track Standards – Heavy Rail, RC-0506-02TRK April 2025. It supersedes the GO Transit Track Standards (GTTS) May 2018 and associated bulletins. This edition includes the incorporation of the Recommended Methods, lessons learned from Standard Deviations and Engineering Exceptions, updates to track design and excavation requirements, the addition of At-Grade Crossing inspection requirements, new inspection requirements for operating over skeleton track, as well as re-ordering of clauses, minor modifications, and removal of electrification requirements.

The Metrolinx Track Standards RC-0506-02TRK document is for use by all involved in the design, construction and maintenance of Metrolinx owned track. It is intended for use by suitably qualified professionals familiar with the subject matter.

This document was developed by Metrolinx, Engineering – Track within the Asset Management and Maintenance (AMM) Division.

Suggestions for revision or improvement can be sent to TrackEngineering@metrolinx.com, Attention: Director, Engineering—Track, who may introduce the proposed changes to the Metrolinx Track Standards Committee. The Director, Engineering—Track ultimately has the deciding vote. Include a description of the proposed change, background of the application and any other useful rationale or justification. Proposals shall include your name, company affiliation (if applicable), email address, and phone number.

April 2025

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1.1 Definitions

Table 1-1 Definitions

Term	Definition
Alignment	Maybe interpreted in two distinct contexts: Track Alignment: Refers to the horizontal configuration of the track as observed in plan view, encompassing tangents, curves, and spirals. It defines the position and route of the track on a horizontal plane. Alignment as a Geometry Condition: Refers to deviations from the intended straightness or uniformity of the rails, indicating irregularities in track geometry.
Ambient Temperature	Air temperature as measured by a thermometer, not including humidity or wind chill.
At-Grade Crossing	An intersection where a road, path, or railway crosses railway tracks at the same level.
Ballast Cars	A hopper-style rail car (rolling stock) distributes ballast from the underside of the rail car.
Ballasted Track	A section of track where the tie cribs and shoulders are comprised of consolidated track ballast, which provides adequate vertical, lateral, and longitudinal restraint of the rail.
Box Anchoring Pattern	Rails secured with four (4) anchors per tie, one (1) anchor on each rail on either side of the tie.
Class of Track	The maximum allowable train speed on a subdivision, or portion thereof, must be used to determine the class of track per the table in Track Standard Appendix A.
Closure Weld (Puller Assisted)	The final weld joins and adjusts the two rail ends of CWR together.
Compromise Joint Bars	Rail joint bars connecting rails of different weights and sections.
Compromise Forged Rails	Consists of a single piece of rail, with a forged transition from one rail section to another. Compromise Forged Rails may be universal or “handed,” depending on the rail sections, and are identified just as a joint would be.

Term	Definition
Compromise Transition Rail	A special rail rolled to different rail sections at each end and with reduced rail head through grinding or by other means to provide an adequate transition between different worn rail sections.
Continuous Welded Rail (CWR)	Rail that is welded into lengths of 400 ft (122 m) or greater.
Canadian Rail Operating Rules (CROR)	Canadian Rail Operating Rules
Corrugation	A repetitive longitudinal pattern of shallow wavelike depressions along the rail surface.
Cross Level	The measurement for cross-level must be the difference in elevation, in mm or inches, between the grade rail and the opposite rail, measured at right angles with a level board or track geometry tool.
Crossover	A track connection between two adjacent tracks allows equipment to cross from one track to another.
Crushed Head	A short length of rail, not at a joint, which has sagged across the width of the rail head. Unlike flattened rail, where the depression is visible on the rail head only, the sagging is also visible in the head area. Refer to Appendix H.
Deflector	A safety device installed along the track, designed to prevent dragging equipment from becoming entangled with track components or other critical infrastructure.
Destressing Rail	The operation of removing or adding steel in CWR, to make the longitudinal thermal stress equal (within specified limits) to what it would be if laid stress-free at the Preferred Rail Laying Temperature. Refer to Track Standards Section 4.9.
Detailed Inspection	A thorough documented inspection performed on foot to assess the condition of all track infrastructure and Right-of-Way components.
Diamond (At-Grade Rail-to-Rail Crossing)	An intersection of two tracks at grade with no connecting route between the two tracks.

Term	Definition
Direct Fixation Track (DF)	A type of non-ballasted track with nearly all of the major components easily visible and accessible for inspection and maintenance. As compared to traditional ballasted track, in DF track, the rails are directly secured to a concrete slab eliminating the requirement for ballast and ties.
Double Slip Switch	A combination of a moveable-point crossing and two turnouts interconnected into one assembly. The turnout switches are located between the end frogs of the crossing. A movement entering from any facing point track has the ability to operate to either of the two trailing point tracks.
Dye Penetrant Testing	A non-destructive testing and inspection method, also known as Liquid Penetrant Testing, used to detect surface flaws in material with the use of a cleaner solvent, liquid penetrant, and a developer.
Electric Flash Butt Weld	A process of fusing rail ends together using electric current. Electric Flash butt welds provide a field weld superior to field thermite welds and is always preferred over thermite welds.
Employee	A person qualified in regulatory and company standards employed or contracted by Metrolinx. This definition applies to contract Employees and Employees of other companies and railways operating and/or performing other duties related to these track standards on the host railway trackage.
End of Track Device	A device at the end of a track to prevent rolling stock from going off the ends of the rails.
Engine Burn	Damage to the running surface of the rail caused by a slipping wheel. Refer to Appendix H.
Engineer	A qualified person who practices engineering in the province of Ontario and is licensed by the Professional Engineers Ontario (PEO).
Field Weld	An in-track or track-side welding process for joining two rail sections, typically by thermite welding or flash butt welding.
Fire Watch	A person assigned to observe a location during and after hot work.
Fixed Point	Refers to infrastructure that serves as a reference for various operational and engineering purposes. Examples of Fixed Points include but not limited to open deck bridges, at-grade road crossings, direct fixation, and end of track.
Flange Wear (Gauge Wear)	The reduction in head width of the rail on one side compared to the nominal rail section. It is measured 5/8 in (16 mm) below the top of the rail head. Refer to Appendix G for rail wear limits.

Term	Definition
Flattened Rail (also known as Localised Surface Collapse)	A short length of rail, not at a joint, which has flattened out across the width of the rail head. Flattened rail occurrences have no repetitive regularity and thus do not include corrugations and have no apparent visual cause, such as a weld or engine burn. Refer to Appendix H.
Frog	A track structure used at the intersection of two running rails to provide support for wheels and a passageway for their flanges, thus permitting wheels to transition from one track to another track.
Gauge	The perpendicular measurement between the gauge faces (inner sides) of the two running rails of the same track taken at 5/8 in (16 mm) below the top of the rail head.
Grade Crossing Standards	Road/Railway Grade Crossings: Technical Standards and Inspections, Testing and Maintenance Requirements, established by the Department of Transport (Transport Canada), and the GO Transit Grade Crossing Design Standard as amended from time to time.
Grinding/Milling Supervisor	Worker overseeing the rail grinding and milling operation with special knowledge of the track performance at a specific location or over a specific area.
Guard Rail	A rail installed on bridges, high embankments, and other designated locations as a safety appliance. It is intended to contain and guide derailed rolling stock, keeping the vehicle upright on the track structure.
Head Wear (Vertical Wear)	Also known as loss of vertical height, is the reduction in the total height of the rail compared to the nominal rail section, measured in the center of the head of the rail. Refer to Appendix G for rail wear limits.
Heavy Geometry Inspection Vehicle (HGIV)	A heavy vehicle with equipment capable of testing track geometry, rail wear and rail flaws under loaded conditions. As such, measurements obtained with this vehicle are considered dynamic geometry measurements representative of the track in a loaded condition.
Hot Work	Any work involving a source of ignition, such as grinding, cutting of rail, field welding, etc.
Insulated Joint (Bolted and Glued)	A rail joint in which electrical insulation is provided to stop electrical current from flowing from one rail to another, separating sections of track into distinct circuits for signal shunting and operation of signal system and crossing protection.
Interlocking	An arrangement of interconnected signals and signal appliances for which interlocking rules and special instructions are in effect.

Term	Definition
Joint	Locations where two rail ends meet and are connected with joint bars.
Light Geometry Inspection Vehicle (LGIV)	A vehicle with equipment capable of testing track geometry and gauge under unloaded conditions.
Match Marks	Match marks are placed on the base of the rail extending onto the tie plate, switch plate or clip holder, on an unanchored or unclipped track tie. Used when releasing the rail to determine the rail neutral position of the rail (field side reference marks) and the rail movement during the destressing process (gauge side match marks). Refer to Track Standards Section 4.9.
Million Gross Tons (MGT)	The total weight that travels over a section of track.
Movement Over Rail Breaks	A course providing training to authorize a person in Movement Over Rail Breaks capacity as defined by Rules Respecting Track Safety of Transport Canada and Metrolinx Track Inspection Guidelines Competency Management Procedure.
Multi-Use Path (MUP)	A path designed to accommodate the movement of pedestrians and cyclists.
New Rail	Is rail that has never been in service.
Out-of-Face Rail Replacement	Continuous rail replacement/relay programs more than 200 ft (61.0 m) in length where rail conditions nearing the end of service life are replaced with mechanized equipment.
Out-of-Face (Continuous) Surfacing	The continuous raising of track to restore track surface, cross-level, and alignment.
Out-of-Face Tie Replacement	Continuous replacement of six (6) or more ties in a 39 ft (11.9 m) section, or four (4) or more consecutive ties in a 39 ft (11.9 m) section.
Partial Worn Rail (PW)	Is rail that has been in service.
Plug Rail	Spot/localized rail replacement used for preventative track maintenance and/or to remove a rail defect from the parent rail.
Positive Protection	The track(s) is protected in accordance with CROR Protection of Track Work (Rules 41, 42, 841, and 842) or Track Occupancy Permit (TOP Rules 849 to 864 inclusive).
Preferred Rail Laying Temperature (PRLT)	The target installation temperature of welded rail in a particular area. See Track Standards Section 4.7.

Term	Definition
Preferred Rail Laying Temperature Range (PRLTR)	The tolerance or range for the PRLT. See Track Standards Section 4.7.
Rail	A long rolled steel section used as a running surface for equipment and track units.
Rail Bound Manganese (RBM)	Refers to manganese steel used in Special Trackwork components such as frogs, switches, and crossings. Manganese steel is known for its high toughness, wear resistance, and ability to withstand impact.
Rail Grinding	A process that involves removing metal from the rail surface using rotating grinding wheels (stones). Rail grinding is usually performed by production rail grinders, or switch and crossing grinders.
Rail Laying Temperature (RLT)	The actual rail temperature at which the CWR is installed.
Rail Milling	A spark and dust-free rotational cutting process where metal is cut out of the rail surface in the form of chips through the use of cutter heads, which consist of carbide inserts.
Rail Neutral Temperature (RNT)	The actual rail temperature at which the rail is neither in tension nor compression.
Railway (Metrolinx)	A company that operates and/or dispatches trains within their corresponding right-of-way.
Rail Seat	The flat area of ties where the rail is supported and secured to the tie.
Rail Temperature	The temperature of the rail.
Reference Marks	A pair of vertical lines located on the field side web of the rail, each placed to a minimum of 5 ft (1,524 mm) away from a Thermite Field Weld, joint or planned rail cut, at opposite ends of a rail repair, used to check whether rail was added or removed from track. See Track Standards Section 4.9.
Restraining Rail	Rail installed on the gauge side of the low rail through a high degree curve to improve vehicle curving performance. Their primary function is to prevent wheel climb and reduce accelerated rail wear on the high rail by restraining the lateral movement of the wheels from riding up the high rail.

Term	Definition
Right-of-Way (ROW)	Is any Metrolinx-owned land on which a railway line is situated, including yard tracks, sidings, and spurs, including up to the fence line or, if there is no fence at a station, up to the further platform edge.
Rolling Contact Fatigue (RCF)	A type of fatigue damage caused by repeated wheel-rail contact cycles that overstress the rail, leading to surface and subsurface defects such as head checks, shelling, and spalling.
Routine Inspection (Regulatory Inspection)	A regulated visual inspection to assess the general condition of the track infrastructure and ROW, and to identify any defects.
Rules Respecting Track Safety of Transport Canada.	Rules prescribe minimum safety requirements for federally regulated standard gauge railway track, and set limits and certain track conditions, both isolated and combined, for safe operations.
Running Rail	Rail carrying all vertical loads of railway vehicles and equipment.
Special Trackwork	A general term used to describe all track hardware that is not standard tie-and-ballast track. Special Trackwork includes turnouts of all sizes, single and double slip switches, and at-grade rail-to-rail crossings (diamonds).
Spot (Non-continuous) Surfacing	Restoring the track surface, cross-level, and alignment through short stretches of track, not more than 19 ft 6 in (5.944 m) in length, when a continuous raise is not necessary.
Spot Tie Replacement	Targeted maintenance activity replacing select defective ties based on inspections.
Superelevation	The amount by which the outer rail of a curve is banked above the inner rail. The amount of cross-level is changed by raising the outer rail (line rail/high rail) of a curve when compared to the inner rail (low rail/grade rail). Superelevation is designed for speed and degree of curve.
Thermite Weld	A process that employs molten metal to permanently join the rail ends. The process utilizes an exothermic reaction of a thermite composition to heat the metal and requires no external source of heat or current.
Tie Crib	The area between ties in which ballast is placed.
Track Buckling	The lateral misalignment of the track structure due to excessive compressive forces in the rail.

Term	Definition
Track Inspection Guidelines (TIG)	A training course to train and qualify a person in Track Inspector capacity as defined by Rules Respecting Track Safety of Transport Canada and Metrolinx Track Inspection Guidelines Competency Management Procedure.
Track Inspector	An Employee who is considered qualified as per the Metrolinx Track Inspection Guidelines and complies with Track Standards Section 2.2.2. Qualified means having undergone and passed a theoretical examination of approved training and an in-field practical examination specific to the role and all applicable competency compliance procedures.
Track Lead	A Track Supervisor or a Track Inspector responsible for overseeing the regulatory compliance of an assigned territory.
Track Occupancy Permit (TOP)	A regulatory required permit that ensures there is no conflicting movement within, or authorized to enter, the TOP limits to be granted unless such movement has been restricted.
Trained	Having undergone and passed approved training specific to the role and passed the required knowledge assessment(s).
Transition Rail	A special rail, which has its rail head reduced through grinding or other means to provide an adequate transition between new and worn rail. This is occasionally referenced as a shaved rail.
Turnout	A track structure by means of which rolling stock and equipment are diverted from one track to another.
Ultrasonic Rail Flaw Testing (UTT)	A non-destructive method of testing the internal structure of rail through the use of high-frequency sound waves.
Unballasted Track	A section of track where the tie cribs do not contain consolidated track ballast and the ballast profile is non-compliant with GTS-2205.
Vmax	The maximum speed permitted based on the degree of curve, superelevation, and unbalance.
Walking Inspection	An inspection performed on foot to assess the general condition of the track infrastructure and ROW.
Weld Repair Bars	Temporary use of joint bars, with slotted bolt boles and relief to accommodate welds, for the purpose of aligning rail ends at field welds to allow the passage of trains.
Winter	The period of time between November 15th and March 15th annually.

Term	Definition
Yard	A system of non-main tracks, utilized to switch equipment and for other purposes over which movements may operate subject to prescribed signals, rules and special instructions.
Yard Track	A track found in Yards used for various functions related to the storage, sorting and maintenance of equipment.

1.2 Abbreviations

Table 1-2 List of Abbreviations

Abbreviation	Definition
CWR	Continuous Welded Rail
CROR	Canadian Rail Operating Rules
CWZ	Continuous Work Zone
DF	Direct Fixation Track
DP	Dye Penetrant
E&AM	Engineering & Asset Management
GDP	Ground Disturbance Permit
GEI	General Engineering Instructions
GIMP	Geotechnical Instrumentation and Monitoring Plan
GOI	General Operating Instructions
HGIV	Heavy Geometry Inspection Vehicle
LGIV	Light Geometry Inspection Vehicle
MGT	Million Gross Tons
MUP	Multi-Use Path
PW	Partial Worn Rail
PRLT	Preferred Rail Laying Temperature
PRLTR	Preferred Rail Laying Temperature Range
PEO	Professional Engineers Ontario
RBM	Rail Bound Manganese
RCF	Rolling Contact Fatigue
RLT	Rail Laying Temperature
RNT	Rail Neutral Temperature
ROW	Right-of-Way
SPMDD	Standard Proctor Maximum Dry Density
TIG	Track Inspection Guidelines
TOP	Track Occupancy Permit
UTT	Ultrasonic Rail Flaw Testing
WPM	Workplan Methodology

2 Introduction

2.1 General

2.1.1 The Standards, practices, and procedures contained herein must be followed to ensure the safety of the Railway and to comply with regulations.

2.1.2 The maintenance and construction standards and practices contained herein must apply to all heavy rail track and ROW owned or operated by Metrolinx (“the Railway”) and UP Express, which is a division of Metrolinx.

2.1.3 These Standards are intended to comply with Transport Canada (TC) Rules Respecting Track Safety; however, in the event of conflict, the more restrictive requirement must apply.

2.1.4 Changes in railway standards or practices that do not conflict with TC standards may be implemented on a phased schedule or program, at the discretion of the Director, Engineering–Track.

2.1.5 All new or modified track material or equipment must be subjected to review and approval in writing by the Director, Engineering–Track.

2.1.6 The most current version of the Metrolinx Track Standards and all applicable bulletins must be located on the Metrolinx Engineering website at https://www.metrolinx.com/en/metrolinx-technical-standards, under the title “Metrolinx Track Standards.”

2.1.7 The most current version of the Metrolinx Track Standards RC-0506-02TRK is intended for use by suitably qualified professionals. It is not a substitute for coordination and compliance with all applicable local codes, standards, manuals, and approvals for fire protection, life safety, and security measures that are part of the planning, design, and implementation of a railway.

2.2 Track Standards

2.2.1 The Standards within this document are the requirements for constructing, inspecting, and maintaining heavy rail track owned and operated by Metrolinx (“The Railway”). Conditions on track must meet or exceed the minimum requirements laid out in this document. Where conditions on track do not comply with these requirements, immediate action must be taken to:

a) Bring the track back into compliance as per the standards (e.g. protect, repair, speed restriction, etc.); or

b) Remove track from service until the minimum required repairs can be completed.

c) Prior to removing a speed restriction, an inspection must be completed to confirm the condition was repaired; and

d) In addition to the above requirements, the Maintenance Delivery–Manager of Track must be notified immediately.

2.2.2 All Employees responsible for the maintenance, rehabilitation, construction, and/or inspection of track owned and maintained by Metrolinx, must comply with Metrolinx Track Inspection Guidelines Competency Management Procedure, including:

a) Minimum Training Requirements; and

b) Must demonstrate competency compliance in intervals not exceeding 365 calendar days.

2.2.3 All Employees responsible for regulatory inspection of track owned and maintained by Metrolinx, must be trained in Movement Over Rail Breaks in addition to the requirements of Track Standard 2.2.2.

2.2.4 All Employees responsible for the inspection, installation, adjustment, or maintenance of CWR track must be trained and pass a qualifying test on CWR Procedures.

2.2.5 Safety is the most important aspect of any job. Understanding and following safety rules and safe work practices is a condition to work on Metrolinx ROW. When in doubt, Employees must take the safest course of action.

2.2.6 The requirements outlined in Metrolinx Critical Task Checklist & Validation (RC-0404-01) must be followed for all critical maintenance tasks.

3 Electrification Requirements

3.1 General

3.1.1 The content of this section has been removed in this revision of the document. Revised requirements will be developed in consultation with appropriate stakeholders and will be incorporated into this document in subsequent revisions.

4 Rail

4.1 Rail Identification

4.1.1 Rail branding is the raised letters and numbers along the web of the rail. Rail stamping is on the opposite side of the web and has indented letters and numbers.

4.1.2 Branding identifies the rail weight, section, manufacturing method, manufacturer, year, and month rolled.

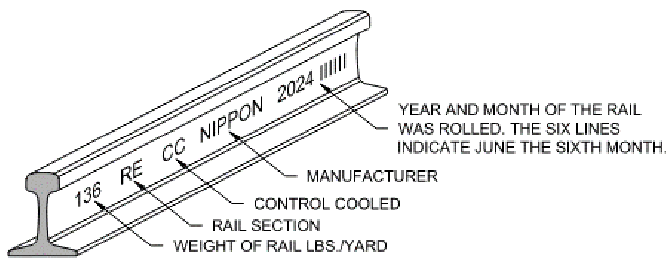


Figure 4-1 Branding Descriptions

4.1.3 Stamping provides traceability to the manufacturing process and can include hardening, heat number, ingot number, rail sequence, and rail type.

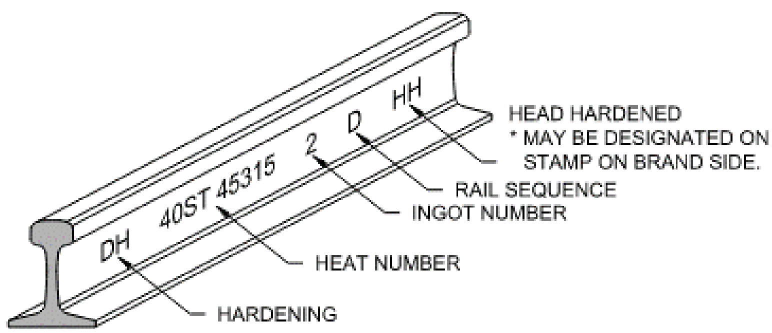


Figure 4-2 Stamping Description

4.1.4 The branding code in Table 4-1, identifies the manufacturing process of rail.

Table 4-1 Branding Codes

Branding	Manufacturing Process
MACKIE, MRC, RC	Control Cooled
CC	Control Cooled
CH	Control Cooled and End-hardened
BC	Control Cooled Blooms
VT	Vacuum Treated – Control Cooled
OP	Other Practices
OH	Open Hearth

4.1.5 Rail identified with stamping as in Table 4-2, must not be put back in track.

Table 4-2 Rail Information

Manufacturer	Stamping	Chemistry
ALGOMA	Cr	Chrome
	CrV	Chrome / Vanadium
	CrVMo	Chrome / Vanadium / Molybdenum
Colorado Fuel and Iron Company (CF&I)	CROMO	Chrome / Molybdenum
	HI SI	High Silicon
Hayange (HAY)	SACILOR – CrSiV	Chrome / Silicon / Vanadium
Klockner - AL	Blank	Chrome / Vanadium
Krupp – AL	Blank	Chrome / Vanadium
Sydney (pre-1976)	HS	High Silicon
Sydney (post-1976)	CS	High Silicon
Sydney	SYSCO – CrCb	Chrome / Niobium
	SYSCO – CrMo	Chrome / Molybdenum
	SYSCO – CrSiV	Chrome / Silicon / Vanadium
Thyssen – AL	Blank	Chrome / Vanadium
Wheeling Pitt	WR	Chrome / Silicon

4.1.6 Rail Hardness is identified by branding or stencilling, as shown in Table 4-3.

Table 4-3 Rail Hardness Branding Information

Branding	Rail Hardening	Branding	Rail Hardening
Blank	Standard Strength (310BHN)	IHHS	Int. Hardness High Strength (350BHN)
SS	Standard Strength (310BHN)	HH	Head Hardened (370BHN)
3HB	Standard Strength (310BHN)	FHH	Fully Head Hardened (370BHN)
IH	Intermediate Strength (350BHN)	DHH	Deep Head Hardened (370BHN)

4.1.7 Rail manufacturers and brands of rails, shown below in Table 4-4, can be reused in track. For rails not found in Table 4-4, they can be reused if approved in writing by the Director, Engineering-Track.

Table 4-4 Rail Manufacturer Information

Manufacturer	Stamping	Type	Manufacturer	Stamping	Type
STN (Cleveland-Cliffs Steelton)	IS / IH / HH	IS / IH / HH	NIPPON (Nippon Steel & Sumitomo Metal Corporation)	DH 340	IH
				DH 370	HH
SDI (Steel Dynamics)	IS / HH	IS / HH		HE 370	HH
ERMS Legacy: EVRAZ USA, RMSM, CF&I, Colorado	IS / HH	IS / HH		HE 400	HH
	DH 390	HH		HEX	HH
	ISHH	IHHS	TZ (Czech / Moravia)	IH	IH
	HCP	HH	ENSIDESA (ArcelorMittal Spain)	IH / LH / HH	IH / LH / HH
	OCP	HH			
			JFE Legacy: NKK	IH / HH	IH / HH

4.1.8 Legacy rail manufacturers and brands of rails that may exist in track are shown in Table 4-5 below.

Table 4-5 Legacy Rail Manufacturers

Manufacturer	Stamping	Type	Manufacturer	Stamping	Type
Algoma	ALGOMA	SS	INLAND	Blank	SS
			International Steel Group	Blank	SS
				Blank	HH
			KLOCKNER	Blank	SS
Bethlehem Steel	FT	FHT	KRUPP	Blank	SS
	HH	HH	Lackawanna	Blank	SS
	MH	SS		Blank	SS
			NKK	NHH	HH
British Steel	FT	HH		SP	HH
			PST (Penn Steel)	PST	SS
Colorado Fuel and Iron Company (CF&I)	IS	HH	PST (HH)	PST	HH
	HH	HH	SYDNEY	Blank	SS
	DH 390	HH	TATA	Blank	SS
	SS	SS	TENNESSE	Blank	SS
Colorado	Blank	SS	THYSSEN	HH	HH
Dominion	Blank	SS		Blank	SS
Dosco	Blank	SS	Vilru	Blank	SS
HAY (Hayange)	Blank	HH	WP (Wheeling Pitt)	MH	SS
ILLINOIS	Blank	SS			

4.2 General Requirements

4.2.1 Scrap rails must be clearly marked with an X of red paint at regular intervals not exceeding 15 ft (4.6 m) to differentiate them from reusable rails.

4.2.2 Scrap rail less than 4 ft (1,219 mm) in length must be removed from the railway ROW at the end of every shift and/or before leaving the site.

4.2.3 Rails used in main track tangents must not be less than 15 ft (4.6 m) long. Rails used in main track curves must not be less than 19 ft 6 in (5.9 m).

4.2.4 When cutting rail, the saw cut must be made:

a) With a saw properly secured to the rail;

b) Square and perpendicular to the rail axis with a variation not to exceed 1/8 in (3 mm);

c) Centered in the crib, if possible, at least 4 in (102 mm) from the side of the tie;

d) No closer than 4 in (102 mm) from any torch mark or drilled hole in the rail; and

e) If a field or flash butt weld is being cut out, make the cut at least 4 in (102 mm) away from the weld to remove the heat-affected zone.

4.2.5 All saw-cut rails, including rail currently in track, must have the exposed ends tested for defects with Dye Penetrant.

4.2.6 Rail having cuts or holes made with an oxy-acetylene torch, an electric arc, or thermal methods must not be used in track unless being cropped for use per Track Standards Section 4.10.10.

4.2.7 Rail must not be struck with a spike maul, steel hammer or similar tool.

4.2.8 Any burrs, fins and sharp edges must be removed after each rail drilling operation using a deburring tool.

4.2.9 Rail for replacements under relay programs must be in accordance with Appendix P.

4.2.10 New rail and new Special Trackwork must be free from rail profile irregularities.

4.3 Plug Rail

4.3.1 Rail used as a Plug Rail must be a minimum rail length of 15 ft (4.572 m) in tangent track or 19 ft 6 in (5.944 m) in curves, or a combination of rail lengths not exceeding 200 ft (61.0 m).

4.3.2 Rail must be inspected to determine suitability for future use. Rail removed, which is planned for local reuse, must be inspected and marked for use in specific tracks.

4.3.3 Rail from rail relays suitable for Plug Rails must be retained. Previously worn rails kept for spot renewals must:

a) Have the last Ultrasonic Rail Flaw Testing (UTT) date and estimated tonnage since the test, written on the web of the rail;

b) Rail which has not been UTT tested and rail with greater than 175 days since the last UTT test must be segregated from rail which has been tested. If required, space rail adequately to allow for UTT testing as per Track Standards Section 18.4. Rail that has been UTT tested must be clearly marked;

c) Have the vertical head wear and gauge wear values, as well as Plug Rail length, written on the top of the head of the rail;

d) Scrapped rail must be clearly marked and separated from reusable rail;

e) Plug Rail must be free from any welds; and

f) Be neatly stacked above grade by rail section and metallurgy. For rail stands along the ROW, ensure the area allows accessibility year-round but doesn't interfere with operations.

4.3.4 Rail used for replacement or plugs in track must have gauge face and vertical head wear mismatch values within maximum allowable limits as identified in Track Standards Section 4.6 and Appendix G.

4.3.5 When removing rail defects by replacing with a Plug Rail, the following conditions must be adhered to on main tracks containing CWR:

a) The Plug Rail must be UTT tested and marked per Track Standards Section 18.4. All rail that is saw cut must have the exposed ends tested for longitudinal defects with Dye Penetrant.

b) Gauge face and vertical headwear must be within the limits prescribed in Appendix G;

c) Must have gauge face and vertical head wear mismatch within maximum allowable limits identified in Track Standards Section Track Standard Section 4.6 and Appendix G.

d) Must have hardness equal to, or better than, the parent rail (e.g. if the replacement is in a curve and the parent rail is a head-hardened rail, then the Plug Rail must also be head-hardened);

   i. The following rail chemistries must not be reinstalled:

      1) British, Workington, Vilru, or Bethlehem FT;

      2) Any of the rails listed in Table 4-2;

      3) "A" rail (rails with the letter "A" in the heat number; and

      4) "OH" rail (Open-Hearth);

e) Types of rail are (does not apply to insulated glued joints):

i. Standard carbon (referred to as 3HB or 310 Brinell Hardness);

ii. Intermediate hardness (350 Brinell Hardness); and

iii. Head-hardened (370 Brinell Hardness).

f) If the correct type of rail is unavailable, item e of the above standards must be modified as follows:

i. A Plug Rail of a different type may be installed on a temporary basis. This temporary Plug Rail must not be welded into track. The Maintenance Delivery—Manager of Track must be notified in writing upon installation of temporary plug rail.

ii. The temporary Plug Rail must be removed within 60 days of installation and replaced with a Plug Rail meeting the condition criteria of items a, b, c, d and e above.

4.4 Handling and Unloading Rail

4.4.1 Only industry-approved and certified rail tongs and grapples can be used for loading, unloading, and distributing rail.

4.4.2 Dragging rail along the track is prohibited unless all the following conditions are met and permission is obtained in writing from the Director, Engineering—Track:

a) A thorough job briefing and field-level assessment are conducted;

b) The Employees have a means of radio or cell phone communication;

c) Employees conducting the activity must have readily available a list of phone numbers for fire-fighting agencies;

d) The Employees are equipped with water and fire extinguisher foam in accordance with Track Standards Section 23;

e) Any open deck bridges must be wetted down prior to making the move, and rollers must be used to prevent damage to the ties;

i. Extra caution must be taken to prevent damage to the guard rails and the fastening system.

f) At least two (2) Employees must remain on site to monitor the site until they are certain there is no fire risk;

g) The rail is not dragged faster than 3 mph (5 km/h);

h) The rail must be dragged on the base of the rail;

i) The dragging distance must be identified and submitted for approval;

j) Steel-on-steel contact must be avoided while dragging;

k) Inspect for damage to fasteners (spikes, anchors, clips, etc.) behind the movement, especially in curve locations;

l) On arrival at destination, the rail must be thoroughly inspected for damage, particularly to the base of the rail. If plant or field welds are damaged, they must be cut out before the rail is used; and

m) Rail must not be dragged through Special Trackwork without protection of Special Trackwork components. The protection methodology must be defined and submitted for approval;

4.4.3 Dragging rail with lengths greater than 80 ft (24.4 m) must be done only with appropriate rail dragging devices.

4.4.4 When using rail tongs to drag rail under 80 ft (24.4 m) in length, the rail tongs must be 8 tonnes or greater.

4.4.5 When dragging rail over at-grade crossings or other similar locations, rollers must be used.

a) A traffic management plan must be defined as per Ontario Traffic Manual Book 7 and submitted to Metrolinx E&AM—Track for approval.

4.4.6 Dragging rail over concrete and steel ties is prohibited unless rollers or similar products are used to protect the surface of the concrete and steel ties, and to prevent spark (fire) risks.

a) Dragging rail over direct fixation track is prohibited.

4.4.7 Rail loaded in gondolas with tongs for reuse should be:

a) Loaded with the rail standing upright and orderly through appropriate spacing and placement of dunnage;

b) Loaded to the capacity of the equipment or less. The 70-ton gondola capacity, by rail section, is as per Table 4-6; and

c) Loaded in such a way as to avoid rail extending outside of the gondola car.

Table 4-6 Rail Capacity of 70-Ton Gondolas

136RE	132RE	115RE
3,154 lin. ft. (961 lin. m)	3,250 lin. ft. (991 lin. m)	3,680 lin. ft. (1,122 lin. m)

4.4.8 Where unloaded rail presents a walking hazard, it must be covered by a General Bulletin Order (GBO). A work plan methodology for unloading CWR from a rail train must be submitted and approved prior to commencement of work.

4.4.9 The owner of the equipment and the operator are responsible for ensuring that all rail unloading equipment and hardware are in good working condition.

4.4.10 Rail must be unloaded using a crane with magnets, approved rail grapples, tongs, or threader, and rail must not be dropped.

4.4.11 Rail must be center marked to balance the lift. Tag lines must be used when lifting rail with tongs.

4.4.12 CWR strings and Plug Rails may be left between the rails in wood tie track territory until the next shift (within 24 hours) provided that:

a) The CWR string height does not exceed 1 in (25 mm) above the top of the running rail;

b) Deflectors are placed at each end of rail;

c) The CWR rail ends are bypassed and secured at the ends with spikes in accordance with Standard Plan GTS-1108 for bridge guard rails;

d) In curved track, rail must be secured to prevent movement toward the low rail; and

e) It is permissible to place rail on an open deck bridge for the purposes of installation, provided the above is adhered to.

4.4.13 Rail stored adjacent to the track must be kept outside of the Standard Train Envelope defined in Appendix X.

a) Rail stored in curves must be lined away from the track and adequately secured to prevent rail ends from kicking out into the clearance envelope; and

b) Any rail shorter than Plug Rail length cannot be left in the ROW and must be removed.

4.5 Laying Rail

4.5.1 Rail of different metallurgies must not be mixed in any given stretch of track.

4.5.2 The gauge of track after laying must be uniform. Rail must be laid to the gauge shown in Table 4-7 and constructed within tolerance as per Appendix O.

Table 4-7 Gauge for High Degree Curves

Degree of Curve	Gauge in inches	Gauge in mm
Up to 14°00′	56-1/2	1435
14°01′ to 16°00′	56-5/8	1438
16°01′ to 18°00″	56-3/4	1441
18°01′ to 20°00′†	56-7/8	1445
20°01′ to 22°00′ †	57	1448
22°01′ to 24°00′ †‡	57-1/8	1451
24°01′ and over †‡	57-1/4	1454

† All curves over 18 degrees also require review by external stakeholders that have running rights on Metrolinx territory and must be approved in writing by the Director, Engineering–Track.
‡ Metrolinx bi-level coaches specify a minimum horizontal radius of 250 ft (76.2 m)

4.5.3 In order to maintain correct gauge, at least every third tie must be gauged on tangents and in curves greater than two degrees (2°). Where poor tie conditions exist, additional gauging may be required.

4.5.4 On completion of the rail laying, cribs must be filled with ballast. If any Priority Defects per Appendix C are found, track must be surfaced and lined within 48 hours, unless otherwise approved in writing by the Director, Engineering—Track.

4.5.5 Rail installation in jointed track must meet all requirements outlined in Track Standards Section 5.

4.5.6 When newly laid rail joins rail previously in track, the old rail should be built up by welding at the joint, if necessary, to protect the end of the newly laid rail.

4.5.7 Where rail end mismatch exceeds 1/8 in (3 mm) on the top or the gauge side of a rail joint, it must be repaired promptly by grinding, welding, or replacement of the rail, which may include the use of transition rail. Until such time as these repairs are made, movements over the mismatch must not exceed the speed for the appropriate Class of Track, as prescribed by Table G-4 in Appendix G.

4.5.8 Rail ends with excessive flow must be repaired by slotting. Crushed or battered rail ends must be repaired by welding. Please see Appendix I.

4.6 Rail Wear

4.6.1 When rail wear reaches the increased monitoring limits as defined in Appendix G, the rail must be monitored and measured quarterly and noted on inspection documents.

a) Measure at least three (3) locations throughout the curve, and the locations should be 100 ft (30.5 m) – 200 ft (61 m) apart (shorter spacing for short curves);

b) Mark the rail with paint or paint stick at the measurement points and take measurements at this location to ensure repeatability; and

c) The underside of the rail head must be physically inspected.

4.6.2 Rail on curves at approximately 95% of their urgent rail wear limits must be inspected on foot on a weekly basis and include taking rail wear measurements. Inspection measurements are to be documented and issued to Maintenance Delivery—Manager of Track.

4.6.3 Rail must not be transposed.

4.6.4 If rail is continued in service beyond the vertical wear limits in Table 4-8, high clearance joint bars must be used on the gauge side of rail for repairs and spot replacements.

Table 4-8 Rail Wear for High Clearance Joint Bar Requirement

Rail Size	136 lb.	132 lb.	115 lb.	100 lb.
Rail Wear	14.3 mm	9.5 mm	7.9 mm	6.3 mm
	9/16 in (0.5625)	3/8 in (0.375)	5/16 in (0.3125)	1/4 in (0.25)

4.6.5 Appendix G Table G-1, Table G-2 and Table G-3 identify the wear limits when rail must be removed from the track. At the discretion of the Director, Engineering—Track, if the worn rail that meets or exceeds the urgent limits is to be left in track:

a) A speed restriction as near as possible to the equilibrium speed or zone speed, whichever is more restrictive, must be applied, and the rail must be replaced within 30 days;

b) If the rail cannot be replaced within 30 days, a speed restriction of equilibrium speed or a Class 2 speed restriction, whichever is more restrictive, must be applied for the subsequent 30 days;

c) If, after 60 days from the initial inspection, the rail has not been replaced, a Class 1 speed restriction must be applied; and

d) The Director, Engineering—Track may modify these requirements as required upon further review, including additional inspection requirements. The condition of the rail (e.g. shells, spalls, corrugation, or any other rolling contact fatigue) must also be taken into consideration.

4.6.6 If the worn rail is on or within 100 ft of a Turnout closure, bridge, overpass, tunnel, or underpass where the supporting structure is within 25 ft of the nearest rail, the wear limits are only 75% of the wear limits as shown in Appendix G Table G-2.

4.6.7 The underside of the rail head must be physically inspected when rail head shelling, spalling, corrugation, or any other RCF is present.

a) Measure at least three (3) locations throughout the curve, and the locations should be 100 ft (30.5 m) to 200 ft (61 m) apart (shorter spacing for short curves).

4.6.8 Where rail wear has resulted in joint bars being impacted by wheel flanges, until the rail can be replaced, the rail ends must be welded or a high clearance bar(s) must be applied, and train speed must be restricted to the equilibrium speed.

4.7 Continuous Welded Rail

4.7.1 All Employees must properly protect and promptly report any unusual and/or unsafe conditions observed developing in CWR to the Maintenance Delivery—Manager of Track.

4.7.2 All supervisory personnel, including Track Foremen and Track Inspectors on whose territory CWR is laid, must be familiar with the causes, high-risk conditions, track work, inspection procedures, and speed restriction requirements to avoid track buckling.

4.7.3 The PRLT and PRLTR values are outlined in Table 4-9.

Table 4-9 Preferred Rail Laying Temperature and Range

PRLT	PRLTR
100 °F (37.7 °C)	100- 115 °F (37.7 – 46.1 °C)

4.7.4 CWR must be installed and anchored within the PRLTR without further adjustment. Rail must be destressed if:

a) CWR is installed below the PRLTR;

b) Any locations where rail is added below the PRLTR;

c) 1 in (25 mm) or more of rail within 1,000 ft (305 m) has been added;

d) The track is lifted or lowered by 1 in (25 mm) or greater; and

e) Any other activities that result in a change of RNT.

4.7.5 If rail cannot be destressed due to the conditions in Track Standards Section 4.7.4 above prior to a rail temperature increase greater than 40 °F (22 °C) above the RLT, then a speed restriction of 30 mph must be applied until the rail is destressed.

4.7.6 Newly installed track in CWR territory must be destressed upon completion of construction activities. A Destressing plan and timeline must be reviewed and approved by Metrolinx E&AM—Track as part of the Workplan Methodology. Under no condition must rail be left in a non-destressed state following the onset of spring.

4.7.7 The RLT must be measured with two (2) thermometers measuring within 2 °F (1 °C) once the rail has been fully fastened. The RLT must be measured at three (3) different locations in each rail string, written on the web of the rail, and must not be removed until destressing is completed as per Track Standards Section 4.9.

4.7.8 When rail temperatures are expected to exceed the PRLTR within the planned shift, all track work that has the potential to impact the stability of the track bed in accordance with Appendix J must be suspended, until such time as the weather cools to within the PRLTR.

a) This work is inclusive of excavations adjacent to track that extends into Zone 2 or 3, as defined in Appendix W, utility installations, track work, including but not limited to tie renewal, turnout or track panel replacement, surfacing, ballast cleaning (shoulder or otherwise), undercutting, lining, other track construction works, and crossing rehabilitation.

b) The Director, Engineering—Track may provide an exception to this requirement for suspension of work in the case of emergency safety-related work.

i. In case an exemption is granted, work must proceed only when sufficient action has been taken to protect the track infrastructure from heat-related damage and or alignment/surface defect(s), and the risk has been mitigated to the satisfaction of the Director, Engineering—Track; and

ii. Where an out of service defect is already present, exemption is not required for maintenance crews to provide the necessary remedial actions.

4.7.9 Rail temperature must be physically measured and recorded periodically throughout the day with an approved, accurate thermometer, according to the manufacturer's specifications. Measurements must be taken away from all sources of natural and artificial heat and cold, including but not limited to the sun, wind, rain, etc. Measurements are typically taken on the web near the base of the rail. Rail temperature in cold weather is typically equal to the ambient temperature. As a guideline, in hot weather, the rail temperature is equivalent to the ambient temperature plus 30 °F (16 °C).

4.7.10 CWR must not end on open deck bridges or closer than 200 ft (61 m) from the back wall of the bridge.

4.7.11 A list of the Rail Laying Temperatures marked on each string, the string numbers, alloy (if any), mileage, and date of laying must be compiled and kept up to date by the Track Lead with copies of the Metrolinx Rail Laying Reports submitted to the Maintenance Delivery—Manager of Track.

4.7.12 Use six-hole joint bars with four (4) bolts installed on standard joints that are planned to be eliminated through field welding. To facilitate welding:

a) The hole nearest the end of the two abutting rails must not be drilled;

b) A joint gap not exceeding 3/8 in (9.5 mm) is to be left;

c) Every tie must be fully box anchored for 200 ft (61 m) in both directions; and

d) All temporary joints must be welded prior to the onset of Winter unless an extension is approved in writing by Metrolinx E&AM-Track;

i. Any temporary joints that are unable to be welded prior to Winter must be fully drilled, bolted and every tie must be fully box anchored for 200 ft (61 m) in both directions and fully spiked (Pattern D) as per Appendix R for 19 ft 6 in (5.9 m) on both sides of the joint. Any temporary joint introduced during Winter requires only four (4) bolts to be installed.

ii. Eight-hole joint bars with a minimum of six (6) bolts may be installed on tangent track if approved in writing by the Director, Engineering—Track.

4.7.13 On completion of the day's work, all rail laid must be spiked as per the applicable spiking pattern in Appendix R, bolted and anchored per standard.

4.7.14 Adzing ties must be completed as required when performing gauging and/or changing tie plates, Out-of-Face or spot tie replacement.

4.8 Maintenance of Thermal Stress in Rail

4.8.1 Detailed standards for destressing CWR are contained in Track Standards Section 4.9, 13.3 and 14.5. Standards for handling rail failures in CWR are contained in Track Standards Section 4.10.

4.8.2 Precautions must be taken to monitor and record the length of rail installed during rail repairs and track work. Whenever practicable, rail will not be added to CWR track; any rail added must be removed as per Track Standards Section 4.9.

4.8.3 When a rail is to be changed, reference marks will be made on the field side web of the rail prior to cutting the CWR. They will be on each side of the location where the cuts are to be made and where the mark will not be covered by joint bars or removed by changing the rail.

a) All previously made reference marks must be painted over with black paint; and

b) See Track Standards Section 4.10.7 for information on reference marks.

4.8.4 The reference marks and the measured distance between them will be written on the field side web of rail beyond the reference mark with white paint stick.

4.8.5 When addressing a failure in CWR:

a) If the rail ends have pulled apart, the distance of separation of the two rail ends will be noted. The distance recorded on the rail must then be the measured distance between the reference marks minus the separation of the rail ends;

b) While repairing a track buckle or other failures and if the rail ends bypass each other, the distance recorded on the rail must be the measured distance between the reference marks plus the amount the rail ends bypass; and

c) After the rail has been changed, measure the distance between the reference marks. If the distance changes over the original measured distance, the amount of rail added or removed minus the rail joint gaps will be marked on the rail, and the information will be forwarded to the Track Lead, who must inform the Maintenance Delivery—Manager of Track.

4.8.6 The Track Lead will be responsible for monitoring and keeping records of the locations and amounts of rail that is added or removed to be adjusted.

4.8.7 Continuous welded rail must be maintained so that it is in a state of zero thermal stress when rail temperatures are within the PRLTR.

a) Continuous welded rail may drift into tension or compression, so that it is stress-free at some temperature outside the PRLTR, as a result of activities such as track surfacing, tie renewals, ballast cleaning, track lining, and curve rail renewal. Even if the track is not worked on, the rail can shift and go out of destress as a result of rail breaks, emergency brake applications, worn or defective anchors, poor quality or insufficient ballast, Permanent Slow Order locations, or soft subgrade. On vertical curves and gradients, rail is generally seen to move slowly downhill, resulting in an excessively low stress-free temperature at the bottom and an excessively high stress-free temperature at the top.

b) A speed restriction may be required in locations where the stress-free temperature has decreased to a level of concern.

4.8.8 Except in the case of emergencies to maintain operational service, no surfacing and lining, rail replacement, or tie renewal will be performed if the rail temperature is or is projected to be above the PRLTR within 24 hours unless approved by the Director, Engineering—Track.

4.8.9 Track work activities impacting the lateral stability of the track structure must be protected by the appropriate speed restriction. The tables in Appendix J contain the speed restrictions and the appropriate timeframe and/or tonnage for their removal on ballasted CWR track.

4.9 Destressing Rail

4.9.1 Destressing must be scheduled and completed when the rail temperature is below the PRLT.

4.9.2 When destressing, the rail temperature at the time of destressing must be marked on the rail, and all previous temperature markings must be painted over with black paint.

4.9.3 When it is evident that the stress-free temperature of a section of rail has decreased to a level of concern, it must be protected in accordance with Track Standards Section 15.20 and the stress-free temperature must be adjusted back to the PRLT. The method of destressing involves removing rail anchors or elastic fasteners, cutting both rails and removing rail to achieve the correct rail-laying temperature.

4.9.4 Prior to cutting the rails, the following must be completed:

a) Rail anchors must be tightened for at least 200 ft (61 m) on each side of where the rail is to be cut;

b) All ties must be fully box anchored at least 200 ft (61 m) on both sides of the rail being destressed prior to making the cut;

   i. All new anchors installed are to be Improved Fair type or equivalent as approved by the Director, Engineering—Track. All anchors reused must not be broken, damaged, defective, or sprung to the point it will not stay on the rail base.

c) In concrete tie territory, chording clips and risers must be distributed, as well as tie pads and insulators, if required;

d) Reference marks must be made with white paint stick on the field side web of the rail at a minimum of 5 ft (1,524 mm) away from both sides of the joint or planned rail cut;

e) Starting at the reference marks, match marks must be made with white paint on the gauge side base of the rail extending onto the tie plates or concrete ties on unanchored/unclipped ties at approximately 100 ft (30.5 m) intervals throughout the length to be destressed; and

f) The last 200 ft (61 m) of CWR before jointed rail must also be destressed.

4.9.5 The rail must be cut and may need to be trimmed or placed in a position that will permit the rail ends to bypass each other.

4.9.6 The rail anchors/rail clips must be removed, and the track spikes must be nipped for installation of risers for the length of rail being destressed to allow for the free movement of rail.

4.9.7 The rail must be raised above the tie plates or tie pads on all types of ties using risers or elevating rollers every 12 to 15 ties with a minimum height of 3/8 in (9 mm). Gauge side match marks must be used to ensure rail movement to neutral state has been achieved.

a) For rail replacements, the use of power vibrators is permitted when used in conjunction with heaters.

4.9.8 In concrete and steel tie areas, all rail clips and insulators must be removed, and chording clips must be installed approximately every 20 ties on curves up to four degrees (4°) and every 15 ties on curves four degrees (4°) and over.

4.9.9 Following the completion of items Track Standards Section 4.9.4 through 4.9.8, the rail now in the raised position on risers or elevating rollers is stress-free at the current rail temperature as it is unrestricted.

a) When the rail is stress-free (rail has been allowed to move freely), the Rail Laying Temperature at this location must be clearly marked on the web of the rail along with the date, contractor’s company name and the foreman’s initials;

b) When the rail is stress-free, a second set of match marks must be added to the gauge side base of the rail with white paint at the same stations as the matchmarks were made on the field side base of the rail. These match marks must be used during the destressing process to ensure required movement at each station.

4.9.10 Knowing the length of rail being destressed, the PRLT, and the present rail temperature, the calculations can now be completed to determine the rail length adjustment required. The CWR Thermal Expansion Chart is contained in Appendix L.

a) Calculations for total movement at each station must be marked beside the match mark at each station.

4.9.11 Prior to making the adjustment, check the match marks on the 200 ft (61 m) of rail that was fully box anchored beyond the rail that was being destressed for movement on both ends of the destressing limits.

4.9.12 Make the adjustment and check the gauge side match marks to ensure that proper movement has been achieved.

4.9.13 Remove elevated rollers and risers. Tap down the raised spikes and apply rail anchors/rail clips. In concrete and steel tie areas, apply insulators and clips. The chording clips are not removed until they are encountered when the clip installation reaches their location.

a) During the field welding process, all track work must stop to avoid a defective weld.

4.9.14 The PRLT must be marked with a white paint stick adjacent to the rail laying temperatures that had previously been marked. The previously marked rail laying temperatures must be covered with black paint.

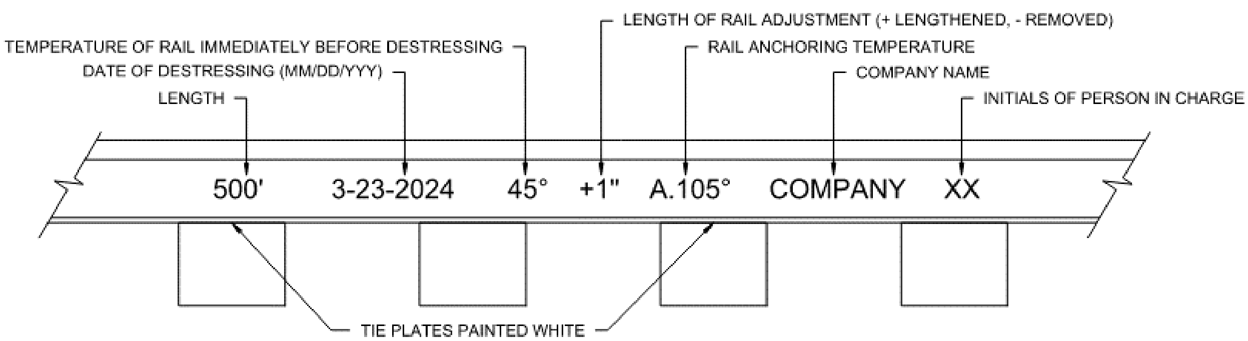


Figure 4-3 Rail Markings for Destressing

4.9.15 The total length of tangent rail that may be destressed at any one time is 3,000 ft (914 m). Under this scenario, the cut is made at 1,500 ft (457 m), and the two ends pulled together.

a) During Winter, the maximum length of tangent rail that may be destressed at any one time is 1,600 ft (487m). Under this scenario, the cut is made at 800 ft (244 m), and the two ends pulled together; and

b) For destressing rail in curves, a rail heater must be used for curves greater than 2˚, and the maximum length of rail that may be destressed at any one time is 1,500 ft in summer and 800 ft in Winter.

4.9.16 For destressing of road crossings, refer to Track Standards Section 14.5.

4.9.17 For destressing of turnouts and other Special Trackwork, refer to Track Standards Section 13.3.

4.9.18 The Rail Laying Forms must be submitted to the Maintenance Delivery-Manager of Track within 24 hours of rail installation.

4.9.19 Destressing documentation and records must be submitted to the Maintenance Delivery–Manager of Track, the Track Lead, and Metrolinx E&AM–Track within 48 hours of completion of any destressing work, using the prescribed Metrolinx Rail Destressing Form.

4.9.20 Below is an example of destressing calculation.

Example 1 – Rail Ends Pull Apart

A 3000 ft (915 m) section of rail at 65 °F needs to be destressed.

Length of rail to be destressed:	3000 ft
PRLT:	100 °F
Temperature difference from PRLT:	(100-65) = 35 °F

Movement required: Rail length (ft) x Temperature Difference from PRLT (°F) x 0.00008
= (3000*35*.00008) = 8.4 in

Note: If the rail separates when cut, more than the adjustment required (8.4 in), the rail was at a stress-free state at a temperature higher than the PRLT.

Adjustment Required:	8.4 in (8-7/16 in)
Actual Gap Measured in the Field:	9 in
Difference:	(9 in – 8-7/16 in) = 9/16 in less rail than required

Note: A thermite weld will add 1 in of steel to the rail

Length of rail to be removed:	(1 in – 9/16 in) = 7/16 in (11 mm)

When the 7/16 in (11 mm) of rail is removed the rail must be pulled back leaving a 1 in (25 mm) gap for the thermite weld. The rail would be stress free when the rail temperature is at 100°F.The Metrolinx Welding Manual must be consulted for the proper procedures.

Example 2 – Rail Ends Bypass Each Other

A 3000 ft (915 m) section of rail at 65 °F needs to be destressed.

Length of rail to be destressed:	3000 ft
PRLT:	100 °F
Temperature difference from PRLT:	(100-65) = 35 °F

Movement required: Rail length (ft) x Temperature Difference from PRLT (°F) x 0.00008
= (3000*35*.00008) = 8.4 in

Note: If the rail ends bypass each other when cut and anchors removed, the rail was in a stress-free state at a temperature lower than the PRLT.

Adjustment Required:	8.4 in (8-7/16 in)
Actual Gap Measured in the Field:	Rail ends bypass by 3 in (75 mm)
Difference:	(8-7/16 in + 3 in) = 11-7/16 in (291mm) more rail than required.

Note: A thermite weld will add 1 in of steel to the rail

Length of rail to be removed:	(1 in + 11-7/16 in) = 12-7/16 in (316 mm)

Removing 12-7/16 in (316 mm) of rail leaves a 9-7/16 in (240 mm) gap. The rail must be pulled back 8-7/16 in (214 mm) and thermite welded (Note, the 1 in (25 mm) gap is left for the thermite weld). This rail would now be stress-free when the rail temperature is 100°F (PRLT). The Metrolinx Welding Manual must be consulted for the proper procedures.

4.10 Failures in CWR

4.10.1 An In-Service Rail Failure is an occurrence of any type of rail break, rail weld failure, rail joint bar failure, or rail joint pull apart (break of the rail joint bolts) and the associated remedial action must be reported promptly to the Maintenance Delivery–Manager of Track or designate.

4.10.2 Where CWR has pulled apart, broken, or is cut for removal of defect, a record of pre-cut/break neutral temperature will be made when it can be determined. This must be submitted to the Maintenance Delivery–Manager of Track within 24 hours. The information required is:

a) Subdivision, track identification, mileage, GPS coordinates, tangent or curved track, left or right rail facing increasing mileage, remedial action, and if any TSOs were applied;
b) Rail and ambient Temperature at the time of break, pull-apart, or cut, or at the time of arrival on site;
c) Gap size, Offset;
d) Defect type (if identifiable);
e) Rail weight, manufacturer, metallurgy, rolling year and month, rail hardness, vertical and flange wear measurements;
f) If at a weld, type of weld, the date of the weld, weld number, and welder identification, as well as the rail wear measurements on both sides of the weld;
    i. Location and distance to adjacent tie;
    ii. Distance to adjacent drilled holes;
g) Fastener pattern and type;
h) Distance to fixed locations;
i) Distance to adjacent welds or joints;
j) Tie composition and condition;
k) Ballast condition; and
l) Track geometry measurements.

4.10.3 For rail breaks, a clear photo of the broken rail ends, both side views, top and bottom, must be taken and submitted to the Maintenance Delivery–Manager of Track within 48 hours of the incident for metallurgical testing, including a minimum of 12 in (305 mm) of the physically broken rail ends.

a) Rail ends will be sprayed with penetrating lubricant or equivalent to prevent oxidation;
b) For longitudinal failures, longer pieces may be required;

c) Have the subdivision, milepost, track ID rail side (left or right rail facing increasing mileage), date and direction of increasing mileage written in white paint stick on all pieces. See Figure 4-4;

d) Where rail breaks into multiple pieces, attempt to reassemble the rail, then place match markings from the pieces to the surrounding rail. Include all pieces with the shipment; and

e) Rail pieces must be numbered with a white paint stick to identify the number of rails associated with the rail break. The number of rails submitted must be provided in the reports to ensure all rails have been received by Metrolinx.

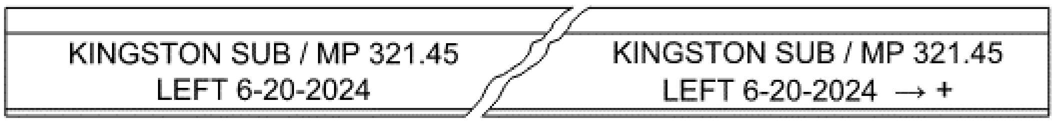


Figure 4-4 Marking a Broken Rail

4.10.4 Broken rail ends will be retained by the contracting party for two (2) weeks in case it is determined to send them off-site for further examination.

4.10.5 Four types of failures can be detected in CWR:

a) Visually detected failures;

b) Ultrasonically detected failures;

c) Signal system detected failures;

d) Magnetic particle detected failures.

4.10.6 Immediate protection and repairs are required for the following:

a) Certain rail defects, weld defects, and breaks as per Appendix I;

b) Pull-aparts;

c) Track buckles;

d) It is essential that any type of failure receives prompt attention and action to restore safe movement of traffic.

4.10.7 Prior to cutting rail, reference marks must be made with white paint stick on the field side web of the rail at a minimum of 5 ft (1,524 mm) away from both sides of the joint or planned rail cut. The distance between the marks must be measured and marked with white paint stick on field side web of the rail prior to the cut being made. This will create a reference to confirm whether any rail was added or removed during the repair. The use of reference marks includes:

a) Marking the location where rail is to be cut. Center this mark in a crib;

b) Write the following information on the parent rail immediately beyond the reference marks. Do not write within the 5 ft (1,524 mm) on either side of the cut location. This area is reserved for the welder's information. See Figure 4-5.

i. The actual distance between the reference marks minus any gap;

ii. Gap distance;

iii. Rail and ambient temperature at the time of the rail cut, pull-apart, rail break, or upon arrival at site;

iv. Length of the rail added and removed;

v. Length of defect rail removed and length of Plug Rail installed;

vi. Foreman's initials and company name; and

vii. Date.

4.10.8 Dye Penetrant Testing must be performed on all rail ends during rail work except for new rail.

a) Mark the rail "DP" when rail is tested with Dye Penetrant.

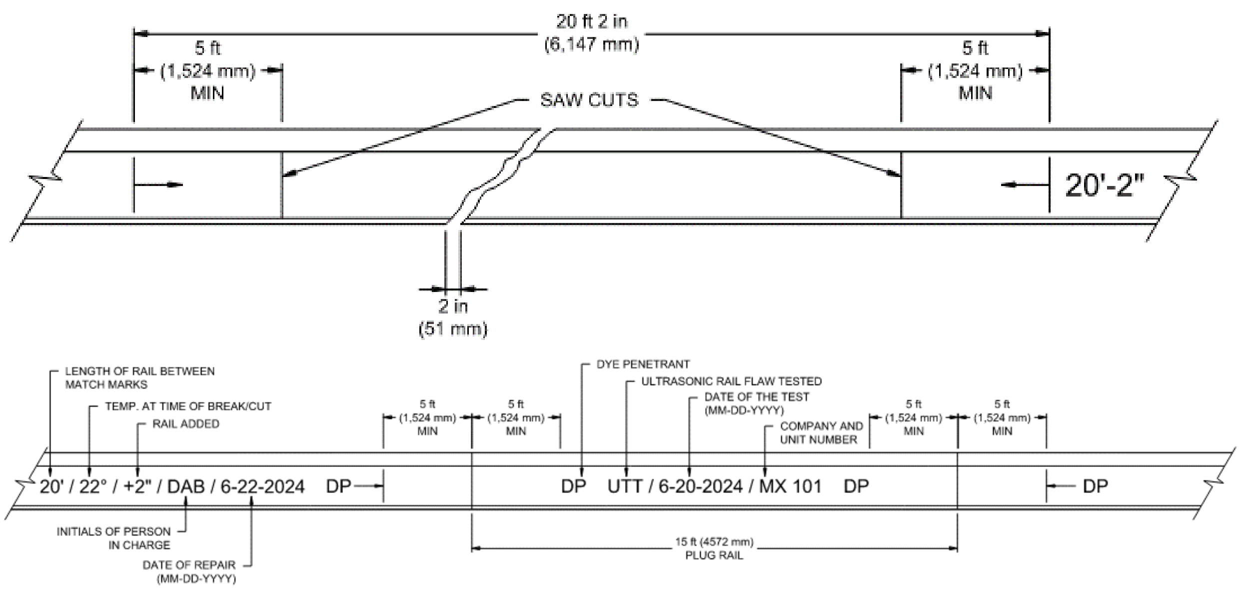


Figure 4-5 Rail Markings for Repairs

4.10.9 Vertical split head defects may develop from one rail to another through plant and field welds.

4.10.10 To restore the track to operational condition, torch cutting of the rail is allowable, provided that:

a) A minimum of 4 in (102 mm) of rail must be removed; and

b) Movements over the torch cut are limited to 10 mph and supervised by a Qualified Employee with established communication with the movement.

4.11 Repairing Pull-Aparts

4.11.1 When a pull-apart occurs, corrective action must be taken by either applying heat or expanders to bring the rail ends together or by installing a Plug Rail.

4.11.2 Do not use rail heating rope for heating rail on open deck bridges.

4.11.3 Replace all bolts with new bolts and install to proper torque. See Track Standards Section 5.2.

4.11.4 Adjust the anchors for at least 200 ft (61 m) in both directions from the pull-apart. Every tie must be fully box anchored for 200 ft (61 m) in both directions. See Track Standards Section 4.7 for further instructions on joints in CWR for failures.

4.11.5 If the rail temperature is below the PRLTR, the track that pulled apart must be destressed to the PRLT. Destressing must be completed for a minimum of 200 ft (61 m) on either side of the pull-apart, length of track permitting.

4.11.6 Arrangements must be made to have the closure rail welded in before the rail ends batter.

a) If the rail cannot be welded immediately, see Track Standards Section 4.7.12 for temporary joint requirements if closure weld cannot be completed immediately.

4.11.7 A minimum of 1 in (25 mm) and a maximum of 1-1/8 in (28 mm) must be removed from the closure rail for each thermite weld.

a) Rail must be destressed as per Track Standards Section 4.9.

4.11.8 Always record the amount of steel if added. This information is necessary for welding and destressing, and must be completed as soon as possible, but not longer than specified by the requirements in Track Standards Section 4.9.

4.11.9 The cause of the pull-apart must be determined and forwarded to the Maintenance Delivery–Manager of Track. Possible causes include:

a) Noncompliant ballast profile and section;

b) Insufficient, improperly adjusted or defective rail anchors;

c) Improperly destressed rail;

d) Unstable roadbed, resulting in rail creep changing the rail neutral temperature;

e) Emergency track work performed with the rail temperature above the PRLTR;

f) Excessive tension due to extreme cold or a sudden drop in temperature;

g) Out-of-Face Surfacing activities which alter the rail neutral temperature;

h) Improper train handling and directional running; and

i) Poor or lack of joint maintenance.

4.12 Track Buckling Causes and Prevention

4.12.1 Track Buckling is a constant threat during times of high or rapidly rising temperatures. It is a particular concern on CWR territory in the spring and summer months, generally between the hours of 11:00 and 20:00.

4.12.2 Hot weather inspections must be arranged by the Maintenance Delivery—Manager of Track to cover the track during these times.

4.12.3 Remedial action must be taken by either removing the track from service, placing a speed restriction or destressing the rail when any of the following is apparent:

a) Excessive rail movement through fasteners in a localized area;

b) Rail lifting up under the spike heads and/or rail base lifted out of seat (rail canting);

c) Rail pushing against both shoulders of the tie plates and concrete ties;

d) Short flat misalignments in curves;

e) Gaps or voids at the ends of the ties indicating lateral movement of the track;

f) Track having a wavy or non-uniform alignment;

g) Churning of ballast caused by tie movement or bunching ties resulting in gauge and line kinks;

h) Longitudinal movement of stock rail in relation to the switch point; and

i) Signs of track buckling due to removal of rail fasteners when rail stresses are not at a neutral state.

4.12.4 When surfacing near high-risk locations Track Standards Section 12.2 and Track Standards Section 12.3 must be followed.

4.13 Repairing a Track Buckle

4.13.1 Whenever ambient temperature exceeds 86 °F (30 °C) or during periods of significant seasonal increase in temperature (i.e. Spring), hot weather track patrols are required. Refer to Track Standards Section 15.19.

a) When the rail temperature is above the PRLT, and there are signs of a potential track buckle, Positive Protection must be applied, and the rail must be cut. Record temperature of rail, limits of rail movement, amount of rail cut out, and width of joint gap when bolts and bars are applied. Report this information to the Director, Engineering-Track, Maintenance Delivery—Manager of Track and the Track Lead for further instructions.

4.13.2 When a track buckle occurs, Positive Protection must be applied, and the following temporary repair must be completed:

a) Make cuts in the CWR near the buckle and line the rail ends so they can freely bypass each other, remove rail anchors, clips, insulators, and raise spikes 225 ft (69 m) on either side of the buckle allowing rail movement, line the track and install joints or Plug Rail.

b) Until destressing is completed, trains are to be operated at a speed specified by the Employee in charge not exceeding Class 1.

4.13.3 In the event that a track buckle was repaired by lining without cutting the rail, and the track was lined exceeding 1 in (25 mm) for one-third of the length of the curve or more, a temporary speed restriction must be placed as per Appendix J. The track must be destressed when the permanent repairs are made.

4.13.4 Permanent repairs must include applying new anchors, adding ballast to shoulders and cribs, replacing defective ties, line, surface, and stabilize track to original design and cut out rail, destress, and field weld.

4.13.5 After the track is fully repaired, it must be protected by the appropriate speed restriction indicated in the tables in Appendix J.

4.13.6 Promptly notify the Track Lead, Maintenance Delivery—Manager of Track, and Director, Engineering-Track of the temperature of the rail at the time of the buckle was discovered.

4.14 Remedial Action for Broken Rail or Defect

4.14.1 The Track Employee or Signal & Communication (S&C) Maintainer that arrives at the location of a broken rail first, must inspect the track for 300 ft (91 m) in both directions from the break. The inspection must include looking for pieces of equipment and for damage to the rail or track structure (e.g. wheel and dragging equipment marks).

4.14.2 The location of the rail break and findings from the above inspection must be communicated to the Maintenance Delivery—Manager of Track. A report must be submitted to the Director Engineering—Track.

4.14.3 Each defective rail must be marked with yellow paint marking on both sides of the web and base.

4.14.4 When removing rail defects from track, careful examination of all rail ends must be performed utilizing Dye Penetrant to ensure the defect has been completely removed.

4.14.5 When the rail temperature is within the PRLTR:

a) If thermite welds can be made at the time of repair, cut out the rail, including the defect (centered), within at least the minimum length specified in Track Standards Section 4.2.3. Install a permanent closure rail 2 in (51 mm) shorter than the rail cut out to account for the two (2) thermite welds required;

b) If welds cannot be made at the time of defect repair, install a closure rail with temporary joints, leaving no gap. Arrangements must be made to have the closure rail welded in before the rail ends batter. When a temporary closure rail is to be welded, the reference marks and original measurements noted on the rail must be consulted;

c) The amount of rail added or removed must be written with white paint stick on the web of the rail;

4.14.6 When the rail temperature is below the PRLT:

a) If welding is possible at the time of the repair, cut out the rail, including the defect (centered), within at least the minimum length specified in Track Standards Section 4.2.3. Install a permanent closure rail 2 in (51 mm) shorter than the rail cut out to account for the two (2) welds required. Bring together rail ends using hydraulic rail pullers or by heating so as to leave a 1 in (25 mm) gap for each weld. All permanent closures are required to be the same metallurgy and approximate wear as the rail removed;

b) If welds cannot be made at the time of repair, install a closure rail with temporary joints;

c) The closure rail is to be the same length as the rail cut out to allow for future welding;

d) The rail ends must be brought together with a hydraulic rail puller or by heating to leave no joint gap;

e) Arrangements should be made to have the closure rail welded in before the rail ends batter. Depending on traffic levels, excessive batter may occur in as little as two (2) weeks;

f) 1 in (25 mm) of rail, for each thermite weld, must be removed from the closure rail at the time of welding;

g) When a temporary closure rail is to be welded, the reference marks and original measurements noted on the rail must be consulted to ensure the appropriate rail length is being maintained;

h) If it is expected that the joint will be under significant tension (such as prolonged winter exposure or an expected drop in temperature) or if the joint is in a location with a history of pull-aparts, the joint should be installed with all six (6) bolts and every tie will be fully box anchored for 200 ft (61 m) in either direction;

i) If the rail ends separate more than 3 in (76 mm), a temporary repair should be made by installing a closure rail of a length equal to the opening, leaving a gap at each joint no greater than 3/8 in (9 mm);

j) Always record the amount of steel, if added. This information is necessary for making the permanent repair, which should be completed as soon as possible.

4.14.7 When the rail temperature is above the PRLTR:

a) Box anchor every tie in both directions for 200 ft (61 m) starting at a point 8 ft (2.4 m) on either side of the defect;

b) Refer to Track Standards Section 4.10.10 for details on torch-cutting rail;

c) Temporary repair will be made by cutting out the defect and any torched rail, and installing a Plug Rail;

d) Drill the four (4) outer holes and install joint bars and bolts, leaving no joint gap;

e) Record the amount of steel removed. This information is necessary for making the permanent repair.

4.14.8 Extra care must be taken on Direct Fixation Track on structures when a broken rail is found. The gap measurement must be provided to the Maintenance Delivery—Manager of Track. Destressing must be completed per Track Standards Section 4.9.

4.15 Defective Rails

4.15.1 When a rail in track contains a defect, the following procedure must be followed:

a) Identify the rail surface condition. Detailed descriptions of rail surface irregularities can be found in Appendix H;

b) Check surface of rail for depth of defect and the underside of the rail head for deflection with straight edge. The remedial action for these defects can be found in Track Standards Section 4.16 and Appendix I;

c) If Shelly Rail is present, measure depth of shells;

d) Visually check underside of rail head for indication of crack-out in the upper fillet area;

e) Apply remedial action from Appendix I and notify the Maintenance Delivery—Manager of Track of the defect condition.

4.15.2 When a rail in track contains any of the defects listed in Appendix H, operation over the defective rail is not permitted until:

a) The rail is replaced; or

b) The remedial action in Appendix I is initiated.

4.15.3 On Class 1, 2, and Class 3 Track with less than 20 MGT annually, where no hazardous material and no passenger service operates, all defects must be removed as soon as conditions permit but in no case longer than the next ultrasonic test car run.

4.15.4 Defective rails and rail breaks must be reported to the Maintenance Delivery—Manager of Track.

4.15.5 When a defect is found on a Class 1, 2, or Class 3 track carrying less than 20 MGT annually, where no hazardous material and no passenger service operate, refer to and apply the appropriate remedial action codes A through H of Table I-3 in Appendix I.

4.15.6 Refer to and apply the appropriate remedial action codes 1 to 13 of Table I-4 in Appendix I, when a defect is found in:

a) Class 3 track carrying passenger service or hazardous materials; or

b) Class 4 and 5 track.

4.16 Crushed Heads or Localized Surface Collapse and Rail End Batter

4.16.1 The criteria in Table I-1 of Appendix I must be used in restricting the operating speed over crushed heads, localized surface collapse and rail end batter until such time as the rail defect can be corrected.

4.16.2 During Winter Months, Table I-2 of Appendix I applies to in-track rail joints.

4.16.3 Depth of crushed heads, localized surface collapse and rail end batter must be determined using a 36 in (914 mm) straight edge and a 3/8 in (9.5 mm) wide taper gauge as per Figure 4-6.

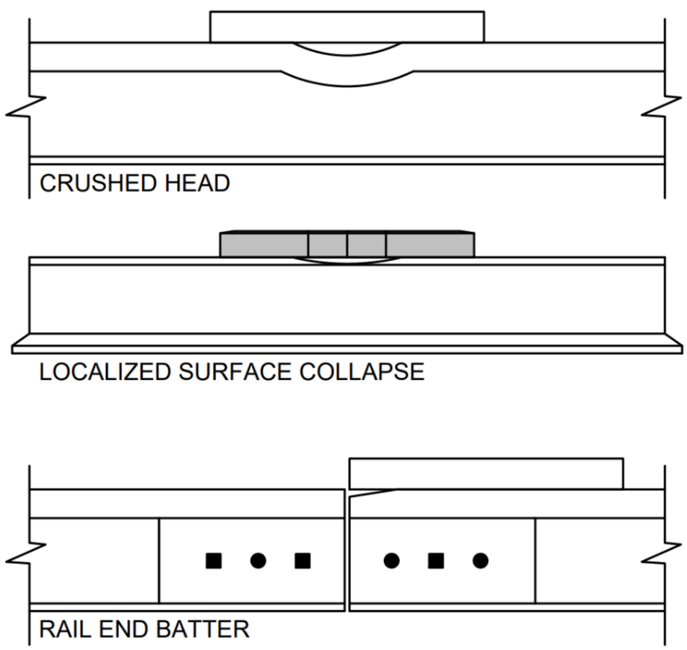


Figure 4-6 Examples of How to Measure Depth of Crushed Heads, Localized Surface Collapse (Flattened Rail), and Rail End Batter (Exaggerated for Illustrative Purposes)

4.17 Authorizing Movements over Rail Breaks and In-Service Rail Failures

4.17.1 This section provides specific criteria for a Track Inspector to authorize a train or engine to proceed safely over rail breaks.

a) For the purpose of this section, a rail break must be considered a complete break of the rail.

b) The practice contained herein for movements over rail breaks may be applied for thermite weld run-throughs, provided approved weld repair bars are applied.

c) A Track Inspector supervising movements over rail breaks must be trained in movements over rail breaks as defined by Transport Canada and as per Track Standards Section 2.2.2.

4.17.2 A train or engine must not be permitted to operate over a rail break when any of the following conditions exist:

a) The rail break is in a tunnel or on an open deck bridge;

b) The rail break is within 500 ft (152.4 m) of an open deck bridge;

c) The ties on either side of the rail break are defective, crushed, or split in the tie plate and/or rail base area;

d) Cracks are observed radiating from the broken rail ends;

e) The rail break occurs in an area of unstable grade;

f) The offset (overhang) is greater than 2 in (51 mm);

g) The gap is greater than 3-1/2 in (89 mm);

h) In the case of a joint area, the rail break extends beyond the limits of the joint bar; or

i) The rail break occurs in an area in which the Director, Engineering—Track has specified that movements over rail breaks are not permitted.

4.17.3 Where none of the above conditions exist, and joint bars are installed with at least one (1) bolt through the center of the rail break, trains or engines are allowed to operate over the rail break at a speed not exceeding 10 mph.

4.17.4 When none of the conditions outlined in Track Standards Section 4.17.2 exist, the rail break is not on a ballast deck bridge, and the gap size is too small to allow for the installation of joint bars with one (1) bolt through the center of the rail break (less than 1-1/8 in (28 mm)) trains may be permitted to operate over the broken rail at a speed not exceeding 5 mph.

4.17.5 If the rail break is at a weld location and bolt holes exist, joint bars, or weld repair bars must be installed, with at least one (1) bolt in each rail end.

4.17.6 The condition of rail breaks, joint bars, weld repair bars and supporting track ties must be observed by a Track Inspector as movements operate over the rail break. Movements must not be permitted to operate over the rail break if the conditions deteriorate to those listed in Track Standards Section 4.17.2.

4.17.7 Movements over rail breaks must be in accordance with Appendix K Figure K-1.

4.18 Defects at CAD Welds and Pin Brazing

4.18.1 CAD welds may be used on Metrolinx Railway; however must not be placed on the head of the rail.

4.18.2 Pin brazing may be used on Metrolinx Railway. See GO Transit Signals & Communications Standards Codes of Practice SCP-005 for additional details.

4.18.3 Where defective CAD weld or pin-brazed bonds have been detected on the rail head between 0 and 20 percent, the following repair procedure must be applied:

a) Grind the field side of the rail head containing the defect and ensure no overheating of the rail head;
b) Grinding must not exceed 1/4 in (6.3 mm). If the defect still exists, the rail must be removed;
c) The grinding must be tapered a minimum of 12 in (305 mm) on each side of the defect;
d) The defect must only be considered as removed on completion of an ultrasonic test; and
e) If the defect is detected a second time by ultrasonic testing, the defect must be protected as per Appendix I and removed from track.

5 Joints

5.1 General Information

5.1.1 In conventional jointed track, each rail must be bolted with at least two (2) bolts at each joint per rail end in Classes 2 through 5 tracks. In Class 1 Track, each joint must be bolted with at least one (1) bolt per rail end.

5.1.2 In the case of CWR in Classes 1 through 5 Track, each rail end per joint must be bolted with at least two (2) bolts.

5.1.3 New bolts must be used for permanent joints.

5.1.4 Different types of joints:

a) Permanent Joints—are fully drilled and bolted. For all joints in CWR, every tie is box anchored for a minimum of 200 ft (61 m) in each direction and fully spiked (Pattern D) per Appendix R for 19 ft. 6 in (5.9 m) on both sides of the joint;

b) Temporary Joints—are joints which are expected to be removed from track or are intended to be welded. In CWR, all holes are drilled except those nearest the rail ends and have at least two (2) bolts per rail end;

c) Supported Joints—are joints (not including insulated joints) that have the center of the joint located over a tie plate. Supported joints cannot be welded without moving the tie; and

d) Suspended Joints— are joints that have the center of the joint located between ties.

5.1.5 Joint bars, including insulated joint bars and compromise joint bars, that are broken or cracked between the middle two bolt holes regardless of the Class of Track, must be replaced immediately.

a) Movements over broken joint bars must follow Figure K-2 in Appendix K.

b) If the joint bar is partially cracked, movements may proceed at track speed if a Track Inspector visually observes all movements over the cracked joint bar. If visual observation of movements over the cracked joint bar cannot be followed, Figure K-2 in Appendix K must be followed.

5.1.6 The middle of each joint bar must be painted white.

5.1.7 Joints can be permanently embedded or temporarily buried if approved in writing by the Director, Engineering—Track:

a) Permanently embedded joints do not require disassembly or removal of the obstruction to inspect the joint, however, every effort practicable must be made to inspect the visible portion of these joints.

i. Permanently embedded joints may need to be exposed in order to repair signals defects.

b) Temporarily embedded or buried locations are locations where ballast, planking or similar material has been placed in the middle or along the tracks. Where CWR joints are buried, wait for the completion of track work before conducting the joint bar inspection. All temporarily embedded joints must be inspected at least annually, regardless of track work.

5.2 Conventional Joints

5.2.1 Proper drilling techniques must be exercised to protect against the harmful effects created by unsuitable drilling practices. Drills must be operated and maintained as per manufacturers' requirements.

a) Proper lubrication of the drill bit must be continuously applied with an applicable lubricator. Water must not be used as a lubricator.

b) Snow or water must never be thrown onto drill bits or rail. This will introduce further problems associated with production of brittle, un-tempered martensite in the rail and drill bit;

c) The condition of rail drilling machines must be checked by a qualified mechanic as per manufacturer's requirements at least once a year; and

d) All holes newly drilled in rail must be deburred.

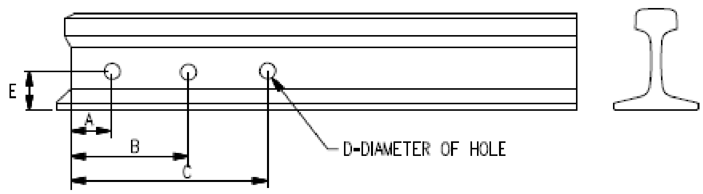
5.2.2 Rail bolt holes must be located using the correct template and indexing bar. The indexing bar must be placed so that the edge of the indexing bar matches the end of the rail.

5.2.3 The diameter of the hole drilled must be of the appropriate size for the rail section. See Table 5-1 for details.

5.2.4 Only joint bars of the correct design for the rail section, drilling pattern, and bolt type must be used. Refer to GTS-1201, GTS-1202, GTS-1203 for details.

Table 5-1 Drilling Data for Rails

Rail Size	A	B	C	D	E	Spacing
100ARA	2-11/16 (68)	8-3/16 (208)	13-11/16 (348)	1-3/16 (30)	2-3/4 (70)	2-11/16 : 5-1/2 : 5-1/2 (68 : 140 : 140)
115RE	3-1/2 (89)	9-1/2 (241)	15-1/2 (394)	1-3/16 (30)	2-7/8 (73)	3-1/2 : 6 : 6 (89 : 152 : 152)
132RE 136RE	3 -1/2 (89)	9-1/2 (241)	15-1/2 (394)	1-5/16 (33)	3-3/32 (79)	3-1/2 : 6 : 6 (89 : 152 : 152)



All units in inches (mm)
When drilling for temporary joints, omit dimension for “A” hole

5.2.5 Rail joints must be slotted to prevent flowed rail and chipped joints. Refer to Standard Plan GTS-1113.

5.2.6 Where track panels are installed in CWR track, the joints must be staggered by a minimum of two (2) tie cribs except for emergency preparedness panels and turnouts, or as approved in writing by the Director, Engineering–Track.

a) Where three (3) or more consecutive square joints exist, speed must be limited to that of Class 3 Track, and minimum joint stagger must be corrected.

5.2.7 When jointed rail is installed, the minimum joint stagger must be 12 ft (3.65 m) with a tolerance of + 2 ft (609 mm). See Track Standards Section 16.2.8.

5.2.8 Expansion space between rail ends, when laying bolted rail or track panels, must be provided. Expansion space of the proper dimension between rail ends can be obtained through the use of non-conductive shims of the correct thickness as per Table 5-2 below. A lubricant must be applied on the rail within the area of the permanent joint bar at time of installation. Temporary joints that are planned to be welded are not to be lubricated. Expansion shims must be removed after the rail is properly spiked, the bolts tightened to their corresponding torque, and rail anchors applied.

Table 5-2 Expansion Gap Required for Rail Temperature

Expansion Gap	40 ft (12.2 m) Rail Temp.	
	(°F)	(°C)
5/16 in (7.9 mm)	Below 6	Below -14
1⁄4 in (6.3 mm)	6 to 25	-14 to -4
3/16 in (4.8 mm)	26 to 45	-4 to 7
1/8 in (3.2 mm)	46 to 65	7 to 18
1/16 in (1.6 mm)	65 to 85	18 to 30
0	Above 85	Above 30

Expansion Gap	80 ft (24.4 m) Rail Temp.	
	(°F)	(°C)
5/16 in (7.9 mm)	Below 35	Below 1
1/4 in (6.3 mm)	35 to 47	1 to 8
3/16 in (4.8 mm)	48 to 60	8 to 15
1/8 in (3 mm)	61 to 73	15 to 23
1/16 in (1.6 mm)	74 to 85	23 to 29
0	Above 85	Above 30

5.2.9 Rail joints must not be installed closer than:

a) 20 ft (6.1 m) from the edge of road crossings; and

b) 20 ft (6.1 m) to the face of the back-wall off an open-deck bridge, nor less than 4 ft (1,219 mm) from the face of the backwall on an open-deck bridge.

5.2.10 Joint bars must be applied, and the bolts tightened before the rail is spiked. Bolts in rail joints must be tightened in the following sequence:

a) The two (2) bolts nearest the rail ends;

b) The second bolts from the rail ends;

c) The third bolts from the rail ends.

5.2.11 Tighten track bolts with track wrenches or power wrenches set to the proper torque settings as per Table 5-3 below. Care must be exercised when tightening bolts to avoid damage and over-torquing of the bolts.

Table 5-3 Torque to be Applied to Rail Joint Track Bolts

Size of Bolt (in)	7/8	1	1-1/8
Torque ft-lb	375	490	705
Torque N-m	508	664	955

5.2.12 Prior to returning the track to service, all of the rail installed must be bolted with a minimum of two (2) bolts per rail end per joint.

5.2.13 In wood tie territory where the rail is spiked, spikes securing the joint bar must include one (1) reversed spike on both the field and gauge sides.

5.2.14 Both sides of the joint must be supported by the same composition of tie (hardwood, concrete, or steel as required) and must be separated from a different tie composition by at least four (4) ties.

5.3 Insulated Joints

5.3.1 Insulated joints must comply with all applicable standards for conventional joints.

5.3.2 Continuous (glued) insulated joints are fully bonded, and must be used in CWR.

5.3.3 Non-continuous insulated joints, including encapsulated (coated) insulated joints, are not bonded and must be used in jointed rail sections.

5.3.4 Mitred glued joints shall not be installed on Metrolinx tracks.

5.3.5 Defective insulated joints must be repaired or replaced immediately. Refer to Metrolinx SCP-008 for additional information.

5.3.6 Continuous insulated joints must be tested by qualified signals Employees prior to installation.

5.3.7 Non-continuous insulated joints must be tested by qualified Signals Employees after installation, prior to the track going back in service.

5.3.8 S&C Maintainers must report defective insulated joints to Maintenance Delivery—Manager of Track promptly.

5.3.9 S&C Maintainers must advise the track forces of the location of insulated joints for proper signal operation. The location must not be changed without the approval of the Maintenance Delivery—Manager of Signals.

5.3.10 Fibre-insulated joint bars are not permitted on Metrolinx tracks.

5.3.11 Insulated tie plates must be used on ties within 2 in (51 mm) of the end post of an insulated joint.

5.3.12 Proper insulated joint clips (GTS-1322), fully driven in place, must be used.

5.3.13 The center of the insulated joint (including the end post) must not be over a tie.

5.3.14 Rail ends where non-bonded insulated joints are to be installed must conform to the following:

a) The end face must be saw cut, Dye Penetrant Tested, and bolt holes drilled to the proper size and location for the rail section;

b) All rough edges and burrs must be removed from the end face and the bolt holes;

c) Rail surface must be cleaned of steel shavings/filings and cutting dust before encapsulated bars are applied;

d) Batter must not exceed 1/32 in (0.79 mm);

e) The heights of the adjacent rails must not differ by more than 1/32 in (0.79 mm).

5.3.15 All rust, scale, dirt or other foreign matter must be removed from the rail joint area and from the joint bars before the joint is installed.

5.3.16 If the end post projects outside the rail head profile, it must be trimmed. Trimming the end post must not exceed 1/16 in (1.6 mm) inside the rail head profile.

5.3.17 Both sides of the insulated glued joints must be supported by the same composition of tie and must be separated from a different tie composition by at least four (4) ties.

5.3.18 Insulated joints must be anchored as per Metrolinx standards.

a) Non-continuous insulated joints installed in CWR must be fully box anchored at every tie for 200 ft (61 m) in both directions.

5.3.19 Rail anchors must not be applied on the sides of ties that may come in contact with signal wires. Anchors removed from these locations must be relocated to the next available tie to maintain total anchorage requirements.

5.3.20 Rail end overflow must be removed at insulated joints by slotting as per Metrolinx standards. The gap created by the slotting must be cleaned before the silicone sealer is applied to prevent foreign material entering.

5.3.21 Rail end repair at a non-continuous insulated joint must include the removal of the insulating material, placement of straight bars, weld including cooling process and placement of new insulation. This work must have signal support.

5.3.22 Insulated joints that are no longer required must be removed from track within 14 days unless otherwise approved in writing by Metrolinx E&AM-Track, and the Maintenance Delivery—Manager of Track must be notified.

a) Redundant insulated joints must be double-bonded until removed from track.

5.3.23 In wood tie territory, eight (8) 9 ft (2.74 m) ties must be installed between each pair of insulated joints.

a) For continuous insulated joints, tie spacing must be 19-1/2 in (495 mm). The insulated joints must be staggered at 39 in (990 mm);

b) For non-continuous insulated joints, tie spacing must be 18 in (457 mm). The insulated joints must be staggered at 36 in (915 mm); and

c) Not applicable within turnouts.

5.3.24 In concrete and steel tie territory insulated joints must be staggered to take advantage of the existing tie spacing as defined in Appendix O.

5.3.25 In DF track, insulated joints must be installed as per design.

5.3.26 Insulated joints must be staggered at a maximum of 4 ft 3 in (1,295 mm) for non-continuous insulated joints and a maximum of 4 ft 6 in (1,372 m) for continuous insulated joints. Final location of insulated joints must be confirmed with qualified signals personnel prior to installation.

5.4 Compromise Forged Rails and Joints

5.4.1 Compromise Joint Bars are only permitted in non-main tracks unless otherwise authorized by the Director, Engineering—Track.

a) Existing 132/136 Compromise Joint Bars on mainline must be scheduled for replacement where possible.

5.4.2 To determine the hand of the joint, stand in the center of the track with your back to the heavier rail section facing the lighter rail section. When the Compromise Joint Bar is on your left-hand side, it is a left-hand joint. When the Compromise Joint Bar is on the right-hand side, it is a right-hand joint.

5.4.3 A Compromise Joint Bar consists of one gauge side and one field side bar per set. The rail sections the compromise bar will fit are indicated at each end of the bar.

a) The Compromise Joint Bars for a No Hand compromise joint consist of an A bar and a B bar. See Standard Plans GTS-1210 to GTS-1213.

5.4.4 Compromise Joint Bars must not be modified from their initial design to fit a different rail section.

5.4.5 Compromise Joints Bars must not be installed in, on, or within 20 ft (6.1 m) of a turnout, bridge, at-grade crossing, and tunnel.

5.4.6 Compromise Joint Bars and Compromise Forged Rails must be identified in track with blue paint.

5.4.7 Compromise Forged Rails and Compromise Joint Bars must be fastened and fully supported with the correct ties under the corresponding rail section.

a) The center of Compromise Forged Rails or Compromise Joint Bars must be centered in a tie crib.

5.4.8 All Compromised Forged Rails must comply with the forged length as per Standard Plan GTS-1112.

5.5 Weld Repair Bars

5.5.1 Weld Repair Bars are only to be used to temporarily bolt around and support a broken rail, a failed weld, or a suspected weld defect. See Track Standards Section 4.17 and Appendix K.

a) Weld Repair Bars must not be used on a compromise field weld and/or the forged portion of a Compromise Forged Rail;

6 Rail Grinding and Milling

6.1 Rail Grinding with Self-Propelled Grinding Machines

6.1.1 Crossing surfaces adjacent to the rails should be removed. This will permit appropriate grinding and milling across the entire rail head.

a) At crossings, grinding and milling must continue for 80 ft (24.4 m) beyond the ends of the crossing.

6.1.2 Rail segments through hot box detectors, wheel impact detectors, and any other wayside equipment must not be ground or milled unless signal support is arranged to protect signal appliances.

6.1.3 Wayside lubricator system actuators, ramps, wiping bars and other parts which might be damaged must be lowered or removed prior to rail grinding or rail milling operations but must be placed back in service following grinding or milling prior to resuming train traffic.

6.1.4 Rail grinding and rail milling profiles must be reviewed and approved by Metrolinx E&AM-Track.

6.1.5 Corrective grinding or milling must be undertaken when:

a) Corrugation exists to the extent that the average slope from peak to trough of the corrugation exceeds 0.002 inches per inch (0.002 mm per mm);

b) There is evidence of longer, rapidly growing cracks in the rail;

c) Spalling, shelling, or other rail surface conditions are preventing ultrasonic inspection in accordance with Appendix I; or

d) The running band requires correction.

6.1.6 Before grinding and/or milling commences, the following preparation work must be done:

a) A complete survey of the rail condition, including but not limited to RCF testing, rail profile, and wear measurements, must be made;

b) The track geometry must be in compliance with the appropriate Class of Track;

c) To the extent possible, all replacement rail must be installed and field welds completed;

d) Engine burns, rail end batter, stock rail batter or any defects which would be deeper than 0.010 in (0.25 mm) after the planned grinding, must be removed prior to grinding;

e) Areas that cannot be repaired or that habitually deteriorate at a rate greater than that of the adjacent rail, must be removed and replaced with permanent closures prior to grinding and/or milling.

6.1.7 A Grinding or Milling Supervisor must accompany the grinding or milling machine, and their responsibilities must include:

a) Performing pre-inspections of rail condition;

b) Ensure that there is adequate communication between the control operators and the conductor;

c) Ensure that the machine's progress and performance is optimum;

d) Ensure metal removal and levelling tests are performed on a regular basis;

e) Coordinate fire patrols during the periods of the year when such patrols are necessary and communicate regularly with appropriate fire protection agencies;

f) As grinding and milling may present site-specific hazards associated with Fire Life Safety, see Track Standards Section 23;

g) Keep a daily log of machine performance and ensure that the daily reports are correct;

h) Inspect around insulated joints, turnouts, and other locations where filings could disrupt the signal system; and

i) Ensure on-track lubricators are applying grease to the gauge corner of the high rail and to the top of the low rail on newly ground curves prior to the passage of train traffic.

6.1.8 After grinding or milling is complete, the rail head must be consistent with the designed and approved rail profiles.

6.1.9 Rail grinding and milling activities must not bring the rail wear limits below those defined in Appendix G.

6.2 Turnout Grinding and Milling

6.2.1 When grinding or milling turnouts with a switch and crossing grinder or milling machine, the following procedures will apply:

a) The frog must not be ground or milled. The grinding or milling wheels should be raised at the last joint (or weld) before the frog and lowered at the first joint (or weld) after the frog. Pick-up and set-down points must be consistent and not closer than 2 ft (609 mm) from the nearest weld before the frog;

b) Switch point rails must not be ground or milled between the point end and the end of the head side planning;

c) When the difference between the vertical dimension of the running surface of the switch point and the stock rail, in the switch point rise area, is reduced by wear to 3/16 in (4.8 mm), the stock rail must be ground to restore the 1/4 in -

5/16 in (6.3 – 7.9 mm) dimension. See Track Standards Section 17.5 and Figure 17-2; and

d) At turnouts, grinding and milling must continue for 80 ft (24.4 m) beyond the point of switch and heel of frog.

6.2.2 Preventive and corrective maintenance grinding of switch points, stock rails, frogs, and diamond crossings must adhere to the requirements in the Metrolinx Welding Manual.

6.3 Rail Grinding and Milling on or near Bridges and Structures

6.3.1 Grinding must not be performed within 50 ft (15.2 m) on either side of any structure not scheduled for grinding unless this area, including the first 200 ft (61 m) of the bridge deck, is wetted down with a fire retardant foam/water mixture. In this case, grinding can be performed to within 25 ft (7.6 m) on either side of the structure.

a) This requirement is not applicable to bridges where no components of the bridge are constructed from wood (including ties of open-deck bridges).

6.3.2 Milling is permitted up to the back wall of a bridge. During dry conditions and summer months, the first 200 ft (61 m) of the bridge deck must be wetted down.

a) This requirement is not applicable to bridges where no components of the bridge are constructed from wood (including ties of open-deck bridges).

6.3.3 Rail grinding or milling on bridges must be scheduled during winter months or under wet conditions.

6.3.4 During the pre-grinding/milling survey inspections, the Grinding or Milling Supervisor, along with the Track Lead, will establish and agree on a list of bridges to be ground and/or milled.

6.3.5 The Track Lead or Maintenance Delivery—Manager of Track will then contact the Maintenance Delivery—Manager of Bridges and Structures and notify them of the bridge(s) to be ground and/or milled.

6.3.6 The Maintenance Delivery—Manager of Bridges and Structures must examine all structure(s) for fire hazards and provide an assessment of the risks present. This assessment will include:

a) A mitigation plan for each structure, outlining the precautions to be taken in terms of additional fire protection, including:

i. Requirements for post-grind patrols;

ii. List of local fire department contacts;

iii. Any specific fire suppression requirements unique to a structure (i.e. Presence of local Fire Department required); and

iv. Any special requirements for removal of fire susceptible material near and under the bridge.

6.3.7 Prior to grinding and/or milling, the Grinding and Milling Supervisor must ascertain from the Track Lead that:

a) All bridges on the grinding and/or milling list have been inspected for fire hazards and assessed by the Maintenance Delivery—Manager of Bridges and Structures; and,

b) All fire precautions and patrols are in place as outlined in the mitigation plan for grinding and/or milling.

c) If all these conditions cannot be ascertained, then no grinding and/or milling of the bridge(s) must be done.

6.3.8 The grinding and/or milling equipment must not leave the structure until either a patrol or the necessary fire-fighting equipment is physically in place (at least three (3) Wajax cans filled with fire retardant foam/water mixture). Water may be used when foam retardant mixture is depleted. A job briefing must be performed, and Employees must understand their duties.

6.3.9 A fire suppression system must accompany the grinding and/or milling equipment to mitigate fire risk.

a) When grinding and/or milling on a bridge, a fire suppression system must be continuously operated.

b) The fire suppression system must be equipped with a fire-retardant foam/water mixture.

6.3.10 On timber structures, once grinding is complete, operate the fire suppression system over the entire bridge, including 200 ft (61 m) on each side, at least once to wet down any sparks left by the grinding operation.

6.3.11 On timber structures, once the milling operation is complete, operate the fire suppression system over the entire length of the bridge, including 100 ft (30.5 m) on each side at least once.

6.3.12 When grinding and/or milling in the area of timber structures, a fire inspection must be performed after passing over these structures. This inspection includes viewing the structure with thermal imaging devices.

6.3.13 For additional fire prevention requirements, see Track Standards Section 23.

7 Rail Friction Management

7.1 Wayside Lubricators

7.1.1 All new main track curves over four degrees (4°) must be protected by a wayside lubrication system and be subjected to the criteria stated herein. The Director, Engineering-Track will determine whether lubricators are required for non-main track.

7.1.2 Locations for wayside lubricators must be determined through the following:

a) Consideration of maintenance access and power source;

b) Wayside lubricators must be located away from watercourses, turnouts, diamonds, open deck bridges, locations of heavy trespasser activity, hot box detectors and Signal & Communications installations.;

c) Wayside lubricators must be kept at least 100 ft (30.5 m) from insulated joints;

d) Wayside lubricators must be located away from stopping points (such as station platforms, controlled locations/points, etc.), and normal points of sanding, sink holes, and frost heave areas;

e) Wayside lubricators should be installed no closer than 1/2 mile (800 m) from a public road crossing;

f) Rail lubricant disbursement properties;

g) Grade of track; and

h) The Total Central Angle of Curves (TAC) which can be calculated using the formula below to determine the number of wayside lubricators required. More than one single wayside lubricator will be required if the sum total of TAC values for successive curves exceeds 600;

$$TAC = \frac{D_c \times \left(L_c + 0.5(L_{s1} + L_{s2})\right)}{100}$$

$$D_c = degree\ of\ curvature$$

$$L_c = Length\ of\ curve\ (ft)$$

$$L_{s1} = length\ of\ entry\ spiral\ (ft)$$
$$L_{s2} = length\ of\ exit\ spiral\ (ft)$$

7.1.3 Track conditions at the location of the wayside lubricator must be as follows:

a) Rail wear must be such that the wiping bars are not damaged by passing wheels;

b) Gauge at the lubricator must be maintained to 56 1/2 in (1,435 mm);

i. Existing tie plates on wood ties must be replaced with cast plates.

c) Wayside lubricators must not be installed on ties with worn insulators, loose or sprung rail clips;

d) On wood ties, ties must be fully spiked for 30 ft (9.1 m) on either side of the lubricator;

e) All track ties within the limits of the applicator bars must be sound and free of plate cutting;

f) All other track material, such as tie plates, spikes, and anchors., must be in good condition;

g) Wayside lubricators must be installed in accordance with the manufacturer's instructions.

7.1.4 Track must be covered with woven geotechnical fabric designed for the specific application for a distance of 50 ft (15.2 m) to either side of a wayside lubricator and installed per the manufacturer's recommendations.

a) Every spring remove the fabric from the track to inspect the track, noting ballast conditions, tie conditions, plate and fastener conditions, and replace with new fabric. The existing fabric must be disposed of in an environmental waste facility.

7.1.5 Electric wayside lubricators (solar-powered or 120 Volt AC) are recommended for all new installations.

7.1.6 The location of electric wayside lubricators should be selected in consultation with the S&C department, which will advise on electric power availability.

7.1.7 Electrical hook-ups to electric wayside lubricators must be made by qualified personnel. Ground Fault Circuit Interrupters must be used on all 120 Volt installations.

7.1.8 Solar panels for electric wayside lubricators must be located and mounted according to manufacturer's instructions, where the maximum amount of sunlight will be obtained. A protective shield is recommended to prevent damage to the solar panels.

7.1.9 Batteries of electric wayside lubricators must be maintained as per manufacturer's recommendations.

7.1.10 The exact locations of installation must be determined in the field through a joint inspection with the Director, Engineering—Track or delegate.

7.1.11 Maintenance of the wayside lubricators must include, but not be limited to:

a) Wayside lubricators must be inspected on foot at least once per month;

i. Any wayside lubricator found not working must be documented and reported to the Maintenance Delivery—Manager of Track.

b) In track circuit territory, including but limited to CTC territory or in a crossing approach, care must be taken to ensure that no part of the wayside lubrication system grounds or shorts out the rails. This includes checking that metal-reinforced hoses do not contact the rails and ensuring that the lubricator does not interfere with permanent and temporary bond wires;

c) The lids of wayside lubricators must be kept locked except when maintenance is being performed;

d) Hydraulic fluid levels in hydraulically activated wayside lubricators must be checked and filled according to manufacturer's instructions;

e) Mechanical pump drive connections must be inspected and lubricated on a regular basis;

f) All hold-down bolts, clamps, etc., must be kept tight; and

g) Wheel sensors.

7.1.12 The area immediately around wayside lubricators must be kept as clean as possible. Packaging materials and contaminated grease must be disposed of in an environmentally approved manner. The protective shield must be inspected and cleaned as part of the regular lubricator maintenance.

7.1.13 With the exception of the lubrication specified for rail grinding and milling, Metrolinx does not permit any top-of-rail lubrication.

7.1.14 The grease must be puddled when the reservoir is being filled to remove any air pockets.

7.1.15 The grease reservoir must never be allowed to pump dry.

7.2 Lubricating Products

7.2.1 Only approved grease is to be used in wayside lubricators as approved by the Director—Engineering, Track.

7.2.2 Summer and winter grade greases will be used during the appropriate seasons.

8 Field Welding

8.1 General Information

8.1.1 All welding must conform to the requirements specified in the Metrolinx Welding Manual.

8.1.2 Prior to welding, rail must be visually examined for physical defects and must meet the criteria herein for alignment and wear.

8.1.3 Field welds, thermite and Electric Flash Butt (EFB) welds must be located as close as possible to the center of tie cribs. A field weld must not be positioned directly over a track tie or a direct fixation plate.

8.1.4 Position of field welds on the same rail must be:

a) Greater than 6 ft (1.83 m) from an existing thermite weld;

b) Greater than 3 ft (914 mm) from an existing field or plant EFB weld; and

c) No less than 4 in (102 mm) from the edge of a tie or track works providing support.

8.1.5 The distance from the end of rail to the nearest edge of any drilled hole in the rail must be greater than 4 in (102 mm).

8.1.6 Number of consecutive field welds, on the same rail, must be limited to a maximum of four (4) welds in 39 ft (11.9 m) for any new field welds.

8.1.7 Field welds on adjacent rails must be staggered by 4 ft (1,219 mm) or a minimum of two (2) tie cribs.

8.1.8 All rail ends must be saw cut. The cut must be square and perpendicular to the rail axis, with a variation not exceeding 1/8 in (3 mm), and all burrs must be removed.

8.1.9 All rail that is saw cut must have the exposed ends tested for defects with Dye Penetrant.

8.1.10 Rail expanders must be used on all closure welds during destressing, and anytime the rail temperature is at or below the PRLT. Closure weld is the final weld that joins and adjusts the two rail ends of CWR together.

a) Rail expanders must not be removed until the weld has cooled below 700 °F (372 °C) and the rail has been longitudinally restrained (i.e. anchors or elastic fasteners have been applied).

8.1.11 Upon completion of the field weld:

a) Ties supporting the rail on either side of the field weld must be firmly tamped for 16 in (406 mm) on both sides of the rail, and ballast section restored;

b) Wood ties must have spike holes plugged with chemical plugging and spikes installed to the applicable pattern as per Appendix R;

c) Concrete and steel ties must have the rail clips, insulators and rail seat pads restored;

d) Anchors must be applied and tightened to the applicable pattern 200 ft (61 m) in each direction and on both rails;

   i. Ensure anchors are applied no closer than 2 in (51 mm) to a field or plant weld. If an anchor cannot be applied, the anchors on both rails must be moved to another tie.

e) Tie cribs must be cleaned of all EFB and thermite field weld debris before the ballast section is restored;

f) The area around the weld must be cleaned. This includes the removal of all rail ends, bolts, joint bars, weld debris and packaging. The burning of flammable debris and/or burring of non-flammable debris is not permitted on Metrolinx ROW.

8.1.12 Field welds must be ground to the tolerances in the Metrolinx Welding Manual. Field weld dimensions outside the tolerances will be reground to comply, or the weld must be removed.

8.1.13 All track work within 200 ft (61 m) must be stopped during the drop and for the first five (5) minutes following.

8.1.14 If the field weld location is within 200 ft (61 m) of a public at-grade road crossing, road traffic must be stopped for the same timeline as above.

8.1.15 Temporary bonds or rail bypass cables must be applied around a cut within a crossing circuit, as per Track Standards Section 22.3, to prevent the requirement for deactivation and/or nuisance ringing.

8.2 Field Welding

8.2.1 During the grinding of thermite welds, the parent rails must not be ground. The removal and grinding of the base risers must conform to the Metrolinx Welding Manual.

8.2.2 Thermite welding and/or thermite welds are not permitted in or within 20 ft (6.1 m) of at-grade road crossing surfaces.

8.2.3 Thermite welds are recommended to be performed in dry weather conditions as outlined in the Metrolinx Welding Manual.

8.3 Cold Weather Field Welding

8.3.1 Cold Weather is defined as:

a) Temperature between 40 °F (5 °C) and 5 °F (-15 °C); or

b) Presence of light moisture conditions, including wind, rain or snow.

8.3.2 Thermite welding is not permitted when the temperature is below or expected to drop below 5 °F (-15 °C).

8.3.3 EFB welding is not allowed when temperature is below or expected to drop below -10 °F (-23 °C).

a) Low-consumption electric flash butt welding is not permitted on Metrolinx ROW.

8.3.4 Hot thermite material has the potential to become explosive whenever it comes in contact with moisture. The source of moisture can be in the form of snow or frost on ballast, rain, sleet, and/or frost.

a) A minimum of a 10 ft (3.05 m) around the weld area must be clear of snow, ice and moisture. It may be necessary to dry the ballast with a turbo torch;

b) Where embankment constraints are present, clear snow, ice, and moisture to edge of the sub-ballast or subgrade, as well as a walkway to the disposal area;

c) Use a turbo torch to clear the disposal area of snow or moisture 3 ft (914 mm) in diameter and apart from the work area to safely receive the slag pot;

d) A dry location such as a steel drum or a rack on the back of a truck must be used to place field welding waste material; and

e) It is recommended to install an approved drip pan with dry sand under the weld area to prevent any excess molten metal from contacting any moisture that may be present. It may be necessary to heat the ballast with a turbo torch to allow installation of the drip tray.

8.3.5 Rail expanders/pullers must be used during cold weather thermite welding in accordance with Metrolinx Welding Manual.

8.4 Welding on Bridges

8.4.1 If any portion of the bridge structure, including the support, is constructed of flammable material, permission must be obtained from Maintenance Delivery—Manager of Bridges and Structures to perform any method of welding.

8.4.2 Rail on a bridge requiring thermite welding and/or arc welding must be welded off the bridge when possible, and then installed on the bridge after all work on the weld is finished. However, when there is no alternative to doing the welding on a bridge, follow the precautions below:

a) Contact the Maintenance Delivery–Manager of Bridges and Structures and the Maintenance Delivery–Manager of Track to ensure they are aware of and authorize the work plan methodology describing the work, risks and mitigations required to perform the work;

b) Before any welding is undertaken, a site inspection must be made to identify any hazards, and in particular, anything that may catch fire. Any loose combustible material, such as dry vegetation, must be removed. The entire structure must be examined. Do not assume that if no combustible is visible from above, the bridge is fire-safe;

    i. A ballast deck timber trestle is as combustible as an open deck timber trestle and must be treated as such.

c) A thorough job briefing must be conducted with all personnel involved, to determine what will be done in case of accident or fire. Where sufficient personnel and equipment are not available to take care of any accident or fire that may occur, welding must not be undertaken;

d) During arc welding, the area around the weld must be wetted down to reduce the risk of fire;

e) When thermite welding must be performed on open deck bridges, a 1/4 in (6.3 mm) thick steel sandbox partially filled with sand and placed between the ties is required in case of a run-through. Bridge timbers must be spread by the Bridges and Structures forces so that the box may be installed. Welding must not be undertaken without the use of the sandbox;

f) The bridges and structures forces must reinstate the bridge timber spacing after the sandbox is removed;

g) The wood ties, wooden back walls and bridge timbers, plus the area around the structure, must be wetted with water and fire retarding foam additive to lessen the chance of fire from hot work activities;

h) During hot work activities, a designated fire watch person(s) must be assigned. Fire watch person(s) must understand their duties, be in a position to fight fire before the work commences and ensure that suitable fire fighting equipment is in position. See Track Standards Section 23 for minimum training and fire fighting equipment requirements;

i) Where the fire watch person(s) is positioned under the bridge, fire-fighting equipment and fire watch person(s) must also be available on the bridge deck;

j) The fire watch will remain on-site inspecting for any smouldering fires until the weld has cooled to ambient temperature; and

k) Additional precautions may be required as per Track Standards Section 23.

9 Ties

9.1 Timber Tie Installation and Maintenance

9.1.1 Timber ties must be made from hardwood and in compliance with the Metrolinx Timber Tie Specification:

a) No. 1 Grade, 7 in x 9 in x 8 ft 6 in (178 mm x 229 mm x 2591 mm) for all main tracks and sidings, and spaced at 20-3/8 in (518 mm) on center for Class 2 and above, or spaced at 21-3/4 in (552 mm) on center for Class 1.

b) No. 2 Grade, 6 in x 8 in x 8 ft 6 in (152 mm x 203 mm x 2591 mm) are not permitted for new construction. Legacy No. 2 Grade ties must be spaced at 21-1/4 in (540 mm) on center.

9.1.2 Timber ties must be installed perpendicular (square) to the rails and centered with the track, with the end of the tie approximately 18-1/2 in (470 mm) from the field edge of the rail base on a No. 1 Grade tie.

9.1.3 Crossing ties must be composed of 9 ft (2.74 m) long hardwood ties and must be spaced at 18 in (457 mm) on center throughout the crossing.

a) Crossing ties in concrete tie territory must be composed of 10 ft (3.05 m) long hardwood ties.

9.1.4 Crossing ties must extend at least five (5) ties beyond the end of the crossing surface, including sidewalks and MUP.

9.1.5 Turnout ties installed must:

a) Be the correct length for the location to be installed in the turnout per the appropriate Track Standard plan;

b) Not be cut to get shorter lengths;

c) If there is no alternative to field cutting, turnout ties must be cut square, have the cut end treated with creosote and the proper end plate installed; and

d) Be installed so that lacing of standard ties does not occur at the end of the long tie in locations such as crossovers.

9.1.6 Open-deck bridge ties must be supplied and installed according to the Metrolinx General Guidelines for the Design of Bridges and Structures.

9.1.7 Treated ties must not be handled with any tool and/or equipment attachments that have sharp points that will penetrate beyond the depth of the treatment.

9.1.8 Cut spike holes in all wood ties must be plugged with an approved chemical plugging compound before re-spiking.

a) Cedar or Treated hardwood timber tie plugs may be used in temporary applications or as directed and approved by the Director, Engineering–Track.

9.1.9 Any fastener holes left empty must be chemically plugged to restrict moisture from entering the tie.

9.1.10 Ties must not be allowed to become center-bound.

9.1.11 When ties are being installed in controlled locations, such as turnouts, at insulated joints, within the limits of signalized crossings, or wayside equipment locations, Metrolinx E&AM – Signals and Communications must coordinate the work.

9.1.12 All ties must be inspected yearly by the Track Lead or their designate, or by electronic means.

9.1.13 In preparation for a tie renewal program:

a) The Track Lead must prepare a list that will show the number of defective ties in each track mile to facilitate accurate distribution. The Track Lead must ensure that this is done and report the number of ties marked to the Metrolinx Track Specialist;

b) The Track Lead must mark defective ties to be replaced and place a suitable marker every 20th or 25th tie prior to the unloading of the ties, depending on the bundled amount. Ties must be marked in a manner readily identifiable to the operators of the tie equipment. In no case must ties marked in track exceed the number allotted for the program;

c) Ties scheduled for installation must be unloaded and distributed as follows:

   i. Restrict the distribution of ties along the ROW on high fills to avoid losing ties down the slopes and/or into waterways. Place ties at the nearest staging area with level ground conditions.

   ii. Ties must be banded and stored two weeks before the planned work project. Individual ties must be distributed 48 hours before their planned installation. If work is postponed following the distribution of ties, the pre-distributed materials must be sorted, aligned, and re-banded in bundles of at least ten (10) ties and at least two (2) rows.

   iii. The work plan methodology and associated risk assessment must clearly identify the pre-distribution of ties. Pre-distribution must not occur within 200 ft (61 m) of an at-grade crossing or turnout or in a high-trespassing location.

d) The Track Lead must determine the ballast quantities required for a major Out-of-Face Tie Replacement program to accommodate surfacing and to restore cribs and shoulders to standard ballast section (See Standard Plan GTS-2205);

e) The Track Lead will arrange to distribute ballast prior to the arrival of a tie gang, when practicable. Ballast should be distributed along the shoulders of the existing ballast section on tangent track but only on the high side of curves unless otherwise required. Unloaded ballast must not bury fasteners;

f) All ties removed from track must be stacked in piles of 20 to 40 and placed parallel to the track. These piles must be on the opposite side of the track from any wire line where possible, and where they will not obstruct the sight lines or affect drainage. Ties must not be piled adjacent to timber trestle back walls, track with high embankments, rock cuts, within 200 ft (61 m) of an at-grade crossing or turnout, or in a high-trespassing location, or where there is a possibility that they may slide into a lake or river;

g) Defective ties must not be left in between the rails or between tracks;

h) Ties removed from the track must be disposed of as directed by the Maintenance Delivery—Manager of Track

i) Following any tie installation and replacement work, any unused ties and defective ties must be removed from Metrolinx ROW as follows:

   i. For spot tie programs, all unused and defective ties must be removed within 48 hours.

   ii. For Out-of-Face Tie Replacement programs, all unused and defective ties must be removed within one week (7 days).

j) Defective ties must not be stored for more than one month (30 days) on Metrolinx ROW.

9.1.14 The following definitions of defective hardwood ties must be used:

a) Broken Tie - Tie that is cracked or broken through the entire depth of the tie.

b) Split Tie - Tie with a vertical split end to end for the entire depth and length of the tie.

c) Split Tie End - Tie end with a vertical split into the spike holes or split the full depth and wide enough to permit ballast to come through. The tie can no longer hold surface and gauge.

d) Cut Tie - Tie that is rail or plate cut or adzed to a depth of 2 in (51 mm) or more on No. 1 Grade ties, or 1 in (25 mm) or more on No. 2 Grade ties.

e) Crushed Tie - Tie that has the bearing surface under the rail crushed, splintered or rotted, 1 in (25 mm) or more, to the extent that it cannot hold surface, line or gauge.

f) Spike Killed Tie - Condition may be indicated by numerous vertical splits at the tie end, loose or raised spikes, rail or plate movement of more than 1/2 in (12.7 mm) or unloaded and loaded wide gauge.

g) Decayed Tie - Tie that is decayed and cannot hold rail fasteners, gauge or surface.

h) Damaged Tie - Tie that has been damaged by derailment, dragging equipment, or fire to the extent that it cannot hold surface, line or gauge.

i) Worn Tie - A tie worn or rounded on the bottom from vertical movement of the tie in the ballast, resulting in poor surface and line and an inability to hold spikes.

9.1.15 Class 1 and Class 2 tracks must have one (1) tie whose centerline is within 24 in (609 mm) of the rail joint location, and Classes 3 through 5 tracks must have one (1) tie whose centerline is within 18 in (457 mm) of the rail joint location.

a) Each rail joint in Class 1 and Class 2 tracks must be supported by at least one (1) non-defective tie whose centerline is within 48 in (1,219 mm) of the joint, as shown in Figure 9-1.

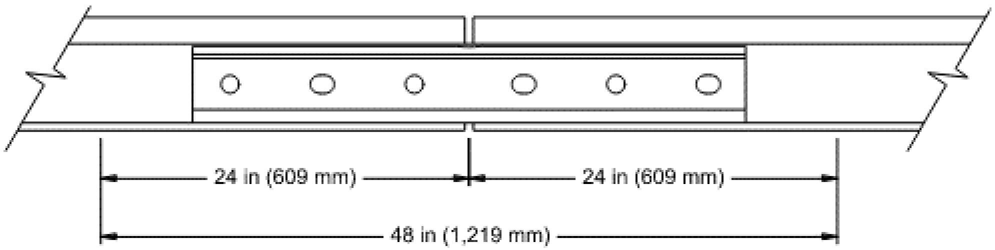


Figure 9-1 Location of Non-defective Tie at Joints - Class 1 and Class 2 tracks

b) Each rail joint in Class 3 through 5 tracks must be supported by at least one (1) non-defective tie whose centerline is within 36 in (914 mm) of the joint, as shown in Figure 9-2.

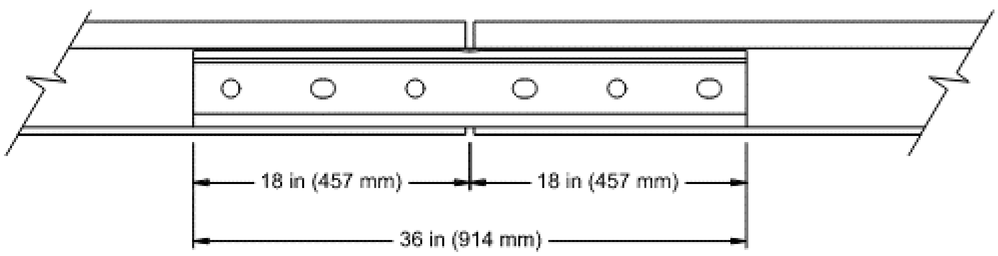


Figure 9-2 Location of Non-defective Tie at Joints - Class 3 through 5 tracks

i. In Class 3 and above track, a second non-defective tie must be installed within 30 days of discovering the above condition. The second tie must be within 24 in (609 mm) of the center of the joint.

9.1.16 The number of non-defective ties in any 39 ft (11.9 m) segment of track must never be less than values indicated in Table 9-1 and must be effectively distributed to support the entire 39 ft (11.9 m) segment.

Table 9-1 Number of Non-defective Ties per 39 ft (11.9 m) Length

Class of Track	Minimum Number of Non-Defective Ties per 39 ft (11.9 m) Length	
	Tangent up to 2°	Turnouts and curves greater than 2°
5	12	14
4	12	14
3	10	10
2	8	9
1	5	6

9.1.17 For all Classes of Track, a spot tie renewal program must be planned when clusters of defective ties are found to be:

a) Four consecutive defective ties in tangent or in a curve up to two degrees (2°);

b) Three or more consecutive defective ties in a curve greater than two degrees (2°); or

c) Defective ties in the joint area as per Track Standards Section 9.1.15.

9.1.18 The maximum number of defective ties per mile must not exceed the quantities in Table 9-2.

a) A spot tie renewal program or an Out-of-Face Tie Replacement program must be planned prior to the defective ties reaching the maximum limits in Table 9-2;

b) Speed Restrictions must be applied based on the values in Table 9-1.

Table 9-2 Maximum Number of Defective Ties per Mile

Class of Track	Maximum Number of Defective Ties / Mile
5	930
4	930
3	1200
2	1400
1	1600

9.1.19 When renewing defective ties, regardless of method of installation:

a) When a priority gauge defect is present, gauge must be corrected;

i. If more than four (4) consecutive ties are renewed, the track will also require gauging.

b) Ballast removal from the ballast section must be minimized;

c) All ties installed must be spiked and anchored as per the applicable standard, the ballast section restored, and the ties properly tamped before the end of each shift. Any adjacent ties hanging must be tamped;

d) Tie spacing must be adjusted as ties are installed;

e) Do not adze new ties;

f) To allow a train to operate over the tie renewal process during the planned shift, not more than three (3) consecutive track ties on tangent track or two consecutive track ties on curved track may be left un-spiked when the three (3) adjacent track ties are non-defective and spiked as per standard. The speed must be limited to 10 mph;

g) Track ties on either side of all joints and, including the joint track ties must be spiked, the joint must be inspected, tightened if required, and the speed must be limited to a maximum of 10 mph;

h) Any broken, damaged, defective, excessively worn (1/4 in (6 mm) or greater shoulder wear) and single shoulder tie plates must be replaced when the tie is renewed;

i) All new anchors installed are to be Improved Fair type or equivalent as approved by the Director, Engineering-Track. All anchors reused must not be broken, damaged, defective, or sprung to the point that they will not stay on the rail base; and

j) When replacing a defective tie with a track geometry tag, ensure the geometry tag is attached to the new tie installed at that location as per Standard Plan GTS-0726.

9.1.20 Ties must not be installed when the rail temperature is above or expected to be above the PRLTR in the next 24 hours unless directed by the Director, Engineering–Track, who must specify all necessary precautions to be taken, including but not limited to increased inspections, a more restrictive speed restrictions than indicated in Appendix J, mandating the use of a stabilizer or a production tamper, or limiting work to emergency applications where the track is already out of service, impassable or exceeds urgent defect limits for Class 1.

9.1.21 During tie renewal programs:

a) The track must be inspected for surface, line, and ballast section before the end of each shift prior to placing the track in service;

b) The track must be protected by the appropriate speed restriction as per Appendix J; and

c) To reduce speed restrictions, production tampers and dynamic track stabilizers must be incorporated into the Out-of-Face Tie Replacement programs.

9.1.22 Prior to moving from a work site, it is the responsibility of the tie gang program Supervisor to ensure that speed restrictions associated with the tie installation are transferred to the Track Lead. The Track Lead is then responsible to monitor the speed restrictions and reduce or remove them as conditions permit.

9.1.23 In CWR territory, Class 1 through 5, the maximum number of consecutive ties that can be renewed in a single pass must be as per Table 9-3:

Table 9-3 Maximum Number of Consecutive Ties for Renewal

	Number of Consecutive Ties	
	Tangent track up to 2° curves	Curves greater than 2°
With a Junior or Production Tamper	5	4
With Hand tamping or Hydraulic Tools	3	2

9.1.24 Crossing ties replaced as part of crossing rehabilitation works may all be changed in a single pass and/or installed as a panel provided the following is complied with:

a) Road crossing surface is replaced following the completion of the track rehabilitation at the road crossing;

b) Road crossing approaches are restored and are of sound condition;

c) The appropriate speed restriction is applied for crossing rehabilitation track work as per Appendix J; and

d) The track is destressed as per Track Standards Section 14.5.

9.1.25 Turnout ties and track ties within a CTC-controlled location in CWR territory may be replaced in a single pass, provided the appropriate speed restriction is applied for spot surfacing.

9.1.26 Fibre optic cables and obstructions, such as rail lubricators, transponders, and guard rails for protection of structures or switch areas that may be damaged or cause interference to the production gang must be clearly marked or removed.

a) If guard rails for bridges, tunnels, or overhead structures are removed, requirements in Track Standards Section 21 must be followed.

9.1.27 Gauge rods must not be used on Metrolinx tracks. Any Gauge rods found must be promptly removed, and the appropriate number of ties must be installed.

9.1.28 Track shims can be installed on wood ties:

a) As the final option to correct surface defects in frozen ballast conditions;

b) Ensure the shims are the same size as the tie plate and have pre-drilled holes corresponding to the tie plate they are under;

c) Rubber shims are the preferred type however, wooden shims may also be used in temporary applications or as directed and approved in writing by the Director, Engineering-Track;

d) Where possible, only one (1) shim of required thickness must be used to correct the surface defect;

e) The spikes used must penetrate at least 4 in (102 mm) of the tie, where this is not possible, shim spikes must be installed;

f) All anchors must be removed through the area of shimming, and in CWR territory, the approach to the area must be box anchored for 200 ft (61 m) in each direction;

g) Where shims are installed in excess of 1 in (25.4 mm), bracing and shims must be applied as specified by the Director, Engineering-Track; and

h) Within 30 days of the ballast section thaw:

i. All shims must be removed;

ii. Permanent surface repairs must be completed; and

iii. Appropriate anchoring pattern must be restored.

9.2 Transition Ties

9.2.1 Transition tie sets in CWR territory may be changed out in a single pass provided that:

a) The ties are being replaced in conjunction with ballast rehabilitation work;

b) Upon completion of work, the ballast section must be fully restored with a minimum of 12 in (305 mm) shoulder and a 2H:1V slope to the sub-ballast; and

c) The appropriate speed restriction is applied as per Appendix J.

9.2.2 Transition ties must extend far enough to ensure that any rail joint, including bonded insulated joints, are placed on the same composition of tie and the rail joint is separated from another tie composition by at least four (4) ties.

9.2.3 In all combinations cited in Track Standards Section 9.2, the timber transition tie of the greatest length must be placed adjacent to the infrastructure with the greater unfrozen track modulus. Typical approximate track modulus values are:

a) Wood-tie track, after tamping track modulus = 1,000 psi (6.90 MPa);

b) Wood-tie track, compacted by traffic track modulus = 3,000 psi (20.7 MPa);

c) Plastic composite-tie track, compacted by traffic track modulus = 3,000 psi (20.7 MPa);

d) Concrete-tie track, compacted by traffic track modulus = 6,000 psi (41.4 MPa);

e) Direct fixation track, track modulus = 9,000+ psi (62.1 MPa).

9.2.4 Where wood ties adjoin an open-deck bridge structure or trestle:

a) A transition tie set consisting of two (2) 9 ft (2.74 m) ties, two (2) 10 ft (3.05 m) ties, and two (2) 11 ft (3.35 m) ties spaced at 20 in (508 mm) must be installed; and

b) Where the ballast wall does not permit the specified tie lengths, use longest tie lengths possible. See Standard Plan GTS-1108.

9.2.5 Where concrete ties adjoin an open-deck bridge structure, concrete ties must not be installed closer than 20 ft (6.1 m) to the back wall of the structure.

a) A transition tie set consisting of twelve (12) 11 ft (3.35 m) ties spaced at 20 in (508 mm) must be installed; and

b) The spacing between the concrete tie and the transition tie must be 20 in (508 mm).

9.2.6 Where concrete ties adjoin wood ties, a transition tie set must be installed, which consists of:

a) Four (4) 9 ft (2.74m) ties, four (4) 10 ft (3.05 m) ties, and four (4) 11 ft (3.35m) ties spaced at 20 in (508 mm); or

b) Twelve (12) 10 ft (3.05m) ties spaced at 20 in (508 mm).

c) The spacing between the concrete tie and the transition tie must be 20 in (508 mm).

9.2.7 Where concrete ties adjoin a wood tie turnout, a transition tie set must be installed, which consists of the following:

a) Four (4) 9 ft (2.74m) ties, four (4) 10 ft (3.05 m) ties, and four (4) 11 ft (3.35m) ties spaced at 20 in (508 mm); or

b) Twelve (12) 10 ft (3.05m) ties spaced at 20 in (508 mm); and

c) The spacing between the concrete tie and the transition tie must be 20 in (508 mm).

9.2.8 Where steel ties adjoin concrete ties:

a) A transition tie set consisting of four (4) 9 ft (2.74m) ties, four (4) 10 ft (3.05 m) ties, and four (4) 11 ft (3.35m) ties spaced at 20 in (508 mm) must be installed; and

b) The spacing between the concrete tie and the transition tie must be 20 in (508 mm).

9.2.9 Permanent transition tie sets must not be placed within horizontal curves nor within spirals. The distance between transition tie sets and spirals, Tangent to Spiral (TS) and Spiral to Tangent (ST) geometry points, and simple Curves, Beginning of Curve (BC) and End of Curve (EC), must be the greater of:

a) Preferred minimum: 200 ft (61 m), unless otherwise approved in writing by Metrolinx E&AM-Track; and

b) Absolute minimum: 40 ft (12.2 m).

   i. Installation of permanent and temporary transition tie sets within 40 ft (12.2 m) of spirals or in full body of curves must be reviewed and approved by the Director, Engineering–Track.

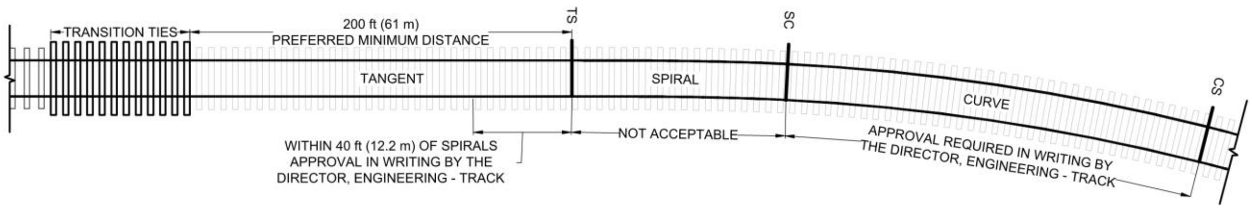


Figure 9-3 Transition Ties in Proximity to Horizontal Curves

9.2.10 Temporary transition tie sets may be installed in maximum two-degree (2°) track curves provided the following conditions are met:

a) In hardwood tie territory, cast tie plates and fasteners are used throughout the transition tie set; and

b) The transition tie set is removed from track within 180 days (6 months).

9.2.11 Temporary transition tie sets may be installed in 2° - 10° track curves provided the following conditions are met:

a) Cast tie plates and fasteners are used throughout the transition tie set;

b) Twelve (12) 10 ft (3.05 m) track ties are installed at 20 in (508 mm) centers;

c) The transition tie set is removed from track within 28 days (4 Weeks).

9.2.12 In all cases, the track-bed width must be designed and constructed to accommodate the transition tie sets, provide for the minimum ballast shoulder width and sloped profile for CWR, and provide a flat walking surface width of at least 20 in (508 mm) for Railway personnel.

9.3 Concrete Tie Installation and Maintenance

9.3.1 Concrete ties must be handled in such manner to prevent chipping, spalling, cracking or other damage during loading, shipping, unloading and stockpiling. Do not drop or skid ties and only use lifting devices appropriate for handling concrete ties. Steel material must not contact any part of the concrete.

9.3.2 Concrete ties must be spaced at 24 in (609 mm) on center except in high-degree curves as per Track Standards Section 19, or in special track applications as directed by the Director, Engineering–Track.

9.3.3 Concrete ties must be supplied in accordance with the Metrolinx Concrete Tie Specification.

9.3.4 All components of the fastening system for concrete ties must be compliant with the requirements in Metrolinx Concrete Tie Specification. Any proposed alternative replacement components must be approved in writing by the Director, Engineering–Track prior to their use.

a) Rail Clips;

   i. Only elastic rail clips are accepted;

   ii. Rail clip installation and removal must not damage the tie, shoulder, rail clip, insulator or the rail; and

   iii. Galvanized rail clips must be installed at heavy salt locations such as station platforms, layover facilities, at-grade crossings, and tracks located adjacent to roads or freeways with heavy traffic activity.

b) Rail Seat Pads;

c) Insulators; and

d) Embedded Shoulders.

9.3.5 When rail heaters are used during rail installation or destressing, place removed insulators and rail clips in a position that will not be in contact with the heat from the rail heater. Care must be taken to keep the heater moving so as not to damage the tie pads. Tie pads must be inspected after the use of heaters, and any tie pads damaged, melted, curled, or dislodged must be replaced and reset.

9.3.6 To avoid damage to the insulator post, embedded shoulders and/or shattering of the plastic coating of the insulators, insulators must not be forced into position by aggressive hammering. A rail positioner tool must be used to provide a suitable gap between the base of the rail and the embedded shoulder.

9.3.7 If for any reason temporary joint bars are installed, they must be removed as soon as possible and replaced with field welds.

9.3.8 When changing out rail, the rail seat pads and the concrete tie rail seat area must be closely inspected for signs of rail seat abrasion.

9.3.9 Rail seat pads must be inspected for indentations, tearing, cracking, damage from heat source, wear and thinning, especially on the field side. All defective rail seat pads must be replaced.

9.3.10 Field side insulators must be inspected for crushing or wearing of the post section. Crushed insulators must be replaced.

9.3.11 Track Geometry for any track with concrete ties must be maintained to a minimum of Class 4 track standards.

9.3.12 When mechanically surfacing the track, the tamping heads must be adjusted for the increased width and depth of the concrete tie. When using ballast regulators on concrete ties, the plow must be modified to avoid contacting, removing or damaging the rail clips. The ballast regulator operator must inspect the track for missing rail clips after the initial plow operation of the regulator. The Employee in charge must inspect the track for missing rail clips behind the ballast regulator.

9.3.13 Rail seat abrasion (degradation) is erosion of the concrete surface under the rail seat pad. It can cause wide gauge and change in rail cant. The surface of the rail seat becomes rough in the early stages. If not corrected, this condition will advance and will result in the loss of several millimetres in the depth of concrete in severe cases. The degradation can result in the loss of restraint by the rail clip, change in rail cant and gauge widening. The Track Lead and the Maintenance Delivery—Manager of Track must be notified promptly so that corrective action can be planned.

9.3.14 Inspect for signs of rail seat abrasion (degradation). These include:

a) Rail seat pads curling, squeezing out, or bleeding at the sides of the rail seats;

b) Rail tie pads are worn through or indenting into the surface of the rail seat;

c) Change in rail cant;

   i. Each degree of rail cant is equal to 1/8 in (3 mm) of gauge widening.

d) Signs of rail running through the rail clips or missing clips;

e) Displaced or missing insulators;

f) Concrete dust or slurry adjacent to the rail seat pad.

9.3.15 When signs of significant rail seat abrasion appear, a more detailed inspection must be undertaken by unclipping the rail and jacking to view the rail seat. The Maintenance Delivery—Manager of Track and Track Lead must be notified immediately.

a) Defective ties must be identified and marked for replacement;

b) If there is deterioration or abrasion at any point under the rail seat of 1/2 in (12.7 mm) or more, the tie must be considered defective and replaced.

9.3.16 Concrete ties with any of the following conditions must be considered defective:

a) Tie broken transversely under one or both rail seats;

b) Tie broken transversely between the rail seats and showing signs of further concrete deterioration such as loss of tension in pre-stressing wires, exposure of wires, crumbling;

c) Tie broken longitudinally, resulting in loss of ability to hold cast shoulder(s) in place;

d) When the embedded shoulder can be pulled out or mover laterally more than 3/8 in (9.5 mm) relative to the tie, is rotated or is missing;

e) Broken, damaged or worn embedded shoulders impacting rail clip placement and insertion;

f) Concrete worn from the bottom of the tie to the lowest level of pre-stress wires;

g) In any 39 ft (11.9 m) length of track, there must not be more than:

   i. Seven (7) defective ties on tangent track;

   ii. More than five (5) defective ties on curves; and

   iii. No more than two (2) defective ties in a row.

h) Damaged ties due to derailments must be inspected for evidence of progressive deterioration;

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

j) A tie can sustain substantial damage to the concrete at the ends without seriously affecting the performance of the tie. If the concrete ends are damaged but the tie maintains gauge and the embedded shoulders are not damaged or loose, the tie must not be considered defective;

k) When the base of the rail can move laterally more than 3/8 in (9.5 mm) in curves two-degree (2°) or greater, or move laterally more than 1/2 in (12.7 mm) in tangent or curves less than two-degree (2°);

l) When the longitudinal rail restraint is unable to be maintained;

m) Embedded shoulders on the field side of the high rail in curves must be inspected for hairline separations of the shoulder where it enters the tie. This condition can result in several consecutive ties failing. Should one (1) broken embedded shoulder fail in this manner, the adjacent ties must also be inspected.

9.3.17 Ties must not be allowed to become center-bound (transverse cracks in the middle third of the tie indicate a center-bound condition).

9.3.18 In concrete tie territory, cribs filled to a minimum of 1 in (25 mm) below the top of tie ends. Ballast and ballast fines must not be left on and around the concrete tie fastening system.

9.3.19 Broken, loose, sprung, or missing rail clips must be replaced.

9.3.20 Concrete ties must not be drilled or modified in any way from their design.

9.4 Concrete Tie Repair Procedure

9.4.1 Ties with honeycombing and air voids are indicative of conditions such as poor mixing, vibration, and/or consolidation, must be rejected.

9.4.2 The surface of the rail seat must have a smooth, formed finish. Rail seat air voids in excess of 1/4 in (6.3 mm) diameter by 1/8 in (3 mm) deep must be rejected.

9.4.3 Voids in the rail seat between 1/8 in (3 mm) diameter and 1/4 in (6.3 mm) diameter may be repaired with high-strength epoxy paste.

9.4.4 At the tie ends, exclusive of tendon extending beyond the end of the tie, ties with any tendon exposed more than 1 in (25 mm) due to honeycombing, air voids, spalling, corner and edge breaking, or other reasons must be repaired or rejected.

9.4.5 Simple air voids in the side of ties (45° slopes outwards below the rail seat) up to 3/8 in (9.5 mm) diameter by 1/4 in (6.3 mm) deep is acceptable. Voids between 3/8 in x 1/2 in (9.5 mm x 12.7 mm) and 3/4 in x 1/2 in (19 mm x 12.7 mm) may not exceed two (2) per tie, but may be repaired with high-strength epoxy paste. Air voids larger than 3/4 in x 1/2 in (19 mm x 12.7 mm) must be rejected.

9.4.6 Tie corner/top/side/bottom breakage that exposes a broken surface in excess of 10 in^2 (64.5 cm^2) must be repaired with the specified repair material in accordance with the manufacturer's recommendations for all breaks above the top row of wires.

9.4.7 Surface breaks less than 10 in^2 (64.5 cm^2) may need to be patched, at the discretion of the Director, Engineering-Track, for any ties within 50 ft (15.2 m) of station platform limits, at-grade crossings, or pedestrian crossings.

9.4.8 Tie patching should only be done on concrete breaks that are greater than 10 in^2 (64.5 cm^2) and only when the break has not structurally affected the tie.

a) Note that patching of the tie is for cosmetic purposes only, and does not improve the performance of the tie for the design loads.

9.4.9 It is recommended that for any patching of the concrete ties Ardex TWP mortar mix is used. Other products must be approved in writing by the Director, Engineering-Track.

9.4.10 A latex binder is optional with the above specified mortar mix. Where a latex binder is required, use DA4 CHEM AD Bond (J-40) or equivalent Dayton Superior Product.

9.4.11 Before mixing the patching materials, the proposed area must be dry and free of dirt and loose materials. It is recommended to use a wire brush or wheel, and a propane torch to remove surface water.

9.4.12 Thoroughly spray the damaged area with the latex binder, if applicable.

9.4.13 Mix 1/2 cup of water and 2 cups of mortar mix. Add small amounts of water to achieve a consistency similar to wall plaster.

9.4.14 Apply patching material in thin layers over the broken area until the broken area is completely filled. If required, spray additional latex binder to aid in finishing.

9.4.15 Cover the patched area with plastic during the curing process.

9.4.16 Any repairs to concrete ties cannot be made when the ambient temperature is below or is expected to dip below 40 °F (5 °C).

9.5 Steel Tie Installation and Maintenance

9.5.1 Permanent steel ties must not be installed on main track, unless approved in writing by the Director, Engineering—Track.

9.5.2 Uninsulated steel ties must not be permitted in signalized territory.

9.5.3 Steel ties must only be permitted for installation in layover facilities and within the USRC. Within the USRC, insulated steel ties are permitted between the John St and Jarvis St ladder tracks.

9.5.4 Galvanized connecting hardware must be installed at heavy salt locations such as station platforms, layover facilities, at-grade crossings and tracks located adjacent to roads or freeways with heavy traffic activity.

9.5.5 Steel ties must be installed on a pre-ballasted grade as defined by Track Standards Section 11.2.2.

9.5.6 Steel ties must be installed as per the Manufacturer's Instructions (for example, when using Narstco ties, use the Narstco Steel Tie and Turnout Set Assembly Instructions).

9.5.7 Hollow steel switch ties are permitted for use at turnout locations, and other locations as approved by the Director, Engineering – Track.

9.6 Other Types of Ties

9.6.1 Installation locations for composite ties must be approved in writing by the Director, Engineering–Track. Composite ties must be installed as per manufacturers instructions.

9.6.2 No other types of ties must be permitted on Metrolinx railway corridors without written approval from the Director, Engineering – Track. Plates, Fasteners, and Other Materials

10 Plates, Fasteners, and Other Materials

10.1 Tie Plates

10.1.1 In Classes 1 through 5, tie plates must be installed on all hardwood ties under the running rails. Tie plates must not be installed under guard rails protecting structures unless directed by the Director, Engineering–Track.

10.1.2 Tie plates must be selected for installation in accordance with Appendix S.

10.1.3 Where cast tie plates are used, as per Standard Plans GTS-0501, they must be installed either on every tie or on every other tie under both rails on the same tie, as directed by the Director, Engineering–Track.

a) If cast tie plates are required to be installed under one rail at a time, track geometry measurements must be completed prior to the track being placed in service, and any applicable speed restrictions must be applied.

10.1.4 The reuse of tie plates must be as directed by the Director, Engineering-Track, however:

a) Broken, cracked, corroded or damaged tie plates must not be reused; and

b) Single shoulder tie plates must not be reused and must be upgraded as per Appendix S.

10.1.5 Rolled plates must not be installed or reinstalled in any Metrolinx-owned track unless approved in writing by the Director, Engineering–Track.

a) Approved rolled tie plates are permitted in existing turnout applications only.

10.1.6 Tie plates with excessively worn spike holes or shoulders greater than the limits shown below must be removed from track and not be reused:

a) Spike holes worn more than 1/4 in (6.3 mm);

b) Lag or spike screws holes worn more than 1/4 in (6.3 mm); and

c) Tie plate shoulders worn more than 1/4 in (6.3 mm).

10.1.7 Tie plates must be installed as per the following requirements:

a) The tie plates must have full, even bearing on the track ties;

b) The field side tie plate shoulder must be square against the field side base edge of the rail;

c) The tie plate must be the proper plate size for the rail base installation;

d) The tie plate must be centered on the tie with the edge of the tie plate to the edge of the tie on both sides of the tie being of equal distance;

e) The rails must be canted toward the center of the track; and

f) Each tie plate must have the same cant (1:40);

i. Tie plates used for track work activities on Metrolinx-owned portion of the Galt Subdivision must match the adjacent track tie plates. The use of 1:20 cant plates must be permitted for this purpose.

10.1.8 Ensure there are no foreign objects between the rail base and the tie plate. This must include the tie plate shoulders and spike heads.

10.1.9 Any alterations of tie plates are not permitted.

10.2 Rail Anchors

10.2.1 Anchors must be Improved Fair Type Anchors or approved equivalent as determined by Director, Engineering—Track.

10.2.2 Rail anchors for the appropriate rail base size must be applied on wood ties as follows:

a) Uniformly along the rail firmly against ties;

b) In Box Anchoring Pattern on the same tie;

c) On ties perpendicular to the rail. Skewed ties must be straightened before anchoring;

d) On the gauge side of the rail. Rail anchors may be applied on the field side of the running rail in Special Trackwork;

e) Using only the proper tools or machines when applying or removing rail anchors to avoid damaging the anchor or risking injury. The use of a spike maul is prohibited;

f) No closer than 2 in (51 mm) from a plant or field weld;

g) The application must not interfere with or damage signal wires; and

h) The rail anchor must be fully engaged with the base of the rail, and the base of the rail must be sitting inside the rail seat of the rail anchor. Do not overdrive the rail anchor.

10.2.3 When changing rail or renewing ties, all rail anchors removed must be reapplied.

10.2.4 Sprung, cracked, broken or damaged rail anchors must not be installed.

10.2.5 Rail anchors must be removed from the rail while the rail is still in track.

10.2.6 Rail anchors must be removed prior to track shimming. The rail anchors removed must be installed immediately adjacent to the shim location on track ties with no anchors, 50% in each direction. Rail anchors removed during shimming must be replaced when shims are removed.

10.2.7 Rail anchors are not required on wood ties with elastic fastening systems unless additional longitudinal restraint is required.

10.2.8 Rail anchors can be slid along the rail base only with a mechanical rail anchor squeeze/spreader.

10.2.9 Rail anchors required to be manually adjusted must be removed and reapplied.

10.2.10 Rail anchors will only be removed using approved sledgehammers, hand tools for specific types of anchors or mechanized equipment.

10.2.11 In non-CWR track, rail anchors in Class 1 through Class 5 must be applied in a box pattern on every other tie. Where joints restrict rail anchor application, the adjacent tie must be anchored.

10.2.12 Rail anchors must not be installed on the rail opposite of joints, with the exception of turnouts.

10.2.13 Turnouts must be fully anchored to the fullest extent possible.

10.2.14 In all CWR track, rail anchors will be installed in a box pattern on every other tie except:

a) At permanent joints within CWR (joints that will not be welded), every tie must be box anchored for a minimum distance of 200 ft (61 m) in each direction from the joint;

b) When jointed rail abuts CWR, every tie must be box anchored for a minimum distance of 200 ft (61 m) in each direction from the joint;

c) Every tie must be box anchored for a minimum distance of 200 ft (61 m) in each direction from any turnouts, non-glued insulated joints, diamond crossing frogs, and/or a lift rail system;

d) At location of an open-deck bridge, every tie must be box anchored for a minimum distance of 200 ft (61 m) from each abutment;

e) At locations where steel or concrete ties adjoin hardwood ties, every tie must be box anchored for a minimum distance of 200 ft (61 m) in the direction of the hardwood ties; and

f) At road crossings, every tie must be box anchored for a minimum distance of 200 ft (61 m) in each direction if the crossing itself is not box anchored.

10.2.15 When CWR is installed on a bridge with an open deck span, the requirements outlined in Table 10-1 will be used, unless approved in writing by Maintenance Delivery—Manager of Bridges and Structures.

a) The Maintenance Delivery—Manager of Bridges and Structures must identify fixed ends of spans prior to installing CWR;

b) Prior to anchoring CWR on open deck steel Through Plate Girder (TPG), Through truss (TT), and Deck Truss (DT) spans, the Maintenance Delivery—Manager of Bridges and Structures will confirm the requirements for bridge traction bracing;

c) Rail anchor requirements and patterns should be confirmed with the Maintenance Delivery—Manager of Bridges and Structures;

d) On timber span bridges, only box anchor the ties that are attached to the span with boat spikes, usually every other tie or as directed by the Director, Engineering—Track;

e) Movable spans will be anchored as directed by the Director, Engineering – Track; and

f) Where elastic fasteners provide longitudinal restraint, they will be considered equivalent to anchoring.

10.2.16 CWR installed on a ballast deck bridge or span will be box anchored at a minimum of every second tie.

10.2.17 CWR installed on an effective 2% grade or greater must have every tie box anchored for the length of the grade and 200 ft on both the low and high sides of the grade.

10.2.18 Trains may operate over unanchored track at a speed restriction not exceeding 10 mph under authorization from the Track Lead. Such authorization should include instructions to avoid brake application 500 ft (152.4 m) before and through the work area.

Table 10-1 Anchor Requirements for CWR Track on an Open Deck Bridge

<table>
<tr><th>Length of Continuous Open Deck Portion</th><th>Individual Span Length</th><th>Rail Anchor Requirements</th><th>Sliding Joint Requirements</th></tr>
<tr><td>100 ft (30.5 m) or Less</td><td>All Spans</td><td>No rail anchors</td><td>None required</td></tr>
<tr><td rowspan="6">Greater than 100 ft (30.5 m)</td><td rowspan="3">100 ft (30.5 m) or Less</td><td>Box anchor every second tie*</td><td>None required</td></tr>
<tr><td colspan="2">Or</td></tr>
<tr><td>No rail anchors</td><td>Sliding joint(s) required</td></tr>
<tr><td rowspan="3">Greater than 100 ft (30.5 m)</td><td>Box anchor every second tie for 100 ft (30.5 m) from fixed end of span*</td><td>None required</td></tr>
<tr><td colspan="2">Or</td></tr>
<tr><td>No rail anchors</td><td>Sliding joint(s) required</td></tr>
</table>

* Box anchors are to be applied only to ties that are hook bolted to the span (generally every second tie). Box anchor spacing may be extended to every third tie if required to match the bolt spacing. If elastic fasteners are used, every non-hook bolted tie should have an elastic fastener without longitudinal restraint.

10.3 Derails

10.3.1 Derails must not be installed on main tracks.

10.3.2 Derails must be installed:

a) Where there is any possibility of equipment that has been left standing on tracks other than main tracks may be moved by gravity or weather so as to obstruct a main track or siding;

b) At tracks used to tie up equipment on a regular basis. Through tracks must be equipped with derails at both ends. Locations used to tie up engines will be specified by the Metrolinx Operations Division;

c) At entrances and exits of Main and Running Repair Shops. Derail must be applied to each track not less than 40 ft (12.2 m) from doors. Where further safety measures are required, a derail pit may be installed in accordance with drawing Standard Plan GTS-2212;

d) On tracks on which an industry will move equipment; and

e) Where required to protect track conditions, equipment or on-track work where allowed by Operating Rules.

10.3.3 Portable derails must be correctly installed to ensure proper function. Portable derails must be installed in accordance with the Metrolinx GEI and must:

a) Not be used where the speed of equipment to be derailed will exceed 15 mph;

b) Be installed on non-defective ties;

c) Be disposed of if involved in a derailment; and

d) Be stored, locked and secured, when not in use to prevent theft or vandalism.

10.3.4 Permanent derails must only be installed as approved in writing by the Director, Engineering–Track. Removal of a permanent derail must be approved in writing by the Director, Engineering–Track, the Manger of Track–Maintenance Delivery must be notified, and the request must include:

a) Details of proposed operating conditions that will ensure protection from unattended movements; and

b) Confirmation that these operating conditions are in place; and where necessary, operating simulations may have to be carried out to confirm that the derail is no longer required.

10.3.5 The Rail Services department must advise the Director, Engineering–Track of all operational changes in writing which pertain to derail placement. The Director, Engineering–Track will confirm whether or not said operational changes require the installation of additional derails and that adequate operating procedures are in place to protect the situation. Whenever operational changes so dictate, the Director, Engineering–Track must ensure that derails are installed in accordance with Track Standards Section 10.3.2.

10.3.6 All permanent derails to be installed must comply with GTS Plans. Only the following approved types of derails are to be installed:

a) Hinge Type Derail, Standard Plan GTS-2208 *;

b) Sliding Type Derail, drawing Standard Plan GTS-2209 *; and

c) Double Switch Point Derail, drawing Standard Plan GTS-2210.

* Wheel crowders must be used in conjunction with hinge or sliding-type derails.

10.3.7 Older type Hayes cast derails of type A, AP, G, GP, and D are not to be used and when identified in yearly detailed derail inspections will be changed out as scheduled.

10.3.8 Power-operated derails must be installed and maintained in accordance with plans and instructions provided by the Maintenance Delivery—Manager of Signals and Communications.

10.3.9 To eliminate the possibility of equipment running over hinges and sliding-type derails without derailing, it must be the proper model, size, and handedness (e.g., right or left-hand) to fit the running rail.

a) The direction the equipment approaching the derail and the desired direction the equipment must derail determines whether a right or left-hand derail is required;

b) A right-handed derail is installed on the right-hand rail and derails towards the right; and

c) A left-handed derail is installed on the left-handed rail and derails towards the left.

10.3.10 In the derailing position, the derail block must:

a) Cover the ball of the rail;

b) Lie flat on the top of the rail throughout the underside of the derailing block surface;

c) Bear directly on sound ties; and

d) Have no excessive motion when locked.

10.3.11 In the non-derailing position, for hinge and sliding type derails, ensure that the derail is lower than the ball of the rail to prevent contact with rolling equipment.

a) During Winter, snow and ice must be removed to ensure the hinge and sliding type derail may operate properly and remain below the ball of the rail when in non-derailing position.

10.3.12 The correct size of derail to be used on various rail sections is as follows:

a) Size 6: 100 ARA;

b) Size 7: 115 RE; and

c) Size 8: 132RE and larger.

d) On heavily worn 115 RE rail a Size 6 derail may be used at the discretion of the Director, Engineering - Track.

10.3.13 A steel shim of the correct thickness with holes punched or drilled for all fasteners may be necessary under the derail to ensure the derail block lies flat on the top of the rail. Shimming must be limited to 1/2 in (13 mm) before choosing the next derail size.

10.3.14 Operating switch stands of a rigid type (example 31B, 36E(H) or 112E) must be used with switch point derails and sliding type derails. All derails designated as Special Derails in Special Instructions must be switch-stand operated.

10.3.15 Throw of switch point type derails is 4-3/4 in (121 mm) + 1/16 in (1.6 mm).

10.3.16 Throw of sliding type derails must be measured in accordance with Standard Plan GTS-2209.

10.3.17 Hinge and sliding-type derails must be painted yellow.

10.3.18 All derails not equipped with high operating switch stands must have a derail sign in accordance with drawing Standard Plan GTS-720 mounted on a separate post, and erected adjacent to the derail as shown in Standard Plan GTS-2208.

10.3.19 All derails equipped with rigid-type operating stands must have a derail switch target in accordance with Standard Plan GTS-720 mounted on the mast of the operating stand, as shown in Standard Plans GTS-2209 and GTS-2210.

10.3.20 Derails designated as Special Derails in Special Instructions must have a special derail target installed in place of the standard derail target in accordance with drawing Standard Plan GTS-720. Special derails must be operated by a rigid type switch stand.

10.3.21 When derail signs are mounted on the mast of operating stands, they must be attached to the mast so that they are visible when in the derailing position.

10.3.22 When directed by Special Instructions, derails protected by signals (or otherwise marked), will not require derail signs.

10.3.23 Switch stand targets and target tips, whether reflectorized or not, must not be used in connection with derails.

10.3.24 Tracks equipped with a derail must have the switch stand lever painted yellow.

10.3.25 Location for a derail is governed by local conditions such as grade and length of track. Derails must never be located less than 20 feet (6.1 m) behind the clearance point and installed to derail equipment away from the track being protected. Sufficient distance should be allowed so that the derailed equipment cannot continue to move and foul the track being protected.

a) When the derail must be located within 20 ft (6.1 m) to the clearance point, a bent type guard rail must be installed between the rails, as shown on Standard Plans GTS-2208, GTS-2209 and GTS-2210, to provide additional assurance that the derailed equipment will not foul the track being protected.

10.3.26 Derails should not be installed on the inside rail of curves if it can be avoided. If necessary, to install a hinge type or sliding type derail on the inside rail of a curve, a derail wheel crowder must be installed on the outside rail on the same ties.

a) See Standard Plans GTS-2208, GTS-2209 and GTS-2210 for additional details.

10.3.27 Where there are insulated joints, derails must be placed far enough behind the insulated joints so that equipment derails before fouling the track circuit. In CTC territory, derail placement must comply with Signals and Communication SCP-001.

10.3.28 Maximum distances for derail placement must be calculated using the TPC simulation program with the estimated weight of equipment being stored on that track. Table 10-2 is intended to be used as a guideline to assist field personnel in determining the proper derail for a specific location.

Table 10-2 Guideline for Selection of Derail Type

Gradient (%)	Distance in which Free-Rolling Equipment will achieve the following speed: ft (m)			
	8 mph	9 mph	12 mph	15 mph
0.30	1000 (305)	1280 (390)	2350 (716)	3800 (1158)
0.50	485 (148)	615 (187)	1125 (343)	1805 (550)
0.75	310 (94)	395 (120)	700 (213)	1090 (332)
1.00	225 (69)	285 (87)	555 (169)	785 (239)
1.50	155 (47)	190 (58)	330 (101)	510 (155)
2.00	115 (35)	140 (43)	245 (75)	380 (116)

10.3.29 Straight guard rails will be required where the derailing point is:

a) On a high embankment;

b) Near structures that could be struck by derailed equipment;

c) On a curves greater than 8°; and

d) Where possible equipment roll could foul the track to be protected.

e) Refer to Standard Plans GTS-2208, GTS-2209 and GTS-2210 for details.

10.3.30 All derails must be equipped with an approved high-security switch lock that has been chained, or cabled, to the derail or operating switch stand.

10.3.31 Derails and high-security switch locks must be kept lubricated and adjusted to maintain ease of movement.

10.3.32 Track ties to which derails are fastened must be non-defective, supported with good surface finish, and have the top surfaces on the same plane. Hardwood ties must be used unless approved in writing by the Director, Engineering–Track.

a) In steel tie construction, steel ties may be used on sliding and hinge type derails if approved in writing from the Director, Engineering–Track.

10.3.33 Sliding type and hinge type derails must be installed at right angles to the rail. In new installations, the derail must be fastened to the ties with 1 in x 6-1/2 in (25 mm x 165 mm) lag screws as per Standard Plan GTS-1315.

a) Note – tie plates and/or fastening hardware can be removed at the derail location if needed for proper fit;

b) Derails must be fastened with all available holes filled.

10.3.34 Derails must be inspected by the Track Lead or Track Inspector per the frequency defined in Appendix B Table B-5.

a) Particular attention should be paid to the ties, fasteners, and ballast conditions;

b) Check for any distortion, fractures, damage from derailments or accidents, or unusual wear on the derail;

c) The high-security switch lock is in place, secured, and locked; and

d) All derails must be operated in the non-derailing position during inspection.

10.3.35 To prevent hinge-type derails from freezing to the top of the running rail, a narrow weld bead may be added to the underside of the derail body at the center of the rail head.

10.3.36 A handle can be welded onto the body of a hinge-type derail to make operating the derail easier.

10.3.37 Hinge type and sliding type derails must be installed where the speed of equipment to be derailed will not exceed 15 mph.

10.3.38 On non-main track requiring a derail, a wheel crowder must be installed when:

a) An engine or track unit is in use; or

b) Equipment speed could exceed 10 mph.

10.3.39 At engine and equipment repair facilities, wheel crowders must be installed with Hinge type or Sliding type derails.

10.3.40 On non-main track, a double switch point derail will be installed when:

a) The speed of the equipment to be derailed could exceed 15 mph;

b) A private engine or track unit is in use.

10.4 Track Spikes

10.4.1 Each tie plate supporting the rail must be spiked as per the appropriate spiking pattern in Appendix R.

10.4.2 Tie plates with square holes will only be secured by cut spikes. Tie plates with round holes will only be secured with tie screws.

10.4.3 Track and turnout ties will be spiked:

a) With the tie square to the rail and tie plates centered on the tie as per Track Standards Section 10.1.7;

b) With rail at standard gauge;

c) With track spikes driven vertically with the throat of the track spike in contact with the base edge of the rail. Do not drive the track spike head onto the rail base, causing damage to the rail. Track spikes must be driven to a depth such that the track spike head is within 3/16 in (4.8 mm) of top of the rail base. Every effort should be made not to overdrive track spikes;

d) Using only standard spike mauls, pneumatic or hydraulic spiking hammers, or with a spiking machine. Do not strike any part of the rail while spiking;

e) With track spike heads turned away from the joint bars of insulated joints; and

f) At joints, cut spikes must not be installed within 2 in (51 mm) of the end of the joint bar.

10.4.4 When pulling track spikes, a track spike lifter may be used when track spikes cannot be loosened with a claw bar.

10.4.5 Track spikes between the running rail and guard rails, as well as track spikes in tight areas around heel blocks and frogs, will be removed using a four-ball track spike puller and claw bar.

10.4.6 Claw bars must not be struck with mauls or other tools.

10.4.7 Spike lining is not permitted in CWR territory except when it is not possible to line the track.

10.4.8 Spikes installed with shims must follow the requirements in Track Standards Section 9.1.28.

10.4.9 Turnouts must be spiked as per the pattern identified in Figure 10-1.

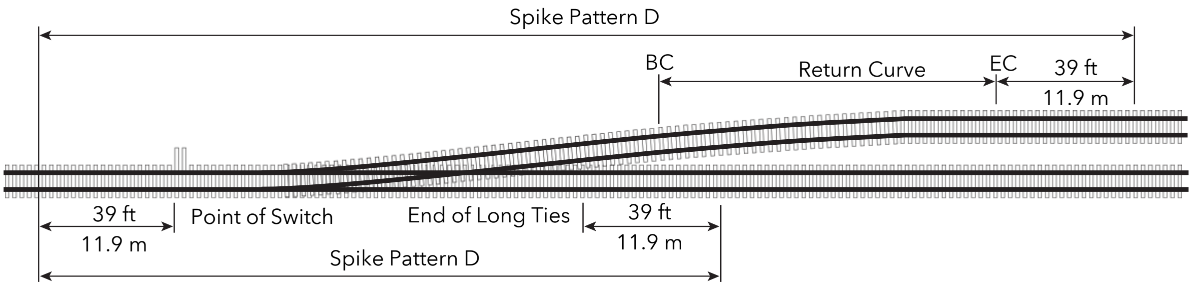


Figure 10-1 Spiking Pattern Through Turnouts

10.5 Wood Tie Screw

10.5.1 Wood tie screw installation will require an 11/16 in (17.5 mm) pilot hole drilled a minimum of 6 in (152 mm) into the turnout or track tie.

10.5.2 Wood screws will be run (turned) into turnout or track tie and not driven.

10.5.3 Timber screws must not be used with washers.

10.5.4 Tie plates fastened with screw spikes or drive spikes must meet the requirements as per Appendix R.

10.5.5 Drive screw spikes can be either driven or turned into the turnout or track tie.

10.5.6 Do not overtighten the screw or screw spikes.

10.5.7 Screws must be removed using an impact wrench or other power wrench. Drive screw spikes must be withdrawn using an impact wrench.

10.6 Elastic Fasteners

10.6.1 Elastic fasteners must match the fastening system of the tie plate, steel tie or concrete tie. Elastic fasteners must be replaced when the elastic fastener is sprung, damaged or corroded.

10.6.2 The appropriate elastic fastener type must be used in their application. Modified “E” 2063 elastic fasteners and modified 4277 insulators must be used at insulated joint locations. Refer to Standard Plan GTS-1322 for details.

10.6.3 Elastic fasteners must be fully applied, and care must be taken to ensure they are not over-driven and/or damage the plate or rail.

10.6.4 Fasteners subject to constant damp conditions (e.g. in tunnels) or to heavy salting (e.g. through station platforms, rail crossings), must be galvanized.

10.6.5 Where elastic fasteners are installed by hand, care must be taken not to strike the shoulder, tie or rail with the elastic clip applicator. Sledgehammers must not be used to install elastic fasteners.

10.6.6 Where elastic fasteners are installed by machine, the operator must ensure that the machine is adjusted to insert the elastic fastener horizontally into place without binding.

10.6.7 When fastening rail to concrete and steel ties, ensure rail seat tie pads, insulators, and elastic fasteners are installed and in good condition.

10.6.8 Do not attempt to nip, lift or reposition a tie using the elastic fastener.

10.6.9 When removing elastic fasteners, use the proper tools and ensure elastic fasteners are not allowed to fly freely when released.

10.6.10 In concrete tie territory where a temporary joint is required, before reopening track for service, elastic fasteners must be removed from one (1) side of the concrete tie to prevent possible shunting of signals system through the inside of the concrete tie.

10.7 End-of-Track Device

10.7.1 Where equipment has the possibility to run off the end of the track, an end-of-track device must be provided for review and approval in writing by the Director, Engineering–Track.

10.7.2 For new construction, wheel stops must not be used.

10.7.3 All end-of-track devices must be installed as per manufacturer recommendations.

10.7.4 See Standard Plan GTS-2214 for fixed bumping post details.

10.8 Distribution of Other Track Material (OTM)

10.8.1 Plates, fasteners and OTM cannot be distributed more than one week prior to their planned installation and must be placed flush with the surface of the tie. If work is postponed following the distribution of materials, the pre-distributed materials must be promptly removed.

10.8.2 The pre-distribution of track material must be clearly identified in the work plan methodology and associated risk assessment. Pre-distribution must not occur within 200 ft (61 m) of an at-grade crossing or turnout, or in a high-trespassing location.

10.8.3 Pre-distributed material limits must be noted in a GBO identifying potential walking hazards.

10.8.4 Following any work, all unused and scrap materials must be removed from Metrolinx ROW prior to the tracks being placed into revenue service.

10.9 Direct Fixation (DF) Track

10.9.1 When a DF fastener plate is required to be replaced, prior to a new plate being installed, the concrete plinth must be inspected to ensure the new plate will be fully supported and to determine the cause of the fastener failure:

a) Any voids found under the fastener plate must be repaired before installing the new fastener plate. Fastener plates must be installed in accordance with the manufacturer's recommendation.

10.9.2 If the anchor inserts for the bolts are higher than the concrete plane by less than 1/8 in (3 mm), it must be ground flush to the concrete surface, and epoxy paint must be applied to the bare steel.

10.9.3 If the anchor insert is found to be defective (e.g., damaged from contact with the fastener plate, plugged with concrete, threads stripped or cross-threaded, too much of the insert ground off), it must be replaced:

a) This is done by core drilling the existing defective insert and grouting a new insert in its place;

b) The new insert must be perpendicular to the bottom plate of the fastener, flush or less than 1/16 in (1.6 mm) below the surface of the concrete, and not in contact with the sides of the cored hole;

c) Any grout to be used must be approved by the E&AM – Bridges and Structures. It is recommended to use a two-component Epoxy grout; and

d) A template for the specific DF plate must be used as a guide for positioning the new insert.

10.9.4 Heavily corroded elastic fasteners must be replaced.

10.9.5 DF track must be kept clean at all times. Locations of heavy sanding and salting must be cleaned at least annually.

10.9.6 Each spring, covered DF track areas near heavy salting locations must be washed off with water to remove any excess salt. Caution must be taken to ensure the runoff is collected and not allowed to enter the public drainage system.

10.9.7 When rail begins to wear in the curves, the gauge of the track needs to be adjusted to meet the requirements of the class of track as per Appendix C and Appendix D. Use the provided DF Fastening Plates to adjust gauge as required.

10.9.8 Restraining rails on DF track must conform to the requirements in Track Standards Section 21.2.

11 Ballast

11.1 General Requirements

11.1.1 Ballasted track must be supported by material which will promote drainage of the track structure and support the track laterally, vertically and longitudinally under dynamic loading imposed by train operation and thermal stresses due to rail temperature variations.

11.1.2 Ballast must conform to the latest version of the Metrolinx Crushed Rock Track Ballast Specification and supplied by the Metrolinx-approved ballast suppliers.

11.1.3 Ballast section must be maintained free of vegetation in accordance with the latest version of the Metrolinx Vegetation Maintenance Requirements Standard.

11.2 Ballast Unloading and Distribution

11.2.1 Ballast section for new construction and rehabilitated track must conform to Standard Plan GTS-2205. For ballast on rail bridges or structures, refer to Metrolinx General Guidelines for Design of Railway Bridges and Structures.

11.2.2 For all new track construction, state of good repair and rehabilitation, place 50% of the total ballast depth (i.e. minimum 6 in (152 mm) under the tie for pre-ballast. Pre-ballast must be graded and consolidated.

11.2.3 Ballast section must meet the following requirements:

a) In wood tie territory, cribs must be filled to a minimum of 1 in (25 mm) below the top of tie;

b) In concrete tie territory, cribs must be filled to a minimum of 1 in (25 mm) below the top of tie ends filling above the concave center of the concrete tie;

c) In steel tie territory, the underside of the steel tie must be completely full of consolidated ballast. This must be confirmed through the steel tie inspection holes;

d) No ballast or ballast fines left on top of track or turnout ties, fasteners, tie plates, or any other Special Trackwork component except as noted in item b above;

e) Ballast shoulder for jointed rail track to be maintained to a minimum of 6 in (152 mm) out from the end of the tie before sloping down at 2H:1V;

    i. In cases where jointed track abuts CWR track, the ballast shoulder must be in compliance with item f below for a minimum of 200 ft (61 m);

f) Ballast shoulder for CWR track must be maintained to a minimum of 12 in (305 mm) out from the end of the tie before sloping down at 2H:1V; and

g) On track beds with multiple tracks and/or adjacent to other tracks, a ballast trough between tracks must be maintained, ensuring a proper 2H:1V shoulder slope within the trough.

11.2.4 When distributing ballast, prior to any movement of equipment, track units and trains on track, the ballast level must be below the underside of the rail head.

11.2.5 Ballast must be removed from turnouts, switch points, switch rods, all flange-ways, through guard rails, at-grade road or rail crossings, and signal appliances which will impede proper operation or passage of wheel flanges.

11.2.6 When unloading and distributing ballast, the amount of ballast required must be unloaded in the correct location in order to reduce wasting ballast. A risk assessment must be completed to determine the methodology at which ballast must be distributed through or on approach to rail-carrying bridges. Ballast car doors must be closed prior to any movement across at-grade road or rail crossings.

11.2.7 When unloading and distributing ballast in the center of the track, a ballast regulator plow, broom or equivalent equipment, not capable of damaging the rail, must be used to distribute ballast evenly.

11.2.8 Care must be exercised when unloading ballast from cars on one side or on curves with superelevation. Prior to movement, the load must be inspected and levelled, as required.

11.2.9 Air dump, tilt side dump style and cross hopper ballast rail cars are not permitted to be utilized on Metrolinx ROW without written authorization from the Director, Engineering—Track.

11.2.10 Prior to unloading/distributing ballast, the method of ballast distribution must be added to the work plan methodology requiring unloading/distributing as part of the work plan submitted for approval. A risk assessment reflecting all known risks and associated risk mitigation plan must be submitted as part of the work plan methodology. Table 11-1 refers to restrictions and requirements for ballast distribution when using ballast cars.

Table 11-1 Levels of Planning

Ballasted Track	Unballasted Track
• Must not distribute ballast on superelevated track sections exceeding 4 in (102 mm). • For sections of ballasted track with superelevation exceeding 4 in (102 mm), a formal Risk Assessment specific to the increased superelevation must be submitted to Metrolinx for review and approval before any actions may be taken.	• Must not distribute ballast on superelevated track sections exceeding 2 in (51 mm) on track-bed where the compaction is unknown or less than 98% SPMDD. For track sections where the subgrade has a compaction degree of 98% SPMDD or greater, the superelevation limit may be increased to 3 in (76 mm).
• Must not shake ballast cars in spirals or curves.	• Must not shake ballast cars.
• The ballast within the ballast cars must not exceed the total weight capacity of the car and must be evenly distributed within the ballast car.	• The weight of the ballast within the ballast cars must not exceed 75% of the total weight capacity of the ballast car when the track-bed compaction degree is unknown or less than 98% SPMDD. For track sections where the track bed has a compaction degree of 98% SPMDD or greater, the weight of the ballast within the ballast car must be governed by the maximum weight capacity of the ballast car. • The weight of the ballast must be evenly distributed within the ballast car.
• Must not distribute ballast on track sections which have reached or exceeded Class 1 track geometry measurements in Appendix D.	
• The ballast must not be unloaded in a manner which creates an unbalanced loading condition within the ballast car.	
• Loaded ballast must be visually inspected by a competent supervisor as defined in the Metrolinx Construction Safety Management Program to ensure the load is safe to travel prior to departure from the loading location.	
• Construction/Skeleton/Unsurfaced track must be inspected, and a record of inspection must be completed prior to operating any equipment/machinery over the track.	

11.2.11 Following any work, any spoiled ballast, backfill or excavated material must not be left stockpiled or reprofiled within the ROW. Reprofiling of spoiled ballast, backfill or excavated material may only be permitted if:

a) There is no potential increased risk to operations (e.g. impeding sightlines, potential excess vegetation growth, etc.);

b) There is no impact to future maintenance work;

c) There is no evidence of a decrease in asset lifecycle (e.g. overloading the top of embankment resulting in slope failures, etc.);

d) There is no potential impact to corridor drainage; and

e) The reprofiling work is maintained within the Metrolinx ROW and does not encroach into adjacent properties.

11.2.12 Following any work, any excess unused new ballast may be left temporarily stockpiled within the Metrolinx ROW, provided the stockpile does not obstruct sightlines, infringe on clearances, or cause any other adverse effects.

11.3 Bridges

11.3.1 Ballast on train crew walkways must be removed to avoid a tripping hazard and to protect the safe passage of the public and traffic under the bridge the same day the ballast unloading/distribution is completed. Removal must be part of the work plan methodology required in Track Standards Section 11.2.10.

11.3.2 Provide from the end of the train crew walkway a well-graded transition zone to the ballasted section without blocking drainage of the track and bridge.

11.3.3 On ballast deck bridges, during ballasting operations, temporary barriers must be provided to protect the public and traffic under the bridge from falling ballast.

11.3.4 As part of the planning process, the bridge must be reviewed to ensure it has sufficient loading capacity for the additional ballast material.

11.3.5 When distributing and regulating ballast, extra care must be taken in the vicinity of open deck bridges to prevent ballast from falling between the ties to the bridge components below. Plywood or similar material must be fastened in place to prevent ballast from falling between the ties for a minimum of 8 ft (2.44 m) from the last open deck tie at each abutment where ballasting activities are taking place. Ballast must not be unloaded on open deck bridges or allowed to spill over onto the bridge deck.

11.4 Public Crossings

11.4.1 At public crossings, ballast unloading and distribution must be done without risk or major inconvenience to the public.

11.4.2 Ballast dropped on the road surface and in the flangeways at the crossing must be removed before the crossing is opened to the public.

11.4.3 In advance of any planned work at an at-grade road crossing, the road authority must be notified, and appropriate road closures must be arranged.

11.5 Undercutting

11.5.1 Take all necessary precautions to avoid track buckling. Pay close attention to the ambient and rail temperature when planning to use under-track plows, sleds, and other specialized undercutting equipment. Fill cribs and restore shoulders with new ballast as soon as possible, but must be completed before the track is put in service for train operation.

11.5.2 Prior to conducting an undercutting program, a tie condition assessment must be completed, and all defective ties must be replaced.

11.5.3 Prior to dumping ballast, the track must be inspected in compliance with Track Standards Section 19.1.12.

11.5.4 The transitions or runoff of gradients must be made on tangent track and must be fully tamped and level to provide a smooth transition from newly ballasted track to track with existing ballast. In no case can the rate of runoff be more than described in Appendix O.

11.5.5 If bridges are within the section of track planned for re-ballasting by an approved method, plans must be made to undercut each bridge approach for a sufficient distance to ensure surfacing runoff meets the requirements outlined in Appendix O.

11.5.6 Following an undercutting program, the disturbed track must be destressed, including 400 ft (122 m) in either direction away from the disturbed section as per Track Standards Section 4.9.

12 Surfacing and Lining

12.1 Surfacing and Lining Requirements

12.1.1 The provisions in this section apply to hardwood and concrete ties.

12.1.2 Track must be lifted and lined to maintain surface and alignment for the appropriate class of track.

a) A printout of the information on the total lift and line of the track section must be provided at the end of each shift.

12.1.3 During surfacing and lining operations, the rate of runoff must conform to the applicable standards in Track Standards Section 16.2.

12.1.4 On the approach to fixed locations while surfacing and lining, the amount of lift and line must be adjusted to match the track profile of the fixed location. Where possible, surface and line away from the fixed location and not towards it.

a) Where surfacing and lining occurs towards fixed locations, both rails must be destressed as per Track Standards Section 4.9, 13.3 and 14.5.

12.1.5 During surfacing and lining, Employees must check the track profile with a level board and visually check the alignment.

12.1.6 After surfacing and lining are completed, the following trackwork is required:

a) Missing, removed, or displaced rail anchors must be reinstated;

b) Missing or damaged elastic fasteners must be replaced;

c) Missing spikes must have holes chemically plugged and replaced;

d) High spikes must be pulled, hole chemically plugged and replaced; and

e) Down ties must be lifted and tamped.

12.1.7 On completion of surfacing and lining, the surface and line must be in compliance with Track Standards Section 16.2 and if applicable, Track Standards Section 19.

12.1.8 Prior to placing the track in service for train operation, the vertical and horizontal clearances for all assets must be measured and confirmed to be compliant with the train clearance envelope as per Track Standards Appendix X.

12.1.9 When tamping ties, 16 in (406 mm) of the tie on either side of the rail must be tamped.

12.1.10 The center of the tie must not be tamped, except for turnout ties and crossing ties.

a) Crossing ties must be fully tamped (including center tamped), stabilized and the track lined and surfaced to the desired elevation; and

b) To avoid a center-bound track, the tamping cycles for the center of track must be less by one cycle.

12.1.11 When tamping transition ties, the entire length of the tie outside the rail must be tamped.

12.1.12 When surfacing in concrete tie territory:

a) Adjust tamper head limit switch to ensure correct cycle depth of tamping tools below bottom of tie. Top of tamping tool must be 1/2 in to 3/4 in (13 mm to 19 mm) below bottom of tie;

b) Ballast regulator plows must be adjusted to ensure no impact on elastic fasteners; and

c) Fastening system must be inspected upon completion of surfacing and lining before track is returned to service.

12.1.13 Track raises of 6 in (152 mm) or more must be avoided.

12.1.14 Individual track lifts must not exceed 3 in (76 mm).

a) The final lift must not exceed 1 in (25 mm).

12.1.15 Dynamic stabilizers must be used between each lift. After the last pass of the surface and line process, the ballast section must be completed before the dynamic stabilizer operates.

a) The dynamic stabilizer must be tested to confirm normal operations immediately prior to commencing surfacing and lining.

12.1.16 When surfacing and lining turnouts in the area of the frog from toe to heel, track jacks must be placed on the rail of the opposite route to the surfacing equipment to assist in lifting the frog without damaging the frog and or base plate.

12.1.17 When surfacing through spring frogs, no lifting action must be applied to any part of the movable wing rail or frog plate.

12.1.18 When regulating through a spring frog the frog must be inspected on foot and cleaned to ensure there are no obstructions in both flange-ways and the movable wing rail is lubricated, free to move and closed.

12.1.19 Track surfacing and lining for activities such as eliminating long line swings, lining curves to the inside, or continuously lining curves in one direction will result in changes to the rail neutral temperature. Rail must be destressed if adjustment is required. See Track Standards Section 4.7.5 for rail destressing requirements. Destressing methodology must follow Track Standards Section 4.9.

12.1.20 When surfacing and lining through a curve:

a) The entire curve must be surfaced and lined, including 100 ft (30.5 m) on both adjacent tangents;

b) A minimum superelevation must be constructed through the curve as per Track Standards Section 19.3;

c) Before surfacing and lining a curve on main tracks, the curve must be staked if it is 3° or more, or if the rail temperature is, or is expected to be in the next 24 hours, more than 50 °F (28 °C) below the PRLT; and

d) Compound curves must be staked prior to surfacing and lining.

12.1.21 To stake a curve prior to surfacing and lining, place at least three (3) reference stakes uniformly spaced around the curve, with the middle stake located near the middle of the curve. Also, place four (4) stakes at key transition points on the curve, including Tangent to Spiral (TS), Spiral to Curve (SC), Curve to Spiral (CS), and Spiral to Tangent (ST) locations. Additional stakes may be used due to the overall length of the curve.

a) Stakes can be placed outside the reach of track equipment or can be 1/2 in x 24 in (12.7 mm x 609 mm) rebar driven in the middle of the track. The track at the location of the stake must be painted, and the measurement from the stake to the near base of the rail must be recorded on the web of the rail with paint marker.

12.1.22 Inspect for curve movement periodically after the work, especially during periods of large temperature changes of 40 °F (23 °C). If the curve is found to have shifted inward more than 1 in (25 mm), it must be lined out or destressed prior to ambient temperature reaching 70 °F (21 °C). If the curve is not lined out or destressed, then a speed restriction must be placed per Track Standards Section 4.9 and Appendix J. The effective rail length added to a curve as a result of chording inwards is calculated in Track Standards Appendix M.

12.1.23 When surfacing and lining track:

a) The rail temperature must be monitored, measured, and recorded regularly; and

b) The ambient temperature forecast for the next 24 hours must be known and considered when planning.

12.1.24 When rail has been added, or the track lined inwards within 400 feet (122 m) of a high-risk location as listed in Track Standards Section 12.2.1, and the rail temperature is above the PRLT, the precautions in Track Standards Section 12.1 must be followed.

12.1.25 Special Trackwork, including turnouts in CWR, must not be surfaced and lined with a tamper until the anchor pattern meets the requirements of Track Standards Section 10.2.

12.1.26 When surfacing and lining turnouts with boltless adjustable rail braces, the switch points and stock rails must be blocked to prevent the stock rail from being displaced from the switch plate.

12.1.27 When surfacing and lining turnouts at ends of sidings or double track, ensure the diverging route is tamped after surfacing and lining the turnout straight route. As much as practicable, the top of rail elevation of the diverging route must be held even with that of the straight route through the return curve. See Track Standards Section 19.3 for details on curve design requirements.

12.1.28 While surfacing and lining turnouts, any ties that cannot be tamped (such as head-block ties, ties adjacent to the rods, frog ties, guard rail ties, point heel block ties, etc.) must be hand tamped, consolidating ballast firmly under the tie on all four sides of the tie with hydraulic hand tools. The standard applies to all Special Trackwork with space restrictions for mechanical tamping.

12.1.29 While surfacing and lining track may result in impacting signal appliances, the Maintenance Delivery—Manager of Signals must be notified in writing and provided a surfacing and lining work plan methodology for review, to provide the required signal support.

12.1.30 Surfacing and lining at impedance bond locations must be completed under the direction of a qualified Signals and Communications Employee.

12.1.31 Prior to surfacing and lining activities within station platform limits, a pre-condition assessment of existing clearances must be completed and measurements recorded for comparison against requirements in Track Standards Section 19.5 and Table 19-7. Measurements must be validated post surfacing and lining activities.

a) Where existing conditions do not permit both the platform and the accessibility platform to meet these requirements, the accessibility platform tolerances must take priority;

b) During the pre-condition assessment, accessibility platform clearances must always be measured from the top of the nearest rail.

12.1.32 Ensure ballast distribution and regulation do not damage adjacent property under highway overpasses, pedestrian walkways, station platforms and shelters. Hoarding must be installed to control ballast brooming and regulating.

a) All unwanted ballast left on walking surfaces must be removed before the next train or end of shift.

12.1.33 When the ballast section is disturbed while surfacing and lining, manually or mechanically, the ballast section must be restored to standard before putting the track back in service.

12.1.34 While regulating ballast, the ballast section must not be subjected to contamination from any source and must adhere to the requirements of Track Standards Section 11.2.3.

12.1.35 On newly constructed and/or disturbed track, the Contractor must re-mobilize to site to surface, stabilize and regulate the track within six (6) to twelve (12) months from the date of In-Service inspection unless otherwise approved by Metrolinx E&AM—Track.

12.2 High-Risk Locations and Clearances

12.2.1 Examples of high-risk locations are as follows:

a) Curves;

b) Open deck bridge approaches;

c) At-grade road crossings;

d) At-grade rail-to-rail crossings;

e) Bottom of a heavy grade;

f) Unstable roadbed;

g) Rock cuts where rail temperatures may be extremely high;

h) Areas having a history of lateral instability;

i) Recent track work with impact on ballast section;

j) Locations where track work was completed in cold weather;

k) Previous track buckle not permanently repaired;

l) Track where pull-aparts or broken rails have occurred and it was necessary to add rail to close the gap;

m) Fixed locations such as turnouts, crossings, and bridges, transitions from wood to concrete ties and locations with directional running zones. In particular, pay special attention to locations where rail has been observed to be moving through a rail anchor towards a fixed location;

n) Known areas of heavy train braking at/or near fixed track locations;

o) Areas with insufficient rail longitudinal restraint (non-compliant anchor pattern, worn anchors, poor-quality anchors or any non-compliance to the Metrolinx Track Standards);

   i. Areas of insufficient rail anchor holding power must be scheduled for correction;

p) Any areas showing signs of high rail compression forces.

12.2.2 When surfacing or lining track where vertical or horizontal clearances are involved, the general track surface, alignment, curve superelevation, and track centers must not be changed without the written approval of the Director, Engineering—Track.

12.2.3 Where permanent reference points are established for the location and elevation of the tracks (such as in tunnels or under overhead bridges), surfacing, and lining must meet the reference point requirements. A workplan methodology must be submitted for review and approval of the Director, Engineering—Track or designate.

a) Where applicable, horizontal curves must be surfaced and lined using the curve geometry tag information installed on the ties.

12.3 Surfacing Steel Ties

12.3.1 When surfacing and lining steel ties:

a) Track tie cribs and shoulders must be full to ensure sufficient ballast is available;

b) Inspection holes, located on either side of the rail seats, must be inspected to ensure the tie pods are full and the ballast section is flush with underside of steel tie;

c) Tamping tools must be raised to compensate for the depth of steel ties vs. wood ties. The depth of steel ties is up to 2-1/2 in (64 mm) different than wood ties. Maximum depth of tamping tools below bottom of steel tie is 3/4 in (19 mm). See Figure 12-1below;

d) It must include four (4) tamping cycles for the 16 in (406 mm) on either side of the rail and three (3) tamping cycles for the center of the steel tie to ensure proper compaction;

e) Ballast regulator plows must be adjusted to ensure no impact on elastic fasteners;

f) When steel ties are interspersed with wood ties, two full surfacing passes must be made. With the first pass, surface the entire track in accordance with Track Standards Section 12.1. For the second pass, adjust the tamping tool depth and only tamp the steel ties, without lifting the track. Always tamp the steel ties last;

g) Fastening system must be inspected upon completion of surfacing and lining before track is returned to service; and

h) Refer to the steel tie manufacturer's instructions for tamping tool settings and further details.

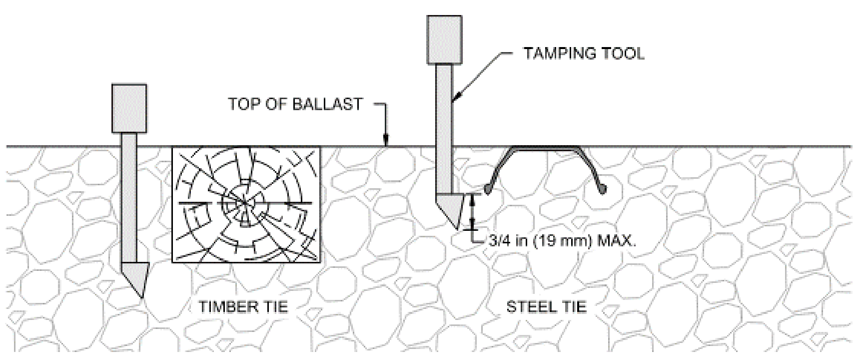


Figure 12-1 Tamping Head Depth Below Steel Tie

13 Installation and Maintenance of Turnouts

13.1 General

13.1.1 Care must be taken when working around turnouts to avoid interfering with the Signal Systems:

a) Turnouts equipped with snow-clearing devices can create a short circuit through the metal ductwork and rail.

13.1.2 When using metal tools, take extreme care not to short across an insulated gauge rod, insulated gauge plate, or insulated joints.

13.1.3 Take extra precautions at locations where snow-clearing devices are installed. Turnouts equipped with snow-clearing devices can create a short circuit through the metal ductwork and rail.

13.1.4 Responsibility for lubrication of switch point plates at hand-operated switches will be assigned by the Maintenance Delivery—Manager of Track.

a) Lubrication for power-operated and dual control switches will be assigned by Signals and Communications manager in accordance with Signals & Communications Standards—General Instructions.

13.1.5 New turnouts must not be installed with spring frogs.

13.1.6 On main tracks, only number 12, number 16, number 20 and number 24 turnouts are permitted as per Appendix O. Installation of other types and sizes of turnouts, including but not limited to the following items, must be reviewed and approved in writing by the Director, Engineering—Track:

a) Equilateral turnouts;

b) Odd-number turnouts;

c) Number 9 turnouts or smaller;

d) Existing number 11 and number 13 turnouts are permitted in the Union Station Rail Corridor (USRC) only. All new designs and installations within the USRC must be approved by the Director, Engineering—Track.

13.1.7 Design of turnouts and crossovers must also conform to Track Standards Section 19.6. Special attention must be taken to avoid car body twists between turnouts and crossovers. See Track Standards Section 19 for reverse curve requirements.

13.2 Installation of Turnouts

13.2.1 All constructed or rehabilitated turnouts must have a detailed turnout inspection, accompanied by an In-service certificate, performed by a Track Inspector as per the Metrolinx Rail Corridor Asset Handover Protocol when any portion of the straight or diverging routes are placed in service. During construction of turnouts or other track components associated with turnout installation, all insulated components affecting track circuits must be tested by a qualified signal person in compliance with Signals & Communications Standards and AREMA Communications & Signals Manual.

a) Testing of the following components must be completed with the appropriate documentation provided prior to Track In-Service sign-off:

i. All insulated switch rods;

ii. Continuous (glued) insulated joints;

iii. Non-continuous insulated joints;

iv. Encapsulated (coated) insulated joints;

v. Insulated Gauge plates; and

vi. Insulated snow-clearing device ductwork.

13.2.2 Do not install and or reuse non-premium turnout components (for example, switch points, not FHH) in any turnout with a rail weight of 115 RE or greater with the following exception:

a) To restore Main tracks to operational condition, a non-premium component may be installed, limiting operating speed to a maximum of Class 2. The component must be replaced within 10 weeks from date of installation.

13.2.3 Turnouts must be installed with switch points and stock rails of the same weight and rail section unless approved in writing by the Director, Engineering–Track.

13.2.4 When turnouts are delivered prefabricated, and on panel cars, the following precautions must be taken when unloading and transporting:

a) Panel turnouts must be completely secured to the racks of the cars whenever the car is moved;

b) The weight of each panel must be known, compared to the load chart of the crane, recorded in the lift plan, and the lift plan must be submitted for approval prior to unloading the panels;

c) Each panel on the car will be fully secured until it is ready to be lifted from the car. The panel will be released once the crane rigging equipment is secured to the panel;

d) Removal of panel tie-down chains will be done from behind the turnout panel;

e) No one is allowed on a panel turnout car when the panel is being lifted. Panels must be controlled and guided with a minimum of two tag lines;

f) Panels will be placed where they will not affect the safety of railroad operations or the public; and

g) All tie-down chains must be placed on the car when the car is empty.

13.2.5 When assembling and installing turnouts:

a) Turnouts must be laid flat to facilitate rail end joint connection and field welding;

b) For turnouts with heater ducts, excavate deep enough at duct locations to prevent humping of track; and

c) Place and secure hardwood blocking between the open switch point and the stock rail, at each rod location, to prevent the stock rail from lifting out of the brace/slide plates.

i. Install switch point clamps on the switch points, at least one (1) per switch rod, to secure the switch point and stock rail.

13.2.6 Turnouts must be designed and installed with a snow clearing device duct.

13.2.7 When turnouts are installed, rehabilitated or built in track, movements must not be permitted to operate through any orientation (straight or diverging routes) until:

a) The frog is properly protected by a guard rail;

b) The switch point is lined, locked, and securely clamped against the stock rail for the route to be used with a minimum of two (2) clamps for a number 12 or number 16 turnout and three (3) clamps for a number 20 or number 24 turnout;

c) The switch points must be connected to a switch stand or switch machine that is adjusted to provide point pressure against the stock rail and locked with a high-security lock;

d) Broken switch point clamps must immediately be removed from service and must not be welded; and

e) Ballast and ballast fines must be removed from all flangeways, fasteners, plates, and movable components.

13.2.8 If a turnout is to remain out of service, the switch points must be connected to a switch stand or machine that is adjusted to provide point pressure against the stock rail. The switch stand or machine will be locked with a private high-security lock, and a tag applied indicating the name and contact information of the Employee securing the switch stand or machine.

13.2.9 When a new turnout is installed in main track, a new 80 ft (24.3 m) track panel must be installed from all three (3) ends, except in crossover applications where the panels must be installed on all four (4) ends.

a) In hardwood tie territory, the panels must be constructed using cast tie plates. See Standard Plan GTS-0501 sheet 4 of 5 and sheet 5 of 5;

b) All track panels must be constructed using the same tie type as the new turnout;

c) Transition tie sets must not be installed within the 80 ft (24.3m) new track panel, unless approved in writing by the Director, Engineering—Track;

d) In non-main track territory, every effort should be taken to install the required panels; If physical restrictions prevent 80 ft (24.3m) track panel installation, the length may be adjusted as approved in writing by the Director, Engineering—Track.

13.2.10 Place burlap bags or packing material between switch points and stock rails to block ballast during ballast distribution. Ballast and ballast fines must be removed upon completion of the track work.

a) Extra caution must be taken around switch point roller bodies to ensure no ballast, ballast fines and other debris obstruct inspection, operation and final adjustment;

13.2.11 Switch point rollers must be installed and adjusted after the ballast work is completed to avoid damage from ballast and ballast fines.

13.2.12 Remove ballast from tie cribs to a depth adequate to prevent contact with switch rods and to facilitate winter switch maintenance and drainage.

13.2.13 Switch stands must be square/plumb and securely spiked, bolted, or lagged to/through the hardwood head block ties. Pilot holes must be drilled to avoid splitting the hardwood headblocks.

13.2.14 One (1) fastening hole in each head block tie must be left available for future maintenance adjustments. Main track switch stands must be of an approved rigid type.

13.2.15 Semi-automatic switch stands are prohibited and must not be installed.

13.2.16 Low-profile switch stands are to be used where they are located between tracks having track centers of 18 ft (5.49 m) or less.

13.2.17 Table 13-1 and Table 13-2 has adjusting recommendations for any crank eye style switch stand.

Table 13-1 Throw for Type 22 Switch Stands

Throw Adjustment ± 1/32″ (0.79 mm)	Crank Eye Adjustment ± 1/16″ (1.6 mm)
4-1/2″ (114 mm)	2-1/16″ (52 mm)
4-5/8″ (117 mm)	2-3/16″ (56 mm)
4-3/4″ (121 mm)	2-1/4″ (57 mm)
4-7/8″ (124 mm)	2-5/16″ (59 mm)
5″ (127 mm)	2-7/16″ (62 mm)

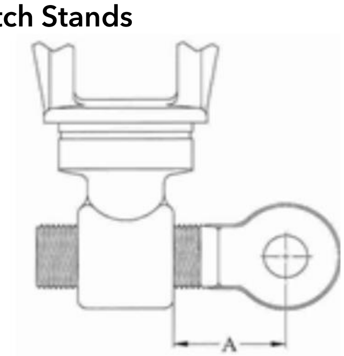


Table 13-2 Switch Adjustment

Near Point	Far Point	Crank Eye on Stand	Clevis on Connecting Rod
Fits properly	Too tight	Screw in	Screw in
Fits properly	Too loose	Screw out	Screw out
Too tight	Fits properly	Screw in	Screw out
Too loose	Fits properly	Screw out	Screw in
Too tight	Too tight	Screw in	None
Too loose	Too loose	Screw out	None

13.2.18 Switch point protectors and switch point guards may be installed if approved in writing by the Director, Engineering–Track to protect switch points on non-main track. The maximum applicable operating speed and degree of curvature are indicated in Table 13-3.

Table 13-3 Switch Point Protector Usage Guidelines

Product Name	Maximum Curvature	Maximum Speed	Traffic Volume
Nolan Switch Point Protector	All Curves	10 MPH	< 25 cars/week
Inside Point Protector Guard Rail	20°	15 MPH	All
Field Side Point Protector	2°	15 MPH	All

13.2.19 Ensure the field-mounted protector fits properly against the field-side web of the stock rail and flow on the gauge side of the straight stock rail is ground off. After grinding flow, operate switch points in the open and closed position to make sure the throw and switch point/stock rail tension were not negatively impacted. If required, switch stand may need to be adjusted.

13.2.20 The limits for adjustable switch point guard bar settings are 3-15/16 in (100 mm) minimum to 4-1/4 in (108 mm) maximum. Switch point guard bars must be adjusted and maintained as per manufacturer's recommendations.

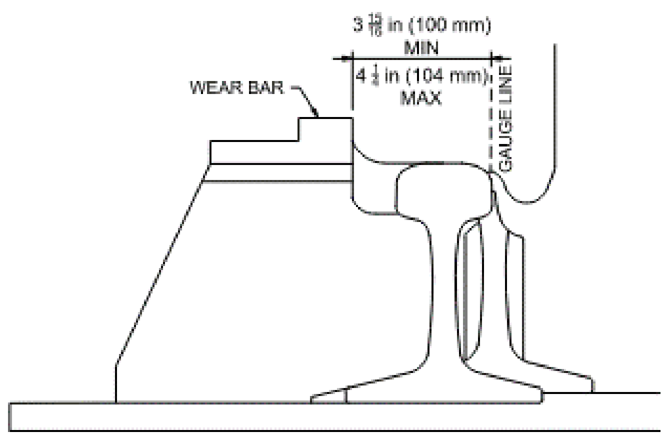


Figure 13-1 Limits for Adjustable Switch Point Guard

13.2.21 On main track, where a switch point experiences excessive wear because the switch is located close to a horizontal curve, a guard rail may be installed on the low side of the curve ahead of the switch point with the approval of the Director, Engineering—Track in writing to provide protection from facing point moves.

13.2.22 On main track, hand-operated switch stands must be equipped with an approved high-security lock secured to the head block ties.

a) This applies to all Dual Control, Power-Operated, and Auto-Normal switches.

b) Switches operated by dual control switch machines require two (2) high-security locks attached to the switch machine to secure the switch point operating lever in hand position. There is a place to install two (2) high-security locks, both locks must be in place.

13.2.23 Whenever possible, switch stands are to be located on the diverging route of the switch, so that the connecting rod is in tension when the switch is in the normal position.

13.2.24 Switch stands on non-main tracks are to be equipped with a hook keeper unless otherwise directed.

a) At locations with high trespass and or where vandalism is a concern, high-security switch locks must be installed as directed by Maintenance Delivery—Manager of Track on the following:

i. Hand-operated turnouts on non-main tracks and other devices such as switch point foot locks, derails, panels to be locked and ROW access points.

13.2.25 Switch rod and connecting rod bolts must be installed with the nuts visible on the top of the switch rod and connecting rod, fastened and secured with lock washers and cotter pins. Prior to installation, inspect all components to ensure they are compatible. The connecting rod bolt attached to the crank eye bolt under the switch stand must be installed with the head of the bolt on top of the connecting rod.

13.2.26 Where switch point foot locks are installed, the added security will be identified by painting the top of the switch stand casting or spindle housing white. These foot locks are found on hand-operated switch stands in proximity to roads and or vehicle traffic.

13.2.27 When installing low profile switch stands, the operating lever must point towards the frog for the normal position.

13.2.28 When installing high-profile switch stands, the operating lever must be positioned so that when the switch is in the normal position, the operating lever faces away from the frog and track. Switch points must fit firmly against the stock rails for the entire length of the planed portion.

13.2.29 Turnout stock rails must be horizontally bent, as shown on the Standard Plan. The JB-60-141 is the only rail bender permitted to field bend stock rails of all metallurgy, for rail weights up to and including the 141 RE section. All other benders, without exception, are limited to bending 115 lb or lighter rail in standard carbon and 3HB metallurgy only.

a) A work methodology for the use of rail benders must be approved in writing by the Director, Engineering—Track or designate prior to their use.

13.2.30 It is important that stock rails are properly seated in the switch plate, have no lateral movement in the switch plates, and switch plates have no movement on the switch ties. Care must be taken during installation of rail braces to avoid over-driving and rotating the stock rails out of the rail seat of the switch plate.

13.2.31 Frog type for a turnout will be determined by traffic patterns:

a) Self Guard Manganese (SGM) frogs must not be installed in turnouts with speeds exceeding Class 1.

i. SGM frogs must be avoided on Metrolinx ROW for new frog installations or replacements.

ii. SGM frogs do not require guard rail installation. The raised guard face of the SGM frog body must not have horizontal wear exceeding 3/8 in (9.5 mm). Restoring the guard face of the frog must be done before rebuilding the frog point.

b) Rail Bound Manganese frogs with low-impact heels may be used in Metrolinx ROW. The design and installation of new RBM frogs must be equipped with low-impact heels.

c) Flange Bearing (Jump) Frogs may be installed:

i. As approved in writing by the Director, Engineering-Track;

ii. Where the volume of equipment on the diverging route is less than 5 MGT per year;

iii. With operating speed on the diverging route over the flange bearing frog limited to 10 mph; and

iv. With gauge on the main line not in excess of 57 in (1448 mm).

13.3 Destressing at Turnouts

13.3.1 Prior to cutting the rail, make reference marks and match marks on the field side of each rail at both ends of the existing turnout or length of tangent track, where the track is to be cut for installation of the turnout. Measure and record the distance between these marks on the web of the rail and on the destressing report. Remove the anchors or elastic rail clips on the track tie where the match marks were applied.

13.3.2 To maintain rail neutral temperature, install box anchoring for 200 ft (61 m) in each direction from the work zone. Cut the rail and remove existing track. Prepare the grade for turnout installation and install.

13.3.3 Starting at the match mark made before the rail was cut, make additional match marks on each rail every 50 ft (15.2 m) for 400 ft (122 m) beyond the last long tie of the turnout and beyond the number 1 gauge plate at the point of switch. Ensure that the match marks start on the rail base and continue onto a tie plate on an unanchored tie. Ensure the match marks are made with paint stick pen and are straight.

13.3.4 Measure, with a steel tape, the distance between reference marks and compare the measurement with the original measurement taken and recorded on the web of the rail. This comparison will indicate if rail was added or removed.

13.3.5 All joints in the turnout must be eliminated by field welding before destressing the new turnout unless approved in writing by the Director, Engineering-Track.

13.3.6 The following steps must be taken to destress a turnout location, where the following requirements cannot be followed due to track configuration limitations, approval in writing from the Director, Engineering—Track is required:

a) Follow the procedures in Track Standards Section 4.9;

b) Measure and mark a 400 ft (122 m) station in each direction from the last long tie of the turnout and number 1 gauge plate at point of switch;

c) Take the ambient temperature and the current rail temperature and record it on the destressing report;

d) Measure 200 ft (61 m) from each direction from the last long tie of the turnout and number 1 gauge plate at point of switch to make a cut for the destressing weld on each rail;

e) Remove the rail anchors and rail clips on all rails in the 400 ft (122 m). Lift the spikes and/or remove the insulator on steel and concrete ties. Raise the rail and place risers between the base of the rail and the rail seat; make sure the rail is lifted out of the rail seat on all ties;

f) Calculate the amount of rail to be removed. Use a rail length of 400 ft (122 m) plus half the length of the turnout installed on each side. Add to this amount any rail added when the panel was installed (see reference marks). The methodology (Thermite vs. EFB) at which welding will occur must be included in the adjustment calculation. The distance to either heat or pull the rail will be this amount less than 1 in (25 mm) for thermite welding. If heat is used, check match marks to ensure expansion is throughout the 400 ft (122 m) unanchored section; and

g) Repeat items a) through f) for all four (4) rails connected to the straight portion of the turnout. If the track off the diverging route is CWR, a) through f) must be completed for the two (2) diverging rails as well.

13.3.7 After the rail is destressed and the rail expander is locked, complete the field welding process. Track work is prohibited during the field welding process and must only resume upon receiving confirmation from the welding foreman that the weld has appropriately cooled as per Metrolinx Welding Manual. After the weld has cooled, remove the risers and re-apply anchors and/or insulators with rail clips to the 400 ft (122 m) of rail that was destressed.

a) For cold-weather thermite welding, rail anchors and/or insulators with rail clips must be applied prior to thermite welding.

13.3.8 Pre and post-destressing activities: the switch must be inspected to ensure the switch points are square, the switch rods are properly positioned between the switch ties, and no movement of the stock rails is observed at the switch point area.

13.3.9 Upon completion of destressing, restore applicable anchoring pattern in accordance with Track Standards Section 10.2.

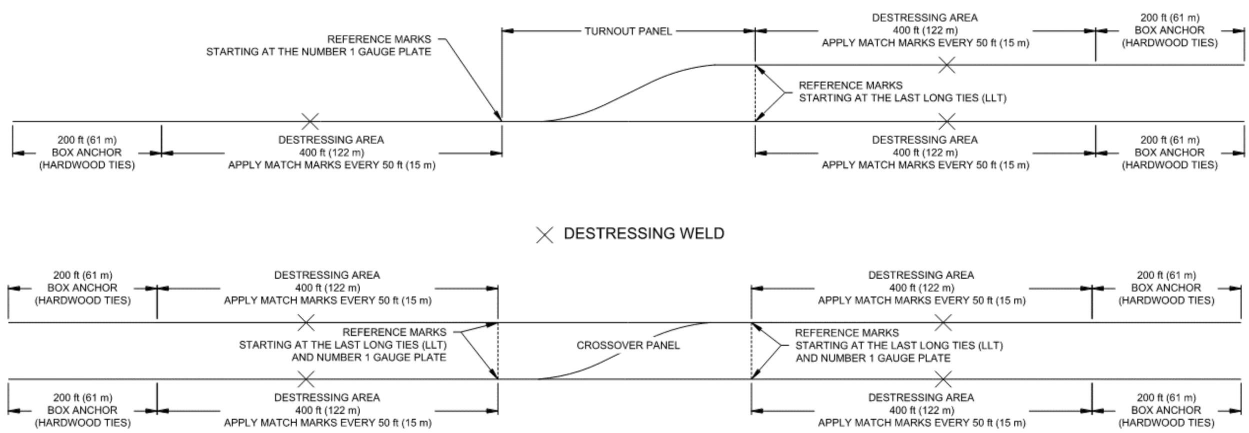


Figure 13-2 Destressing of Turnouts and Crossover Locations

13.3.10 Below is an example for destressing at turnouts.

A number 12 - 136 lb. turnout is installed in track. The RLT is 70°F (21°C). The applicable rail adjustment is calculated by:

Temperature differential	PRLT – RLT = 100 °F – 70 °F = 30 °F
Length of Turnout	141 ft (GTS-0271)
Adjustment for 400 ft gap	400*30*0.00008 = 0.96 in
Adjustment for half the length of Turnout	141*30*0.00008/2 = 0.169 in

Note: A thermite weld will add 1 in (25.4 mm) of steel to the rail

Total adjustment required	0.96+0.169+1 = 2-3/16 in

Steps to destressing the turnout:

1. Cut rail at trailing end of turnout at 200ft away from last long ties and remove anchors.
2. Cut 2-3/16" of the rail and pull or heat to a 1 in (25.4 mm) gap for thermite welding. Weld and re-anchor.
3. Cut rail at facing end of turnout at 200ft away from number 1 gauge plate and remove anchors.
4. Cut 2-3/16" of the rail and pull or heat to a 1 in (25.4 mm) gap for thermite welding. Weld and re-anchor.

13.4 Maintenance of Turnouts

13.4.1 The Signal Maintainer must be notified when any planned work, which may interfere with the functioning of the signals system, is being performed. This work includes, but is not limited to:

a) Surfacing the switch;

b) Switch tie replacement;

c) Switch point welding;

d) Switch point and stock rail grinding;

e) Switch stand or rod replacement;

f) Adjustment of switch point throw, connecting rod and switch stand; and

g) Insulation replacement in switch rods and gauge plates.

13.4.2 Switch stands, switch plates, connecting rod bolts, stock rails, switch points, locks, joints and spring frogs must be kept properly lubricated and free from ice, snow, and other debris to provide easy movement and to protect against excessive wear.

13.4.3 Switch stands, targets, switch tip target assemblies, locks, masts, connecting rods, switch point foot pedals and all other component parts must be kept in good operating condition and must have defective parts repaired or replaced immediately.

13.4.4 Switch stands with bent, twisted or damaged masts must be replaced.

13.4.5 Insulation in switch rods and gauge plates must be maintained to ensure continuity of track circuits.

13.4.6 Switch points must be installed with the running surface of the switch point 1/4 in to 5/16 in (6.3 to 7.9 mm) above the running surface of the stock rail, this dimension is referred to as switch point rise. Switch point rise is measured where the distance between the gauge face of stock rail and gauge face of switch point is 4-1/2 in (114 mm) when closed.

a) When the switch point rise is reduced by wear to 3/16 in (4.8 mm), the location must be monitored, as per Track Standards Section 17.6 for signs of wheel contact on the stock rail.

i. Where wheel contact is evident, the switch point must be replaced or the stock rail ground to restore the 1/4 in to 5/16 in (6.3 to 7.9 mm) dimension.

b) The switch point must be replaced when the switch point rise is reduced by wear to 1/8 in (3 mm) to restore the 1/4 in to 5/16 in dimension (6.3 to 7.9 mm).

c) Where the fit of the switch point is compromised due to a worn stock rail, the stock rail must also be replaced.

13.4.7 Metal flow on switch points and stock rails must be kept ground off to maintain proper contact between the switch point and stock rail, to prevent damage and failures to switch operation. Flow must not exceed 1/16 in (1.6 mm) on switch point or gauge side of stock rail. If flow exceeds this value, it must be documented and planned for grinding prior to reaching a measurement of 1/8 in (3 mm). The flow must be ground off as per the requirements of Track Standards Section 17.5.

a) Grinding of metal flow on switch points and stock rails must be completed using appropriate grinding equipment/machines, for example, a Frog Point and Check Rail Grinding Machine.

13.4.8 Welding of switch points or stock rails is not permitted on any main line track except as permitted in the Metrolinx Welding Manual.

13.4.9 On switch point ends which are chipped or broken, at the point of switch, the switch point must be repaired before the thickness exceeds 3/16 inch (4.8 mm).

13.4.10 Stock rails can be worn exceeding 1/4 in (6.3 mm), providing the switch point is 3/16 in (4.8 mm) below the top of the stock rail as measured at the point of switch.

13.4.11 When the switch point rise as per Track Standards Section 17.6 is reduced by wear to 3/16 in (4.8 mm), the location must be monitored for signs of wheel contact on the stock rail as per Track Standards Section 17.5. Where contact is evident, the switch point must be renewed or the stock rail ground to restore the 1/4 in to 5/16 in (6.3 to 7.9 mm) dimension.

13.4.12 Welding of switch rods, switch clips and connecting rods is prohibited.

13.4.13 Gaps between the switch points and stock rails are unacceptable. The switch points must fit firmly against the stock rail.

a) Gaps between 1/16 in and 1/8 in (1.6 mm and 3 mm) must be repaired within 24 hours. The turnout must be removed from service as per Track Standards Section 13.4.30, if one of the following conditions is also present:

i. Turnouts with spiked rail braces;

ii. Turnouts with bolted rail braces, the rail brace plate is spiked, and there is evidence of plate movement;

iii. Turnouts in curves;

iv. Turnouts where there are hanging ties and/or evidence of pumping ties creating poor surface conditions;

v. Turnouts with defective headblock ties where the switch stand or switch machine is not secure;

vi. Turnouts with rail movement indicating gauge widening under load in the track ahead of the switch points;

vii. Turnouts with worn, chipped or broken switch points; or

viii. Turnouts with horizontal (flange) rail wear ahead of the switch points

b) Where gap(s) measured between the closed switch point and stock rail exceeds 1/8 in (3 mm), the route of the turnout affected must be removed from service.

13.4.14 Switch rods, switch clips, connecting rod and switch stand crank eye bolt must have clearance to avoid contact with the side of the switch tie or the switch plate during operation.

13.4.15 Non-defective tie conditions must be maintained under the switch point heel assembly.

13.4.16 Gauge between the toe and heel of frog and the switch point and heel block, including 80 ft (24.4 m) in front of the switch points, must be maintained to ± 1/4 in (6.3 mm) from standard gauge. Maintenance of gauge throughout the remainder of the turnout must comply with Appendix C.

13.4.17 The rail base of the switch point must not rest on an adjustable switch point roller when the switch point is closed against the stock rail.

13.4.18 In collaboration with Signals and Communications switch point rollers must be cleaned and adjusted to allow the roller to spin freely, reducing the drag and binding of the switch point.

13.4.19 During winter months, the ballast section in the switch point area must be winterized by reducing ballast around all movable components (i.e., ties cribs of throw rods, helper rods, rotary assist assemblies, and under the rail base of the switch point/stock rail) to maintain turnout operation in adverse weather conditions.

a) The ballast section must be restored post-winter and prior to summer months.

13.4.20 Once a frog with manganese inserts has been installed, the frog must be ground at the following minimum intervals to remove metal flow:

a) After the passage of approximately 0.5 Million Gross Tons (MGT) of traffic (approx. 725 10-car GO Trains);

b) After the passage of approximately 1.5 MGT of traffic (approx. 2,174 10-car GO Trains);

c) After the passage of approximately 4 MGT of traffic (approx. 5,800 10-car GO Trains); and

d) After every subsequent 12 MGT (approx. 17,400 10-car GO Trains) or as required to remove flow and lip.

13.4.21 Repairs must be conducted to restore appropriate elevation if a frog point is chipped, broken, or worn more than or equal to 9/16 in (14.3 mm) down and 6 in (152 mm) back and a Class 2 speed restriction must be applied until repairs are completed.

a) If a frog point is chipped, broken, or worn more than 5/8 in (15.9 mm) down and 6 in (152 mm) back, operating speed over that frog must be reduced to Class 1.

13.4.22 Repairs must be conducted to restore appropriate elevation if the tread portion of a frog casting is worn down more than or equal to 5/16 in (7.9 mm) below the original contour, and a Class 2 speed restriction must be applied until repairs are completed.

a) If the tread portion of a frog casting is worn down more than 3/8 in (9.5 mm) below the original contour, operating speed over that frog must be reduced to Class 1.

13.4.23 Bolts for Special Trackwork components must be:

a) Grade 5 for 100 ARA or smaller rail sections. Grade 5 bolts can be identified by three (3) radial lines on the head of the bolt. The use of 100 ARA Special Trackwork must be approved in writing by the Director, Engineering—Track;

b) Grade 8 for 115 RE or heavier rail sections. Grade 8 bolts have six (6) radial lines on the head of the bolt. 136 RE Special Trackwork is recommended for all new construction on Metrolinx-owned territory. All other rail weights for Special Trackwork must be approved in writing by the Director, Engineering—Track;

c) Of the proper length and diameter for the application.

i. Bolts must be equipped with a hardened steel washer;

ii. Only one (1) lock washer or flat washer must be installed on a bolt;

iii. The bolts must have approximately 3/4 in (19 mm) of thread extending beyond the nut;

iv. Bolts will be lubricated using graphite lubricant and tightened to torque values specified in Table 13-4 and Table 13-5.

d) Bolts must be retightened to the required torque 6 weeks after installation.

Table 13-4 Torque to be Applied to Grade 5 Bolts for Special Trackwork

Size of Bolt	1 in (25 mm)	1-1/16 in (27 mm)	1-1/8 in (28 mm)	1-1/4 in (32 mm)
Torque (ft.-lbs)	670	850	1200	1600
Torque (N-m)	910	1150	1630	2170

Table 13-5 Torque to be Applied to Grade 8 Bolts for Special Trackwork

Size of Bolt	1 in (25 mm)	1-1/4 in (32 mm)	1-3/8 in (35 mm)
Torque (ft.-lbs)	840	1675	2500
Torque (N-m)	1140	2270	3390

13.4.24 Switch stands and switch point guard bars must be maintained and adjusted as per manufacturer's recommendations.

13.4.25 Adjustable switch point guard bars will be set to a distance where the gauge side of the stock rail to the wear face of the switch point guard is never less than the initial installation dimension given for each type of switch point guard. Switch point guard bar adjustment will be accomplished by:

a) Measuring the adjustment required to move the switch point guard bar to the appropriate guard length;
b) Adjustment of the switch point guard bar will be for the entire length of the point guard;
c) Removing clips or loosening mounting bolts and removing the required thickness of shims from behind the switch point guard bar housing block;
d) Inserting the required shims between the switch point guard bar and the switch point guard bar housing block;
e) Ensuring all shims have the retaining tabs under the switch point guard bar to prevent displacement under dynamic loading;
f) Ensuring all of the original shims are reinstalled either behind the switch point guard bar or behind the switch point guard bar housing block; and
g) Confirm adjustment is set to the correct measurement for the length of the point guard. Install the removed clips and tighten the mounting bolts;

13.4.26 The maximum allowable switch point guard bar wear is 5/8 in (15.9 mm). No more than four (4) shims can be used to adjust the guard bar.

13.4.27 Where a different rail size is authorized, measure the switch point guards for wear as shown on the Standard Plan for the different new rail size. If the wear is more than the wear limit allowed, the guard must be replaced.

13.4.28 Weld repairs of broken or worn switch point guard bars, or any type of guard rail is prohibited.

13.4.29 Adjustable guard bars used with jump frogs must have shims placed under the guard rail base plate through the area of frog ramping. The shims must match the size and hole punching of the guard rail plate.

13.4.30 When a switch and/or the diverging route of a turnout is removed from service, the turnout must not be operated and must be secured as follows:

a) A private lock must be used with a "switch lock lockout" device affixed to the existing railway lock securing the switch stand as per Standard Plan GTS-1810 A/B;

b) A yellow 3 in x 5 in (76 mm x 127 mm) plastic tag must be placed on the shackle of the lock;

   i. On the tag include the company name, date & time, name and contact information of the certified Employee who removed the switch from service. Include the contact information for the Employee's supervisor and the expected date the switch will be returned to service if applicable.

c) Two (2) switch point clamps must be installed, tightened, and locked with a private lock to secure the closed switch point to the stock rail. One (1) switch point clamp must be installed in the tie crib immediately to the head blocks. The second switch point clamp must be installed in the tie crib immediately adjacent to the last switch rod;

   i. Three switch point clamps must be used for a number 20 or bigger turnout.

   ii. After the switch point clamps are installed, the closed switch point and stock rail must be inspected for gaps that may be created by overtightening the switch point clamp.

d) The RTC, TMD, Yardmaster, or Control Operator, and Director, Engineering–Track must be notified.

13.5 Maintenance of Spring Frogs

13.5.1 Do not put any part of your body between the spring wing rail and the frog point rail.

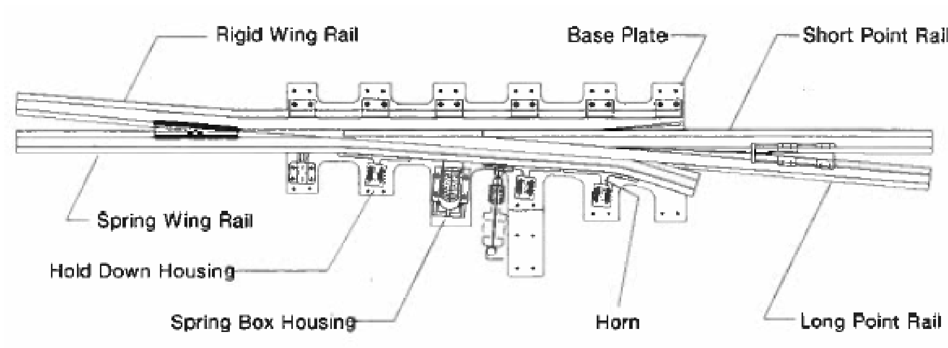


Figure 13-3 Spring Frog

13.5.2 Make sure the spike holes are chemically plugged and the frog base plate is resting flat on the ties, adze or replace ties as required to provide support under the entire spring frog. Check and correct tie spacing for the size of frog and style of base plate being installed.

13.5.3 Guard rails, when installed and maintained to standards, provide protection for the spring frog. The gauge must be 56-1/2 in (1435 mm); the guard check and guard face measurements must comply with Table 17-1 for the Class of Track.

13.5.4 Care must be taken when lifting a spring frog with a tamper. The rail base hooks must not be used to lift the turnout in the frog at the frog base plates. Hand jacks must be utilized on the outside rails of the turnout to assist in lifting the frog.

13.5.5 Clean, inspect, and lubricate the wing rail plates where the wing rail operates during equipment moves. Check the operation of the wing rail to ensure the frog base plate does not restrict the horn clearance. Take measurement between horn and housing to confirm compliance. Operate the wing rail to confirm the spring pressure and wing rail fully opens and closes without sticking.

13.5.6 Maintenance of spring frogs must comply with the following:

a) Non-defective tie and surface conditions must be maintained at the frog heel and toe to keep the horns from contacting the hold-down housings;

b) The gap at the point of frog must measure at least 3/8 in (9.5 mm) between gauge side of the frog point rail and the flange face of the wing rail. The rest of the wing rail must fit firmly against the frog point rail;

   i. The gap at point of frog must not exceed 3/4 in (19 mm).

c) When the wing is fully open, the flange-way must measure at least 1-3/4 in (45 mm);

d) If the wing rail frog is equipped with a retarder, it must delay the closing of the wing rail when working properly; and

e) Lubricate the frog base plate where the wing rail operates.

14 At-Grade Crossings

14.1 At-Grade Rail-to-Rail Crossings

14.1.1 For the installation, maintenance and destressing of at-grade rail-to-rail crossings (railway diamonds), follow the applicable procedures and standards described in Track Standards Section 13.

14.1.2 At-grade rail-to-rail crossings must be designed and installed specifically for each location where two (2) railways intersect. The angle of the intersection determines the design of the Special Trackwork and approach track.

14.1.3 Install continuous insulated joints, as per Track Standards Section 5.3, at all at-grade rail-to-rail crossings as indicated by the signals design, if applicable.

14.1.4 During installation, lifting slings must be used under the diamond frog, not under the diamond frog legs. Tag lines or equivalent must be used to control lifting activities.

14.1.5 The Director, Engineering—Track or delegate, must review and approve the design of the at-grade rail-to-rail crossing and the design and installation of guard rails on approach to the at-grade rail-to-rail crossing.

14.1.6 The subgrade, sub-ballast, and ballast section supporting the at-grade rail-to-rail crossing must be free-draining. The surface of the diamond frog must be maintained at a uniform grade with the approaches.

14.1.7 At-grade rail-to-rail crossings must be fully bolted with bolts of the correct diameter and length. Bolts will be installed with spring or hardened flat steel washers, tightened to the torque shown in Table 13-4 and Table 13-5 of Track Standards Section 13.4.

14.1.8 Diamond frog manganese inserts must:

a) Have the metal flow removed with grinding and slotting at the frequency established in Track Standards Section 13.4.20;

b) Be welded if the tread is worn down 3/8 in (9.5 mm) below the original contour;

   i. 3/8 in (9.5 mm) below the level corners where the raised diamond crossing corner pads have been ground off.

   ii. Repairs must be conducted to restore appropriate elevation if the tread portion is worn down more than or equal to 5/16 in (7.9 mm) below the original contour Operating speed must be reduced to Class 2.

   iii. If worn more than 3/8 in (9.5 mm) below this level, limit operating speed to Class 1 and restore.

c) Be transposed, if manganese castings are of a reversible type, to equalize wear, extend the life of the components, and avoid welding.

14.1.9 Flange-ways must be maintained:

a) With a width no less than 1-1/2 in (38mm); and

b) With a depth no less than 1-3/8 in (35 mm) deep in Class 1 and 1-1/2 in (38mm) in Class 2 and above track.

14.1.10 At-grade rail-to-rail crossings must be kept free of snow, ice and other obstructions.

14.1.11 At-grade rail-to-rail crossing ties must be non-defective and tamped for the entire length of the tie on both routes. Rail crossing ties must be sound and tamped for the entire length of the tie on both routes of the crossing.

14.1.12 At-grade rail-to-rail crossings must have an adequate inventory of a minimum of one (1) complete rail-to-rail crossing set as a spare to maintain operation.

14.2 At-Grade Road Crossings

14.2.1 The Maintenance Delivery—Manager of Signals & Communications must be contacted prior to the execution of maintenance, rehabilitation or construction work affecting signals within or on approach to an at-grade road crossing protected by an automatic warning system to apply appropriate protection as prescribed in Signals & Communications procedures. See Track Standards Section 22.3.

a) While the automatic warning device is deactivated, all Employees must have a clear understanding of the protection utilized. Positive Protection must remain in place until notified by the responsible Signals & Communications Employee that the road crossing has been reactivated as per Metrolinx General Engineering Instructions.

14.2.2 Prior to the execution of maintenance, rehabilitation or construction work on a public at-grade road crossing, advanced notice must be provided to local road authorities and emergency services of proposed detours and anticipated dates and duration of road closures.

14.2.3 At-grade road crossings must comply with the Transport Canada Grade Crossing Standards and the GO Transit Grade Crossing Design Standard (RC-0506-05RCM-01).

14.2.4 When an agreement has been signed and filed for the construction of a new at-grade road crossing, the track must be rehabilitated in preparation for the construction of the crossing, including the installation of the road crossing surface material as per Appendix U, unless approved in writing by Director, Engineering—Track.

14.2.5 Metrolinx is responsible for the physical maintenance of the crossing surface of the travelled road between the rails and for a distance of 5 ft (1,524 mm) beyond the outermost rail of each track for unrestricted/public road crossings. Costs may be recoverable or shared as per Regulatory Order, formal agreement, or License Agreement.

14.2.6 Applicable signage must be installed as per Standard Plan GTS-0720 and must comply with Transport Canada Grade Crossing Standards. An emergency notification sign must be affixed to all signposts, signal masts, or signal bungalows at unrestricted/public at-grade road crossings. The sign must display subdivision name, contact phone numbers and exact milepost of the at-grade road crossing as per Metrolinx Fencing and Anti-Trespassing Requirements.

14.2.7 When an unrestricted/public at-grade road crossing has been granted approval for whistle cessation, Prohibited Whistle (anti-whistling) Signs must be installed in lieu of Whistle Signs and as per Standard Plan GTS-0720.

14.2.8 At-grade road crossings can be classified as either unrestricted or restricted crossings.

a) An Unrestricted Crossing is any public at-grade crossing or an at-grade crossing whose road is one of the following:

   i. A recreation road or trail maintained by a club, association or other organization;

   ii. A road of a commercial or industrial establishment, including a business operated from a residential or farm property, used in connection with the establishment by persons other than the employees of the establishment;

   iii. A road that serves three (3) or more principal residences;

   iv. A road that serves three (3) or more seasonal residences access to which is not controlled by a gate equipped with a lock;

   v. A private road that connects two (2) public roads; or

   vi. A private road maintained by a natural resource company, such as a company involved in forestry or mining activities;

b) A restricted crossing is any At-Grade Crossing not included in the above definition of an unrestricted crossing.

14.2.9 Private Agreement Crossings are at-grade road crossings established under license agreement between Metrolinx and an outside party. These at-grade road crossings must be covered by Metrolinx's standard form of contract or agreement before the crossing is constructed, put into service and/or removed from service.

14.2.10 The view in both directions for vehicles approaching the track must be kept clear within designated sightline triangles in accordance with the Transport Canada Grade Crossing Standards.

14.2.11 At-grade road crossings must be inspected as per Track Standards Section 17 and to ensure no hazards are present to roadway or railway traffic. If a hazard exists, appropriate action must be taken to protect and correct the condition.

14.2.12 Flange-ways for at-grade road crossings must be kept free of all obstructions.

14.3 Construction of At-Grade Road Crossings

14.3.1 All at-grade road crossings must comply with Transport Canada Grade Crossing Standards.

14.3.2 Culverts under at-grade road crossings and under the railway roadbed must be kept clear and free-flowing.

14.3.3 Surface ditches must be graded to direct water away from the track in all quadrants. If this is not possible, an outlet for the water must be created, or the ditch must be connected to a subsurface storm drainage system.

14.3.4 Where the road approach slopes toward the at-grade road crossing, surface water must be intercepted prior to reaching the at-grade crossing and discharged laterally from the roadway. An outlet for the water runoff must be created to drain away from the railway roadbed in coordination with the applicable road authority:

a) If the road surface is unimproved (not paved), a catch basin with metal grating or equivalent must be installed for the full width of the roadway on the uphill side of the at-grade road crossing to intercept runoff.

   i. Where the installation of a catch basin is unfavourable, road resurfacing works must be completed for a minimum distance of 100 ft (30.5 m) on either approach.

14.3.5 The at-grade road crossing must be excavated up to a distance of 5 ft (1,524 mm) beyond the outermost rail of each track and a minimum of 60 feet (18.3 m) on either side of the crossing. The excavation must allow for a minimum of 12 in (305 mm) of clean, free-draining ballast to be installed under the ties:

a) For at-grade road crossing rehabilitation, the excavation of the existing ballast must be to a minimum of 9 in (229 mm) below the bottom of tie.

14.3.6 To avoid disturbing the stability of the roadbed, the depth of excavation must not be below the surface of the sub-ballast.

14.3.7 If site conditions require the over-excavation to the top of subgrade (e.g. excavate both the ballast and sub-ballast), approved sub-ballast material as per Standard Plan GTS-2204 must be placed to a minimum depth of 12 in (305 mm), and compacted to a 98% modified Proctor compaction density prior to the addition of the 12 in (305 mm) of ballast under the tie.

14.3.8 During crossing construction and rehabilitation, new rail must be installed:

a) Fully Head Hardened rail must be used for crossings located in curves unless otherwise approved in writing by the Director, Engineering–Track.

b) New rail to be installed through the at-grade crossing must be joint-free for a length extending at least 25 ft (7.6 m) on either side of the crossing surface, sidewalk, and/or MUP.

14.3.9 All rail ends within an at-grade road crossing surface must be electrically flash butt welded.

a) The electric flash butt weld must be properly ground, including the rail base;

b) All efforts must be taken to minimize the number of welds located within the crossing surface; and

c) Thermite welds are not permitted within a crossing.

14.3.10 When preparing the rail for an at-grade road crossing rehabilitation or when constructing new, all bonded insulated glued joints must be electric flash butt welded into the rail.

14.3.11 The new rail size and section to be installed for the at-grade road crossing must be the same size and section for the subdivision, as a minimum, the rail size and section must be 115 lb RE:

a) Where MGT for the subdivision requires a larger rail size to be installed. The rail size must be installed as per Appendix P.

14.3.12 Cast tie plates must be installed for the full crossing surface, including sidewalk and/or alternate MUP and must extend an additional five (5) ties beyond the crossing surface as per Standard Plan GTS-0501:

a) Cast tie plates must be fully spiked and lagged as per Standard Plans GTS-1325 and GTS-1315 and as per Appendix R.

14.3.13 The appropriate rubber rail seal must be used to accommodate the longitudinal restraint system (e.g., elastic fasteners). Tie plates must conform to Track Standard Section 10.1 and 14.3.12. The manufacturer's instructions must be followed for the installation of the rubber rail seal material.

14.3.14 Where asphalt crossing surfaces are used:

a) The rubber rail seal must be secured to the rail using the approved manufacturer's fastening device in every tie crib, ensuring the rail seals are firmly compressed against the rail. Rail seal must end in a crib area, completed with an approved fastening device on each end, and the ends sealed in with asphalt. Asphalt must extend to the edge of the rail seal.

b) Filter fabric must be installed over the ballast section and ties prior to placement of asphalt crossing surface.

14.3.15 Filter fabrics under the ballast section must not be installed in any at-grade road crossing unless otherwise approved in writing by the Director, Engineering-Track.

14.3.16 Cellular confinement (sometimes called geowebs and geogrids) may be used where the subgrade of the crossing is particularly soft and is prone to pumping, such as in swamp or muskeg locations. They may also be used in other locations where the bearing capacity of the soil is insufficient to sustain the applied highway and railway loading. This can be determined by indications of either excessive water in the soil or if a heel can be pressed into the subgrade. Consideration must then be given to using cellular confinement cells. The Director, Engineering-Track must be contacted for instructions on applicability and type to use.

14.3.17 There are three (3) categories of at-grade road crossing surface length dimensions. The following are the minimum lengths of at-grade road crossing surfaces, as measured at right angles to the center line of the roadway. The travelled portion of the roadway includes sidewalks and/or MUP and must be a continuous surface:

a) Where the travelled portion of the roadway has no shoulders, the at-grade road crossing surface must extend 20 in (508 mm) beyond the travelled portion of the roadway on both ends of the crossing;

b) Where there is a shoulder, paved or unpaved, beyond the travelled portion of the roadway, the at-grade road crossing surface must extend 20 in (508 mm) beyond the shoulder on both ends of the crossing; or

c) Where a sidewalk or MUP is within the same board order/crossing agreement, the at-grade road crossing surface must extend 20 in (508 mm) beyond it on both ends of the crossing.

14.3.18 At newly constructed, reconstructed or rehabilitated public or unrestricted crossings, the crossing surface must:

a) Meet the requirements of Transport Canada Grade Crossing Standards;

b) Have a minimum flange-way width of 2-5/8 in (67 mm);

c) Have a maximum flange-way width of:

   i. 3 in (76 mm) for public sidewalks, paths, or trails designated by the Road Authority for use by persons using assistive devices; or

   ii. 4-3/4 in (121 mm) for all other crossings.

d) Have a minimum flange-way depth of 1-7/8 in (48 mm); and

e) Have a maximum flange-way depth of:

   i. 3 in (76 mm) for public sidewalks, paths, or trails designated by the Road Authority for use by persons using assistive devices; or,

   ii. No limit for all other crossings.

14.3.19 Outer flangeways are not permitted, except at private and construction crossings not designated as a route for persons using assistive devices.

14.3.20 For unrestricted crossings, the at-grade road crossing surface must be constructed and maintained at the same elevation as the rails:

a) At no time must the top of rail be more than 1/2 in (12.7 mm) above or 1/4 in (6.3 mm) below the at-grade road crossing surface at crossings designated for use by persons using assistive devices; and

b) For all other at-grade road crossings, the top of rail must never exceed 1 in (25 mm) above or below the crossing surface. Road resurfacing works must be conducted to correct any deviations more than 1 in (25 mm) and provide for a uniform transition between the at-grade road crossing surface and road approach.

14.3.21 At-grade road crossing surfaces, other than planking or asphalt, must have deflectors installed at each end of the crossing surface to protect from dragging equipment:

a) Asphalt at-grade road crossings must be sloped down at 30° on both ends, from top-of-rail to top-of-tie surface, to create a natural deflector;

b) Planked at-grade road crossings must have the outer ends cut at 30° to form a bevel or taper that will act as a deflector; and

c) For all other at-grade road-crossing materials, steel deflector plates, designed with a 30° slope, must be firmly and securely installed against the road-crossing surface to avoid displacement or separation of the road-crossing surface.

14.3.22 The following requirements must be followed for the construction of all new unrestricted at-grade road crossings:

a) The at-grade road crossing surface must be centered on the travelled portion of the roadway and conform to the minimum guidelines outlined in Transport Canada Grade Crossing Standards;

b) At-grade road crossing surface must extend for a distance of at least 20 in (508 mm) from the outside of each rail;

c) Road approaches to the at-grade road crossing must be on an even grade, with no abrupt breaks, to ensure low clearance vehicles traverse without impacting the track or the road crossing surface;

d) Unless approved in writing by the Director, Engineering-Track, unrestricted at-grade road crossings must have a road approach gradient not exceeding 2% for 26 ft (8 m) extending from the nearest rail, and not greater than 5% for 33 ft (10 m) beyond; and

e) Road approaches the at-grade road crossing for sidewalks, and MUP must have an approach gradient not exceeding 2% for 16 ft (4.9 m) from the nearest rail of the at-grade road crossing, unless designated by the road authority for use by persons using assistive devices, the approach grade must not exceed 1% within 16 ft (4.9 m) of the nearest rail.

14.3.23 The at-grade road crossing surface must be selected based on the requirements identified in Appendix U:

a) The selection of the at-grade road crossing surface must be completed in collaboration with the road authority; and

b) When constructing new and/or completing at-grade road crossing rehabilitation, the applicable board order/crossing agreement must be reviewed to ensure compliance with all requirements.

14.3.24 Where heavy vehicles operate on long descending approaches to an at-grade road crossing, stopping sightline distances must be increased.

a) Refer to Transport Canada Grade Crossing Standards for further details on roadway grade crossings, stopping distances, and sightlines.

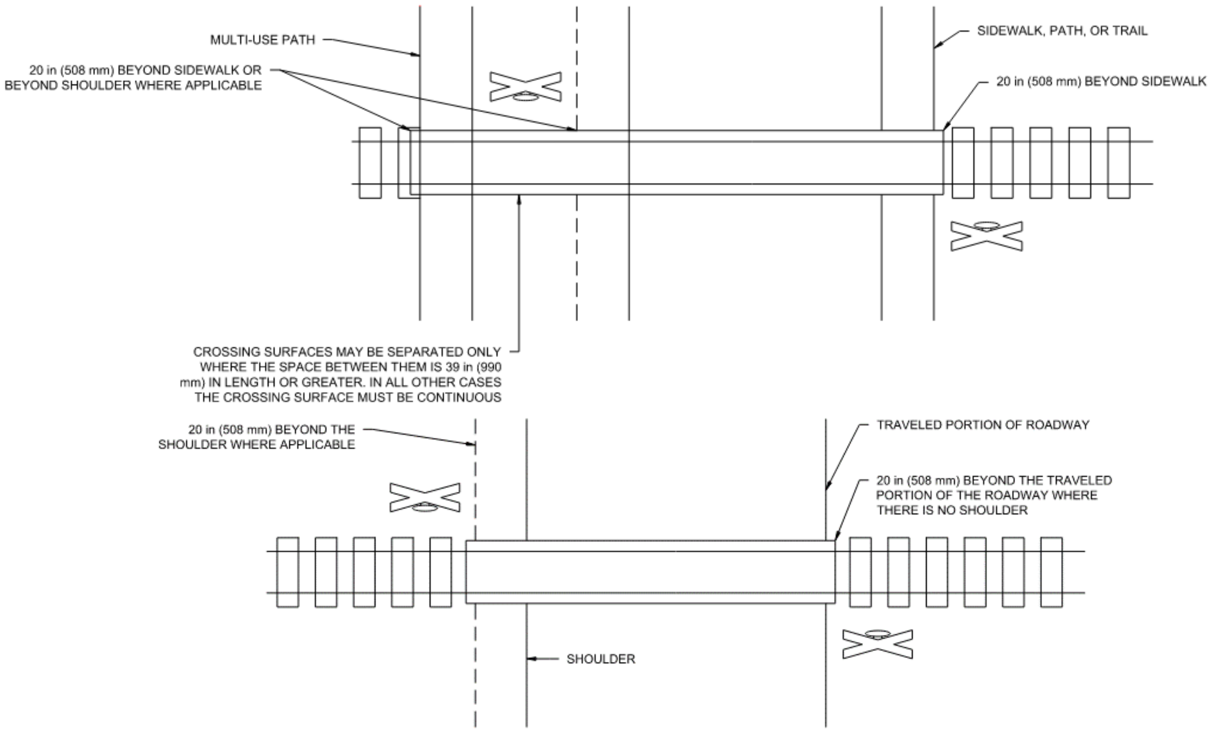


Figure 14-1 Metrolinx At-Grade Crossing Surface Requirements

Notes:

1. The minimum width of at-grade road crossing surface for public roads for vehicle use is 26 ft (7.9 m), measured at a right angle to the centerline of the roadway.
2. The minimum width of the at-grade road crossing surface for a sidewalk and/or MUP is 5 ft (1524 mm) measured at right angles to the centerline of the sidewalk and/or MUP.

14.4 At-grade Road Crossing Surfaces

14.4.1 The following are a few examples of at-grade road crossing surfaces as listed in Appendix U that are approved and a brief description of each:

a) Full Depth Softwood Planking

At-grade road crossing surface consisting of 10 in (254 mm) wide softwood planking laid parallel to the rails over the ties. Planking is placed between the rails and on the outside of each rail over top of filter fabric.

b) Sectional Treated Hardwood Timber

At-grade road crossing surface consisting of prefabricated treated hardwood timber panels (bolted horizontally) approximately 8 ft (2.4 m) long. Two (2) panels form a 16 ft (4.9 m) surface between the rails placed on filter fabric and secured to the ties by lag screws.

c) Bituminous (Asphalt)

At-grade road crossing surface consisting of an asphalt surface over the entire crossing area. The hot mix asphalt is laid in three (3) layers parallel to the running rails and roller compacted. The depth of asphalt must be full depth from top-of-tie to top-of-rail. Asphalt must be placed with an approved rubber rail seal installed and clamped on the running rails. The rubber rail seal on the gauge side forms a standard flangeway, the rubber rail seal on the field side eliminates any gap between the running rails and the asphalt.

d) Precast Concrete Panels

At-grade road crossing surface consisting of precast concrete panels in a steel frame. The panels come in various widths such that one (1) panel fits between the rails and one (1) panel fits on the outside of each rail. Rubber rail seals are installed on either side (flange and field) of the running rails. The rubber rail seal on the gauge side forms a standard flangeway, the rubber rail seal on the field side eliminates any gap between the running rails and the precast concrete panel. The ends of concrete panels are protected by steel plate deflectors. The panels are secured to the ties by lag screws.

e) Full-Depth Rubber Crossing

At grade road crossing surface consisting of molded virgin or recycled rubber panels with / or without steel plate reinforcing. The panels are installed to extend from each web of the running rail creating their own watertight flange-way. The exterior panel is installed on the outside of each running rail and fits tight to the rail with no flangeway or gap. The panels may be secured to the ties by lag screws or set in place using small stabilizer clips and gauge end block supports. The ends of rubber panels are protected by steel plate deflectors. Crossings, including a sidewalk and/or MUP, the sidewalk and/or MUP must be paved with hot mix asphalt.

14.4.2 Where precast concrete panels are installed, the concrete panels must be coated with a sealer to prevent deterioration caused by salt. The panels must be inspected annually for concrete deterioration and the sealer reapplied as required.

14.5 Destressing for At-grade Road Crossings

14.5.1 This standard applies to destressing requirements of all at-grade road crossing installation, rehabilitation and construction.

14.5.2 Prior to cutting the rail, every tie must be box anchored for a minimum distance of 200 ft (61 m), commencing 400 ft (122 m) away from each end of the crossing panel.

14.5.3 Apply reference marks on the field side web of rail where the cuts are to be made. Starting at the reference marks, working away from the crossing panel, place match marks on the field side of the rails at 50 ft (15.2 m) intervals for 400 ft (122 m) in each direction towards the box anchored ties. Ensure the match marks start on the rail base and extend onto the tie plate of an unanchored tie, remove anchors and/or elastic rail clips where necessary. Ensure the match marks are made with a white paint stick and are straight.

a) Each side of the at-grade road crossing must be destressed, unless authorized in writing by the Director, Engineering—Track.

14.5.4 Prior to cutting the rail, measure and record the distance between the reference marks on each individual rail.

14.5.5 Cut and remove the existing rail, measure, and record on the web of rail and Metrolinx prescribed destressing form, the distance between the reference marks after the existing rail is removed. This measurement reflects the rail movement (if any) of the parent rail remaining in track (positive or negative). The distance between the reference marks must be periodically monitored.

14.5.6 All welds must be completed prior to destressing.

14.5.7 The following procedure must be followed when destressing at-grade road crossings:

a) Follow the requirements of Track Standards Section 4.9;

b) To establish a destressing joint, cut the rail 200 ft (61 m) from the box anchored ties towards the crossing panel;

c) Remove all rail anchors and elastic rail clips between the box anchored ties and the at-grade road crossing surface; and

d) Determine the appropriate rail laying and/or neutral temperature of the rail at time of destressing. Using the established RLT and/or RNT, calculate the amount of rail movement required as per Appendix L. The length of rail to be destressed includes half the distance of the at-grade road crossing surface and all rail lengths up to the box anchored ties. Add to the required movement the proper amount of rail to be removed to complete field welding. During the destressing process, monitor the gauge side match marks on each rail length being destressed to ensure appropriate movement is achieved at each station. Apply anchors or elastic rail clips when the proper movement is achieved. Repeat this process on each side of the at-grade road crossing.

14.5.8 Complete the field welding procedure (electric flash butt or thermite) at the destressing location. After allowing the field weld to cool, remove the risers, restore the insulators and elastic rail clips, reapply the spikes, remove box anchor, and restore anchor pattern as per Track Standards Section 10.2.

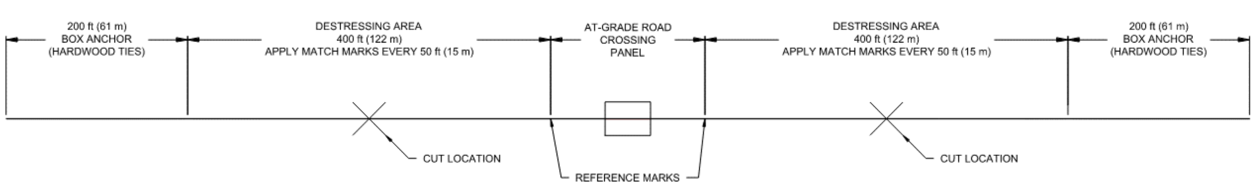


Figure 14-2 Destressing both sides of an at-grade road crossing

14.5.9 Cut the rail to create a destressing joint dividing the 400 ft (122 m) section at the "X" marks labelled "cut location" in Figure 14-2. Remove all exposed anchors and/or elastic rail clips and raise spikes from the rail base to allow for efficient rail movement. Leave the anchors, spikes, and/or elastic rail clips covered by the at-grade road crossing surface.

14.5.10 Below is an example of destressing through an at-grade road crossing where the track is embedded within the road crossing surface.

Example

A crossing is being rehabilitated, and a new crossing panel of 170 ft is installed through a 50 ft at-grade road crossing surface. The rail temperature at time of destressing is 60 °F. What is the required adjustment?

Temperature differential:	PRLT - RLT = 100 °F - 60 °F = 40 °F
Length of crossing panel installed:	170 ft
Length of road crossing surface:	50 ft
Adjustment for 200 ft. gap:	(200*40*0.00008) = 0.64 in

Adjustment for 200 ft + 1/2 the crossing panel not embedded in the crossing surface + 1/2 the road crossing surface:

(200+60+25) = 285 ft

(285*40*0.00008) = 0.91 in

(200*40*0.00008) = 0.64 in

Total adjustment required:	0.64 in + 0.91 in = 1.55 in

Note: A thermite weld will add 1 in (25.4 mm) of steel to the rail
Total adjustment required must also include the methodology for field welding as per Track Standards Section 8.

14.6 At-grade Construction Crossings/Temporary Planking of Track

14.6.1 The installation and location of all at-grade construction crossings and/or temporary planking of tracks must be approved by Metrolinx E&AM-Track.

14.6.2 All at-grade construction crossings and temporary planking of track must be constructed per Track Standards Section 14.3 and Standard Plan GTS-2301.

14.6.3 A condition assessment of the existing track infrastructure must be completed and recorded by a Track Inspector. The Track Inspector must provide a list of the required track improvements for correction before installation.

14.6.4 Filter fabric must be placed under the at-grade construction crossing surface or temporary planking covering the track structure, including ties, fasteners, and the ballast section.

14.6.5 An at-grade construction crossing and/or temporary planking constructed in multi-track territory must have the ballast section in between the adjacent planked crossings protected with filter fabric and covered with a compacted granular material to create a smooth crossing surface.

14.6.6 The crossing surface must consist of:

a) 7 x 10 in (178 mm x 254 mm) planks for all rail sizes except for 100 lb rail where 6 x 10 in (152 mm x 254 mm) planks must be used;

   i. 8 x 10 in (203 mm x 254 mm) planks may be used for 132/136RE rail.

b) Planking must be installed parallel to the running rails over the filter fabric covering the ties. Five (5) planks are placed between the running rails, and one (1) plank is placed on field side of each running rail;

c) Lag screws and washers must be installed to secure the at-grade construction crossing to the tie. Lag screws must be staggered to avoid splitting the tie; and

d) Flange fillers must be used on both the gauge and field sides.

14.6.7 At-grade construction crossings and temporary planking must have:

a) Approach grades suitable for the intended use and adequate sightlines available as per Metrolinx General Engineering Instructions;

b) A crossing surface of approved material extending at least 20 in (508 mm) beyond the travelled width on both sides measured at right angles to the at-grade crossing; and,

c) Be of an overall safe width suitable for the intended use and not less than 20 ft (6.1 m).

14.6.8 At-grade construction crossing planks must be cut at the ends to form a bevel at 30° for the full depth of the plank, creating a surface to act as a deflector.

14.6.9 At-grade construction crossings and temporary planking in concrete or steel tie territories must be lagged into No. 2 Grade hardwood treated ties, installed in the cribs between the concrete or steel ties and spiked to the rail base:

a) Crossing planks may require field modification to accommodate the use of elastic rail clips and/or anchors; and

b) Upon removal of the at-grade construction crossing and/or temporary planking in steel tie territory, the track must be fully surfaced with a mechanized tamper.

14.6.10 Planks and filter cloth must be removed at least annually for a track inspection and to complete any necessary repairs as determined by a Track Inspector unless otherwise approved by Metrolinx E&AM–Track. Construction crossings categorized as "Heavy Use" must be replaced every three (3) years or as required. During replacement of the planks, the track infrastructure must be inspected by a Track Inspector.

14.6.11 The contractor requesting the installation of an at-grade construction crossing and/or temporary planking must ensure

a) The road surface and flangeways are kept clear of snow, ice, and other debris at all times. Foreign materials must not be swept into the ballast section;

b) Crossings remain anchored as per Track Standards Section 10.2;

c) Crossings are removed once the crossing is no longer required; and

d) Crossings are inspected as per Track Standards Section 15.

14.6.12 At-grade construction crossings must not be installed until lockable chain link gates are in place protecting the full width of the crossing.

14.6.13 Each gate must include padlock fixing points in the closed position. Chains must not be used as part of the locking mechanism.

14.6.14 Fence gates must be installed such that the swing cannot foul the tracks, as per Metrolinx Fencing and Anti-Trespass Requirements.

14.6.15 Only approved railway locks must be used to secure the gates and secure access to the Metrolinx ROW.

14.7 At-Grade Road Crossings, Road Surface Maintenance and Inspections

14.7.1 All at-grade road crossings under Metrolinx authority as per Track Standards Section 14.2.5 must be classified as specified in Table 14-1, based on the maximum posted speed limit for the road and the average daily traffic count.

14.7.2 The average daily traffic count on an At-Grade Crossing is determined by:

a) Counting and averaging the daily two-way traffic on the At-Grade Crossing or part of the road approach to the crossing; or

b) Estimating the average daily two-way traffic on the At-Grade Crossing or part of the road approach to crossing.

Table 14-1 Classification of At-Grade Crossings

Average Daily Traffic (number of motor vehicles)	91 - 100 km/h speed limit	81 - 90 km/h speed limit	71 - 80 km/h speed limit	61 - 70 km/h speed limit	51 - 60 km/h speed limit	41 - 50 km/h speed limit	1 - 40 km/h speed limit
53,000 or more	1	1	1	1	1	1	1
23,000 - 52,999	1	1	1	2	2	2	2
15,000 - 22,999	1	1	2	2	2	3	3
12,000 - 14,999	1	1	2	2	2	3	3
10,000 - 11,999	1	1	2	2	3	3	3
8,000 - 9,999	1	1	2	3	3	3	3
6,000 - 7,999	1	2	2	3	3	4	4
5,000 - 5,999	1	2	2	3	3	4	4
4,000 - 4,999	1	2	3	3	3	4	4
3,000 - 3,999	1	2	3	3	3	4	4
2,000 - 2,999	1	2	3	3	4	5	5
1,000 - 1,999	1	3	3	3	4	5	5
500 - 999	1	3	4	4	4	5	5
200 - 499	1	3	4	4	5	5	6
50 - 199	1	3	4	5	5	6	6
0 - 49	1	3	6	6	6	6	6

14.7.3 Inspections of at-grade road crossings must be completed for the full width of the crossing surface as per Table B-6 in Appendix B and in accordance with the GO Transit Grade Crossing Design Standard.

14.7.4 Road surface defects are categorized as Potholes, cracks, and surface discontinuities. All defects must be repaired within the prescribed timelines from date of inspection.

14.7.5 Potholes must be inspected, monitored, and repaired in accordance with Table 14-2 and Table 14-3.

14.7.6 The surface area and depth of a pothole must be measured by an Employee responsible for performing regulatory track inspections or by an Employee responsible for performing track infrastructure maintenance activities.

14.7.7 The surface area of a pothole does not include any area that is depressed and not yet broken fully through the surface of the at-grade crossing.

Table 14-2 Potholes on Improved (Paved) Surface of At-Grade Road Crossing

Class of At-Grade Crossing	Surface Area	Depth	Repaired within
1	93 in² (600 cm²)	3-1/8 in (80 mm)	4 days
2	124 in² (800 cm²)	3-1/8 in (80 mm)	4 days
3	155 in² (1000 cm²)	3-1/8 in (80 mm)	7 days
4	155 in² (1000 cm²)	3-1/8 in (80 mm)	14 days
5	155 in² (1000 cm²)	3-1/8 in (80 mm)	30 days

Table 14-3 Potholes on Unimproved (Non-Paved) Surface of At-Grade Crossing

Class of At-Grade Crossing	Surface Area	Depth	Repaired within
3	232 in² (1500 cm²)	3-1/8 in (80 mm)	7 days
4	232 in² (1500 cm²)	3-7/8 in (100 mm)	14 days
5	232 in² (1500 cm²)	4-5/8 in (120 mm)	30 days

14.7.8 Cracks must be inspected, and monitored, and if a crack on the improved (paved) surface of an At-Grade Crossing has a width greater than 1-7/8 in (48 mm) wide and a depth of greater than 1-7/8 in (48 mm) deep for a continuous distance of 9 ft 10 in (3 m) or more, the crack must be repaired within the time set out in Table 14-4 to this section.

Table 14-4 Cracks on Improved (Paved) Surface of At-Grade Crossing

Class of At-Grade Crossing	Repaired within
1	30 days
2	30 days
3	60 days
4	180 days
5	180 days

14.7.9 A surface discontinuity is a vertical discontinuity creating a step formation at joints or cracks in the improved (paved) surface of an at-grade road crossing, including changes to road surface materials (asphalt to concrete, etc.).

14.7.10 A surface discontinuity must be inspected, monitored, and repaired if its height is greater than or equal to the height set out in Table 14-5 in this section.

Table 14-5 Surface Discontinuities on Improved (Paved) Surface of At-Grade Crossing

Class of Highway	Height	Repaired within
1	1-7/8 in (48 mm)	2 days
2	1-7/8 in (48 mm)	2 days
3	1-7/8 in (48 mm)	7 days
4	1-7/8 in (48 mm)	21 days
5	1-7/8 in (48 mm)	21 days

15 Track and ROW Inspection

15.1 Class of Track

15.1.1 The maximum allowable train speed on a subdivision, or portion thereof, including applicable Permanent Slow Orders, must be used to determine the class of track as per Appendix A Table A-1.

15.2 General Information

15.2.1 Track inspectors must ensure the track is safe for operation at authorized speeds. All unsafe conditions found by inspectors must be properly protected and reported to the Maintenance Delivery––Manager of Track.

15.2.2 All tracks must be inspected in accordance with the schedules listed in Appendix B and the latest Transport Canada Rules Respecting Track Safety, whichever is more restrictive.

15.2.3 Track inspection must be completed on foot or by traversing over the track in a track unit, the speed must allow the track inspector to visually inspect the track structure for compliance with Metrolinx Track Standards and Transport Canada Rules Respecting Track Safety.

15.2.4 Mechanical, electrical, and other track inspection devices may be used to supplement visual track inspection. Results must be reviewed at the same frequency as inspection requirements.

15.2.5 While traversing over the track in a track unit, the track inspector may inspect up to two tracks at one time provided:

a) All main tracks must be traversed by a track unit or inspected on foot on alternate inspections at least once every two weeks, and each siding or crossover must be traversed by a track unit or inspected on foot at least once every month;

b) The inspection must be of the track in which the track inspector is traversing, and the second track must be directly adjacent to the track unit and with sufficient visibility of the adjacent track in the opinion of Metrolinx;

c) Track inspection records must indicate all track(s) included in the track inspection and indicate track(s) traversed by the track unit, adjacent tracks inspected, or inspected on foot. Track inspection records must clearly specify to and from locations by means of identifiable locations:

   i. Record of inspection must be submitted the same day the inspection was completed, or within 24 hours if the inspection occurred after 21:59.

d) The track inspector's view of the track(s) must be unobstructed by tunnels, bridges, differences in ground elevation, station platforms or any other circumstances or conditions interfering with a clear view of the tracks they are inspecting;

e) The track inspection must not be conducted at night or under other conditions where visibility is obscured; and

f) All elements as described in Table V-1 are able to be inspected.

15.2.6 When the track is occupied by equipment, the track inspection must be completed on foot by walking on each side of the track.

15.2.7 Yard tracks may be inspected from an adjacent roadway, the next required track inspection must be completed with the track traversed by the track unit or inspected on foot.

15.2.8 All routes leading into foreign railway yards and industrial tracks must be inspected up to the marked delineation point, as marked on the rail, using a white paint stick.

15.2.9 Inactive tracks must be secured in a manner preventing occupancy and must be inspected before being placed in service to ensure the track is safe for movements at the authorized speed.

15.2.10 The Maintenance Delivery—Manager of Track has the authority to schedule additional track inspections. If required, these inspections must be completed to contribute to safe railway operation under the following conditions:

a) Strong winds in excess of 60 km/h, which may cause trees or other obstacles to fall on the track;

b) Heavy rain, freezing rain, snow or repeated freeze-thaw cycles, which may cause high water, washouts, plugged culverts, rock falls, or mudslides;

c) Extreme temperature swings and hot or cold temperatures, which may cause track buckling or rail breaks;

d) Long dry period combined with track maintenance activities, or during any train operations that may cause fires;

e) After an earthquake. See Track Standards Section 15.2.12 below;

f) After a freight train performs an emergency brake;

g) After a passenger train performs an emergency brake on a track with a grade of 1.5% or steeper;

h) After an incident involving a collision;

i) Any other occurrence which may have damaged or disturbed the track structure; and

j) Curve movement, ballast displacement:

i. When curve movement is evident, the track inspector must continuously monitor signs of rail stress. Stakes must be applied at the centerline of track at 100 ft (30.5 m) intervals throughout the curve. Measurement between stakes and base of rail must be documented on the web of the rail with paint marking the location of each stake.

15.2.11 In preparation of and during significant weather events, the Metrolinx Weather Protocols (RC-0604-02) must be enacted and followed.

15.2.12 Speed restrictions must be applied depending on the severity of the earthquake.

Table 15-1 Earthquake Response Levels

Earthquake Magnitude (Richter Scale)	Response Level	Radius from Epicenter
0.0 – 4.99	1	50 mi (80 km)
5.0 – 5.99	3	50 mi (80 km)
	2	200 mi (320 km)
6.0 – 6.99	3	300 mi (480 km)
7.0 or greater	3	400 mi (640 km)

a) Response Level 1 – Resume maximum operating speed. The need for additional inspections must be determined by Maintenance Delivery—Manager of Track.

b) Response Level 2 – Speed restricted to 30 mph within the specified radius of the epicenter until inspections have been performed.

c) Response Level 3 – Trains within the specified radius of the epicenter must be stopped and may not proceed until inspections have been performed.

15.2.13 Track inspectors, at a minimum, will be equipped with the following:

a) Level board and track gauge (capable of measuring switch point rise);

b) 62 ft (18.9 m) string line with clamps or magnets;

c) 36 in (914 mm) straight edge and taper gauge(s);

d) Rail wear gauge(s);

e) Tape measure;

f) Rail thermometer;

g) Frog flangeway gauge(s);

h) Spray paint, high visibility ribbon, and paint stick marker;

i) Inspection mirror with telescoping handle;

j) Counter–clicker type;

k) Operable GPS unit; and

l) The most recent track geometry car report, track chart and curve list.

15.3 Frequency of Inspections

15.3.1 Minimum track inspection frequencies must comply with the Transport Canada Rules Respecting Track Safety and Appendix B, whichever is more restrictive.

15.3.2 The frequency of inspections are defined as follows:

a) Twice Weekly – a minimum of two (2) inspections each week (Sunday to Saturday), with no more than three (3) days between inspections;

b) Weekly – A minimum of one (1) inspection each week (Sunday to Saturday), with no more than ten (10) days between inspections;

c) Twice Monthly – A minimum of two (2) inspections each month (between the 1st and the last day of each month) and with no more than 20 days between inspections;

d) Monthly – A minimum of one (1) inspection each month (between the 1st and the last day of each month) with no more than 40 days between inspections;

e) Quarterly – A minimum of one (1) inspection each quarter (Jan 1st to Mar 31st, Apr 1st to June 30th, July 1st to Sept 30th, Oct 1st to Dec 31st), with no less than 60 days between inspections and no more than 100 days between inspections;

f) Three times annually – a minimum of one (1) inspection each four (4) months (Jan 1st to Mar 31st, Apr 1st to June 30th, July 1st to Sept 30th, Oct 1st to Dec 31st) with no less than 90 days between inspections and no more than 180 days between inspections;

g) Twice Annually – a minimum of one (1) inspection every six (6) months (Jan 1st to Jun 30th, July 1st to Dec 31st), with no less than 120 days between inspection and no more than 225 days between inspections; and

h) Annually — one (1) inspection per year (Jan 1st to Dec 31st), with no less than 180 days between inspections and no more than 400 days between inspections.

15.3.3 Each turnout, at-grade rail crossing, movable bridge lift rail, derail, or other special trackwork must be inspected on foot as per the requirements in Appendix B.

a) In the case of track that is used less than the inspection frequency identified in Appendix B, each turnout, at-grade rail crossing, movable bridge lift rail, derail, or other special trackwork must be inspected on foot before it is used.

15.4 Methods of Inspection

15.4.1 Inspection methods include walking, or in a track unit traversing the track in accordance with Track Standards Section 15.5 Table 15-2 and with the recommended inspection checklist tabulated in Table V-1.

15.4.2 When a hi-rail unit is used for inspection, the Employee must travel at a speed that allows the person making the inspection to visually inspect the track but not exceeding the speeds prescribed in the Metrolinx GEI.

a) Every effort must be made to alternate direction of visual inspections when possible.

15.4.3 Track must be inspected by train, at least monthly, riding a forward-facing unit. Inspection by train will provide a view of the track and ROW and will give an indication of ride quality, but it is not included in the count of required inspection by Transport Canada:

a) The Track Lead or designate must inspect their area of responsibility at least once every month from the engine of a Metrolinx train (including GO Trains and UP Diesel Multiple Units).

15.4.4 Walking track inspections must be completed to monitor priority locations and areas of known problems, as outlined in Track Standards Section 15.5 Table 15-2 for the following tracks:

a) Class 3, 4, and 5 main tracks;

b) Sidings, Class 1, and 2 main tracks carrying more than 25 MGT of traffic per year;

15.4.5 The Maintenance Delivery—Manager of Track must direct walking inspections on Class 1 and 2 main track and sidings that carry less than 25 MGT of traffic.

15.4.6 In addition to the priority locations in Track Standards Section 15.5, Table V-1 provides a checklist that should be followed for on-foot, routine, and on-train inspections.

15.5 Areas for Inspections

15.5.1 The areas for inspection are included, but not limited to those found in Table 15-2.

Table 15-2 Areas for Inspection

	Rail
a	Areas with high numbers of fatigue-related rail defects
b	Rail defects protected by joint bars
c	Rail damage which has been alleviated by grinding
d	Areas approaching urgent limits for wear. Where rail wear is at the increased monitoring limit, the underside of the rail-head must be physically inspected*
e	Locations prone to overstressed rail, such as: i. areas where rail repairs have been made (too little or too much rail installed) ii. curves iii. areas of severe rail corrugation iv. areas of heavy brake application (e.g. approaches to PSO locations) – moving rail v. areas of buffer rails or any joints adjoining CWR vi. areas of steep grades and sags vii. areas of insufficient or damaged rail anchors, or significant rail movement

	viii. derailment sites or derailment-damaged rail
f	Signs of rail moving through anchors and elastic fasteners
g	Short misalignment and kinks in tangent track
h	Track center spacing
Joints	
a	Cracked or broken joint bars
b	Gauge or top-of-rail mismatch between rails
c	Pumping action of joint under traffic
d	Weak tie condition under or surrounding the joint
e	Tie plate movement on top of the tie
Bolts	
a	Loose, bent, frozen, broken, and missing track bolts
Plates	
a	Rail base improperly seated in plates
b	Cracked, broken, missing, or damaged tie plates
c	Tie plate movement on top of the tie
d	Areas prone to ice build-up under the tie plate
Fasteners	
a	Bent, high, missing, loose, broken and incorrect screw spikes
b	Broken, missing, loose, bent or improperly driven spikes
c	Spiking pattern is incomplete or incorrect
d	Missing, broken, loose, seized (frozen) and wrong elastic fasteners
e	Missing, damaged, or deteriorated Insulator Pads
Wood Ties	
a	Cluster of defective ties
b	Wide gauge problem areas with ½ in (13 mm) or greater; Narrow gauge problems with ¼ in (6 mm) or less
c	Excessive change in cant (positive or negative)
d	Areas prone to hanging ties, such as insulated joints, road crossings, culverts, bridge approaches and frost heaves
f	Areas with high dynamic braking or aggressive braking, such as controlled locations, PSOs, or stations
Concrete or Steel Ties	
a	Signs of rail movement
b	Loose or damaged embedded shoulder
c	Signs of rail seat abrasion – excessive cant or gauge, rail movement, displaced, missing or curled rail seat tie pad
d	Areas with historical clip failure
e	Areas prone to hanging ties, such as insulated joints, road crossings, culverts, bridge approaches and frost heaves
f	Ties damaged by derailment or cracks in the rail seat or through the embedded shoulders
g	Tie deterioration from pumping – rounded tie bottoms or rebar exposure
h	Signs of end splitting
Ballast	
a	Sinkholes
b	Mud pumping locations
c	Frost heave locations
d	Areas of weak ballast shoulders
e	Areas where recent program work has left ballast disturbed
f	Adequacy of the ballast section at sags, culverts, ballast deck bridges, bridge abutments and locations where vehicles have been driven along the ROW or where footpaths may cross tracks
g	Signs of churning ballast
Roadbed / Slope Stability	
a	Areas historically prone to track geometry problems (surface, line, cross-level)
b	Slope stability problems (slip, rock falls, or mud slides)
c	Slope of subgrade/excavation
d	Excavations encroaching Zone 2 and Zone 3

Drainage	
a	Areas prone to ponding water (drainage ditches, blocked culverts, low-lying areas, etc.)
b	Area of high or increased surface run-off (adjacent developments, high water tables, etc.)
c	Culverts
Transition Areas	
a	Bridge approaches
b	Areas of track structure or track stiffness changes, such as concrete tie to timber or steel tie transition areas
c	Signs of rail or tie movement
Derailment Areas	
a	Substandard conditions or temporary repairs
b	Locations of square joints associated with panel installation
Direct Fixation Track	
a	Bolts are properly tightened
b	Check clips are properly attached and secured; not rusted
c	Significant concrete cracking

* Under Rail Head Inspection

a. It is acceptable to conduct under head inspections with an inspection mirror.
b. Look for cracks that cause head-web separation defects or vertical split heads. The indications are:
   i. In the early stage, a wavy, wrinkled line appears in the fillet under the head.
   ii. In mid-stage, a small crack will appear along the fillet on either side of the rail head, indicating growth through the web. The crack will progress longitudinally.
c. If any of the above indications are found, a 10 mph speed restriction must be applied and the rail must be replaced immediately.
d. If none of the above indications are found, but rail surface shelling, spalling, and/or corrugation are present, the location must be monitored and additional under rail head inspections must be completed, until the rail is removed from track.

15.6 Walking Curve Inspections

15.6.1 Walking curve inspections require:

a) Knowledge of the correct design superelevation for the curve;
b) Review of geometry car reports for the locations of gauge, cant, and other geometry conditions;
c) Inspection of both the high and the low rail, noting:
   i. Excessive gauge corner wear, measuring and recording periodically;
   ii. Excessive flattening of the low rail, measuring and recording periodically;
   iii. Adequacy of lubrication on the rail, where applicable; and
   iv. Proper ballast shoulder and roadbed slope on each side.
d) Alignment or surface deviations in the track;
e) Signs of gauge widening from rail wear, plate movement or insulator crushing; and
f) Inspection to be completed when ties are not covered with snow or ice, and the tie and fasteners are visible.

15.6.2 For walking curve inspections on wood tie territory:

a) Observe screw spikes and cut spikes for signs of lift, breakage, throat wear or rotation;

b) Tap plates, spikes, and screw spikes with a lining bar for signs of loose or broken fasteners:

i. When a broken screw or spike is found, perform a detailed inspection of the surrounding area to determine the extent of the broken fasteners.

c) Record any cracked, broken, worn or damaged tie plates, including tie plates with a single shoulder; and

d) Record plate pushing or plate cutting with excessive rail cant – both inward and outward.

15.6.3 For walking curve inspections on concrete and steel ties:

a) Walking along both field sides, noting the condition of the clips, pads, insulators, and cast shoulder;

b) Record any outward rail movement or other signs of rail seat abrasion.

15.7 Joint and Joint Bars

15.7.1 Each joint bar in CWR must be inspected on foot each calendar year at the frequency indicated by class of track and annual tonnage in Table B-3 and Table B-4 in Appendix B. This includes:

a) Insulated joints in CWR track;

b) Jointed rail within CWR; and

c) Joints within or adjacent to switches, at-grade rail-to-rail crossings, at-grade road crossings, at-grade rail-to-rail crossings and lift/expansion rails are exempt from periodic joint inspection provided that they are inspected in the monthly walking inspections for these devices.

15.7.2 Joints requiring on-foot inspection are any joints located in a CWR string or any joint in a segment of rail between CWR strings that are less than 200 feet (61.0 m) apart. When there is a segment of jointed rail greater than 200 feet (61.0 m) between CWR strings only the joints adjacent to the CWR must be inspected.

15.7.3 Walking inspections must be completed on all jointed tracks per frequencies outlined in Appendix B.

15.7.4 If any of the following conditions contained in Table 15-3 are found at a joint in CWR and are not a regulatory defect and cannot be corrected immediately, on-foot follow-up inspections will be required until such time as the condition is corrected.

Table 15-3 Rail Joint Conditions and Remedial Actions

Rail Joint Condition	Action[1]
Broken joint bars and visible cracks in joint bar	Replace bar immediately (See Track Standards Section 5.2)
Loose bolts	Tighten Bolt[2]
Bent bolts	Replace bolts*
Missing bolts[3]	Replace bolts (See Track Standards Section 5.2)
Tie(s) not effectively supporting joint	Tamp tie(s) Replace or repair tie(s) immediately* (See Track Standards Section 9.1)
Broken or missing tie plate(s)	Replace tie plate(s)
Deteriorated insulated joint	Replace/repair joint* (See Track Standards Section 5.3)
Rail end batter	Repair by welding joint or removing rail* (See Appendix I)
Rail end mismatch that reaches limits in Table G-4	Replace rail, weld or grind. (See Track Standards Section 4.5)
Longitudinal rail movement greater than 2 in (51 mm)	Adjust rail anchors, tighten bolts, add or remove rail at appropriate time
Wide rail gap greater than 3/8 in (9.5 mm)	Adjust rail gap and secure joint*
Joint vertical movement (profile) that exceeds 75% of the allowable threshold for the designated class of track [4]	Surface joint*
Fouled[5] ballast present in conjunction with joint vertical movement that exceeds 75% of the allowable threshold for the designated class of track	Surface joint and provide drainage*
Rail anchors at permanent joints within CWR	Replace missing/damaged anchors (Track Standards Section 10.2.14)

[1] Action may also consist of placing a speed restriction or removing the track from service.
[2] On main track and within CWR, loose bolts must be replaced immediately or marked for replacement within 30 days. In yard tracks, if the bolt continues to loosen, is stripped, or is rusted, it must be replaced.
[3] A minimum of two bolts fully tightened per rail must be in place at each joint.
[4] Joint vertical movement is the apparent visible movement measured at the joint.
[5] Fouled ballast is defined as ballast contaminated with unwanted materials such as fines, soil, debris or organic matter.
* Or conduct follow-up inspections every other week until the defects are repaired or removed.

15.7.5 Jointed and CWR main track requires on-foot inspection of all rail joints on bridges to be undertaken at the following frequencies:

a) Track with less than 10 MGT annually; and

b) Track with 10 MGT or greater twice annually.

15.7.6 Compromise bars must be inspected on foot monthly.

15.8 Ballast Inspections

15.8.1 When performing inspections, frequently check for line or surface deviations due to insufficient ballast.

15.8.2 A location has an insufficient ballast defect if either end of the tie is fully exposed or 50% empty cribs of six (6) or more consecutive ties coupled with a track surface or alignment deviation exceeding priority limits for the designated class of track:

a) When the ambient temperature exceeds 85 °F (29 °C) or is expected to exceed 85 °F (29 °C) within the next 24 hours and either condition exists, reduce the speed to the next lower class of track and continue to monitor until repaired. Speed restriction may be removed, and monitoring will not be necessary when the ambient temperature drops below 85 °F (29 °C).

15.8.3 Ballast must conform to Track Standards Section 11.

15.8.4 Where areas of insufficient ballast shoulder is found, the surrounding area must be inspected for potential voids or slope erosion.

15.9 Direct Fixation (DF) Track

15.9.1 DF track must be inspected as per Table B-6 in Appendix B.

15.9.2 All bolts must be inspected to ensure they are tight.

15.9.3 Elastic fasteners must be inspected during regulatory inspections.

15.9.4 Missing elastic fasteners must be scheduled for replacement. The number of missing fasteners must not exceed three consecutive ties.

15.9.5 Cracks in concrete are a normal occurrence. Any cracks greater than 1/64 in (0.4 mm) must be reported to the Maintenance Delivery—Manager of Bridges and Structures.

15.10 Derails

15.10.1 All derails, including related signage and operating mechanisms, must be inspected monthly on foot and must conform to the requirements in Track Standards Section 10.3.

15.10.2 Derail inspection frequency is dictated by Table B-5 in Appendix B.

15.10.3 When conducting a monthly inspection of a derail, the following must be inspected, and all defects reported:

a) Derail is of the proper size, type, and fit, and no components are damaged;

b) The ties under the derail are sound, fasteners intact, and the tie fully supports the derail;

c) Lock is present and applied to the derail;

d) Derail is painted yellow to ensure it is clearly visible;

e) Is operated in the on and off position, including switch stand if present, to ensure proper working order; and

f) Derail signs, where required, are in place and visible.

15.10.4 When conducting an annual detailed inspection of a derail, in addition to the monthly inspection requirements, the following must be inspected and all defects reported:

a) Inspect guard rail (if applicable) and ensure it is installed per Standard Plans GTS-2208 and GTS-2209;

b) Proper lubrication of the derail is evident and freely opens, including switch stand (if applicable);

c) If the derail is equipped with a switch stand:

i. Lock is present and applied to the switch stand;

ii. The switch point throw must be measured and recorded; and

iii. Switch point derails must have a detailed turnout inspection conducted.

15.11 End-of-Track Devices

15.11.1 End-of-track devices must be inspected on foot and must conform to the requirements of Track Standards Section 10.7.

15.11.2 End-of-track devices must be inspected at the same frequency as derails, refer to Table B-5 in Appendix B for details:

a) End of track devices installed on main track must be inspected at the same frequency and time as routine track inspections.

15.11.3 When conducting an inspection of an end-of-track device, the following must be noted:

a) The ties are sound, and the rails fully support the device;

b) All fasteners are in place and tight;

c) The end of track device is visible and free of vegetation and debris; and

d) All components are in good condition. Bent or damaged elements must be reported to the Maintenance Delivery–Manager of Track.

15.12 Culverts and Drainage

15.12.1 General inspections of all culverts and surface drainage conditions must be conducted by track inspectors in conjunction with track inspections.

15.12.2 Culvert and surface drainage inspections must be completed to ensure:

a) The flow of water remains unobstructed and clearly visible both upstream and downstream of the inlet and outlet;

b) Site conditions have not changed in a manner that impacts drainage through assessment of land use and ditch condition;

c) The structural integrity of the culvert is sufficient to support track, ballast, and embankment material, and no voids are observed in the ballast or embankment; and

d) Identification of maintenance activities required prior to the next inspection.

15.12.3 Culverts with a diameter of 10 ft (3.05 m) or less must be inspected on foot every five (5) years:

a) Increase frequency of inspection to annually depending on conditions of the culvert; and

b) E&AM—Bridges and Structures may specify additional inspection requirements, which must be completed accordingly.

15.12.4 Underpass pedestrian tunnels or culverts over 10 ft (3.05 m) require annual on-foot inspection with no more than 540 days between inspections:

a) The E&AM—Bridges and Structures may specify additional inspection requirements, which must be completed accordingly.

15.12.5 In the cases where defects are observed, the Maintenance Delivery—Manager of Bridges and Structures must be notified immediately to determine remedial action required.

15.12.6 The Track Lead must arrange for regular inspections of beaver dams on their territory and take the necessary protective action if conditions are hazardous. Refer to Metrolinx High Water Management Plan (RC-0408-01) for additional details.

15.12.7 An up-to-date list of beaver dams will be maintained on each Track Lead's territory. The list should include:

a) The subdivision mileage;

b) The side of the track on which the dams are located;

c) The number of dams;

d) Whether the dams are upstream or downstream;

e) The distance to each dam from the track;

f) Remarks regarding the dams;

g) Water fluctuation; and

h) The date of the inspection.

15.12.8 If it is determined that there is a head of water upstream of the Beaver Dam that poses a concern to the safety of the railway crossing(s) downstream of the dam, then remove the end portion(s) of dam to slowly draw down water to a safe level. Report all beaver dam locations to the Maintenance Delivery—Manager of Bridges & Structures. Refer to Metrolinx High Water Management Plan (RC-0408-01) for additional details.

15.12.9 Additional information is located in Track Standards Section 21.3.

15.13 High Water and Run-Off Inspections

15.13.1 Inspections by the Maintenance Delivery—Bridges and Structures group and the Track Lead must be completed every spring, and as required. Inspection reports are to be submitted to the Maintenance Delivery—Manager of Bridges and Structures, noting any concerns.

15.13.2 At the onset of spring, when there is a heavy precipitation event, or when flooding conditions may be present, the following steps must be taken to prevent bridge, culvert and track infrastructure washouts:

a) All Employees should be on the lookout for water-related problems as a component of their regular duties. Concerns must be reported to the Maintenance Delivery—Manager of Bridges and Structures;

b) All Employees must report inlet conditions to the Maintenance Delivery—Manager of Bridges and Structures, noting:

   i. Watercourses with lower or higher than normal flow discharges. If creek discharges are less than usual or if debris and mud are evident in the flow, an upstream watercourse blockage may exist;

   ii. Flow constraints, such as debris building up at the culvert inlet, must be removed to restore normal flow through the culvert;

   iii. Water ponding at the inlet to a culvert. Remedial actions must be taken to reduce water levels at the inlet; and

   iv. Water levels are higher on one side of the track than on the other side.

c) Track and bridge inspectors must inspect bridges for track alignment, cross-level and surface defects; and

d) Typical conditions experienced around bridges during high water flows experienced during heavy precipitation or spring conditions of snowmelt and ice movement are:

   i. Scour conditions at substructures (piers and abutments). Eddying or dirty water around the substructure base may be a sign of scouring;

   ii. Failure of supports (particularly for trestle-type bridges) due to ice loads or debris;

   iii. Loss of substructure support causing subsidence or sway of bridges;

   iv. Inadequate bank protection during spring runoff conditions; and

   v. Failure or poor condition of ice protection measures such as noses on piers or upstream protection structures.

15.13.3 Refer to Metrolinx High Water Management Plan RC-0408-01 for additional details.

15.14 Gas Welded Rail Inspection Policy

15.14.1 This policy must be in effect from October 1 to March 1 and other times when the ambient temperature falls below 25 °F (-4 °C).

15.14.2 For main track that contains gas-welded continuous welded rail, the minimum inspection frequency is amended as follows:

a) Three (3) times weekly with at least one (1) calendar day between inspections;

b) The Track Lead must make every effort to personally perform at least one (1) inspection per week; and

c) Additional inspections on other tracks with gas-welded continuous rail must be performed as directed by the Director, Engineering–Track.

15.15 Record of Inspections

15.15.1 All persons engaged in performing regulatory inspections will prepare and sign a record of each regulatory inspection on the day the inspection is made in accordance with Transport Canada Rules Respecting Track Safety and the Metrolinx Track Standards. The report must be retained for at least one year after the date of the inspection. Inspection reports must be submitted through the Metrolinx Maintenance Management System (MMS).

15.15.2 Records must include the following:

a) The track(s) inspected, including the "from" and "to" mileages of the main track and other tracks inspected;

b) The time and date of the inspection;

c) Name, title, employee ID and signature of the Track Inspector;

d) The method of inspection (walking, from a track unit, or by train, and whether the track traversed or observed from an adjacent track);

e) The type of inspection (e.g. routine, detailed);

f) The location and nature of any rail or track defects referencing requirements of the Metrolinx Track Standards and the Transport Canada Rules Respecting Track Safety; and

g) The remedial action taken, the date of the action, and signed off by the Track Inspector who inspected the work.

15.15.3 The following inspection forms should be used for inspection:

a) Track Inspection Form for regulatory defects;

b) Track Inspection Form for non-regulatory defects;

c) Monthly Yard and Other Track Inspection Form;

d) Monthly Turnout Inspection Form;

e) Detailed Turnout Inspection Form;

f) Track Crossing Inspection Report;

g) Annual Derail Inspection Form;

h) Joint Bar Inspection Form (Jointed Track);

i) Joint Bar Inspection Form (CWR track);

j) Derail Inspection Form; and

k) Bumping Post Inspection Form.

15.16 Extreme Cold Weather Inspections

15.16.1 Daily cold weather track inspections will be undertaken on mainlines under the conditions in Table 15-4.

Table 15-4 Conditions for Cold Weather Inspections

Track Conditions	Either Condition Met	
	Extreme Cold Ambient Temperature	Rapid Drop in Ambient Temperature
Susceptible to Cold	< -13 °F (< -25 °C)	>45 °F (>25 °C) in 24 hrs
All Tracks	< -22 °F (< -30 °C)	

15.16.2 Tracks must be considered susceptible to cold weather if any one of the following conditions applies:

a) Non-signalized territory;

b) Jointed and/or gas-welded rail; or

c) Rail segments with a history of frequent in-service rail failure.

15.16.3 Additional track inspections should also be considered during the first "cold snap" of the season, where temperatures drop to below -4 °F (-20 °C).

15.16.4 During winter, at times of snow accumulations, watch for signs of fastener failure on curves equipped with rolled plates and 16 in (406 mm) modified eccentric plates with welded e-clip shoulders. Disturbance of the snow may be evidence of lateral movement of the rail and tie plates due to weakened fasteners and cracked tie plates and may be accompanied by lifting/canting of the plate.

15.17 Cold Weather Speed Restrictions

15.17.1 The following cold weather temporary speed restrictions must be put in place when the ambient temperature is expected to fall to or below -13 °F (-25 °C):

a) All passenger trains must be restricted to a speed of 60 mph or track speed, whichever is more restrictive; and

b) All freight trains must be restricted to a speed of 40 mph or track speed, whichever is more restrictive.

15.17.2 Track protected by a 'cold weather speed restriction' must be inspected daily.

15.18 Ice Jacking

15.18.1 During the winter months, under snow conditions, inspectors must look for icing between the tie plates and the base of the rail. Progressive ice build-up may cause the rail base to clear the shoulders of the tie plate, resulting in a wide gauge under loaded conditions. The condition can be discovered to some extent by looking for a disturbance in the snow along the field side of the high or low rail of a curve or cracking in the undisturbed surface of the snow. A fresh snowfall may hide this disturbance, making additional checks essential.

15.18.2 In locations where ice build-up is likely to occur, snow must be removed, and tie plates examined for ice build-up.

15.18.3 Ice jacking is most likely to occur where one or more of the following conditions exist:

a) Hanging ties;

b) Center bound track;

c) Poor tie condition, including excessive plate cutting;

d) Poor surface conditions;

e) High spikes;

f) Corrugated rail;

g) High ballast or build-up of engine sand in the tie cribs directly under the rail;

h) Close proximity to at-grade road crossing;

i) Worn plates and fasteners; and/or

j) Where poor drainage conditions exist, allowing water to pool in the track structure, including the ballast section.

15.19 Hot Weather Inspections

15.19.1 Whenever ambient (air) temperature exceeds 86 °F (30 °C), or during periods of significant seasonal increase in temperature, a hot weather track patrol must be undertaken between the hours of 11:00 and 22:00. The Maintenance Delivery–Manager of Track may require additional inspections if the conditions change or if deemed necessary.

15.19.2 Hot weather patrols may be suspended if temperatures have stabilized, and previous inspections have shown that the track structure is stable and complies with Metrolinx Track Standards.

15.19.3 A seasonal increase in ambient temperature is defined as a change in temperature greater than 20 °C (36 °F) within 24 hours.

15.20 Hot Weather Speed Restrictions

15.20.1 Hot weather TSOs must be applied on portions of Subdivisions where the temperature threshold exceeds 90 °F (32 °C) or any one of the following track conditions are known to exist:

a) Lateral or vertical movement of rail;

b) Rail that is riding up or out of the tie plates or is crowding the shoulder of the tie plates on curves;

c) Deviations in alignment;

d) Movement of ties (e.g. gaps or voids in ballast at tie ends or in cribs);

e) Rail base not properly seated in the plates;

f) Insufficient ballast section (e.g. weak shoulders, empty cribs, hanging ties), especially at fixed locations;

g) Rail moving through anchors or spikes;

h) Ties plowing ballast longitudinally along the track;

i) Areas where rail is considered “Tight steel” (e.g. areas of frequent dynamic brake application, approaches to PSO’s or speed changes, bottoms of grades, station stops experiencing directional running, etc.);

j) Areas where joints adjoin CWR. Bolts must be inspected for straightness when rail gaps are closed;

k) Recently completed track work;

l) Cluster of high spikes and poor ties;

m) Longitudinal movement of a switch point in relation to stock rail, resulting in improper switch adjustment;

n) New installations of culverts, turnouts, and road crossings;

o) Rail gaps that are not closed when the rail temperature is 40 °F (22 °C) above the PRLT must be reported to the Maintenance Delivery—Manager of Track and the Track Lead;

p) Shimming areas must be inspected closely for high spikes and spike-killed ties and anchor patterns not properly reapplied after shimming activities;

q) Curves in CWR territory. Watch for rail canting to the outside of the curve. The high rail will lift off the tie plate on the gauge side, the low rail on the field side;

r) Welds in curves. Poor alignment of welds will result in heavy rail wear. Additional excessive forces will be placed on the high rail, causing inside spikes to lift, and track to go out of line;

s) Compromise rail joints;

t) Locations where rail repairs were performed during winter to replace service failed or defective rails;

u) In areas of severe corrugation in curves, attention should be paid to rail creep;

v) Areas of grade, roadbed and track instability; or

w) Any other areas having a history of lateral instability, site of derailment, washout, etc., or where Track Leads have a concern.

15.20.2 When the ambient temperature is expected to exceed or exceeds the 90 °F (32 °C) threshold level, a speed restriction of:

a) 15 mph below the zone speed/PSO speed or 60 mph, whichever is greater, for passenger trains, must be applied; and

b) 15 mph below the zone speed/PSO speed or 40 mph, whichever is greater, for freight trains must be applied.

15.20.3 When deterioration of these conditions are present as listed in this section, a Class 2 speed restriction or less must be placed or the track removed from service until repair or adjustment is made.

15.20.4 When there are indications that a track buckle is to occur (see Track Standards 4.12 for more information), immediately take the following steps to protect train traffic until the condition is corrected:

a) Place a 10 mph speed restriction; or

b) Remove track from service, if the situation warrants.

15.20.5 Track Standards Section 15.20 does not supersede timetable instruction.

16 Track Geometry

16.1 Track Geometry Maintenance Standards

16.1.1 All tracks that are in service must meet or exceed the track geometry safety standards defined in the Metrolinx Track Standards - Heavy Rail and the Transport Canada Rules Respecting Track Safety.

16.1.2 Track geometry standards are defined for seven classes of track based on maximum operating speeds for passenger and freight trains.

16.1.3 Track Geometry can be measured by a Light Geometry Inspection Vehicle (LGIV), Heavy Geometry Inspection Vehicle (HGIV), Manual Track Geometry Recording Unit or by hand measurements.

16.1.4 The Track Lead or designate is responsible for:

a) Checking the deterioration in track geometry between regulatory tests;

b) Ensuring track geometry is maintained with the track geometry standards, or providing appropriate track protection; and

c) Accompanying the Heavy Geometry Inspection Vehicle when it is testing main line track in their respective territory.

16.1.5 Deviations exceeding the minimum safety requirements for track geometry are defined as "URGENT" defects and are prescribed in Appendix D.

a) When an URGENT defect is detected, the following actions must be taken to protect the track:

i. Repair the defect to meet the minimum safety requirements;

ii. reduce the speed to the appropriate class of track based on the defect severity; or

iii. remove the defective portion of track from service.

b) Where a portion of track exceeds the URGENT limits, one of the following actions must be immediately taken before the operation of the next train over the defect(s):

i. The defect(s) must be repaired to within the allowable tolerance;

ii. Except as prescribed below for PRIORITY and NEAR URGENT defects, if the defect is a speed-related type, a speed restriction must be placed restricting trains to a maximum speed which is within the track class allowed for the severity of the defect(s), refer to Appendix D; or

iii. Track must be removed from service if defects exceed Class 1 limits.

c) URGENT defects must be corrected and signed off within 48 hours of detection:

i. Where an URGENT defect requires a three-class speed reduction or more, the defect must be corrected and signed off within 24 hours of detection.

16.1.6 Deviations exceeding 90% of the minimum safety requirements for track geometry are defined as "NEAR URGENT" defects and are prescribed in Appendix C:

a) NEAR URGENT defects must be corrected and signed off within 30 days of detection; and

b) Where a NEAR URGENT defect cannot be corrected and signed off within 30 days of detection, one subsequent light or heavy track geometry inspection must be completed within the 30-day period.

16.1.7 Deviations exceeding Metrolinx maintenance tolerances are defined as "PRIORITY" defects and are prescribed in Appendix C.

a) PRIORITY defects must be monitored for escalation, and scheduled for correction. This plan and schedule must be submitted within 30 days of detection. Priority defects should be corrected within 90 days or as directed by the Maintenance Delivery—Manager of Track.

16.1.8 PRIORITY defects must be monitored until repaired within the period specified in these standards to eliminate escalation to a NEAR URGENT or an URGENT defect.

16.1.9 Multiple "PRIORITY" surface or alignment defects must be considered "URGENT" when:

a) Three or more non-overlapping surface or alignment defects occurring within a distance equal to five times a specified cord length must be considered URGENT, and their limits are defined in Appendix D.

16.1.10 The following approach is to be used in responding to PRIORITY defects and combinations of PRIORITY defects:

a) Address combinations of PRIORITY defects (defects within 100 ft (30.5m) of each other) in the following order:

i. Combination defects on spirals;

ii. Combination defects on full body of a curve;

iii. Combination defects near changes in track modulus such as bridge approaches, crossings, turnouts, and changes in track tie type; and

iv. All other combination priority defects.

b) Address all other PRIORITY defects.

16.1.11 Any occurrence of an alignment defect and a surface defect within 11 ft (3.35 m) of one another, or an alignment defect and a warp 31 defect within 11 ft (3.35 m) of one another must be treated as an Urgent combination defect for the class of track and action must be taken to protect the track as prescribed in Track Standards

Section 16.1.5. Two combinations of track geometry defects and their limits are defined in the Combination Defects Table D-3 in Appendix D.

16.1.12 While unloaded measurements are taken to determine compliance with Metrolinx Track Standards, the estimated movement of the rail, when loaded, must be added to the unloaded measurement.

16.1.13 For speed-related track geometry defects recorded during heavy track geometry vehicle inspections, Appendix E and Appendix F maybe used to determine the speed restriction to be applied for the 72-hour period following the HGVI operation:

a) If the track defect was not repaired before the expiration of the 72-hour period, the speed restriction must be revised to comply with the class of track in Appendix D for the measured value of the defect.

16.1.14 Details of remedial action or speed restriction applied must be recorded on the exception reports, initialled and dated for all URGENT, NEAR URGENT, and PRIORITY defects.

16.1.15 Details of remedial action applied must be recorded on the exception reports, initialled and dated for all PRIORITY defects.

16.2 Track Geometry Conditions

16.2.1 Gauge

a) The maximum allowable deviations for gauge-related defects are listed in Appendix D;

b) Standard gauge is 56-1/2 in (1,435 mm) on tangents and curves up to 14 °. Refer to Table 4-7 for gauge in curves greater than 14 °;

c) Gauge must not be allowed to exceed 57-3/4 in (1,467 mm). If loaded or unloaded gauge measurement is found to exceed this limit, the track must be removed from service;

d) Where gauge is found to be less than 56-1/4 in (1,429mm), the following remedial action must be taken:

i. If the change in gauge over a distance of 31 ft (9.5 m) or less exceeds 1/2 in (12.7 mm), a Class 3 speed restriction must be placed;

ii. If the change in gauge over a distance of 20 ft (6.1 m) or less exceeds 1-1/2 in (38 mm), a Class 1 speed restriction must be placed.

e) The track must be removed from service if the gauge is found to be less than 56 in (1,422 mm) and repaired.

16.2.2 Rail Cant

a) Changes in rail cant may impact gauge measurements:

i. Inward cant may result in gauge tightening; and

ii. Outward cant may result in gauge widening.

b) Gauge side rail base-to-base distance for various rail sections are defined in Table 16-1 and shown in Figure 16-1;

Table 16-1 Gauge Side Rail Base-to-Base Distance

Rail Section	Distance	Height of Rail	Difference from Standard Gauge
136 RE	53-3/4 in (1,365 mm)	7-5/16 in (186 mm)	2-3/4 in (70 mm)
132 RE	53-7/8 in (1,368 mm)	7-1/8 in (181 mm)	2-5/8 in (67 mm)
115 RE	54 in (1,372 mm)	6-5/8 in (168 mm)	2-1/2 in (64 mm)

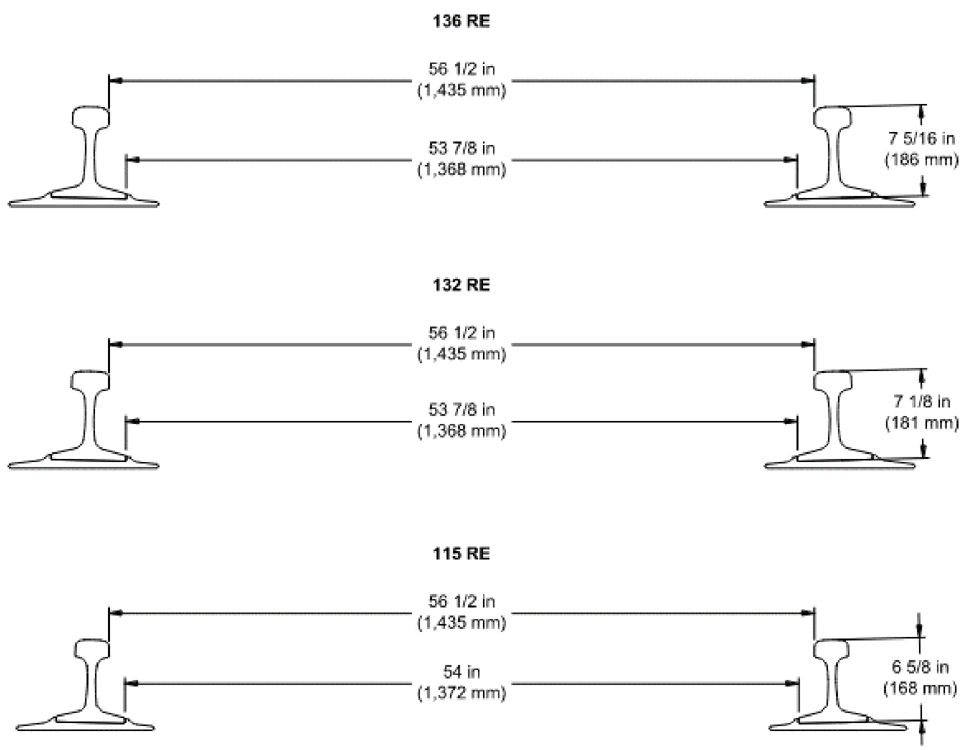


Figure 16-1 Gauge Side Rail Base-to-base Distance

c) A one (1) degree change in rail cant results in a change in gauge of approximately 1/8 in (3 mm) in all rail sections:

i. Rail cant may be determined by measuring the gauge side rail base-to-base distance, comparing measurement to the track gauge measurement, the flange wear and the height of the rail section.

$$Cant \approx \tan^{-1}\left(\frac{(Gauge_m - Base_m) - (\Delta_{Design}) - Wear_{flange}}{Height\ of\ Rail}\right)$$

$Gauge_m$: $Measured\ Gauge\ Value\ (in)$
$Base_m$: $Measured\ base\ to\ base\ distance\ (in)$
Δ_{Design}: $difference\ from\ standard\ gauge\ as\ per$ Table 16-1 (in)
$Wear_{flange}$: $Horizontal\ rail\ wear\ (in)$

16.2.3 Alignment

a) The maximum allowable deviations for alignment-related defects are listed in Appendix D;

b) The measurement for alignment must be the maximum mid-ordinate (positive or negative) in inches, of a 62 ft (18.9 m) or 31 ft (9.5 m) chord measured at the gauge point, 5/8 in (15.9 mm) below the center of top of rail head:

   i. On curved track, the high (outside) rail must be used as the line rail. On tangent track, either rail may be used as the line rail, but the same rail must be used throughout the tangent; and

   ii. The line rail for a turnout for the diverging route is the curved closure rail between the switch point and the frog. The line rail for the straight route must be the straight stock rail.

c) The maximum mid-ordinate shall be established by centering visible misalignments on the chord;

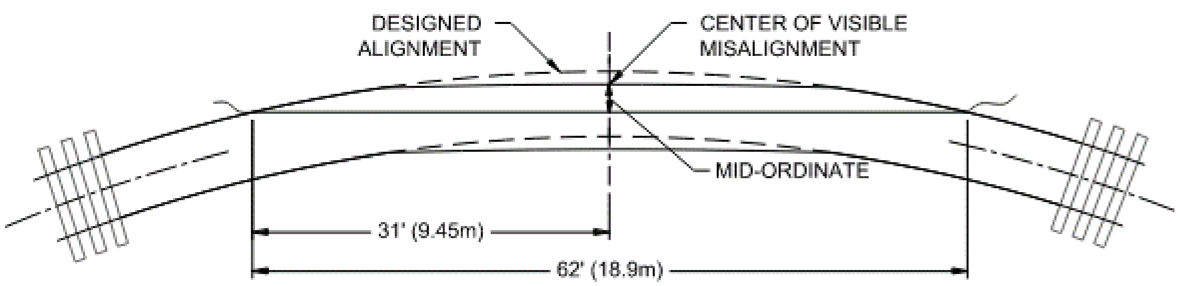


Figure 16-2 Alignment Defect Measurement

d) To determine the alignment deviation in a curve:

   i. Determine the existing degree of the curve in the field by averaging the mid-ordinate measurements at eleven (11) stations marked out in the field. The stations established at 15 ft 6 in (4,724 mm) must include the midpoint station (largest area of deflection assumed to be a defect) plus five (5) stations on either side. If the curve is less than 155 ft (47.2 m), then the average is taken throughout the full length of the body of the curve.

ii. If 62 ft (18.9 m) chords are used, the mid-ordinate (in inches) is in a 1:1 relation with the degree of curve. If 31 ft (9.5 m) chords are used, the mid-ordinate (in inches) must be multiplied by four (4) to obtain the degree of curve;

iii. If using a 62 ft (18.9 m) chord, place stations every 15 ft 6 in (4,724 mm) for five (5) stations on either side of the center of the point of misalignment for a total of eleven (11) stations;

iv. The difference between the midpoint measurement at the point of misalignment and the uniformity of the curve is the alignment deviation; and

v. If the 31 ft (9.5 m) chord is used, place eight (8) stations on either side of the center of the point of misalignment.

16.2.4 Superelevation

a) Except as provided in Appendix D, for deviation from zero cross level at any point on tangent track, the outside rail of a curve must not be lower than the inside rail;

b) Superelevation in a curve must not exceed 6 in (152 mm). Curves exceeding 6 in (152 mm) of elevation require a plan to reduce elevation;

c) Design superelevation and minimum superelevation must meet the requirements identified in Track Standards Section 19.3;

d) The superelevation on a curve is based on the degree of the curve and zone speed. If the superelevation decreases, the curve must be checked for Vmax;

e) The designated elevation at any point on a curve is determined by averaging the elevation over the same track segment as used in Track Standards Section 16.2.3d) above; and

f) Where superelevation is runout onto tangent track per the conditions in Track Standards Section 19.3, designated elevation in the spiral and tangent must be based on the maximum allowable runout permitted:

i. Where the runout requirements cannot be met, speed must be reduced accordingly as per Appendix D.

16.2.5 Surface

a) Surface is the vertical alignment or the surface uniformity in the vertical plane;

b) The maximum allowable deviations for surface-related defects are listed in Appendix D;

c) The measurement for Surface must be the maximum positive or negative mid-ordinate, in inches or millimeter, of a 62 ft (18.9 m) chord measured along the top surface of the rail;

d) The maximum mid-ordinate must be established by centering visible peaks or sags on the chord.

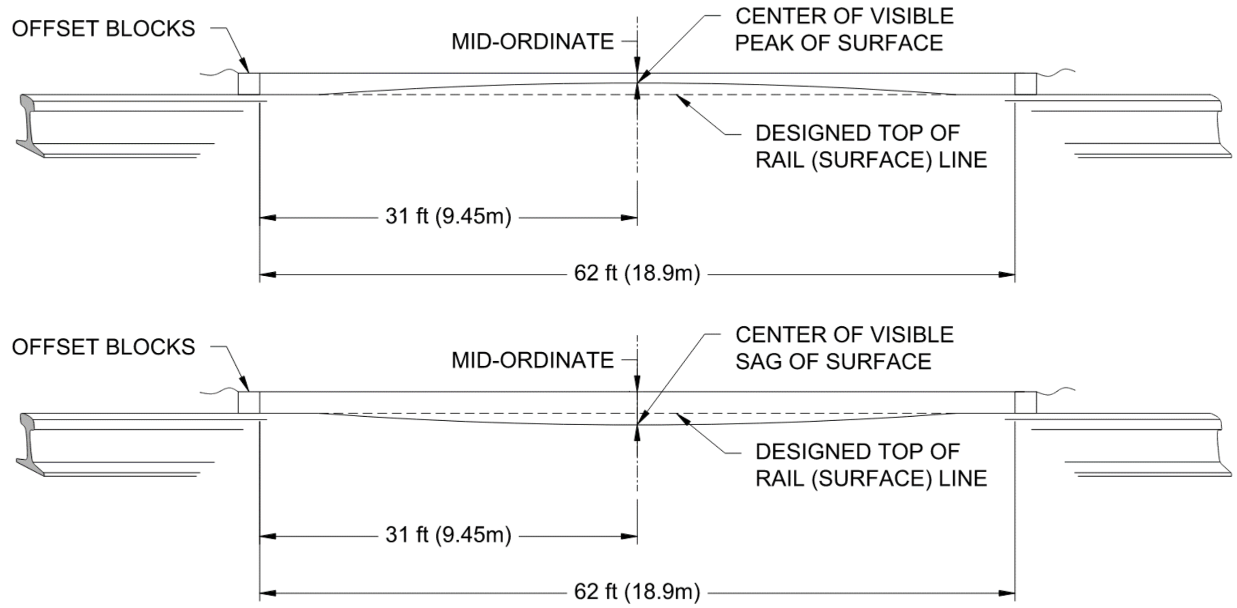


Figure 16-3 Surface Defect Measurement

16.2.6 Cross-Level

a) The maximum allowable deviations for Cross Level related defects are listed in Appendix D;

b) On curved track, the grade rail is the low (inside) rail. On tangent track, either rail may be used as the grade rail, but the same rail must be used throughout the tangent;

c) The difference in cross-level measurements must be used to calculate WARP 31 and WARP 62. Measurement for cross-level must be taken every 7 ft 9 in (2.36 m) or less to ensure the maximum cross-level measurements are recorded. The maximum allowable measurements for WARP 31 and WARP 62 related defects are listed in Appendix D:

   i. Note, it is possible to have several combinations of differences in cross level within any 31 ft (9.5 m) or 62 ft (18.9 m). It is essential that the inspector determine the maximum difference. The inspector must determine the maximum difference in measurements for each defect category;

   ii. WARP 31 is defined as the difference in cross-level between any two points less than 31 ft (9.5 m) in spirals; and

   iii. WARP 62 is defined as the difference in cross-level between any two points less than 62 ft (18.9 m) apart on tangents, spirals or curves.

16.2.7 Runoff

a) Runoff is the elevation difference in the track structure over a 31 ft (9.5 m) section; and

b) The runoff at the end of the raise, when surfacing track, or when surfacing into any fixed structure, in any 31 ft (9.5 m) of track cannot exceed the URGENT limits for the Class of track found in Appendix D.

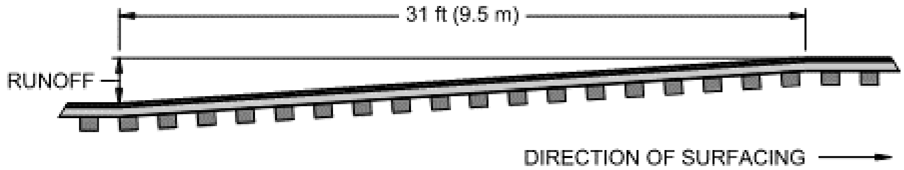


Figure 16-4 Runoff Measurement

16.2.8 Harmonics (Rock and Roll)

a) Harmonics is the motion on rolling stock created through a series of low staggered joints;

b) To control harmonics (Rock and Roll) on Class 2 through 5 jointed tracks with staggered joints, the cross-level differences must not exceed 1-1/4 in (32 mm) in all of six consecutive pairs of joints, as created by seven low joints;

c) Jointed track with joint stagger less than 10 ft (3.05 m) must not be considered as having staggered joints; and

d) Joints within the seven low joints, but outside of the regular joint spacing, must not be considered as joints with respect to harmonic.

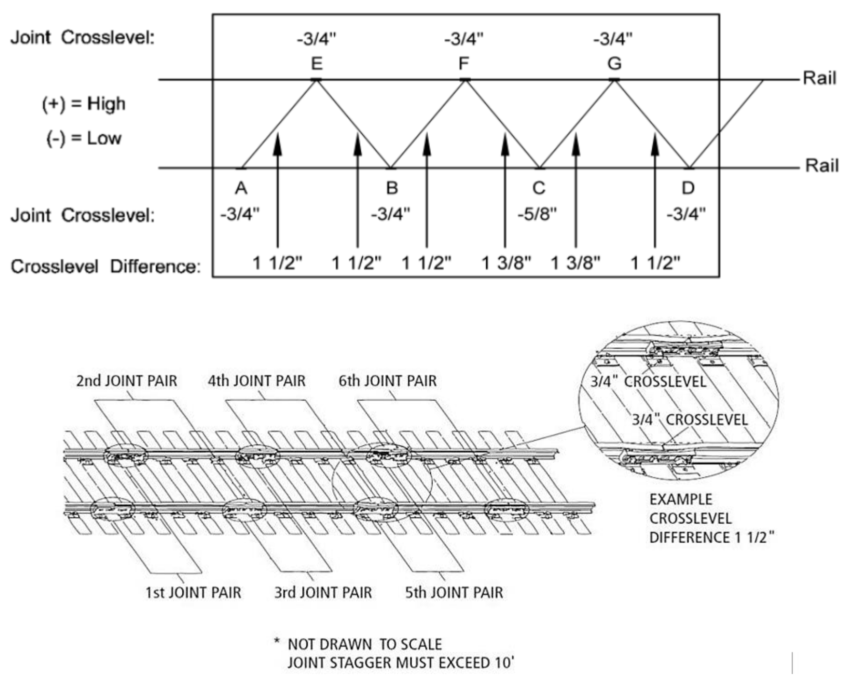


Figure 16-5 Harmonics

16.2.9 Combination Cant Defect

a) When measurements of rail cant, flange wear, and wide gauge all exceed the values in Table 16-2 or Table 16-3 below, then the appropriate remedial action as indicated in the tables must be taken, whichever is more restrictive; and

b) When repairing combination cant defects, address the cant first.

Table 16-2 Urgent Defect for Combination Cant

Combination Cant URGENT Defect				
Combination Cant Defect Threshold			Remedial Action Required	
Flange Wear	Rail Cant (toward field side)	Track Gauge	Class 1 & 2 Track	Class 3, 4, & 5 Track
13/32 in. (10.3 mm)	4°	57-1/8 in (1,451 mm)	Repair Immediately or place a 10 mph speed restriction until repaired.	Repair immediately or place a 25 mph speed restriction until repaired

Table 16-3 Near Urgent Defect for Combination Cant

Combination Cant PRIORITY Defect			
Combination Cant Defect Threshold			Remedial Action Required
Flange Wear	Rail Cant (toward field side)	Track Gauge	Class 1 to 5 Track
3/8 in (9.5 mm)	3.5°	57 in (1,448 mm)	Inspect within 72 hours and repair within 30 days. If not repaired within 30 days, apply speed restrictions per Table 16-2 until repaired.

17 At-Grade Rail-to-Rail Crossings, Special Trackwork and Turnout Inspections

17.1 Types of Inspections

17.1.1 There are three (3) types of inspections:

a) Routine Inspection;

b) Walking Inspection; and

c) Detailed Inspection.

17.2 Frequency of Inspections

17.2.1 Turnouts, At-Grade Crossings, and Special Trackwork must be inspected at the minimum frequencies specified in Table B-6 of Appendix B.

17.2.2 The Maintenance Delivery—Manager of Track and the Director, Engineering – Track have the authority to mandate additional inspections.

17.3 Record of Inspection

17.3.1 A record of each Routine, Walking and Detailed Turnout, At-Grade Crossing, and Special Trackwork Inspection must be completed in accordance to Track Standards Section 15.15.

17.4 Walking Turnout Inspection

17.4.1 Inspect and record the general condition of the following specified items:

a) The switch stand is securely fastened to the head block ties using proper head block bolts, track spikes, or lag screws;

   i. The head block ties are non-defective and perpendicular to the rail.

   ii. The switch stand, when operated in the straight and diverging position, displays no sign of evident wear and does not require added effort to operate; and

   iii. Stands equipped with an oil lubrication spigot or grease fittings must be verified to ensure appropriate lubrication has been applied.

b) Inspect if the switch points are making contact for the entire planed portion of the stock rail and switch point;

i. Turnouts on non-main track must be observed in the straight and diverging routes; and

ii. Where possible, turnouts on main track must be observed in the straight and diverging routes.

c) Inspect the switch point throw and compare to the switch stand adjustment for any lost motion. Any loss in motion must be investigated and corrected. Loss of motion may be caused by worn components that may need replacement to allow for proper switch point throw;

i. On main track turnouts (power, dual control, and hand operated), the S&C Maintainer must be present for point-throw adjustments.

d) Inspect the wear and condition of the eyebolt and its position in the switch stand spindle (where applicable), inspect the wear and condition of the connecting rod, all switch rods and fasteners, and the clearance between ties;

e) Inspect the switch points and stock rails for wear, chipping, and metal flow to ensure proper fit between the planed portions of the switch point and stock rail. The switch points must fit tightly against the stock rail when properly adjusted. No gaps are permitted when the switch points are in the closed position;

f) Where switch points are chipped, broken or gapped at the point of switch, and/or metal flow is present, repairs must be conducted as per Track Standards Section 13.4. Inspect the positioning of the switch points; switch points must remain square with no overhang on the gauge plate, and the end of the switch point must be within 1 in (25 mm) from the edge of the gauge plate as per Track Standards Plans. If skewing is found during inspection, the switch points must be squared, and adequate rail anchors must be installed to restrain rail movement;

g) Inspect the riser slide plates for excessive wear and/or abrasion between switch point base and riser slide plates. Inspect rail braces for proper adjustment, securement, and support of the stock rail to ensure rails are properly seated. If the turnout includes switch point rollers, inspect the rollers for excessive wear and ensure they are free turning;

i. Switch points in the closed position must not be resting on the switch point rollers.

ii. Riser slide plates with surfaces worn more than 1/8 in (3 mm) must be replaced.

h) Inspect all shoulder and turnout plates for proper fit and securement to the rail base and for any excessive lateral plate cutting/wear;

i) Inspect all bolt and nut assemblies to ensure they are not broken, worn, or missing. Inspect for appropriate size and length and ensure cotter pins are installed;

j) Inspect the frog for any movement by verifying the condition, wear, and correct installation of the ties, plates, and fasteners. Inspect the general condition of the frog and guard rails, including but not limited to the following:

   i. The frog point and tread portion of the frog casting for signs of wear, breaks, metal flow, or chipping. If present, remedial actions must be applied as per Track Standards Section 13.4;

   ii. Location of wheel contact through transfer areas;

   iii. Loose bolts, rivets, elastic rail clips, spikes, head and tail washers, and other fasteners;

   iv. Gaps between frog and base plates;

   v. Excessive guard rail contact and wear;

   vi. Guard rails are properly located in their longitudinal position in relation to the 1/2 in point of frog;

   vii. Frog channel and flangeway clearances;

   viii. Interface areas between the manganese inserts and rail binding components;

   ix. Riser components for proper fit and elevation of wheel flange; and

   x. Lubrication of movable points and wing rails.

k) Inspect frogs and guard rails to determine if bolts are of the correct size, length, and grade. Inspect all bolts and rail joints for proper fit and securement throughout the turnout;

l) Inspect the alignment and surface on the straight and diverging routes of the turnout;

m) Check the foot guards, where applicable;

n) Inspect the top surface of the switch points where the gauge face of the closed switch point is 4-1/2 in (114 mm) from the gauge face of the stock rail to ensure the outer edge of the wheel tread does not contact the gauge side of the stock rail;

o) Inspect the switch lock or keeper;

p) Inspect the condition of the reflectorized targets for legibility, turnout identification, and track identification;

q) Inspect the heel block assembly to ensure the spread of the block is correct in relation to its positioning between the switch point and stock rail and to ensure the appropriate joint bars are installed;

r) Inspect the general condition of the turnout ties and ensure they are square to the straight route in lateral turnouts, and square to the centerline in equilateral turnouts; and

s) Inspect the ballast section to ensure crib areas and tie shoulders are appropriately supported and are free draining. Inspect for any gaps between the rail seat and tie plates where signs of track surfacing are required.

17.4.2 Inspect all switch rods (connecting, helper, and basket) and clip assemblies for damage, bent, broken, missing components, or deteriorating insulation. Switch rods must not be bent or corroded to a depth exceeding 1/8 in (3 mm).

a) Visually deteriorated insulation in switch rods and gauge plates must be replaced.

17.4.3 Inspect the switch point stop blocks for wear and proper securement to the switch point. Ensure that the stop blocks are damage-free and fit appropriately against the stock rail.

17.4.4 Inspect the switch point rise for signs of wheel contact on the stock rail. Where wheel contact is evident, the switch point must be replaced or the stock rail ground as per Track Standards Section 13.4.

17.4.5 Inspect the frog point for flange wear, if present, verify all gauge, guard check and guard face measurements of the turnout for the Class of Track, as per Table 17-1.

17.4.6 Spring Frogs

a) Inspect the clearance between the horn and hold-down housing to ensure the horn does not bind on either side of the hold-down housing. Clearance must not exceed 1/4 in (6.3 mm);

b) Inspect the clearance between the bottom of the horn to the wear plate. Clearance must not exceed 1/8 in (3 mm);

c) Springs must have a compressive force sufficient to hold the wing rail against the point rail.

   i. The wing rail on 115 RE, 132 RE, and 136 RE spring frogs, when closed, are designed with a gap of 3/8 in (9.5 mm) at the half inch point. The gap must not exceed 3/4 in (19 mm).

17.4.7 Inspect the wing rail and base plates for proper fit and contact between each.

17.4.8 Inspect the wing rail to ensure the outer tread portion of the wheel does not contact the gauge side of the wing rail.

17.4.9 On SGM frogs, inspect the wear on the raised guard. If wear is evident, verify the measurement from the raised guard to the 5/8 in (16 mm) point on the gauge side of the frog point.

a) If the wear exceeds 4-3/8 in (111 mm), operating speed must be reduced to 10 MPH.

17.4.10 For more information on Turnout inspections, see Table 17-2.

17.5 Detailed Turnout Inspection

17.5.1 A detailed turnout inspection must be completed at least annually, as per Table B-6 of Appendix B.

17.5.2 Detailed turnout inspections must also include all walking inspection requirements in Track Standards Section 17.5.

17.5.3 During detailed turnout inspections, all switches must be operated in the straight and diverging routes.

a) All mainline turnouts will be jointly inspected annually by a Track Inspector and S&C Maintainer.

17.5.4 Inspect, measure, and record the following specified items:

a) Track gauge and cross-level every 5 - 10 ft (1.52 - 3.05 m), or approximately every four (4) ties, starting 80 ft (24m) in front of the No. 1 gauge plate to 80 ft (24m) behind the last long tie on the straight and diverging routes of the turnout;

i. Where measurements are being performed on a rail-to-rail grade crossing as per Track Standards Section 17.7, gauge and cross-level must be taken 80 ft (24m) on either side of the last long tie on each route if owned by Metrolinx.

ii. In addition to and as part of the above gauge and cross-level intervals, the following locations must be identified, measured, and recorded:

a) Point of switch;

b) First switch rod;

c) Last switch rod;

d) Each switch point stop block;

e) Switch point heel block;

f) Mid-point of curved closure rail;

g) Mid-point of straight closure rail;

h) Toe of frog;

i) 1/2 in point of frog; and

j) Heel of frog.

b) Guard rail flangeway gap. This measurement must be 1-7/8 in +/- 1/8 in (48 mm +/- 3 mm);

c) Guard Check Gauge and Guard Face Gauge. Guard check gauge is the distance from the gauge line of the frog to the guard line of the guard rail face, as measured across the track at right angles. Guard face gauge is the distance between the guard face of the guard rail and the guard face of the frog wing rail as measured across the track at right angles. These measurements must be within the limits shown below in Table 17-1;

Table 17-1 Guard Check Gauge and Guard Face Gauge

Class of Track	Minimum Guard Check Gauge	Maximum Guard Face Gauge
1	54-1/8 in (1375 mm)	53-1/4 in (1353 mm)
2	54-1/4 in (1378 mm)	53-1/8 in (1349 mm)
3,4	54-3/8 in (1381 mm)	53-1/8 in (1349 mm)
5	54-1/2 in (1384 mm) [A]	53 in (1346 mm)

[A] Measurement for heavy point frogs equipped with through gauge plates, use 54-3/8 in (1381 mm).

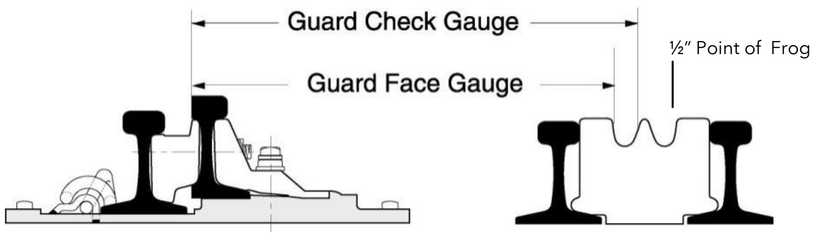


Figure 17-1 Guard Check Gauge and Guard Face Gauge

d) The thickness of the guardrail must be measured, and the face must not be worn more than 5/8 in (15.9 mm);

e) The depth of the flange-ways of a frog as measured with a tape between a straight edge positioned across the wheel bearing (tread) portion of the frog and the bottom of the flangeway:

   i. On Class 1 Track, the depth must not be less than 1-3/8 in (35 mm); or

   ii. On Class 2 through 5 Track, the depth must not be less than 1-1/2 in (38 mm).

f) Switch point rise between the running surface of the switch point and the stock rail where the gauge side between the switch point and stock rails measure 4-1/2 in (114 mm), when closed. This measurement must be between 1/4 in and 5/16 in (6.3 to 7.9mm) to ensure the outer edge of the wheel tread cannot contact the gauge side of the stock rail;

   i. Where wheel contact is evident, remedial actions must be taken as per Track Standards Section 13.4.

ii. The turnout must be thrown in each direction to effectively measure switch point rise.

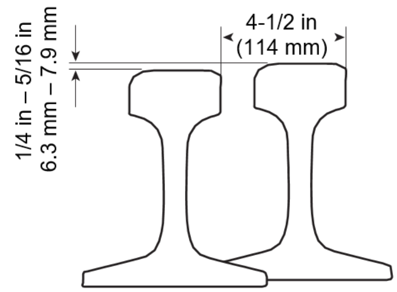


Figure 17-2 Switch Point and Stock Rail Minimum Clearance

g) If an electronic track geometry inspections is completed within a week of the inspection, it may be used to obtain gauge and cross-level measurements as defined in Track Standards Section 17.6.3. above. When electronic track geometry inspections cannot be conducted, as per Track Standards Section 18.5, these measurements must be obtained manually.

17.5.5 The crank eye bolt and switch stand spindle must be inspected and recorded for the following items, where applicable:

a) Crank eyebolt adjustment for 1-1/2 in (38 mm) diameter;

i. Eyebolt extension of 3/8 in (9.5 mm) must be showing beyond the rear of the spindle barrel.

b) Crank eyebolt adjustment for 1-3/4 in (44.5 mm) diameter.

i. Eyebolt extension of a minimum of 7/8 in (22 mm) must be showing beyond the rear of the spindle barrel.

17.5.6 Inspect the movement between the handle, top casting, and spindle mast. When movement is excessive and the crank eyebolt can no longer be adjusted, the turnout must be removed from service as per Track Standards Section 13.4.30 and the switch stand replaced.

17.5.7 Spring frogs must be inspected in detail twice annually as per Table B-6 of Appendix B. Additionally, follow the inspection procedure listed below.

a) Check for breaks or cracks in the rails or castings;

b) Inspect the pressure of the spring holding the wing rail closed by forcing the wing rail open and allowing it to close;

i. If there is insufficient pressure to close the wing rail, inspect the spring box for broken springs.

c) Check that all of the stops are in place and doing their job. If you see bent stops or mushrooming on the face of the stops, perform the following test: jack the wing open enough to place a 1-7/8 in (48 mm) block in the flange-way. If you can slide a 1/4 in (6.3 mm) taper or step gauge between the web of the rail and any of the stops, they need to be repaired. They can be repaired by cutting them off and re-welding the stop closer, or the welder can weld a repair plate to the face of the stop;

d) Our spring frogs are designed to be open 3/8 in (9.5 mm) at the 1/2 in point of frog. But the spring wing rail should fit tightly against the frog along the entire length of the straight portion of the wing rail;

e) Make sure that all bolts are in place and tight. The proper bolt torque for 1-3/8 in (35 mm) bolts is 2,500 ft.-lbs., and 840 ft.-lbs. For 1 in (25 mm) bolts. Thin head bolts are used along the spring wing on spring frogs. These bolts are not visible in the normal closed position and should be inspected by jacking open the spring wing. Replace only with thin head bolts. Remember do not put any portion of your body between the spring wing and the fixed point without adequate blocking;

f) Inspect the anchor pattern. All switch and track ties should have solid box anchors for 200 ft (60.9 m) behind the turnout, 200 ft (60.9 m) ahead of the turnout and solid anchors through the turnout;

g) Check the side clearance between the hold-down housings and the horns. If the closure rails have moved, it is possible to bind the rail open;

h) Look for signs of ballast pumping, unstable subgrade, or tie condition that may allow the wing rail to gap open;

i) If the spring frog is equipped with a wing rail retarder (shock absorber), check its function monthly. The proper closing time of the wing rail should fall between one (1) and three (3) minutes. If the area under the retarder has evidence of oil being present, the retarder may have failed; and

j) All snow and ice buildup near a spring frog should be removed. Every Employee (Track, S&C, B&S) that traverses these frogs should make a point of stopping and inspecting the frog and cleaning any ice and snow that is evident.

17.6 Failures in Spring Frogs

17.6.1 Despite their reliability, there can be failures in a spring frog. The most common failures and associated remedial actions and speed restrictions are listed below:

a) Broken springs—Even with a missing spring, the frog opening should not be much bigger than a RBM frog. However, with a broken spring that cannot be replaced before the next train, it is recommended that movement be only on the straight side. Speed should be limited to no more than 25 mph. A close inspection of the hold-down horn clearance, the stops, and the guard check gauge should be made. When replacing broken springs on a frog with double springs, replace both springs at the same time. When tightening a new spring, the bolts should be tightened until the spring is depressed 1 in (25 mm).

b) Broken fixed point—This condition is more dangerous than a broken point on a RBM frog. The wheel dropping down in the broken area may get low enough to catch the wing rail. The fixed point can be welded, but it is recommended that speed be no greater than 10 mph and each train watched over the frog until repaired.

c) Excessive wear on the wing rail - It is somewhat unusual to see much flange wear on the wing rail, but still is a possibility. If there is flange wear in excess of 3/8 in (9.5 mm), the frog should be considered for replacement. No speed restriction is necessary but a detailed inspection should be made to determine a possible cause of the wear.

d) Pumping in the heel and/or broken toe pan - Pumping in the heel is usually caused by bad surface conditions. If allowed to exist, these conditions can cause failure in the hold-down housing. A broken toe pan is a warning sign that something has gone wrong. There should very rarely be enough pressure to crack the toe pan. If a track inspector encounters this condition, they must look for other problems like running rail or inadequate anchors, possibly even a car has been off in the frog.

17.7 At-Grade Rail-to-Rail Crossing Inspection

17.7.1 Inspections of all railway crossings at grade (diamonds) must be conducted as follows:

a) Each time the crossing is travelled over by hi-rail or on foot, it must be visually inspected for defects;

b) Annually on foot measuring and recording track gauge, cross-level, guard check gauge, guard face gauge, and flangeway dimensions;

c) Monthly on foot inspecting and recording the general condition of the following but not limited to, fasteners, castings, rails, frogs, ties, surface, and alignment, reference Table 17-2; and

d) Applying the same procedures found in Track Standards Section 17.3, 17.4, 17.5, and 17.6 where applicable.

Table 17-2 List of Inspection Areas

Checklist Item	Requirements
Ballast and Drainage	• Cribs must be full to within 1 in (25 mm) top of tie. • Ballast shoulder not less than 12 in (305 mm) at end of tie. • Ballast must be free draining with no indications of standing water.
Line, gauge, surface, and cross-level	• Per Track Standard 16, Appendix C, and Appendix D.
Ties	• Non-defective and load-bearing as per Track Standards Section 9. • Proper length and spacing.
Plates	• No broken, cracked or missing. • Stops and shoulders welded to baseplate. • Shoulder and rail seat wear must not exceed 1/8 in (3 mm) horizontally or vertically. • Enlarged and/or elongated fastening holes must not exceed 1/8 in (3mm).
Rails	• Defect-free, including RCF (spalling, shelly, corrugation), and excessive rail wear as per Appendix G. • End batter or mismatch not exceeding 0.040 in (1 mm).
Fasteners	• Fully spiked or fastened with lag screws and rail clips. • Spikes driven to within 3/16 in (5 mm) or lag screws drawn down. • Rail clips installed properly, and shoulders not broken, cracked, or weld missing. • Anchor pattern complete with no missing, sprung, or anchors away from tie.
Castings	• No breaks, cracks or chipping in manganese inserts. • No breaks in spacer blocks or rail braces. • The tread portion of a frog casting must be in compliance with Track Standard Section 13.4. • Metal flow must be ground.
Bolts	• No loose, bent, broken or missing. • All torqued as per Track Standard Section 13.4. • Spring washers, flat washers or cotter pins present as required. • Bolts are of correct strength, length, and diameter.
Rail Anchors	• On main track or in CWR territory: o 200 ft (61 m) of box anchoring on every tie must be applied on all tracks at the railway crossing; o 200 ft (61 m) of box anchoring on every tie must be applied in all directions immediately beyond the railway crossing. • In jointed track, rail anchors must be installed in a box pattern on every other tie, as per Track Standard Section 10.2.
Insulation	• In place and functional, including end post. • Not visibly damaged; hardware in place and secure.
Flange-ways	• Clear of obstruction and foreign objects. • Not less than 1-1/2 in (38 mm) deep for Class 2 through 5. Not less than 1-3/8 in (35 mm) deep for Class 1. • Not less than 1-3/4 in (44 mm) wide.
Guard Check Gauge / Guard Face Gauge	• Guard check gauge – not less than that dimension in Track Standard Section 17.5. • Guard face gauge - not less than that dimension in Track Standard Section 17.5.
Joints	• Insulated and standard joints are secured and supported throughout limits of ownership for railway crossing maintenance.

18 Electronic Track Inspection

18.1 General Information

18.1.1 An Electronic Track Geometry Inspection vehicle is an automated track inspection vehicle used to measure, calculate and record geometric parameters of the track.

18.1.2 Two types of track geometry inspection vehicles, defined below, can be used to measure and evaluate track geometry.

a) Light Geometry Inspection Vehicle (LGIV) must be capable of measuring at least:

   i. Alignment/Curvature;

   ii. Superelevation/Cross Level;

   iii. Unloaded Gauge; and

   iv. Track geometry parameters calculated from these recorded measurements as indicated in Appendix C and Appendix D, and from Transport Canada Rules Respecting Track Safety, whichever is more restrictive.

b) Heavy Geometry Inspection Vehicle (HGIV) must have a minimum vertical wheel load of 10,000 lbs (4,545 kg) and be capable of measuring at least:

   i. Surface/Longitudinal Profile;

   ii. Alignment/Curvature;

   iii. Superelevation/Cross Level;

   iv. Loaded and Unloaded Gauge*; and

   v. Track geometry parameters calculated from these recorded measurements as indicated in Appendix C and Appendix D, and from Transport Canada Rules Respecting Track Safety, whichever is more restrictive.

   vi. L/V ratio used for testing must be calculated based on the formula below

$$L/V = \frac{(\mu * F_N) + 3000\ lbs}{F_N}$$

$$F_N: The\ vertical\ load\ in\ lbs$$

$$\mu: Constant\ (0.4)$$

   For safety reasons, test loads must be turned off when actual loaded gauge readings reach 57-3/4 in (1,466 mm), which is equivalent to 1-1/4 in (32 mm) wide gauge.

18.2 Types of Testing Requirements

18.2.1 There are three types of testing requirements:

a) Track Geometry Measurement;

b) Rail Flaw Detection and Rail Surface Measurement; and

c) Rail Wear Measurement.

18.3 Frequency of Inspections and Testing

18.3.1 Minimum track inspection frequencies must be as outlined in Appendix B Table B-7 and Table B-8.

18.3.2 An electronic track geometry testing/inspection must be completed for all tracks.

18.3.3 If a portion of track cannot be tested and or inspected at the required frequency, the Director, Engineering–Track may permit, in writing, a reduced frequency in compliance with minimum Transport Canada Rules Respecting Track Safety frequency.

18.3.4 If the Transport Canada Rules Respecting Track Safety required testing/inspection frequency is not met, Metrolinx must, before the expiration of the time or tonnage limits:

a) Inspect the portion of track with an LGIV and be governed by the results of that inspection or perform one additional routine track inspection per week until the required electronic track geometry inspection can be completed;

b) In the case of Class 2 to Class 5 track, the next required electronic track geometry testing/inspection must be completed with a heavy geometry inspection vehicle;

c) Reduce class of track to bring the track into compliance with electronic track geometry testing frequency until an electronic track geometry test can be made; or

d) If a portion of a crossover cannot be inspected at the required frequency Metrolinx must, before the expiration of time and/or tonnage limits, perform a detailed inspection of the crossover.

18.3.5 Rail flaw detection testing must be completed for all tracks.

a) Where rail flaw detection testing cannot be completed on yard tracks and layover facilities, the untested track speed must not exceed 10 mph and removed from service if the track is not tested within 400 days of the last known test.

b) If the Transport Canada Rules Respecting Track Safety required testing/inspection frequency is not met, Metrolinx must, before the expiration of the time or tonnage limits:

i. Conduct a valid search for internal defects using hand testing; or

ii. Reduce class of track per Appendix B.

18.4 Rail Flaw Detection (Ultrasonic)

18.4.1 Rail on main tracks, including crossovers and sidings contained on such lines, will be ultrasonically tested (UTT) at the frequencies prescribed in Appendix B. The Director, Engineering-Track may increase the testing frequency or request additional rail flaw testing at critical locations or on non-main track as required. This section also covers the following two areas:

a) Partially worn rail purchased from 3rd parties;

b) Rail removed from track if it is to be reused.

18.4.2 A qualified person must conduct the ultrasonic inspection of rail. Rails that have been ultrasonically tested must be kept segregated from those that have not been tested and will display the markings as detailed below.

18.4.3 Rails to be tested out of track must be wire brushed to remove rust and scale. Rails must have a complete ultrasonic test for the full length of the rail using equipment capable of traversing single rails. Such equipment is not capable of testing the ends of the rail. Therefore, both rail ends must be tested using portable hand test units. Rail head surface defects that prevent the ultrasonic inspection of the rail cut out or the rail scrapped.

18.4.4 Rails tested under this standard and found to be free of external and internal defects will be either identified by the letters “UTT” (for Ultrasonically Tested) or “UTC” (for Ultrasonically Certified), depending on the rails origin. These rails must be marked by a minimum of 2 in (51 mm) high characters on the web of the rail with a white paint stick, along with the date tested. Rails tested must be marked in the web starting 3 ft (914 mm) from the end of the rail.

a) “UTT” must be used to identify the rail was generated internally by Metrolinx;

b) “UTC” must be used to identify whether the rail was obtained from an external source.

18.4.5 Rail tested under this standard and found to contain a defect must be marked:

a) With permanent yellow paint on the web of the field and gauge side of the rail

b) With white paint stick, 2 in (51 mm) high, right side up characters on the web of the field and gauge side of the rail indicating:

i. Defect number, type, size; and

ii. Milepost / Date of Test / Company and Unit Number.

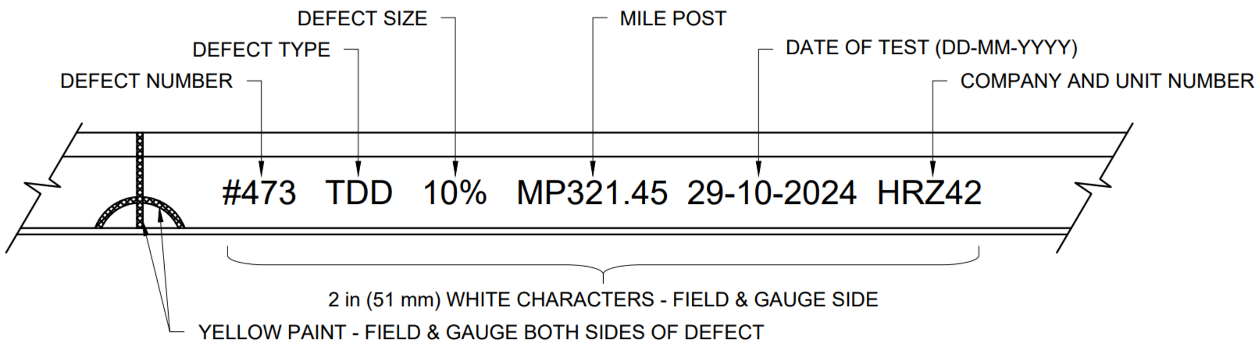


Figure 18-1 Markings for Rail Defects

18.4.6 Partially worn rail purchased from third parties must have an accompanying written certification that the rail has been ultrasonically tested after being removed from track and has been found to be free of internal defects. Rail must be marked with the letters "UTC", along with the date of the test and supplier initials. Company-owned rail sent to 3rd parties for welding must be tested, certified, and marked in the same manner.

18.4.7 Rail which contains a defect and has been removed following a rail flaw detection run may be reinstalled or stockpiled for later use, providing that all of the following is adhered to:

a) The defect has been removed from the rail;

b) Rail ends are Dye Penetrant Tested (See Track Standards Section 4.14); and

c) The rail is marked on the web with the letters "UTT" and the date it was ultrasonically inspected by the Rail Flaw Detection car.

18.4.8 For new construction, ultrasonic testing of rail is not required if it is new rail with an accompanying mill certificate indicating it passed the ultrasonic test.

18.4.9 For new construction, all partially worn rail must be ultrasonically tested prior to placing the new tracks in service. Rail removed from track with:

a) Less than 175 days since the last ultrasonic rail flaw detection run can be reinstalled in track without speed restriction. However, the rail must be marked as per Track Standard 18.4.5 immediately after being removed from track and then must be placed on the racks for storage.

b) Greater than 175 days since the last ultrasonic rail flaw detection run must be considered as not having been ultrasonically tested and must be ultrasonically tested as soon as possible. Upon completion of the ultrasonic test, the rail must be marked as per Track Standard 18.4.5 and placed on the racks for storage;

   i. If absolutely necessary to reinstall the rail without ultrasonically testing the rail after its removal from track, that portion of track must be speed restricted to maximum Class 2 track until such time as the rail has been ultrasonically tested.

18.4.10 If a piece of rail is cut from a length of rail previously tested and marked UTT or UTC, the markings UTT or UTC and the date of test must be transferred to the piece of rail cut off, so that both pieces are correctly marked.

18.4.11 No Test Rail (NTR) is rail that the rail flaw detector car is unable to test for whatever reason. Defect code NTR will appear on the list of defects.

18.4.12 If an NTR is detected in Class 3 to Class 5 track, one of the following actions must be implemented:

a) Mark the defective rail as per Track Standard Section 18.4.6 using the following coding:

i. NT1 – Rail found to be an NTR for the first time; or

ii. NT2 – Rail found to be an NTR for a second consecutive UTT inspection.

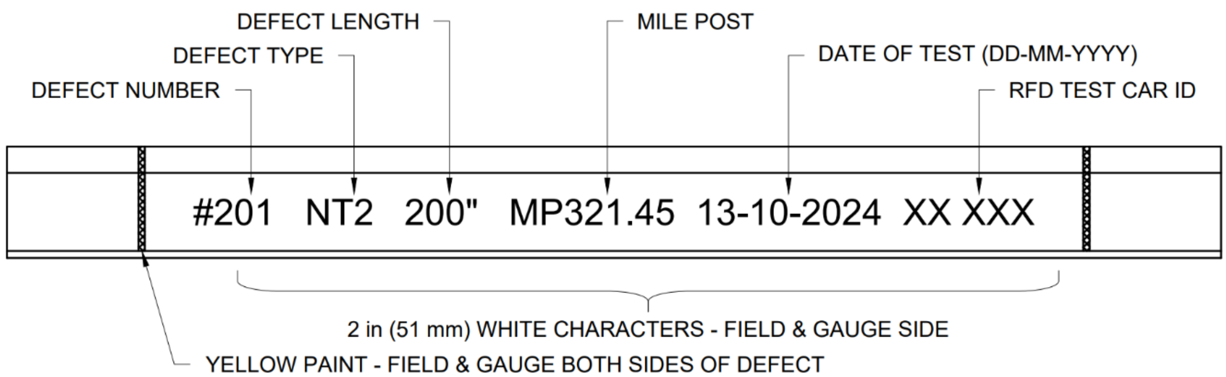


Figure 18-2 No Test Rail Markings

b) After an NTR is detected for the first time, the rail must be re-inspected ultrasonically within 30 days.

i. If the NTR is on a major structure (bridge, overpass, or tunnel), there must be an immediate one (1) class reduction in speed. A second consecutive NTR in the same location will require a Class 2 speed restriction and the rail must replaced within seven (7) days.

c) After a second consecutive NTR in the same location for Class 3 to Class 5 track, a Class 2 speed restriction must be placed and the rail replaced within seven (7) days.

18.4.13 To correct a NTR, any of the following remedial actions must be taken:

a) Perform ultrasonic test with handheld equipment and ensure proper test performed;

b) Determine the cause of the NTR and take corrective action on the rail to remove the reason for the NTR;

c) Replace the rail; or

d) Reduce speed to Class 2 and change the rail within seven (7) days unless otherwise directed by the Director, Engineering–Track.

18.4.14 No Test Rail after remedial actions are taken which allow for a successful UTT inspection, must be marked as per Track Standard Section 18.4.5 by the RFD operator with the following:

a) "UTT," company name and unit number, date of successful UTT inspection and operator's initials.

b) Black paint must cover over previous yellow paint and white characters.

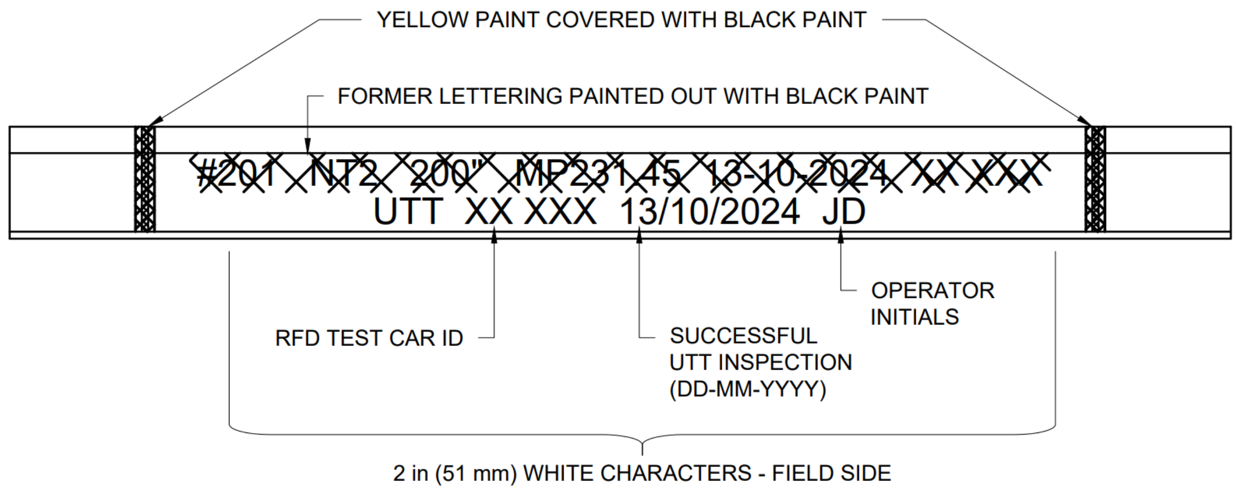


Figure 18-3 Removal of NTR Markings

18.4.15 Refer to Track Standard Sections 4.15 and 4.16 for details on handling rail failures and defects.

18.5 Track Geometry Testing

18.5.1 All Urgent defects must be corrected as soon as possible, and in no case speed restrictions must be removed until the Urgent defect remedial actions are completed and verified in the field.

18.5.2 All Priority and Near Urgent defects must be monitored and corrected as per the requirements of Track Standards Section 16.1.

18.5.3 Details of remedial action or speed restriction applied must be recorded on the exception reports, initiated and dated for all defect types.

18.5.4 All gauge defects determined by the loaded gauge method must be field verified.

a) Field validation of all loaded gauge values identified must be done using an approved hydraulic pressure tester capable of applying at least 4000 psi of horizontal pressure between each rail, and in no case greater than 5000 psi. Only ENSCO and Geismar are approved manufacturers for hydraulic Manual Gauge Pressure Testers (MGPT).

b) Maintenance, storage, operation, and calibration of the MGPT must be performed as per manufacturers recommendation.

c) A MGPT cannot be used through at-grade road crossings. The loaded gauge measurement provided by the HGIV must be treated as accurate and immediately repaired or protected.

d) If the MGPT confirms that a defect exceeds the limits prescribed in Appendix D for the class of track, immediately apply the appropriate speed restriction if not already in place and repair the defect.

   i. If the defect is within the acceptable limits for the class of track, track protection can be released contingent on a repair plan submitted to Metrolinx.

e) When performing a test with an MGPT, the following, but not limited to, must considered to assess the integrity of the track. When these conditions are present, the results may produce a greater number of exceptions than with the HGIV. The Metrolinx Track Standards must be utilized to assess additional conditions besides just the loaded gauge measurement.

   i. Conditions of rail fasteners;

   ii. Conditions of rail profile, including bases of rail;

   iii. Tie condition, including rail seat abrasion; and

   iv. Rail cant.

Figure 18-4 MGPT Adjacent to Track Level

18.6 Rail Wear Testing

18.6.1 Rail wear testing must be done simultaneously with track geometry testing when using the HGIV technology or any other inspection vehicle capable of simultaneously measuring rail wear.

18.6.2 The Track Lead is responsible for reviewing the rail wear report and comparing it to previous reports. This will aid the Track Lead in determining areas for planned rail replacement programs.

18.6.3 If automated rail wear testing is not available, the Track Lead must manually measure and record the rail wear at least annually.

18.6.4 Rail wear must be in conformance to Track Standards Section 4.6, and not exceed the limits in the applicable table in Appendix G.

18.6.5 If rail wear meets or exceeds increased monitoring limits, the underside of the head must be physically inspected.

a) See Track Standards Section 15.5 for details on under rail head inspection.

19 Track Design, Rehabilitation and Construction

19.1 Standards for Construction and Rehabilitation of Tracks

19.1.1 Appendix O indicates the standards and tolerances for the construction and rehabilitation of Metrolinx track and Special Trackwork.

19.1.2 Only Metrolinx-approved track materials must be used for track work on Metrolinx ROW.

19.1.3 All new main track construction must use concrete ties, except in at-grade road crossings, or as directed by the Director, Engineering–Track.

a) All new tracks within rail platform limits must be constructed with concrete ties and galvanized elastic fasteners.

19.1.4 All new track construction and rehabilitation must include installation of track geometry tags for various curve geometry points as per Standard Plan GTS-0726.

19.1.5 Direct fixation track must be designed to support Cooper E-80 train loading with diesel impact. The design and components must be approved in writing by Metrolinx E&AM-Track.

19.1.6 All new track construction and rehabilitation must adhere to track bed / subballast requirements in Standard Plan GTS-2204.

19.1.7 Access road and adjacent roadways are to be designed and built as per requirements in Standard Plan GTS-2204, Sheet 2 of 3.

19.1.8 All track designs must be reviewed and approved in writing by Metrolinx E&AM–Track.

19.1.9 A detailed in-service inspection must be completed by a Track Inspector for all newly constructed or rehabilitated track work and Special Trackwork. An In-service certificate must be signed upon completion of the in-service inspection as per the Metrolinx Rail Corridor Asset Handover Protocol when any portion of track or Special Trackwork are placed in service on main and non-main tracks.

19.1.10 Track and signals maintenance personnel require access to the track, signals, and wayside infrastructure with road vehicles. Emergency vehicles also require access to the rail corridors at times. Provisions for maintenance road access to critical railway infrastructure (e.g. special trackwork, signal bungalows, controlled locations, etc.) must be considered and included in all new corridor expansion design projects. Road access within the rail corridor must be designed and constructed to complement future asset maintenance, inspection, and emergency requirements.

19.1.11 Tracks designated for Maintenance of Way (MOW), with a minimum length of 1,200 ft (365.8 m), must be considered within corridor expansion projects.

a) These MOW tracks and locations must have adequate access by vehicles; and

b) Locations must be reviewed by the Maintenance Delivery—Manager of Track.

19.1.12 For new track construction or after the track has been undercut, prior to unloading ballast, the track must be inspected by a Track Inspector with the appropriate tools and equipment to validate that the Unballasted Track meets all other Class 1 requirements.

a) If Class 1 urgent thresholds are exceeded, the track must be corrected to a minimum of Class 1 tolerances using power jacks, ballast bags or other means to stabilize the track structure.

i. Equipment, and track unit operation must comply with Metrolinx General Engineering Instructions.

b) A record of the inspection must be recorded and signed by the Track Inspector the same day the inspection was completed, and submitted to E&AM—Track within seven (7) days.

19.1.13 Temporary access and/or construction staging tracks used for movement and/or staging of track construction machinery and/or equipment must meet the minimum track standards for Class 1 track, including but not limited to requirements for track geometry, tie spacing, and ballast section.

19.1.14 Temporary Concrete Barriers (TCB) installed adjacent to tracks to form Continuous Work Zones (CWZ) must adhere to requirements of Standard Plan GTS-3006 and the Metrolinx General Engineering Instructions (GEI).

19.1.15 Any signage within the ROW required as part of the project work must be installed prior to the track being placed in-service by the Contractor and in accordance with the relevant GO Transit Track Standard Plans and the Metrolinx General Operating Instructions (GOI).

19.1.16 Machinery and equipment to support Metrolinx construction, rehabilitation and maintenance activities not easily removed from Metrolinx ROW, may be left on Metrolinx ROW while not in use, and must comply with the following requirements:

a) The equipment is parked at a minimum of 25 ft (7.6 m) from the nearest rail of any in-service track;

b) The equipment must not be left within 500 ft (152.4 m) of an at-grade road crossing;

c) The equipment must not be parked in a location impeding sightlines;

d) The equipment operation is disabled, and access to the equipment is locked;

e) All booms, tools or extendable attachments must be retracted, set in the lowest position and locked out;

f) The parking and securement of equipment must be protected against vandalism and unwanted movement;

g) The equipment owner and responsible contractor's contact information must be communicated to the Maintenance Delivery–Manager of Track.

   i. A tag must be applied to the equipment indicating the name and contact information of the owner and responsible contractor securing the equipment.

h) Equipment may be parked within 25 ft (7.62 m) of the nearest rail if approved in writing by Metrolinx E&AM–Track. The following information must be provided:

   i. Start and end date;

   ii. Type of Equipment;

   iii. Exact location including mileage, and side of corridor;

   iv. Distance from the nearest rail of any in-service track;

   v. Confirmation that the equipment will be stored in a location where all portions of the machinery are outside of the standard clearance envelope;

   vi. Details of how the distance will be marked in the field and validated at the end of each shift;

   vii. Confirmation that daily photos will be submitted to Metrolinx E&AM-Track at the end of each shift; and

   viii. A GBO will be required if the equipment is parked within 15 ft (4.57 m) of the nearest rail.

19.2 Track Clearances and Centers

19.2.1 The requirements for track clearances and track centers apply to all Metrolinx tracks, regardless of location, and/or if the condition is temporary or permanent.

19.2.2 The clearances between the track structure and adjacent railway structures must meet or exceed dimensions shown in Standard Plan GTS-3003.

a) In horizontal curves, a lateral allowance for track curvature of 1 in (25 mm) per degree of curvature must be provided by widening the clearance envelope on both sides.

   i. On bridges, a lateral allowance for track curvature must be added as per the Metrolinx General Guidelines for Design of Railway Bridges and Structures.

b) In horizontal curves with superelevation, additional clearance must be provided by rotating the clearance envelope to account for the track superelevation as per Standard Plan GTS-3004.

19.2.3 All clearance envelopes must be perpendicular to the plane of the top of rails.

19.2.4 For new construction, rehabilitation and maintenance activities, track centers must comply with the minimum distances between track centerlines prescribed by Table 19-1.

Table 19-1 Minimum Track Center-to-Center Spacing

Track Type	Minimum Track Centers
Main Tracks	13 ft (3,970 mm)*
Passenger Station tracks without an island platform	13 ft (3,970 mm)*
Main and Siding Track	14 ft (4,270 mm)
Main tracks and parallel yard tracks	14 ft (4,270 mm)
Yard Tracks	14 ft (4,270 mm)
Yard Tracks with pedestrian walkways	16 ft (4,880 mm)
Yard Tracks with a service road between tracks (road at top of tie elevation)	24 ft (7,320 mm)
Yard Track with a service road and lighting poles	28 ft (8,540 mm)
Yard track with 2-way road between tracks	32 ft (9,760 mm)
Yard Track with 2-way road and lighting poles	33 ft (10,060 mm)
Ladder and other tracks	15 ft (4,580 mm)
Parallel Ladder tracks	18 ft (5,490 mm)

* 3,970 mm includes an 8 mm buffer for construction tolerances as per Appendix O Table O-2

19.2.5 The minimum track centers prescribed by Table 19-1, must be increased to account for curvature and superelevation as follows:

a) By adding 2 in (51 mm) per degree of curvature for the higher degree of curvature up to a maximum of 12 in (305 mm).

b) By adding 2-1/2 in (63 mm) per 1 in (25 mm) of difference in curve superelevation between the adjacent tracks, only where the superelevation of the outer track exceeds the superelevation of the inner track.

Table 19-2 Example of Track Spacing Widening for Curvature and Superelevation

Track No.	Track Type	Minimum Track Spacing	Degree of Curvature	Actual Superelevation	Track Position
Track 1	Main	14 ft	1.1	2.5 in	Outside
Track 2	Siding		1	1 in	Inside

Minimum Track Spacing (A)	Widening for Horizontal Curvature (B)	Widening for Superelevation (C)	Minimum Required Track Spacing (A) + (B) + (C)
14 ft	2 in x 1.1 degree = 2.2 in	2.5 x (2.5 - 1) in = 3.75 in	14 ft + 2.2 in + 3.75 in = 14 ft 6 in (4,420 mm)

19.2.6 All existing structures, bridges, snowsheds, overhead timber bridges and tunnels which met previous clearance requirements but encroach within the clearance limits prescribed herein must not be considered as having less than standard clearances and must be permitted to remain until the restrictive feature is modified or replaced.

19.2.7 Clearances not meeting the requirements of this section, are permitted in the following circumstances:

a) Within main shop, diesel or car shop facilities;

b) Doorways to access buildings;

c) Ramps, platforms and elevated structures to facilitate loading, unloading, servicing and maintenance of locomotives, cab cars and passenger equipment;

d) Locomotive and car wash facilities; and

e) Temporary restrictions necessary to facilitate construction or repair of overhead structures, in which case the train crews are to be notified through an appropriate GBO or foreman’s instructions.

19.2.8 Should it not be possible to construct to the above clearance measurements, the Director, Engineering—Track must be advised. The proposed encroachment must not impact railway safety and, the appropriate Metrolinx departments and Transport Canada, where required, must be advised of the less than standard clearance.

19.2.9 Track centers between the existing main and adjacent tracks must be maintained as per Track Standards Section 19.2 and Table 19-1. The distance between track centers that are non-compliant must be reported to the Director, Engineering—Track and Maintenance Delivery-Manager of Track.

19.2.10 Requests for approval of less than standard clearances must be submitted to the Director, Engineering-Track and must include the following information:

a) Reasons for less than standard clearance;

b) Confirmation and reasoning that track cannot be realigned to avoid the less-than-standard clearance or that the restricting object cannot be placed where it would no longer represent a restriction;

c) If the less than standard clearance will be permanent or temporary; and

d) A drawing showing the relative position of the track and the obstruction, with cross sections at each point of less than standard clearance indicating the vertical clearance from the top of rail and the horizontal clearance from the centerline of the track, together with the location of the restricted clearance sign.

19.2.11 At locations where the Director, Engineering—Track has approved a less than standard clearance, a restricted clearance sign must be erected and maintained adjacent to the track on which the restriction is located and at an adequate distance from the restriction. Where physical impediments preclude the erection of such a sign, the less-than-standard clearance will be identified in special instructions. See Standard Plan GTS-720 for additional detail.

19.2.12 Any track lifts or realignments that may affect clearances to adjacent or overhead structures must receive prior approval in writing by the Director, Engineering–Track, and when warranted, operational bulletins issued restricting train movements.

19.3 Horizontal Track Geometry Design (Alignment)

19.3.1 Horizontal track geometry design must meet the requirements of AREMA and the Metrolinx Track Standards. Where these standards differ, the more restrictive must apply.

19.3.2 Horizontal track geometry refers to the layout of a railway track in the horizontal plane, including tangents, curves, and spirals, which ensures smooth and safe train movement. Various types of curves and associated geometry point descriptions are indicated in Standard Plan GTS-0726.

19.3.3 Horizontal Points of Intersections (PIs) must not be used in design in lieu of a horizontal curve, unless approved in writing by Metrolinx E&AM–Track.

19.3.4 Turnout return curves must be designed as per Standard Plan GTS–0007. In all other arrangements, the minimum radius for a return curve must match the radius on centerline of turnout provided in the applicable GTS plan.

19.3.5 Superelevation refers to the vertical distance by which the outside rail (high rail) of a curve is elevated above the inside rail (low rail). This measurement is taken from the center of one rail to the center of the other rail.

19.3.6 Equilibrium superelevation (Eq) (also known as balanced superelevation) is the elevation that exactly overcomes the effect of negotiating a curve at a given speed and degree of curvature. The Equilibrium superelevation can be calculated using equation (1).

$$E_q = 0.0007\, D_C\, V^2 \qquad (1)$$

E_q: $Equilibrium\ Superelevation\ (in)$
D_C: $Degree\ of\ Curvature\ (decimal\ degrees)$
V: $Speed\ (mph)$

19.3.7 Actual superelevation (Ea) refers to the actual amount of elevation constructed in the curved segment of track.

19.3.8 Unbalanced superelevation (Eu) is the difference between equilibrium superelevation (Eq) and the actual superelevation (Ea) for any given combination of speed and curvature. Where the unbalanced superelevation is zero (Eu = 0), the curve is balanced or at equilibrium (Eq = Ea). Unbalanced superelevation can be calculated using equation (2):

$$E_u = E_q - E_a \qquad (2)$$

E_u: *Unbalanced Superelevation* (in)
E_q: *Equilibrium Superelevation* (in)
E_a: *Actual Superelevation* (in)

19.3.9 Overbalance is the amount of elevation that exceeds equilibrium elevation and is produced by the operation of a train around a curve at less than equilibrium speed.

19.3.10 The maximum allowable operating speed (Vmax) for each curve is determined by equation (3):

$$V_{max} = \sqrt{\frac{(E_a + E_u)}{0.0007\ D_C}} \qquad (3)$$

V_{max}: *Maximum Operating Speed* (MPH)
E_a : *Actual Superelevation* (in)
E_u: *Maximum Unbalanced Superelevation* (in)
D_C : *Degree of Curvature* $(decimal\ degrees)$

For the purposes of calculating V_{max} only, the actual superelevation for each 155 ft track segment in the body of the curve is determined by averaging the elevation for 11 points through the segment at 15 ft 6 in (4.72 m) spacing. If the curve length is less than 155 ft (47 m), average the points through the full length of the body.

The degree of curvature is determined by averaging the mid-ordinate of a 62-ft chord for 11 points through the 155 ft (47 m) segment at 15 ft 6 in (4.72 m) spacing. The degree of curvature will be measured and recorded at all 11 points, or if the curve length is less than 155 ft (47 m), average the points through the full length of the body.

a) Equilibrium speed is the maximum speed at which a train can operate when the track is superelevated to the equilibrium superelevation. Equilibrium speed can be calculated using the Vmax formula with an Eu set to 0.

19.3.11 The unbalanced superelevation (Eu) must meet the following criteria:

a) The maximum unbalanced superelevation must be limited to the following values:

Table 19-3 Maximum Unbalanced Superelevation

Unbalanced Superelevation	Maximum limits
Canadian Pacific Kansas City Freight trains	Eu (f) = 1 in (25.4 mm) – design purposes Eu (f) = 2 in (51 mm) – for maintenance purposes only
Canadian National Freight trains	Eu (f) = 2 in (51 mm) – design purposes Eu (f) = 3 in (76 mm) – for maintenance purposes only
All Passenger trains (Amtrak, etc.)	Eu (p) = 3 in (76 mm)
GO, VIA, and UP Express trains*	Eu (p) = 4 in (102 mm)
VIA LRC*	Eu= 6 in (152 mm)

* Metrolinx and VIA are exempt from Transport Canada rule limiting maximum cant deficiency to 3 in (76 mm).

b) Overbalance (negative unbalance) must be avoided for both passenger and freight trains during design.

i. Where negative freight unbalances are unavoidable, a value up to –1 in (-25.4 mm) is acceptable. Any values lower than –1 in (-25.4 mm) must be reviewed and approved in writing by the Director, Engineering-Track.

c) On main track curves, the actual superelevation must be designed to ensure the curve Vmax4 value (E_u = 4 in) is higher than the design speed and/or timetable speed by a minimum of 5 mph, unless approved in writing by Metrolinx E&AM–Track.

19.3.12 Appendix N lists the balanced superelevations for various curvatures and speeds as well as values used to prescribe the maximum speed (Vmax) allowed for track maintenance.

19.3.13 The actual superelevation (E_A) for curved track must meet the following criteria:

a) The minimum actual superelevation must be 1/2 in (12.7 mm) on Class 2 track or higher. Preferred minimum superelevation on all Metrolinx tracks is 1/2 in (12.7 mm).

b) The maximum design actual superelevation (E_A) must be limited to 5 in (127 mm).

c) The actual superelevation must be rounded up to the nearest 1/4 in (6 mm).

d) The actual superelevation value on circular curves must be constant between SC and CS geometry points. Changes in superelevation must be designed in spiral limits at a uniform rate of change.

19.3.14 For each applicable type of train traffic, determine the balanced superelevation and establish the maximum and minimum actual superelevation for each train traffic using the appropriate amount of unbalanced superelevation permitted.

a) The maximum elevation for the curve will be the lesser of the maximum elevations calculated, the minimum elevation for the curve will be the greater of the minimum elevations calculated;

b) The elevation for the curve will be within this range. The minimum and maximum superelevation calculated will ensure ride quality and safety for each type of traffic. Selection must be made with consideration to local traffic and conditions using the following guideline:

i. Using a superelevation value close to the maximum superelevation will result in the weight of slower trains being transferred to the low rail causing accelerated wear of the low rail; and

ii. Using a superelevation value close to the minimum superelevation will result in faster trains producing greater lateral forces through the curve, contributing to gauge widening and gauge face wear.

19.3.15 Spirals designed into curves provide a gradual transition (at uniform rate) for both curvature and superelevation from tangents into curves and from curves into tangents:

a) On non-main tracks in curves, spirals must be designed and constructed where conditions permit.

19.3.16 The minimum spiral length must be the greater of the two lengths calculated in the equations for Passenger Comfort (4) and Vehicle Torsion (5):

Table 19-4 Minimum Spiral Length Equations

Class of Track	Minimum Spiral Length Equations	
1-3	$L_s = 1.63\, E_u V_p$ $L_s = 62\, E_A$	(4) (5)
4 and above	$L_s = 1.63\, E_u V_p$ $L_s = 82.7\, E_A$	(4) (5)
L_s: *Length of Spiral* (ft) E_u: *Unbalaced Superelevation for Passenger trains* (in) V_p: *Maximum Passenger Speed* (MPH) E_A : *Actual Superelevation* (in)		

19.3.17 The Passenger Comfort Equation (Equation 4) is used to ensure that the ride quality around the curve is appropriate for the speed of the passenger train and for the superelevation applied.

a) In certain conditions, such as near open deck bridges or between reverse curves, the required length of spiral may not be available. If the spiral length for passenger comfort cannot be obtained this length of the spiral may be reduced by an amount not exceeding 25% as approved in writing by the Director, Engineering—Track.

19.3.18 The Vehicle Torsion equation (Equation 5) ensures cars can physically negotiate the curve. The equation is designed so that the superelevation is never run off at a rate greater than 1 in (25 mm) in 62 ft (18.9 m). For safety reasons, this condition must always be met.

a) At certain locations, such as near open deck bridges or between reverse curves, the required length of spiral may not be available. In order to maintain the appropriate run-off rate, the superelevation would then need to run out onto the tangent. The following conditions must be met and approved in writing by the Director, Engineering—Track:

i. The rate of change of superelevation does not exceed 1 in (25.4 mm) in 62 ft (18.9 m) as per the Vehicle Torsion Equation (Equation 5);

ii. At least 75% of the superelevation is run out on the spiral;

iii. The maximum allowable speed of passenger trains on the curve is 60 mph (Class 3) or less;

iv. The requirements for Passenger Comfort are still met. The length of spiral is not less than 75% of that required for Passenger Comfort (Equation 4); and

v. Where superelevation is run out on tangent between reverse curves, a minimum of 100 ft (30.5 m) of tangent track with zero superelevation must be designed between curves.

19.3.19 Compound Curves are defined as two (2) curves of varying degrees of curvature in the same direction connected together.

a) On main track, spirals must be designed and constructed between any two parts of a compound curve if the degrees of curvature differ by 0°30’00” or more; and

b) If the superelevation changes through a compound curve, regardless of the change in degrees of curvature, a spiral must be designed and constructed between the two (2) portions of the compound curve.

19.3.20 The minimum spiral length between parts of a compound curve must be the greater of the two (2) lengths calculated in Passenger Comfort (4) and Vehicle Torsion (5) equations identified in Track Standards Section 19.3.16, where:

a) In Passenger Comfort Equation (Equation 4), Eu must be the difference between the unbalance values of the two (2) circular curves; and

b) In Vehicle Torsion Equation (Equation 5), Ea must be the difference between the actual superelevation on the two (2) circular curves.

19.3.21 On main track curves, spiral lengths shorter than 64 ft (19.5 m) must be avoided unless approved in writing by Metrolinx E&AM—Track.

19.3.22 On main track curves, the preferred minimum length of the horizontal curve (excluding spirals) is 100 ft (30.5 m), and an absolute minimum length of a horizontal curve (excluding spirals) is 64 ft (19.5 m), unless approved in writing by Metrolinx E&AM—Track.

19.3.23 Where the requirements for either superelevation or spiral length cannot be met, the allowable speed of traffic through the curve must be reduced to allow conformance.

19.3.24 All horizontal curve designs must include the minimum information as indicated in Figure 19-1.

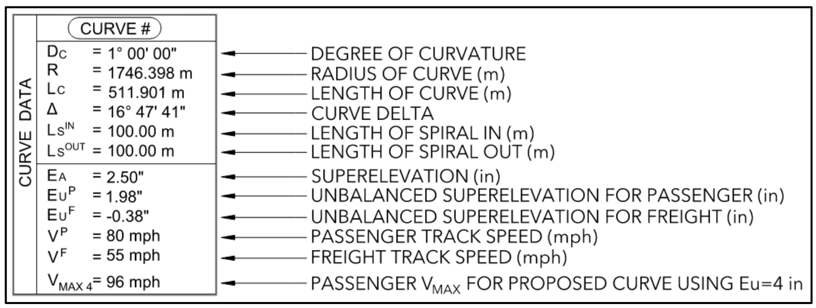


Figure 19-1 Curve Design Information

19.3.25 Track designs must limit the maximum curvature to eight (8) degrees unless approved in writing by the Director, Engineering—Track. Track designs authorized with curvatures exceeding eight (8) degrees must meet the following additional requirements:

a) Metrolinx and other railways' train handling requirements must be identified;

b) Train operating speed must be reduced, as required; and

c) Tie center-to-center spacing must be modified as follows:

   i. 9 ft (2.74 m) Grade #1 hardwood ties must be installed at 18 in (457 mm) on center with cast plates fully spiked, lagged and clipped;

   ii. Steel ties must be installed at 18 in (457 mm) on center; and

   iii. Concrete ties must be installed at 20 in (508 mm) on center.

19.3.26 Reverse curves are defined as two curves in the opposite direction connected with a tangent segment. On main tracks, reverse curves must be separated by a tangent segment as per the following criteria, unless otherwise approved in writing by the Director, Engineering-Track:

a) Where both curves have spiral lengths that are 100 ft (30.5 m) or longer, the tangent length must be at least 100 ft (30.5 m);

b) Where the spiral lengths are less than 100 ft (30.5 m), the tangent length must be increased such that the length of the shortest spiral plus the tangent length is at least 200 ft (61.0 m);

c) Where only one (1) curve has a spiral, the tangent length must be at least 200 ft (61.0 m);

d) Where both curves do not have spirals, the tangent length must be at least 200 ft (61.0 m); and

e) This requirement does not apply to turnout curves and return curves.

19.3.27 On non-main tracks, reverse curves must be separated by a tangent that conforms to Table 19-5.

Table 19-5 Minimum Tangent Lengths Between Reverse Curves for Yard Operations

Degree of Reverse Curves		Recommended Tangent Length
Greater than	Equal to	
0	1°-30′	0 ft (0 m)
1°-30′	3°	10 ft (3.05 m)
3°	4°-30′	20 ft (6.1 m)
4°-30′	6°	30 ft (9.1 m)
6°	7°-30	40 ft (12.2 m)
7°-30	9°	50 ft (15.2 m)
9°	10°-30	60 ft (18.3 m)
10°-30	12°	70 ft (21.3 m)
12°		75 ft (22.9 m)

19.3.28 Below is an example of a horizontal curve calculation.

Example

You are to design a 1°15′00″ curve. What would be the required spiral lengths and appropriate Actual Superelevation?

Zone Speeds:	Passenger (P)	65 mph
	Passenger (P+)	70 mph
	Freight	60 mph

Equilibrium Superelevation:

Passenger (P)

$$E_{q_p} = 0.0007\ D_C\ V^2$$
$$E_{q_p} = 0.0007(1.25°)(65\ mph^2)$$
$$E_{q_p} = 3.70\ in$$

Passenger Plus (P+)

$$E_{q_{p+}} = 0.0007\ D_C\ V^2$$
$$E_{q_{p+}} = 0.0007(1.25°)(70\ mph^2)$$
$$E_{q_{p+}} = 4.29\ in$$

Freight

$$E_{q_f} = 0.0007\ D_C\ V^2$$
$$E_{q_f} = 0.0007(1.25°)(60\ mph^2)$$
$$E_{q_f} = 3.15\ in$$

Find minimum Actual Superelevation (E_A) based on Unbalanced Elevation (Eu) Limits:

Max Eu for Passenger (P) = 3 in
$Minimum\ E_A = 0.70\ in$

Max Eu for Passenger (P+) = 4 in
$Minimum\ E_A = 0.50\ in$

Max Eu for Freight = 2 in
$Minimum\ E_A = 1.15\ in$

Therefore, the minimum E_A that may be applied would be 1.15 in (29 mm), and a maximum E_A that may be applied would be 4.15 in (105 mm).

Choose appropriate E_A with Vmax Consideration:

As per Track Standards Section 19.3.10a, E_A should be selected to achieve a Vmax buffer of 5 mph using Equation 3. For this curve, an E_A of 1.5 in (38 mm) has been selected.

Vmax for Passenger (P)

$$V_{max} = \sqrt{\frac{(E_a + E_u)}{0.0007\ D_C}}$$

$$V_{max_p} = \sqrt{\frac{(1.5 + 3)}{0.0007(1.25)}}$$

$$V_{\square_p} = 71.7\ mph$$

Vmax for Passenger (P+)

$$V_{max} = \sqrt{\frac{(E_a + E_u)}{0.0007\ D_C}}$$

$$V_{max_{p+}} = \sqrt{\frac{(1.5 + 4)}{0.0007(1.25)}}$$

$$V_{max_{p+}} = 79.3\ mph$$

Vmax for Freight

$$V_{max} = \sqrt{\frac{(E_a + E_u)}{0.0007\ D_C}}$$

$$V_{max_f} = \sqrt{\frac{(1.5 + 2)}{0.0007(1.25)}}$$

$$V_{max_f} = 63.2\ mph$$

A minimum of 5 mph buffer between zone speed and Vmax has been achieved for all passenger train speeds, and the selected E_A of 1.5 in (38 mm) is within the required unbalance tolerance.

Minimum Spiral Length Calculation

Spiral length based on Passenger Comfort

$$L_s = 1.63\ E_u V_p$$

$$L_s = 1.63(4.29 - 1.5)(70)$$

$$L_s = 318.34\ ft\ (97.03\ m)$$

Spiral length based on Vehicle Torsion

$$L_s = 82.7\ E_A$$

$$L_s = 82.7\ (1.5)$$

$$L_s = 124.05\ ft\ (37.81\ m)$$

Minimum spiral length is the maximum of these values, rounded up to the nearest meter. Based on the above calculations, 1.5 in (58 mm) of superelevation may be applied with a minimum spiral length of 321.52 ft (98 m).

19.4 Vertical Track Geometry Design (Profile)

19.4.1 Vertical track geometry design must meet the requirements of AREMA and the Metrolinx Track Standards. Where these standards differ, the more restrictive must apply.

19.4.2 The maximum allowable compensated grade for track construction must be 2.0%, unless approved in writing by the Director, Engineering—Track.

a) Compensated grade is a combination of the horizontal degree of curvature and the grade. Every degree of curvature adds 0.04% to the grade.

$$Compensated\ grade = 0.04 D_C + Actual\ Gradient \quad (6)$$

$$D_C: Degree\ of\ Curvature\ (decimal\ degrees)$$

19.4.3 Vertical curves must be used to connect all changes in track profile grades. A vertical curve that is concave upwards is a sag, and a vertical curve that is concave downwards is a crest.

19.4.4 The length of the vertical curves for both sags and crests must be determined using equation 7.

$$L_v = \frac{2.15 \times D \times V^2}{A} \quad (7)$$

L_v: *Length of Vertical Curve* (ft)
D: *Absolute value of the difference in grades* $(decimal)$
V: *Speed* (MPH)
A: *Vertical acceleration* (ft/sec^2)

$$Freight\ Operations\ A : 0.1 (ft/sec^2)$$

$$Passenger\ Operations\ A : 0.6\ (ft/sec^2)$$

19.4.5 The minimum length of vertical curves must be 100 ft (30.5 m).

19.4.6 The minimum distance between vertical curves must be 100 ft (30.5 m).

Table 19-6 Example of Vertical Curve Calculation

Operation	Design Speed (MPH)	Grade in (%)	Grade out (%)	Vertical Acceleration (ft/sec^2)	D	Length of Vertical Curve (ft)	Design Length of Vertical Curve (ft)
Passenger	80	0.50	-1.20	0.6	((0.005 - (-0.012)) = 0.017	$\frac{2.15 \times 0.017 \times 80^2}{0.6} = 390$	915 ft (279 m)
Freight	50			0.1		$\frac{2.15 \times 0.017 \times 80^2}{0.1} = 914$	

19.5 Rail Platforms

19.5.1 All new rail platforms adjacent to tangent track must be located horizontally and vertically in accordance with Table 19-7.

Table 19-7 Rail Platform Horizontal and Vertical Clearances

Location	Track Centerline to Edge of Platform	Gauge Face to Edge of Platform	Horizontal Clearance Tolerance	Vertical Clearance Above Top of Rail	Vertical Clearance Tolerance
Mixed Use Corridors	1632 mm (64 1/4 in)	915mm (36 in)	± 13 mm (± 1/2 in)	127mm (5 in)	+0 mm - 25 mm (- 1 in)
Metrolinx Use Only (Restricted Clearance) Corridors	1632 mm (64 1/4 in)	915mm* (36 in)	± 13 mm (± 1/2 in)	254mm** (10 in)	± 25 mm (± 1 in)
UP Express Use Only Corridors‡	1791 mm to edge of concrete (70 1/2 in) 1730 mm to edge of rubber (68 1/8 in)	1073 mm to edge of concrete (42 1/4 in) 1013 mm to edge of rubber (39 7/8 in)	- 0 mm + 13 mm (+ 1/2 in)	1,220 mm (48 in)	± 13 mm (± 1/2 in)
UP Mixed-Use Corridors‡	1803 mm to edge of concrete (71 in) 1753 mm to edge of rubber (69 in)	1086 mm to edge of concrete (42 3/4 in) 1036 mm to edge of rubber (40 3/4 in)	- 0 mm + 13 mm (+ 1/2 in)	1,220 mm (48 in) 1,207 mm (USRC) (47 3/8 in)	+0 mm - 13 mm (- 1/2 in)
Accessibility Platform	1988 mm (78 1/4 in)	1270 mm (50 in)	± 25 mm (± 1 in)	533 mm (21 in)	± 25 mm (± 1 in)

*807mm (31 3/4 in) permitted for existing platforms in the USRC only.
**203mm (8 in) permitted for existing platforms in the USRC.
‡UP Express platform horizontal measurements can be confirmed by measuring the gap between the train and the platform at the doors. At Pearson Station, the gap should be 49 mm (1 15/16 in) between the platform and the DMU vehicle. At all other UP stations, the gap should be 121 mm (4 3/4 in.) between the platform concrete edge and the UP DMU vehicle
Note: For platform offset requirements, please refer to the current timetables for applicable traffic types, or consult with Metrolinx Operations Division.

19.5.2 For platforms on curved (superelevated) tracks, clearances must be determined through design in accordance with Standard Plan GTS-3004 (Sheet 2) to ensure safe boarding and de-boarding of passengers on both regular and accessible platforms. For reference, the height of the floor of a GO train consist is 25 in (635 mm) above top of rail.

a) The standard distance between the track centerline and platform edge must be increased by 1 in (25 mm) per degree of curvature for platforms on both inside and outside the curves to account for the vehicle end overhang and mid-ordinate shift;

b) The platform height must be adjusted (raised/lowered) in accordance with Standard Plan GTS-3004 to account for the effect of track superelevation and vehicle tilt; and

c) Platforms are not allowed on curved tracks with superelevation values of greater than 3-1/2 in (89 mm).

19.5.3 For additional requirements on platform widths, lengths, and slopes, see the Metrolinx Design Requirements Manual (DRM).

19.5.4 Prior to construction of new station platforms adjacent to an existing track, an assessment of the existing vertical and horizontal track alignment must be conducted through design to ensure that the horizontal and vertical platform offsets can be achieved, and that the existing track surface/cross-level elevations are uniform, in the desired alignment.

19.5.5 Clearance from top of station tunnel structure to underside of the tie must be a minimum of 8 in (203 mm) plus the thickness of the ballast mat and waterproofing.

19.5.6 Top-of-station tunnel structures must have a minimum slope of 0.30% for drainage.

19.5.7 At a minimum, utilities parallel to the track must be located laterally so as not to be within the Zone of Influence of the track. The Zone of Influence is defined as a line extending from the top end of track tie at a slope of two horizontal to one vertical (2H:1V).

19.5.8 At a minimum, the top of utility structures, such as duct banks, pull boxes, maintenance holes, catch basins, etc., must be no higher than the bottom of track tie.

19.5.9 Snow clearing operations on Metrolinx ROW must not place snow on the track structure, including the ballast section, Special Trackwork, signal appliances, interlockings or any railway infrastructure.

a) Salt must not be used within the Metrolinx ROW except for at-grade road crossings and on station platforms.

19.5.10 All track surfacing activities near or adjacent to rail platforms must conform to Track Standards Section 12.

19.6 Special Trackwork

19.6.1 On main tracks, facing point turnouts of the same orientation, forming a reverse movement, must be separated by a tangent of at least 100 ft (30.5 m) in length unless otherwise approved in writing by the Director, Engineering—Track.

19.6.2 On main tracks, facing point turnouts of the opposite orientation must be separated by a tangent of at least 50 ft (15.24 m) in length.

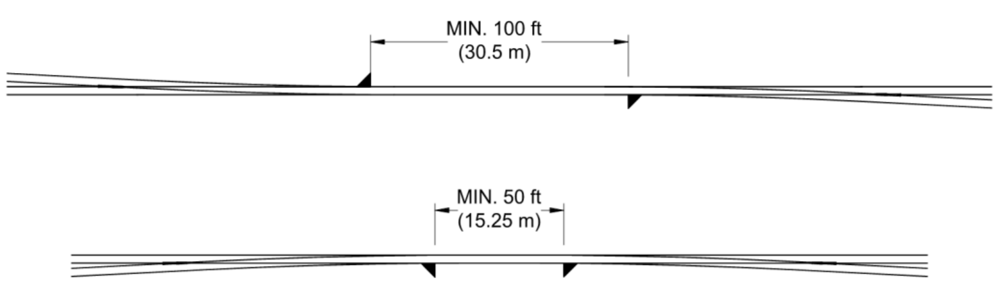


Figure 19-2 Facing Switch Point Separation Requirements

19.6.3 Turnouts must not be installed, rehabilitated, or renewed on main track curves.

a) Turnouts must not be installed within 50 ft (15.24 m) of curves unless otherwise approved in writing by the Director, Engineering—Track.

19.6.4 Turnouts must not be installed in vertical curves.

19.6.5 Turnouts must not be installed within station platform limits.

19.6.6 Turnouts must not be installed on bridges, except in special cases authorized in writing by the Director, Engineering—Track.

a) A turnout must not be installed on an open-deck bridge or within 200 ft (61 m) of the back wall of an open-deck bridge, to allow for the appropriate longitudinal restraint system; and

b) Turnouts must not be installed within 100 ft (30.5 m) of a ballast deck bridge.

19.6.7 Turnouts must not be installed within 200 ft (61 m) of at-grade road crossing surfaces, including sidewalks and other recreational Multi-Use Paths, unless authorized in writing by the Director, Engineering—Track.

19.6.8 Main track turnouts must be separated by a minimum distance of 80 ft (24.4 m) between number 1 gauge plate and the last long tie on the preceding turnout unless otherwise approved in writing by the Director, Engineering—Track in writing.

20 Ground Disturbance

20.1 Ground Disturbance

20.1.1 Ground disturbance work is classified as mechanical excavation, hand digging, daylighting, caisson and borehole drilling, trenching or grading. This includes any work, operation, or activity that results in a disturbance of the soil mass.

20.1.2 It is the responsibility of the Contractor to arrange and conduct locates of all utilities, including but not limited to CN, CPKC, Metrolinx, and Ontario OneCall. Prior to starting any ground disturbance work on the ROW, the Contractor has to ensure that no specific protocols are in place with all utility companies.

20.1.3 Ground disturbance may be suspended by Metrolinx at any time if unsafe conditions are observed. The contractor must stop work and restore the ground disturbance site as per standards.

20.1.4 Prior to the commencement of any work, an approved Work Plan Methodology (WPM) (MX-TRK-FRM-002) must be reviewed and approved by Metrolinx E&AM–Track and other relevant stakeholders.

20.1.5 Prior to the commencement of ground disturbance work within the Metrolinx ROW, an approved Metrolinx Ground Disturbance Permit (MX-TRK-FRM-001) must be obtained. Refer to Metrolinx Frequently Asked Questions and Clarifications on Ground Disturbance Works for more details.

20.1.6 All works, including developments adjacent to the Metrolinx ROW, must adhere to all Metrolinx Standards and policies for all ground disturbance activities.

20.1.7 All ground disturbances within Metrolinx ROW that will potentially impact track assets must be reviewed and authorized by a Geotechnical Engineer.

20.1.8 All ground disturbances must conform to the Occupational Health and Safety Act (OHSA) requirements.

20.1.9 Figure 20-1 below, indicates three excavation zones adjacent to an in-service track. A theoretical ballast toe is used to determine the various excavation zones. The theoretical ballast toe accounts for a 12 in (305 mm) ballast shoulder off of the edge of the tie and an additional 6 in (152 mm) safety allowance in the ballast cross-section. The ballast shoulder is then sloped at a 2:1 slope to a depth of 22-1/2 in (572 mm) below top of tie.

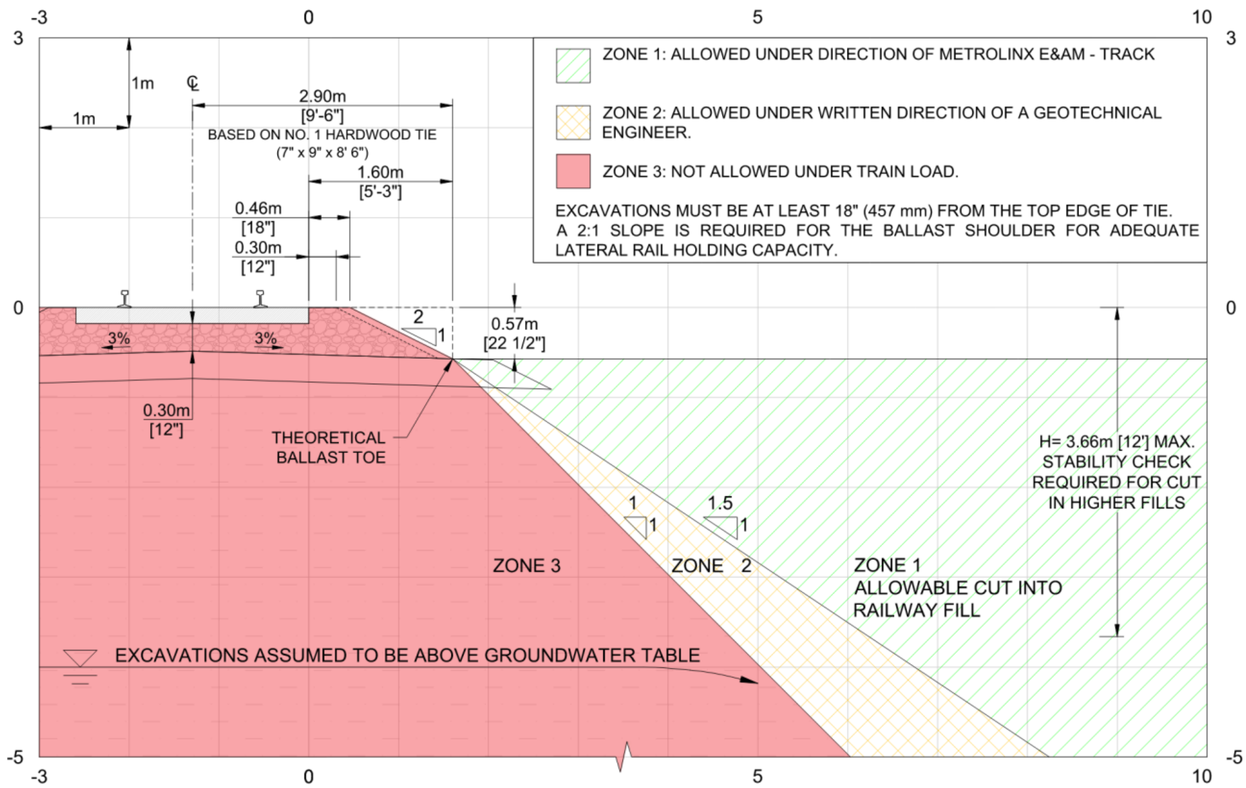


Figure 20-1 Excavation Zones

20.1.10 Excavation zones are defined as follows:

a) Zone 1 is located above a 1.5:1 slope starting from the theoretical ballast toe;

i. Ground disturbance works in Zone 1 are allowed with review and approval by Metrolinx E&AM–Track; and

ii. Excavations with slopes flatter than 1.5:1 are allowed during construction in Zone 1. If construction is suspended or work activity is dormant for 30 days, the slope must be restored to a minimum 2:1 slope or as specified in writing by a Geotechnical Engineer.

b) Zone 2 is located between a 1.5:1 and 1:1 slope starting from the theoretical ballast toe;

i. All requirements found in 20.1.10.a) must be adhered to;

ii. Ground disturbance works in Zone 2 are allowed under live train loading with the written authorization/design from a Geotechnical Engineer or onsite supervision of a Geotechnical Engineer;

iii. All ground disturbance works in Zone 2 must be restored to Zone 1 at the end of the working shift unless authorized in writing by a Geotechnical

Engineer or protected by a shoring system designed by a Professional Engineer; and

iv. A Geotechnical Engineer or their designate (identified in writing) must supervise the backfilling and compaction work.

c) Zone 3 is located within and below the ballast structure, and below a 1:1 slope starting from the theoretical ballast toe.

i. All requirements found in 20.1.10.b) must be adhered to;

ii. Ground disturbance works within Zone 3 are not permitted under live train loads unless it is protected by a shoring system designed by a Professional Engineer;

iii. If shoring is not in place, ground disturbances in Zone 3 must be backfilled, compacted, and restored to Zone 2. Track must inspected by a Track Inspector as per Metrolinx Track Standards prior to any train loading;

iv. A Geotechnical Engineer or their designate (identified in writing) must supervise the backfilling and compaction work before the passage of the next train; and

v. Track and Signalling work with activities limited to only the ballast section does not require a Geotechnical Engineer design and review.

20.1.11 Ground disturbance works in Zone 2 and Zone 3 adjacent to a curved track may require mechanical tamping and dynamic stabilization at the discretion of Metrolinx E&AM–Track if the ballast section is disturbed.

20.1.12 If ground disturbance work causes track movement or settlement is observed, the track must be inspected by a Track Inspector.

20.1.13 If seepage is noted, the work must stop. The work must not resume until the geotechnical engineer provides direction on how to proceed. The Contractor must have groundwater control measures available onsite during ground disturbance works.

a) A geotechnical memo must be provided if the bottom of the ground disturbance work goes below the stabilized groundwater table.

20.1.14 Ballast must not be disturbed during the ground disturbance works. If ballast is found to be substandard due to the ground disturbance, the track must be protected and the ballast restored to the minimum ballast section, as shown in GTS-2205.

a) The protection of the track may include speed restrictions or removing the portion of track from service; and

b) Restoration of the ballast section must be performed by a Metrolinx pre-qualified track contractor in accordance to Track Standard Section 11.

20.1.15 Ground disturbance works greater than 8 ft (2.44 m) in depth must be protected by an adequate barrier as per OHSA requirements.

20.1.16 For any ground disturbance works within 131 ft (40 m) of Special Trackwork, the Contractor must be prepared to rebuild the track structure and Special Trackwork.

20.1.17 Material excavated must not be used as backfill, unless it conforms to the backfilling requirements.

a) Backfill material must not be frozen or highly saturated;

b) Must not contain any topsoil, organic matter, weak materials, and construction debris, and must be approved by a Geotechnical Engineer;

c) Must be able to be compacted to 98% Standard Proctor Maximum Dry Density (SPMDD); and

d) Material not meeting the above criteria, excess material left over from backfilling activities, and/or oversized materials greater than 6 in (150 mm) in size must be discarded and removed from Metrolinx ROW.

20.1.18 All excess soils must be disposed of outside of the Metrolinx ROW in accordance with the Ontario Provincial Regulations. Reprofiling of spoiled ballast, backfill or excavated material may be permitted if:

a) There is no increased risk to operations (e.g. sightline considerations, potential excess vegetation growth);

b) There is no impact to future maintenance work;

c) There is no evidence of a decrease in asset lifecycle;

d) There is no potential impact to corridor drainage; and

e) The reprofiling work is maintained with the Metrolinx ROW and does not spill into adjacent properties.

20.1.19 The bottom of the ground disturbance area must be proof-rolled as directed by the Geotechnical Engineer.

20.1.20 Approved granular materials, as per OPSS 1010, must be placed during the backfill process starting at the bottom of ground disturbance in lifts of 6 in to 12 in (152 mm to 305 mm) up to the bottom of sub-ballast, as directed by the Geotechnical Engineer and compaction must be at least 98% SPMDD.

20.1.21 If the base of ground disturbance is in soft ground, such as silts and clays, avoid running equipment over the bottom of ground disturbance after stripping.

a) Place adequate granular fill layer before circulating over it. Dump trucks are only allowed to run over the compacted granular fill;

b) If clean coarse rock is used for backfill, a non-woven geotextile must be laid at the base of the ground disturbance. The non-woven geotextile may be placed under any applicable geogrid reinforcement, if required.

20.1.22 Limit advanced ground disturbance into the existing fill to only a few days in advance of roadbed construction backfill (preferably less than three (3) days).

20.1.23 Benching for open ground disturbances must be designed by a Geotechnical Engineer.

20.1.24 Permanent timber lagging subject to railway loading is not permitted.

20.1.25 Temporary shoring systems subject to railway loading must be removed upon completion of the work.

20.1.26 Installation of shoring to facilitate Zone 3 ground disturbance works is considered a Zone 3 ground disturbance itself and is not allowed under live train loading.

20.1.27 Drilling of vertical caissons is allowed to be completed in Zone 3 under live train loading with review and approval from E&AM—Track if the following conditions are met:

a) Engineering Analysis and Methodology:

i. A continuous steel casing designed for Cooper E-80 loading must be used and advanced ahead of the auger to ensure there will be no voids and no temporary unsupported face of excavation;

ii. Drilling activities in sound bedrock may be completed, given the steel casing remains in place until completion of pile drilling;

iii. Any pre-work (e.g. guide wall, preparatory excavation works, etc.) to facilitate drilling vertical caissons must adhere to all applicable Track Standard requirements;

iv. A geotechnical memo that is signed, sealed and dated by a Professional Engineer must be provided assuring that the proposed methodology will not be detrimental to railway operations and existing soil conditions are suitable for the proposed drilling activities;

v. A Risk Assessment must be completed with a focus on drilling activities under live train loading, including hazard identification, risk mitigations, and residual risk evaluation;

vi. All WPMs, GIMP, and GDP must be reviewed and approved by E&AM–Track prior to the commencement of work;

b) Track Protection:

i. Track Protection must be in place during drilling activities. If work is taking place behind a CWZ, and without positive protection, railway flag personnel must be present on-site, and an emergency response protocol must be in place to ensure track(s) can be protected in case of an emergency;

ii. Adjacent track(s) must be out of service if the outside edge of the caisson is 13 ft (~4 m) or closer to the track centerline;

iii. Any drilling activities that have the potential to conflict with the train clearance envelope must not be completed when trains are in operation;

c) Track and Ground Monitoring and Inspection:

i. A Geotechnical Instrumentation and Monitoring Plan must be in place as per Track Standards Section 20.2 to monitor the track and ground movement/settlement;

ii. A Geotechnical Engineer must be present on site when drilling through Excavation Zones 2 and 3 and must complete visual inspections, assess any reported ground movement, and propose an action plan if Review and Alarm limits are reached;

iii. A TIG-qualified inspector may be required, at the discretion of E&AM–Track, to perform track inspections if the work has the potential to impact the track structure (including the ballast section). Inspections must be completed as per Metrolinx Track Standards, and reports must be submitted to E&AM—Track within 24 hours of completion;

d) Contingency Plan:

i. The Contractor must have suitable backfill material to fill any unexpected voids to proper compaction under the direction of the Geotechnical Engineer on-site; and

ii. The Contractor may be required, at the discretion of E&AM—Track, to engage a pre-qualified Metrolinx track contractor to be on standby and have the necessary equipment and material available to complete any necessary remedial work in case of any ground or track movements that exceed the Review and/or Alarm limits and re-construct the track;

20.1.28 Shoring systems, dewatering/groundwater control techniques, tunnelling, trenchless drilling, and structures must be designed and conform to the Metrolinx General Guidelines for Design of Railway Bridges and Structures (RC-0506-04STR), Tunnels and Underground Structures Standard (MX-TUS-STD-001) and Metrolinx Trenchless Utility Works Design and Construction Guidelines on Metrolinx Right-of-Way (Heavy Rail) (RC-0506-04STR-03).

20.2 Monitoring

20.2.1 All monitoring requirements for any ground disturbance activities within the Metrolinx ROW can be found in the Metrolinx Trenchless Utility Works Design and Construction Guidelines on Metrolinx Right-Of-Way (Heavy Rail) (RC-0506-04STR-03).

a) Note that Deep In-ground Monitoring Points (DIMP) are not required for ground disturbances that do not involve trenchless activities.

20.2.2 Monitoring requirements for shoring walls, and other construction works related to civil structures adjacent to the railway corridor can be found in the Metrolinx General Guidelines for Design of Railway Bridges and Structures (RC-0506-04STR).

20.2.3 All ground disturbance activities exceeding Zone 1 limits require an approved Geotechnical Instrumentation and Monitoring Plan.

20.2.4 Monitoring must not end when the subgrade, sub-ballast and ballast is frozen. Readings must continue until the end of Winter. The frequency of monitoring must increase at the direction of the Geotechnical Engineer.

20.2.5 At the conclusion of the ground disturbance works, all monitoring points and systems must be decommissioned and removed from Metrolinx ROW upon written approval from the Geotechnical Engineer. Decommissioning must include restoration of the track structure.

21 Bridges and Structures

21.1 Guard Rails

21.1.1 Guard rails must be installed at the following locations:

a) All bridges that have supporting structures extending above the top of the ties;

b) All bridges that have the underside supporting structure protruding beyond the deck of the bridge;

c) All bridges that cross roadways or commercially navigable waterways;

d) All bridges longer than 100 ft (30.5 m);

e) All bridges with curves 2° and over;

f) All tunnels, snow sheds, and rock sheds with timber lining, exposed arch ribs, or other lining or construction that is vulnerable to damage; guard rails are not required on unlined tunnels and tunnels with smooth concrete lining;

g) When new track construction or rehabilitation is within 25 ft (7.62 m) of an existing structure (such as piers for overhead structures) and the track speed is Class 2 or greater; and

h) Any other locations designated by the Director, Engineering—Track.

21.1.2 Existing guard rails must not be removed without written approval by the Director—Engineering Track.

21.1.3 When guard rails are not present on main track where required, a temporary Class 2 speed restriction or posted track speed is required, whichever is more restrictive.

21.1.4 Guard Rails are not required:

a) On the center tracks on bridges with three or more in-service tracks; and

b) Through platform limits at stations.

21.1.5 Guard rails must be installed as per Standard Plan GTS-1108.

21.1.6 Guard rails must be integrated with the signal system as per GO Transit Signals and Communications Standards General Instructions (RC-0506-03SIG-01) to maintain broken rail protection. Guard rails must not contact the tie plates and must be kept clean and free of debris, particularly metal shavings and filings.

21.1.7 In some locations, guard rails are incorporated into the signals system. Employees must take every precaution to avoid shorting out track circuits between the guard rail and the running rail when working around these locations.

21.1.8 In hardwood tie territory, guard rails must be fastened with two (2) spikes per rail, without tie plates on every tie. The last two (2) ties supporting the ends of the guard rails must have four (4) spikes per tie per guard rail to hold position.

21.1.9 In steel tie territory, guard rails must be installed using the appropriate tie and fasteners. Refer to Standard Plans GTS-2103 and GTS-2105 for additional details.

21.1.10 In concrete tie territory, guard rails must be installed using the appropriate ties and clips. Refer to Standard Plans GTS-2004 and GTS-1334 for additional details.

21.1.11 In multi-track concrete tie territory and steel tie territory, ties capable of accommodating guard rail installation must be installed on all tracks where guard rails may be required on adjacent tracks. Guard rails must only be applied where required.

21.2 Restraining Rails

21.2.1 Restraining rails must be considered on any curve 14° or greater and must not be installed unless approved in writing by the Director, Engineering-Track. See Track Standards Sections 4.5.2 and 19.3.25 for additional requirements on high-degree curves.

21.2.2 Restraining rails must be of the type for heavy rail applications and approved in writing by the Director, Engineering–Track.

a) A 33C1 rail section is recommended.

21.2.3 The top of the restraining rail must be a maximum of 1 in (25 mm) above top of running rail.

21.2.4 The restraining rail must be installed adjacent to the low rail.

21.2.5 The restraining rail must be installed through the full body of the curve and the spirals extending 40 ft (12.2 m) into the tangent with a 6 ft (1.82 m) flare on the beginning and end as per AREMA plan no. 509-13.

a) Restraining rails must overlap by 20 ft (6.1 m) where reverse curves requiring restraining rails are present.

21.2.6 All restraining rail connections must be designed to withstand the applied forces, including that of thermal expansion/contraction, train loading, hunting, steering, and other loads.

21.2.7 The flange-way gap must be determined through a Nytram analysis to ensure shared loading between the high rail and restraining rail.

a) This must be completed for new and worn wheels for every type of equipment that will traverse the track affected.

b) Both minimum and maximum operating ranges must be selected but must not be less than 1-1/2 in (38 mm) deep and 1-3/4 in (44 mm) wide.

21.2.8 The flange-way gap between the running rail and the restraining rail must be designed for the specific application and location.

a) On the Pearson Subdivision, the flange-way gap between the running rail and restraining rail must be between 48 and 52 mm. If the gap is measured to be less than or exceeds this range, remedial work is required.

21.2.9 The flange-way gaps must be adjusted upon identification of gauge conditions.

a) The use of shims to adjust the restraining rail is an acceptable practice to ensure the flange-way gap is within the minimum and maximum tolerances. The addition of shims must bring the flange-way gap near the minimum tolerance to be effective.

b) Restraining rail must be replaced when it reaches the prescribed wear limits.

21.3 Track bed and ROW Drainage

21.3.1 Drainage design must take into consideration meltwater produced by snow-clearing devices.

21.3.2 In yards and within the USRC, there must be one surface catch basin for every two turnouts, with the catch basin located no more than 33 ft (10.1 m) from the switch points.

21.3.3 Drainage infrastructure design must facilitate future maintenance activities, including but not necessarily limited to:

a) Provision of vehicular and pedestrian access to catch basins;

b) Provision of cleanouts at appropriate intervals; and

c) Consideration for adjacent track maintenance requirements such as undercutting and track tie replacement.

21.3.4 Ditches, culverts, waterways or any other drainage facility under or immediately adjacent to the track structure and roadbed must be maintained to allow the free flow of water. They must:

a) Be regularly inspected to ensure they are operating as per design;

b) Be maintained free of vegetation and debris so that drainage is not impeded;

c) Not be filled with ballast or with spoils produced from ditching, shoulder cleaning, or undercutting;

d) Not be altered, adjusted, rerouted, or constricted unless approved by a Professional Engineer, all required permits have been acquired, and the Director, Engineering-Track has been notified in writing prior to work taking place; and

e) Be monitored for plugged or frozen conditions which can result in ponding and high water on one side of the track creating differential water level.

21.3.5 Low Impact Development (LID) drainage solutions such as storage or infiltration galleries must not be designed and installed directly beneath the track structure.

21.3.6 Existing drainage infrastructure must be reviewed to ensure there is sufficient capacity for the modified drainage pattern.

21.3.7 Chronic subgrade soft spots, frost heaves or mud boils must be improved by:

a) Designing and installing ditches which flow freely and outlet away from the track structure;

b) Installing cross (lateral) sub-surface drainage spaced along the track or below the track bed; or

c) Engaging a geotechnical engineer to investigate, evaluate and make recommendations for resolutions.

21.3.8 When installing lateral drains to correct drainage issues:

a) Cut to a depth below the granular layer or water pocket and slope the excavation to the toe of subgrade or ditch line;

b) Place filter cloth in the lateral drain, install the lateral drain with clean coarse ballast and wrap the sides and top with the filter fabric; and

c) Locate the lateral drains every 20 to 50 ft (6.1 to 15.2 m) along the track for the length of the soft track or poorly drained condition.

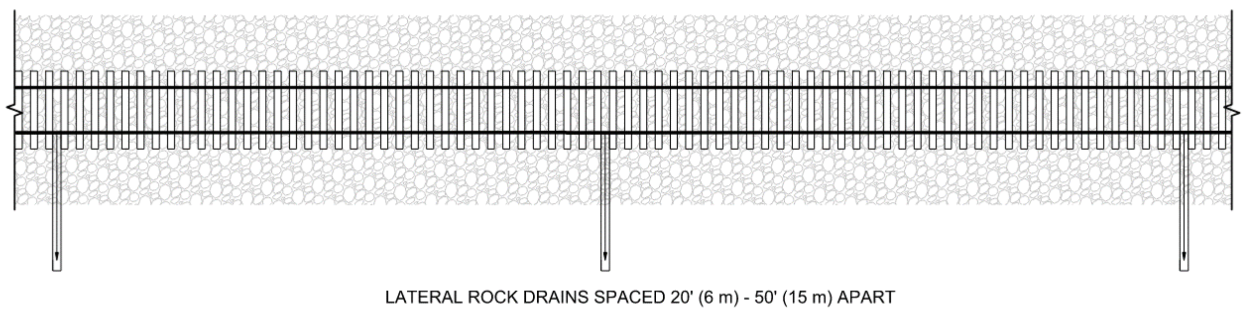


Figure 21-1 Lateral Rock Drains

21.3.9 Rip rap or other fill materials must not remain on the top of embankments, which could be hit by on-track equipment or lead to overloading the subgrade.

21.3.10 Vegetation along and on embankments must be maintained so that stability of the track structure is not compromised.

21.3.11 Adjacent landowners, buildings, and overhead structures must not drain or modify existing drainage ways to divert water onto Metrolinx ROW unless approved in writing by Metrolinx.

21.4 Installation and Extensions of Culverts

21.4.1 Culverts must be installed as per the requirements of the AREMA and Standard Drawings R7A-80.1-1 and R7A-80.1-2 from the Metrolinx General Guidelines for Design of Railway Bridges and Structures.

21.4.2 Culverts must be installed to match the alignment of the flow of water and have as straight an entrance and outlet as possible.

21.4.3 Culverts must be designed and installed as close to the bottom of the stream bed as possible.

21.4.4 When a culvert is placed under a high fill or on a soil base that may settle, the culvert must be cambered (arched slightly upwards).

21.4.5 All culverts must be installed with the entire circumference compacted and all voids filled.

21.4.6 Culverts and culvert extensions must be placed on stable earth or fine granular foundations, absent of large rocks.

21.4.7 Where soft, unstable material is found at the foundation level, it must be excavated 12 in (305 mm) below the flow line grad, backfilled and compacted to grade with screenings of another comparable crushed stone. The building of a suitable foundation must be designed as directed by a Geotechnical Engineer.

21.4.8 When rock is encountered at the foundation level, the rock must be excavated 12 in (305 mm) below the flow line grade, backfilled, and compacted to grade with screenings or comparable crushed stone.

21.4.9 When placing two (2) or more corrugated steel pipes alongside each other, there must be sufficient space between them to allow room for tamping the backfill and to provide side support.

21.4.10 Backfill material must be graded granular material, free from rocks and hard earth clods larger than 3 in (76 mm) in size.

21.4.11 Backfilling must start under the lower part of the pipe, moving up to the sides of the culvert, and placing backfill material in a width equal to the diameter of the culvert pipe on both sides. Backfill must be placed in lifts not exceeding 6 in (150 mm) and compacted as per the Metrolinx General Guidelines for Design of Railway Bridges and Structures.

21.4.12 Tamping must be accomplished by using hand tampers or, where space permits, power tampers or vibrators can be used.

21.4.13 When culverts are replaced by jacking a new pipe adjacent to it, the retired culvert must be completely filled with grout.

21.4.14 Changes to existing culvert size or type, or the installation of additional culverts require a hydrology study and must be submitted to the Maintenance Delivery–Manager of Bridges and Structures for approval.

21.4.15 Where feasible, the preferred method of installation of new culverts is through trenchless installation methods.

21.4.16 In hardwood tie territory, when culverts are installed through open-cut methods (including the removal of a track panel) or when ties are removed to allow the culvert installation, every tie must be box anchored for a minimum distance of 200 ft (61.0 m) commencing 200 ft (61.0 m) from the work area in each direction. Destressing of both rails must be conducted post restoration of the track structure. The destressing limits must encompass the work area, plus 200 ft (61.0 m) in both directions.

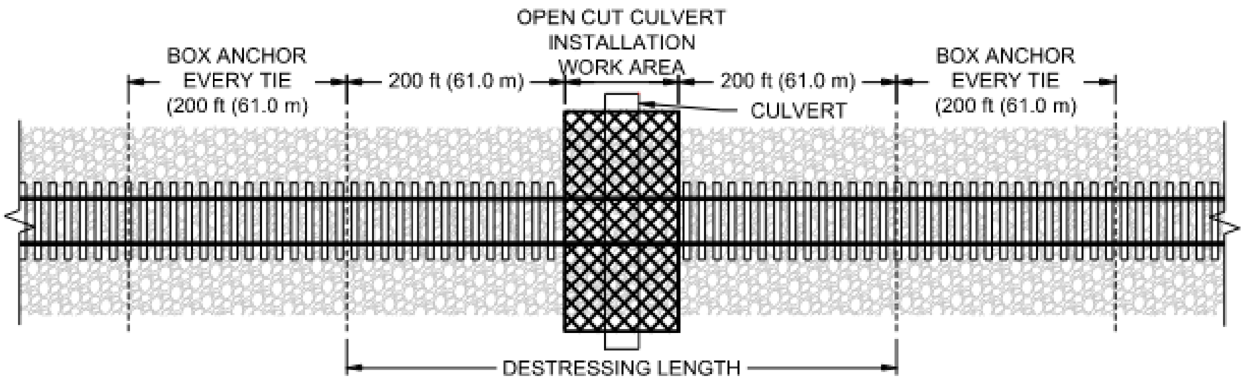


Figure 21-2 Destressing Length for Open-Cut Culvert Installations

21.4.17 Upon completion of the open-cut culvert installations, post-construction track and ground monitoring must be completed as per the requirements in Section 20.2. If requested by the Design Engineer, the duration, monitoring frequency, and spacing of monitoring targets may be modified for shallow culvert installations and must be reviewed and approved by the Director, Engineering—Track or delegate.

21.4.18 General culvert inspection must be undertaken per Track Standard Section 15.12 and under the direction of the Maintenance Delivery—Manager of Bridges and Structures.

22 Signals and Communications

22.1 Precautionary Measures

22.1.1 Anyone performing work on Metrolinx ROW must not damage Signal and Communication (S&C) infrastructure.

a) A precondition assessment of the work area must be completed prior to commencing work to identify S&C infrastructure.

22.1.2 All personnel must observe S&C infrastructure for abnormal conditions and must be prepared to protect Metrolinx assets and the public. The Maintenance Delivery–Manager of S&C must be advised.

a) Locates must be obtained and verified on-site by the signals maintenance contractor before work commences. Locates must include Metrolinx and third-party utilities; and

b) CN, CPKC, and third-party companies (e.g., Bell, Rogers, Telus, Zayo) may have fibre optic cables within Metrolinx ROW. Locates must include all fibre optic cable requests for Metrolinx ROW.

22.1.3 For additional S&C requirements within Metrolinx ROW, please refer to GO Transit Signals & Communications Standards Codes of Practice (RC-0506-03SIG-02) and GO Transit Signals and Communications Standards General Instructions (RC-0506-03SIG-01)

22.1.4 Joints intended to be eliminated with a field welding process in signalled territory must be supported with an approved signals work methodology plan.

22.2 Underground Cables

22.2.1 Table 22-1 is a guideline of the associated risk with these and other equivalent types of activities.

Table 22-1 Risk Association for S&C

Work Activity	Risk
Ditching; Culvert Replacement; Undercutting; Ground Disturbance/Excavation; Bridge Deck Replacement; Derailment Clean-up; Crossing Rehabilitation	High
Surfacing and Ballast Regulating; Out-of-Face Tie Replacement; In-track Flash Butt Welding; Rail Replacement	Medium
Brooming	Low

Note: Work activities impacting the S&C infrastructure must not start without written permission from the Maintenance Delivery–Manager of S&C Manager in the form of an approved work plan and or an issued excavation permit. The Maintenance Delivery–Manager of S&C will assign signal support to oversee the work activities.

22.2.2 Prior to any excavation on Metrolinx ROW, the Maintenance Delivery–Manager of S&C must be notified in writing a minimum of seven (7) days in advance of work.

a) Where it is reasonably practical, the qualified S&C Employee must remain at the excavation site while the work is being performed;

b) Permanent cable markers are installed to indicate the presence of cable and do not indicate the precise location of the buried cable. Cables must be day-lighted for location and depth;

c) Cables may run anywhere on the ROW and at varying depths. Shallow cables may be encountered, especially near culverts, station platforms, underground passageways, and the ends of ducts at approaches to bridges and tunnels;

d) Buried S&C infrastructure may include power distribution circuits energized at potentials as high as 7200 volts AC. Use extreme care when excavating near such facilities to avoid damage to cable or wire insulation. When necessary to protect persons excavating in proximity to hazardous equipment and cables, power distribution circuits in the affected area must be isolated or de-energized for work safety;

e) When it is necessary to isolate or de-energize 7200 Volt circuits, please refer to SCP-1503 in the GO Transit Signals & Communications Standards Codes of Practice (RC-0506-03SIG-02);

f) Excavation in proximity to buried power distribution cables must be completed using a dry vacuum truck or hand tools equipped with wooden handles or insulating material;

g) If buried cables are damaged during excavation, the damage and location must be reported to the S&C Employee on site and the Maintenance Delivery—Manager of Signals & Communications; and

h) During excavation, exposed cables must have temporary supports installed at a maximum of 15 ft (4.6 m) spacing.

22.2.3 Cable installed in bridge troughing must be considered as underground cable. Track Standard Section 22.2.2 applies, including notification of bridge troughing removal, repair or disturbance.

22.2.4 Stakes, flag masts, or signs must not be driven into the ground without locates. Rail mounted flag staffs must be used to display all track flags.

a) This restriction applies to all locations with buried gas or fuel lines.

22.2.5 Shallow stakes, such as grade or line stakes or flags for temporary track protection, must be hand-dug and must not exceed 12 in (305 mm) deep.

22.2.6 Trackside ROW signposts must not be installed without locates in writing and markings placed on the ground. Excavation of the signpost hole must be done in compliance with SCP-1000 of the GO Transit Signals & Communications Standards Codes of Practice (RC-0506-03SIG-02).

22.3 Working within Crossing Circuits

22.3.1 Restrictions for planned work at crossings or within the approach circuit of a crossing:

a) The Maintenance Delivery—Manager of S&C requires a minimum of five (5) business days advance notice in writing;

b) Locates must be obtained and on-site for verification by the S&C Employee before work commences;

c) Prior to excavation, cables must be day-lighted for location and depth;

d) The integrity of the crossing must not be compromised;

e) Nuisance ringing, interference or continuous activation of the crossing warning device must be avoided; and.

f) Manual flagging protection must be in place to protect the crossing warning device interference.

22.3.2 Rail work within an approach crossing circuit for a road crossing equipped with a crossing warning device must be planned to avoid interruption of the normal operation of the protection:

a) The Maintenance Delivery—Manager of Signals & Communications must be notified prior to the application of rail bypass cables or temporary bond wires;

b) The Metrolinx Work Method for the Use of Temporary Rail Bypass Cables (TRBC) must be followed;

c) A specific job briefing must be conducted identifying the use of the temporary bonds and rail bypass cables;

d) Temporary bonds and rail bypass cables must only be applied when rail cutting/welding is expected to be completed within the same shift that the temporary bonds are installed;

e) Positive protection (either TOP or 842 with protection) must be in place prior to applying the Temporary Rail Bypass Cables;

f) The Metrolinx Work Method for the Use of Temporary Rail Bypass Cables (TRBC) form must be completed to record the use of the temporary bonds and rail bypass cables. Temporary rail bonds and rail bypass cables must be an approved type and be a maximum of 100 ft (30.48 m) long of orange S-8 signal bond wire;

g) Track, Welding, S&C and other Employees, trained in the application of bonding and rail repair may install temporary rail bonds;

h) Temporary rail bond may be applied on non-insulated joint;

i. The maximum temporary rail bond length is 60 in (1524 mm);

ii. The S&C Maintainer and Maintenance Delivery–Manager of S&C must be notified of the installation; and

iii. The temporary bond wire must be removed and/or replaced with permanent bonds within 72 hours by a qualified S&C Employee.

i) Rail bypass cables and temporary bond wires must not be installed:

i. At insulated joints;

ii. Within interlocking limits;

iii. Across the track from one rail to the other; or

iv. For the purpose of circumventing normal signal operation.

j) In the event the crossing activates with rail bypass cables applied, perform the following:

i. Check both ends of the cable for tightness and wait 20 seconds to see if the crossing recovers;

ii. If the crossing does not recover, remove and reapply each end of the TRBC, each time waiting 20 seconds to see if crossing recovers; and

iii. If the crossing does not recover, contact the S&C Maintainer and arrange for manual protection of the crossing until the issue is rectified.

k) The temporary rail bond(s) must be removed from the track immediately when the work is complete.

i. Employees must contact the S&C Maintainer prior to the removal of the TRBC;

ii. If the TRBC is removed and the S&C Maintainer has not yet inspected the crossing circuit, instructions must be given to approaching trains that they must be prepared to stop and manually protect the crossing; and

iii. In signalled territory, positive protection and routing must remain in place until the S&C Maintainer has verified the proper operation of the signal system.

23 Fire Prevention

23.1 Precautionary Measures

23.1.1 Prevention of fires on the Railway ROW and structures must be considered at the beginning of each task when working in the ROW.

23.1.2 Fire risk is highest during spring when dry grasses are prevalent. Fire risk can also rise in the summer during extreme hot and dry periods, and anytime work is performed near wooden structures. Regional warnings or advisories should be noted when working in these types of conditions.

23.1.3 Third parties and contractors are required to provide their safe-work procedures to the Metrolinx E&AM-Track prior to commencing work. Those procedures include measures to be taken to prevent fires and to perform Hot Work safely for employees, the public, and the environment and must include details on processes, tools, hazards and exact locations of work.

23.1.4 A 'Right-of-Way and Bridge Fire Risk Assessment, Mitigation and Emergency Response' must be completed prior to any hot work being carried out.

23.1.5 A Fire Watch must be in place during and after the hot work and must:

a) Have adequate communication and contact information to request assistance when required.

b) Be equipped with sufficient fire-fighting equipment to suppress any flare-ups. Sufficient equipment is defined as:

   i. Two (2) filled five (5) gallon (19 L) backpack sprayers;

   ii. Two (2) round-nose shovels; and

   iii. Two (2) Pulaski tools (a hand tool which combines an axe and an adze).

c) Be stationed in a safe position to fight fires as work is being performed.

d) Remain at the location for a minimum of two (2) hours after the work is completed.

23.1.6 Fire prevention and fire awareness training is required for any fire watch Employees.

23.1.7 A Fire Services inspector has the right to request access to the ROW to assess fire safety risk and training.

23.1.8 Hot work activities will be restricted when Fire Danger Status, according to the Canadian Wildland Fire Information System (CWFIS), is "High," "Very High," or "Extreme."

23.1.9 The following risk factors must be considered prior to performing hot work in the ROW:

a) Dry or dead vegetation;

b) Ties or timbers stacked and/or distributed along the ROW;

c) Weather (wind speed/direction, temperature, recent precipitation, humidity, forecasts);

d) Structural materials such as timber caps, stringers, piling, posts, and ties. The older this material is, the higher the risk of igniting;

e) Clothing – greasy and oily clothing can be ignited;

f) Smoking within the ROW must be controlled, and all butts must be buried or disposed of properly;

g) Equipment with steel tracks or cutting heads that can spark;

h) Fueling location and spills; and

i) Parking/vehicle stopping locations should be carefully selected so hot exhaust gases do not ignite dry vegetation.

23.1.10 Working activities addressed through this section include but are not limited to:

a) Cutting rail with a saw or torch;

b) Welding and drilling rail;

c) Working on or near timber structures;

d) Dragging rail; and

e) Rail grinding and milling.

23.1.11 For routine work during "High," "Very High," or "Extreme" Fire Danger Status (according to the CWFIS), additional fire protection must include:

a) Increasing the quantity of water carried on board trucks to at least 90 gallons (340 L), which includes at least four (4) filled five (5) gallon (19 L) backpack sprayers with foaming nozzles;

b) Foam fire suppressant added to the water supply;

c) Centrifugal pumps with at least 100 ft (30.5 m) of 1-1/2 in (38 mm) diameter hose;

d) Wetting of the area where sparks may be generated and in the direction of the wind;

e) Use of spark screens for all cutting, welding, and grinding;

f) Wetting of area after work is complete; and

g) Posting a fire watch after the work is complete.

23.1.12 Hot Work on a structure or a timber-lined structure must include:

a) A site inspection to identify all hazards, in particular, fire hazards, including the structure itself;
b) Removal of dried vegetation and any piled timbers;
c) Wetting of the immediate area and materials in the direction the wind is blowing prior to commencing hot work:
   i. Foam suppressant additive to be mixed with water;
   ii. Foam must be protected from entering any nearby watercourse; and
   iii. Foam makes ties slippery, and additional caution must be exercised.
d) Fireproof mats or packing sand will be placed to protect timber. Sand must not foul any ballast;
e) Spark shields must be used on timber structures in all conditions;
   i. Direct cutting sparks to the center of track.
f) Cutting of structural components or rail must be made:
   i. With a saws-all, abrasive saws or shear for sway brace and hook bolts, drift pins, etc.;
   ii. Using abrasive saws for cutting rail;
   iii. Using a torch is the last option and is only allowed with approval from the Maintenance Delivery—Manager of Bridges and Structures; and
   iv. Using chain saws to cut wood components.
g) Wet the entire area as often as required both during and after the work is completed; and
h) A fire watch must remain in place for a minimum of two (2) hours and until any welds cool to ambient temperature.

23.1.13 Long-term bridge construction or repair projects which involve pile driving, significant torch cutting, or another fire risk must have a fire fighting and prevention plan, that includes pumps and hoses utilizing either river or a minimum of a 300-gallon (1,135 L) portable water tank.

23.1.14 For welding rail on bridges, refer to the Metrolinx Welding Manual.

23.1.15 A fire watch must follow any rail dragging operation, checking for damaged rail fasteners and for fires or smouldering ties.

23.1.16 For rail grinding, refer to Track Standards Section 6.

23.1.17 For field welding, refer to Track Standards Section 8 and the Metrolinx Welding Manual.

23.1.18 In the event of a fire or flare-up on or near any part of a structure, a fire watch must remain in place for a minimum of four (4) hours after the fire has been extinguished.

23.2 Job Briefings

23.2.1 The minimum job briefing required for any hot work must include the following and be in accordance with the Metrolinx Welding Manual Section 3.1:

a) A completed 'Right-of-Way and Bridge Fire Risk Assessment, Mitigation and Emergency Response;'

b) The nearest fire department or fire service;

c) The contact number for fire/emergency services;

d) Access to the location and directions to the site;

e) Any warnings, advisories or work restrictions issued by any agencies concerning fire danger status;

f) Fire-fighting equipment on hand and ensuring operability of such equipment:

   i. A minimum of two (2) five (5) gallon (19 L) backpack sprayers with foaming nozzles;

   ii. A minimum of two (2) round-nose shovels; and

   iii. A minimum of two (2) Pulaski tools (a hand tool which combines an axe and an adze).

g) Fire equipment must be staged no more than 50 ft (15.2 m) from the work location.

Appendices

Appendix A – Class of Track

Table A-1 Class of Track (mph)

Class of Track	Maximum Allowable Speed (mph)	
	Passenger	Freight
1	15	10
2	30	25
3	60	40
4	80	60
5	95*	80
6	110	N/A
7	125	N/A

*VIA LRC Trains -100mph

Table A-2 Class of Track (km/h)

Class of Track	Maximum Allowable Speed (km/h)	
	Passenger	Freight
1	25	15
2	50	40
3	100	65
4	130	100
5	150*	130
6	175	N/A
7	200	N/A

*VIA LRC Trains -160km/h

Appendix B – Track Inspection and Testing Frequencies

Table B-1 Routine Track Inspection Frequencies

Routine Track Inspection Frequency				
Type of Track	Class of Track	Annual Tonnage		
		< 5 MGT	5-15 MGT	>15MGT
All Track	1	Monthly*	Twice Monthly*	Weekly
	2, 3	Twice Weekly	Twice Weekly	Twice Weekly
	4, 5	Twice Weekly	Twice Weekly	Twice Weekly
Yard Track	Category 1†	Twice Monthly	Twice Monthly	Twice Monthly
	All Other	Monthly	Monthly	Monthly
Inactive Track		Before being used		

* For Class 1 tracks where passenger trains / GO Trains operate with passengers, inspection frequency must be weekly.

† Category 1 is defined as a yard track carrying more than 500 cars daily.

Note: Metrolinx yards are considered Class 1.

Table B-2 Walking Track Inspection Frequencies

Walking Track Inspection Frequency				
Class of Track	Annual Tonnage			
	<5 MGT	5 - 15 MGT	>15 - 30 MGT	> 30 MGT
1**	Every 2nd year	Every 2nd year	Every 2nd year	Every 2nd year
2	Every 2nd year	Every 2nd year	Every 2nd year	Annually
3	Every 2nd year	Every 2nd year	Annually	Annually
4,5	Annually	Annually	Annually	Annually

*Note: If electronic or camera inspection of joint bars is performed, walking inspection of tangent track and curves less than 4 degrees in jointed track is not required by Transport Canada.

** Includes non-main track

Table B-3 Walking Jointed Track Inspection

Walking Jointed Track Inspection Frequency					
Class of Track	Annual Tonnage				
	<5 MGT	5 - 15 MGT	>15 - 35 MGT	35 - 80 MGT	>80 MGT
1**	N/A	N/A	N/A	N/A	N/A
2	Every 2nd year	Every 2nd year	Annually	Annually	Twice Annually
3	Annually	Annually	Annually	Twice Annually	Three times Annually
4,5	Annually	Twice Annually	Twice Annually	Twice Annually	Three times Annually

*Note: If electronic or camera inspection of joint bars is performed and is capable of identifying cracked or broken joint bars and loose, broken and missing bolts, walking inspection of jointed track is not required by Transport Canada.

** Includes non-main track

Table B-4 Joint Bar Inspection Frequencies

Joint Bar Inspection Frequency					
Minimum Number of Inspections Per Calendar Year1					
Class of Track	Passenger (MGT)		Freight (MGT)		
	<20	≥20	<40	≥40 and <60	≥60
Excepted Track	N/A	N/A	0	0	0
1	0	0	0	0	0
2	1	1	0	0	0
3	2	2	1	2	2
4	2	3[2]	2	3[2]	4[2]
5	3[2]	4[2]	2	3[2]	4[2]

[1] Where Metrolinx operates both freight and passenger trains over a given segment of track, and there are two different possible inspection interval requirements, the more frequent inspection interval applies.
[2] When extreme weather conditions prevent an inspection of a particular territory within the required interval, the Director, Engineering-Track may extend the interval by up to 30 calendar days from the last day that the extreme weather condition prevented the required inspection.

Note: This table applies to joints found within CWR territory.

Table B-5 Derail Inspection Frequency

Inspection Frequency for Derails	
Type of Inspection	Description
Walking Inspection	Each derail must be inspected on foot at least monthly, observing overall condition.
Detailed Inspection	A thorough detailed observation of each derail must be performed annually. Particular attention should be paid to ties, fasteners, and ballast condition. Check for any distortion, fractures, damage from derailments or accidents or unusual wear on the derail.

Note: Electronic derails must also be inspected by a qualified signals maintainer.

Table B-6 Turnout, At-Grade Crossing, Direct Fixation Track and Special Trackwork Inspection Frequency

Turnout, At-Grade Crossing, and Special Trackwork Inspection Frequency	
Type of Inspection	Description
Routine Inspection	Each time a turnout, At-Grade Crossing, direct fixation track and Special Trackwork components are crossed it must be visually inspected for defects and noted on the track inspection report.
Walking Inspection	Each turnout, At-Grade Crossing, direct fixation track and Special Trackwork components must be inspected on foot at least monthly and observing overall condition. In the case that the track is used less than monthly, each turnout will be inspected on foot before the track is used. Inspections will be noted on the applicable inspection report. For turnouts on Class 4 or 5 track with a tonnage exceeding 35 MGT per year, this inspection must be bi-weekly.
Detailed Inspection	A thorough detailed inspection of the condition of all components in each turnout, At-Grade Crossing, direct fixation track and Special Trackwork component must be performed annually*. Inspections will be noted on the applicable inspection report. *Spring Frogs will be inspected in detail twice annually.

Table B-7 Rail Flaw Testing Frequency

Designated Minimum Rail Flaw Inspection Frequency					
Class of Track	**<5 MGT**	**5 – 15 MGT**	**>15 – 35 MGT**	**35 – 80 MGT**	**> 80 MGT**
Yard Track	N/A*	N/A*	N/A*	N/A*	N/A*
Class 1	N/A*	N/A*	N/A*	N/A*	N/A*
Class 2	Once every 2nd year	Annually	Annually	Twice Annually	Three Times Annually
Class 3	Annually	Annually	Annually	Three times Annually	Four Times Annually
Class 4	Annually	Twice Annually	Three Times Annually	Four Times Annually	Five Times Annually
Class 5	Annually	Twice Annually	Three Times Annually	Five Times Annually	Five Times Annually

Note: Metrolinx yards and layover facilities are considered Class 1.

* All Metrolinx layover facilities, yard, and lead tracks, including non-main tracks and Class 1 main tracks leading from/to these yards, must be hand-tested at least annually. All routes leading to foreign railway yards and industrial tracks must be tested up to the marked delineation point.

Table B-8 Electronic Geometry Inspection Frequency

Designated Minimum Electronic Geometry Inspection Frequency					
Class of Track	**<5 MGT**	**5 - 15 MGT**	**>15 - 35 MGT**	**35 - 80 MGT**	**> 80 MGT**
Yard Tracks	LGIV - Annually†	LGIV - Annually†	LGIV - Annually†	LGIV - Annually†	LGIV - Annually†
Crossovers*	HGIV – Annually	HGIV – Annually	HGIV – Annually	HGIV – Annually	HGIV – Annually
Class 1	LGIV - Annually†	HGIV – Annually	HGIV – Annually	HGIV – Annually	HGIV – Twice Annually
Class 2	HGIV – Annually	HGIV – Annually	HGIV – Twice Annually	HGIV – Twice Annually	HGIV – Twice Annually
Class 3	HGIV – Annually	HGIV – Annually	HGIV - Twice Annually	HGIV – Three Times Annually	HGIV – Three Times Annually
Class 4	HGIV - Twice Annually	HGIV - Twice Annually	HGIV - Twice Annually	HGIV – Three Times Annually	HGIV – Three Times Annually
Class 5	HGIV – Twice Annually	HGIV - Twice Annually	HGIV - Twice Annually	HGIV - Three Times Annually	HGIV - Quarterly

*Track geometry inspection on non-mainline crossovers where track speed is 30mph or less is not required unless otherwise directed by the Director, Engineering—Track. All routes leading to foreign railway yards and industrial tracks must be tested up to the marked delineation point annually through an LGIV†.

†LGIV requirement may be substituted for a device capable of measuring, recording and evaluating deviations in gauge and cross-level.

NOTE: The Director, Engineering—Track can request the use of an HGIV instead of a LGIV based on location.

Appendix C – Priority and Near Urgent Defects

Table C-1 Priority Defects

PRIORITY DEFECTS	Track Class						
	1	2	3	4	5	6	7
Passenger Speed (mph)	**15**	**30**	**60**	**80**	**95***	**110**	**125**
Freight Speed (mph)	**10**	**25**	**40**	**60**	**80**	**N/A**	**N/A**
Wide Gauge	57-1/2 in (1460 mm)	57-1/4 in (1454 mm)	57-1/4 in (1454 mm)	57-1/4 in (1454 mm)	57-1/4 in (1454 mm)	57 in (1448 mm)	57 in (1448 mm)
Narrow Gauge	56-1/8 in (1426 mm)	56-1/8 in (1426 mm)	56-1/8 in (1426 mm)	56-1/4 in (1429 mm)	56-1/4 in (1429 mm)	56-3/8 in (1432 mm)	56-3/8 in (1432 mm)
Gauge in Turnouts	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)	± 1/4 in (6.3 mm)
Alignment Tangent 62 ft (18.9 m)	3-3/4 in (95 mm)	2-1/4 in (57 mm)	1-3/8 in (35 mm)	1-1/8 in (28 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Alignment Curve/Spiral 62 ft (18.9 m)	3-3/4 in (95 mm)	2-1/4 in (57 mm)	1-3/8 in (35 mm)	1-1/8 in (28 mm)	1/2 in (12.7 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Alignment Curve/Spiral 31 ft (9.45 m)	N/A	N/A	7/8 in (22 mm)	3/4 in (19 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Surface	2 in (51 mm)	1-1/2 in (38 mm)	1-1/4 in (32 mm)	1 in (25 mm)	3/4 in (19 mm)	3/4 in (19 mm)	3/4 in (19 mm)
Warp 31 ft (9.45 m)	1-7/8 in (48 mm)	1-5/8 in (41 mm)	1-1/8 in (28 mm)	7/8 in (22 mm)	5/8 in (15.9 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Warp 62 ft (18.9 m)	2-1/4 in (57 mm)	1-3/4 in (44 mm)	1-1/2 in (38 mm)	1-3/8 in (35 mm)	1-1/8 in (28 mm)	3/4 in (19 mm)	3/4 in (19 mm)
Deviation from zero cross-level at any point on tangent track	1 in (25 mm)	1 in (25 mm)	3/4 in (19 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)	1/4 in (6.3 mm)	1/4 in (6.3 mm)

* 100 mph for LRC

Table C-2 Near Urgent Defects

NEAR URGENT DEFECTS	Track Class						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Passenger Speed (mph)	**15**	**30**	**60**	**80**	**95***	**110**	**125**
Freight Speed (mph)	**10**	**25**	**40**	**60**	**80**	**N/A**	**N/A**
Wide Gauge	57-5/8 in (1462 mm)	57-1/2 in (1460 mm)	57-1/2 in (1460 mm)	57-1/2 in (1460 mm)	57-3/8 in (1457 mm)	N/A	N/A
Narrow Gauge	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alignment Tangent 62 ft (18.9 m)	4-1/2 in (114 mm)	2-3/4 in (68 mm)	1-5/8 in (41 mm)	1-3/8 in (35 mm)	5/8 in (15.9 mm)	N/A	N/A
Alignment Curve/Spiral 62 ft (18.9 m)	4-1/2 in (114 mm)	2-3/4 in (68 mm)	1-5/8 in (41 mm)	1-3/8 in (35 mm)	N/A	N/A	N/A
Alignment Curve/Spiral 31 ft (9.45 m)	N/A	N/A	1-1/8 in (28 mm)	7/8 in (22 mm)	N/A	N/A	N/A
Surface	2-3/4 in (70 mm)	2-1/2 in (64 mm)	2 in (51 mm)	1-3/4 in (44 mm)	1-1/8 in (28 mm)	7/8 in (22 mm)	7/8 in (22 mm)
Warp 31 ft (9.45 m)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Warp 62 ft (18.9 m)	2-3/4 in (70 mm)	2 in (51 mm)	1-3/4 in (44 mm)	1-5/8 in (41 mm)	1-3/8 in (35 mm)	7/8 in (22 mm)	7/8 in (22 mm)
Deviation from zero cross level at any point on tangent track	2-3/4 in (70 mm)	1-3/4 in (44 mm)	1-5/8 in (41 mm)	1-1/8 in (28 mm)	7/8 in (22 mm)	3/4 in (19 mm)	3/4 in (19 mm)
Runoff at End of a Raise	3-1/8 in (79 mm)	2-3/4 in (70 mm)	1-3/4 in (44 mm)	1-3/8 in (35 mm)	7/8 in (22 mm)	5/8 in (15.9 mm)	5/8 in (15.9 mm)

**100 mph for LRC Trains*

Table C-3 Near Urgent Defects (Multiple Defects)

NEAR URGENT DEFECTS (Multiple Defects)		Track Class			
		4	**5**	**6**	**7**
Passenger Speed (mph)		**80**	**95***	**110**	**125**
Freight Speed (mph)		**60**	**80**	**N/A**	**N/A**
Multiple Surface	31 ft Chord (9.45 m)	N/A	N/A	3/8 in (9.5 mm)	3/8 in (9.5 mm)
	62 ft Chord (18.9 m)	7/8 in (22 mm)	5/8 in (15.9 mm)	3/8 in (9.5 mm)	3/8 in (9.5 mm)
Multiple Alignment	31 ft Chord (9.45 m)	N/A	N/A	1/8 in (3 mm)	1/8 in (3 mm)
	62 ft Chord (18.9 m)	N/A	N/A	1/4 in (6.3 mm)	1/8 in (3 mm)

For three (3) or more non-overlapping deviations occurring within a distance equal to five (5) times the chord length.
**100 mph for LRC Train*

Appendix D – Urgent Defects

Table D-1 Urgent Defects

URGENT DEFECTS	Track Class						
	1	2	3	4	5	6	7
Passenger Speed (mph)	**15**	**30**	**60**	**80**	**95***	**110**	**125**
Freight Speed (mph)	**10**	**25**	**40**	**60**	**80**	**N/A**	**N/A**
Wide Gauge	57-3/4 in (1467 mm)	57-5/8 in (1462 mm)	57-5/8 in (1462 mm)	57-1/2 in (1460 mm)	57-1/2 in (1460 mm)	57-1/4 in (1454 mm)	57-1/8 in (1451 mm)
Narrow Gauge	56 in (1422 mm)	56 in (1422 mm)	56 in (1422 mm)	56 in (1422 mm)	56 in (1422 mm)	56-1/4 in (1429 mm)	56-1/4 in (1429 mm)
Alignment Tangent 62 ft (18.9 m)	5 in (127 mm)	3 in (76 mm)	1-3/4 in (44 mm)	1-1/2 in (38 mm)	3/4 in (19 mm)	5/8 in (15.9 mm)	1/2 in (12.7 mm)
Alignment Curve/Spiral 62 ft (18.9 m)	5 in (127 mm)	3 in (76 mm)	1-3/4 in (44 mm)	1-1/2 in (38 mm)	5/8 in (15.9 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)
Alignment Curve/Spiral 31 ft (9.45 m)	N/A	N/A	1-1/4 in (32 mm)	1 in (25 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)
Surface	3 in (76 mm)	2-3/4 in (70 mm)	2-1/4 in (57 mm)	2 in (51 mm)	1-1/4 in (32 mm)	1 in (25 mm)	1 in (25 mm)
Warp 31 ft (9.45 m)	2 in (51 mm)	1-3/4 in (44 mm)	1-1/4 in (32 mm)	1 in (25 mm)	3/4 in (19 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)
Warp 62 ft (18.9 m)	3 in (76 mm)	2-1/4 in (57 mm)	2 in (51 mm)	1-3/4 in (44 mm)	1-1/2 in (38 mm)	1 in (25 mm)	1 in (25 mm)
Deviation from zero cross-level on tangent	3 in (76 mm)	2 in (51 mm)	1-3/4 in (44 mm)	1-1/4 in (32 mm)	1 in (25 mm)	7/8 in (22 mm)	7/8 in (22 mm)
Runoff at End of a Raise	3-1/2 in (89 mm)	3 in (76 mm)	2 in (51 mm)	1-1/2 (38 mm)	1 in (25 mm)	3/4 in (19 mm)	3/4 in (19 mm)

**100 mph for LRC Trains*
See Track Standards Section 16.2.1 for more details on narrow gauge restriction.

Table D-2 Urgent Defects (Multiple Defects)

URGENT DEFECTS (Multiple Defects)		Track Class			
		4	5	6	7
Passenger Speed (mph)		**80**	**95***	**110**	**125**
Freight Speed (mph)		**60**	**80**	**N/A**	**N/A**
Multiple Surface	31 ft Chord (9.45 m)	N/A	N/A	1/2 in (12.7 mm)	1/2 in (12.7 mm)
	62 ft Chord (18.9 m)	1 in (25 mm)	3/4 in (19 mm)	1/2 in (12.7 mm)	1/2 in (12.7 mm)
Multiple Alignment	31 ft Chord (9.45 m)	N/A	N/A	1/4 in (6.3 mm)	1/4 in (6.3 mm)
	62 ft Chord (18.9 m)	N/A	N/A	3/8 in (9.5 mm)	1/4 in (6.3 mm)

For three (3) or more non-overlapping deviations occurring within a distance equal to five (5) times the chord length.
**100 mph for LRC Trains*

Table D-3 Combination Defects

URGENT DEFECTS (Combination Defects)		Track Class 1	2	3	4	5
Passenger Speed (mph)		**15**	**30**	**60**	**80**	**95***
Freight Speed (mph)		**10**	**25**	**40**	**60**	**80**
Alignment and Surface	Alignment Curve/Spiral 31 ft (9.45m)	N/A	1 in (25 mm)	7/8 in (22 mm)	7/8 in (22 mm)	N/A
	Surface	N/A	1-1/2 in (38 mm)	1-1/4 in (32 mm)	1-1/4 in (32 mm)	N/A
Alignment and Warp 31	Alignment Curve/Spiral 31 ft (9.45m)	2 in (51 mm)	1-1/4 in (32 mm)	1 in (25 mm)	3/4 in (19 mm)	N/A
	Warp 31 ft (9.45 m)	1-3/4 in (44 mm)	1-1/4 in (32 mm)	1 in (25 mm)	3/4 in (19 mm)	N/A

Any part of one (1) defect must be within 11 ft (3.35 m) of the other defect to be considered a combination defect.
**100 mph for LRC Trains*

NOTE:

Wide Gauge: The distance between the gauge points of the rails 5/8" (16 mm) below the top of the rail may not be more than:
Narrow Gauge: The distance between the gauge points of the rails 5/8" (16 mm) below the top of the rail may not be less than:
Alignment 62 Tangent: The deviation of the mid-offset from a 62 ft (18.9 m) chord may not be more than:
Alignment 62 Curve: The deviation of the mid-ordinate from a 62 ft (18.9 m) chord may not be more than:
Alignment 31: The deviation of the mid-ordinate from a 31 ft (9.45 m) chord may not be more than:
Surface: The deviation from uniform profile on either rail at the mid-ordinate of a 62 ft (18.9m) chord may not be more than:
Warp 31: The difference in cross level between any two points within 31ft (9.45 m) apart in spirals may not be more than:
Warp 62: The difference in cross level between any two points within 62 ft (18.9m) apart may not be more than:
Deviation from zero cross-level on tangent: The deviation from zero cross level at any point on tangent track or reverse cross level elevation on non tangent track may not be more than:
Runoff: The runoff in any 31ft (9.45 m) of rail at the end of a raise may not be more than:

Appendix E – Allowable TSO for HGIV Defects – Passenger

Table E-1 Allowable TSO for HGIV Defects - Passenger

Class of Track	Passenger Train Speed	Defect inch (mm)									
		Wide Gauge	Alignment Tangent 62 ft. (18.9 m)	Alignment Curve 62 ft. (18.9 m)	Alignment Curve 31 ft. (9.45 m)	Surface	Warp 31ft. (9.45 m) Spirals	Warp 62 ft. (18.9 m) Tangents, Spirals, and Curves	Cross-Level Tangents and Curves	Cross-Level Spirals	Runoff at End of Raise
1	15	57-3/4 (1466)	5 (127)	5 (127)	No Limit	3 (76)	2 (51)	3 (76)	3 (76)	1-3/4 (44)	3-1/2 (89)
2	20	57-3/4 (1466)	4-1/4 (108)	4-1/4 (108)	No Limit	2-7/8 (73)	1-7/8 (47)	2-5/8 (66)	2-5/8 (66)	1-5/8 (41)	3-5/16 (84)
	25	57-3/4 (1466)	3-5/8 (92)	3-5/8 (92)	No Limit	2-13/16 (71)	1-13/16 (46)	2-5/16 (59)	2-5/16 (58)	1-9/16 (39)	3-1/8 (79)
	30	57-5/8 (1464)	3 (76)	3 (76)	No Limit	2-3/4 (70)	1-3/4 (44)	2 (51)	2 (51)	1-1/2 (38)	3 (76)
3	45	57-5/8 (1464)	2-3/8 (60)	2-3/8 (60)	1-1/4 (31)	2-1/2 (63)	1-1/2 (38)	1-7/8 (47)	1-7/8 (47)	1-3/8 (35)	2-1/2 (63)
	50	57-5/8 (1464)	2-1/8 (54)	2-1/8 (54)	1-1/4 (31)	2-3/8 (60)	1-3/8 (35)	1-13/16 (46)	1-13/16 (46)	1-5/16 (33)	2-5/16 (58)
	55	57-5/8 (1464)	1-15/16 (49)	1-15/16 (49)	1-1/4 (31)	2-5/16 (58)	1-5/16 (33)	1-3/4 (44)	1-3/4 (44)	1-1/4 (31)	2-1/8 (54)
	60	57-5/8 (1464)	1-3/4 (44)	1-3/4 (44)	1-1/4 (31)	2-1/4 (57)	1-1/4 (31)	1-3/4 (44)	1-3/4 (44)	1-1/4 (31)	2 (51)
4	65	57-5/8 (1464)	1-11/16 (43)	1-11/16 (43)	1-3/16 (30)	2-3/16 (55)	1-3/16 (30)	1-5/8 (41)	1-5/8 (41)	1-3/8 (35)	1-7/8 (48)
	70	57-5/8 (1464)	1-5/8 (41)	1-5/8 (41)	1-1/8 (28)	2-1/8 (54)	1-1/8 (28)	1-1/2 (38)	1-1/2 (38)	1-1/8 (28)	1-3/4 (44)
	75	57-9/16 (1462)	1-9/16 (39)	1-9/16 (39)	1-1/16 (27)	2-1/16 (52)	1-1/16 (27)	1-3/8 (35)	1-3/8 (35)	1-1/16 (27)	1-5/8 (41)
	80	57-1/2 (1460)	1-1/2 (38)	1-1/2 (38)	1 (25)	2 (51)	1 (25)	1-1/4 (31)	1-1/4 (31)	1 (25)	1-1/2 (38)
5	85	57-1/2 (1460)	1-1/4 (31)	1-3/16 (30)	13/16 (21)	1-3/4 (44)	7/8 (22)	1-1/8 (28)	1-1/8 (28)	7/8 (22)	1-5/16 (33)
	90	57-1/2 (1460)	1 (25)	7/8 (22)	5/8 (16)	1-1/2 (38)	13/16 (21)	1-1/16 (27)	1-1/16 (27)	13/16 (21)	1-1/8 (28)
	95	57-1/2 (1460)	3/4 (19)	5/8 (16)	1/2 (13)	1-1/4 (32)	3/4 (19)	1 (25)	1 (25)	3/4 (19)	1 (25)

Note: This table is used for when speed related track geometry defects are detected during track geometry truck inspections. The table may be used to determine the maximum Temporary Slow Order speed to be applied for the seventy-two (72) hour period.

Appendix F – Allowable TSO for HGIV – Freight

Table F-1 Allowable TSO for HGIV Defects – Freight

Note: This table is used for when speed related track geometry defects are detected during track geometry truck inspections. The table may be used to determine the maximum Temporary Slow Order speed to be applied for the seventy-two (72) hour period.

Class of Track	Freight Train Speed	Defect inch (mm)									
		Wide Gauge	Alignment Tangent 62 ft. (18.9 m)	Alignment Curve 62 ft. (18.9 m)	Alignment Curve 31 ft. (9.45 m)	Surface	Warp 31 ft. (9.45 m) Spirals	Warp 62 ft. (18.9 m) Tangents, Spirals, and Curves	Cross-Level Tangents and Curves	Cross-Level Spirals	Runoff at End of Raise
1	10	57-3/4 (1466)	5 (127)	5 (127)	N/A	3 (76)	2 (51)	3 (76)	3 (76)	1-3/4 (44)	3-1/2 (89)
2	15	57-3/4 (1466)	4-1/4 (108)	4-1/4 (108)	N/A	2-7/8 (73)	1-7/8 (47)	2-5/8 (66)	2-5/8 (66)	1-5/8 (41)	3-5/16 (84)
	20	57-3/4 (1466)	3-5/8 (92)	3-5/8 (92)	N/A	2-13/16 (71)	1-13/16 (46)	2-5/16 (59)	2-5/16 (58)	1-9/16 (39)	3-1/8 (79)
	25	57-5/8 (1464)	3 (76)	3 (76)	N/A	2-3/4 (70)	1-3/4 (44)	2 (51)	2 (51)	1-1/2 (38)	3 (76)
	30	57-5/8 (1464)	2-1/2 (63)	2-1/2 (63)	1-1/4 (31)	2-9/16 (65)	1-9/16 (40)	1-7/8 (48)	1-7/8 (47)	1-3/8 (35)	2-5/8 (66)
	35	57-5/8 (1464)	2-1/8 (54)	2-1/8 (54)	1-1/4 (31)	2-3/8 (60)	1-3/8 (35)	1-13/16 (46)	1-13/16 (46)	1-5/16 (33)	2-5/16 (59)
	40	57-5/8 (1464)	1-3/4 (44)	1-3/4 (44)	1-1/4 (31)	2-1/4 (57)	1-1/4 (31)	1-3/4 (44)	1-3/4 (44)	1-1/4 (31)	2 (51)
4	45	57-5/8 (1464)	1-11/16 (43)	1-11/16 (43)	1-3/16 (30)	2-3/16 (55)	1-3/16 (30)	1-5/8 (41)	1-5/8 (41)	1-3/8 (35)	1-7/8 (48)
	50	57-5/8 (1464)	1-5/8 (41)	1-5/8 (41)	1-1/8 (28)	2-1/8 (54)	1-1/8 (28)	1-1/2 (38)	1-1/2 (38)	1-1/8 (28)	1-3/4 (44)
	55	57-9/16 (1462)	1-9/16 (39)	1-9/16 (39)	1-1/16 (27)	2-1/16 (52)	1-1/16 (27)	1-3/8 (35)	1-3/8 (35)	1-1/16 (27)	1-5/8 (41)
	60	57-1/2 (1460)	1-1/2 (38)	1-1/2 (38)	1 (25)	2 (51)	1 (25)	1-1/4 (31)	1-1/4 (31)	1 (25)	1-1/2 (38)
5	65	57-1/2 (1460)	1-5/16 (33)	1-1/4 (32)	7/8 (22)	1-13/16 (46)	15/16 (24)	1-3/16 (30)	1-3/16 (30)	15/16 (24)	1-3/8 (35)
	70	57-1/2 (1460)	1-1/8 (29)	1-1/16 (27)	3/4 (19)	1-5/8 (41)	7/8 (22)	1-1/8 (29)	1-1/8 (29)	7/8 (22)	1-1/4 (32)
	75	57-1/2 (1460)	15/16 (24)	13/16 (21)	5/8 (16)	1-7/16 (37)	13/16 (21)	1-1/16 (27)	1-1/16 (27)	13/16 (21)	1-1/8 (28)
	80	57-1/2 (1460)	3/4 (19)	5/8 (16)	1/2 (13)	1-1/4 (32)	3/4 (19)	1 (25)	1 (25)	3/4 (19)	1 (25)

Appendix G – Rail Wear and Mismatch Limits

Table G-1 Rail Wear Limits

Vertical Wear Limits						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increased Monitoring	19 mm 3/4 in	17 mm 5/8 in	14.5 mm 9/16 in	12 mm 1/2 in	7 mm 1/4 in	5 mm 3/16 in
Urgent	25.5 mm 1 in	22.5 mm 7/8 in	19 mm 3/4 in	16 mm 5/8 in	9.5 mm 3/8 in	6.5 mm 1/4 in
Gauge Face Wear Limits						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increased Monitoring	12 mm 1/2 in				9.5 mm 3/8 in	8 mm 5/16 in
Urgent	16 mm 5/8 in				13 mm 1/2 in	11 mm 7/16 in
Combined Vertical and Gauge Face Wear Limits						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increased Monitoring	24 mm 15/16 in	22 mm 7/8 in	18 mm 11/16 in	16 mm 5/8 in	10.5 mm 3/8 in	8 mm 5/16 in
Urgent	32 mm 1-1/4 in	28.5 mm 1-1/8 in	24 mm 15/16 in	21 mm 13/16 in	14 mm 9/16 in	11 mm 7/16 in

Note: This table identifies the wear limits when rail must be removed from the track. If rail is worn to or beyond the urgent limits in this table and must be left in track, the Director, Engineering-Track must be notified. A speed restriction may be placed and additional inspection frequency specified at the discretion of the Director, Engineering-Track.

Table G-2 Rail wear limits on Bridges, Overpasses or Tunnels

Vertical Wear Limits						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	14.5 mm 9/16 in	13 mm 1/2 in	11 mm 7/16 in	9 mm 3/8 in	5.5 mm 3/16 in	4 mm 1/8 in
Urgent	19 mm 3/4 in	17 mm 5/8 in	14.5 mm 9/16 in	12 mm 1/2 in	7 mm 1/4 in	5 mm 3/16 in
Gauge Face Wear						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	9 mm 3/8 in				7 mm 1/4 in	6 mm 1/4 in
Urgent	12 mm 1/2 in				9.5 mm 3/8 in	8 mm 5/16 in
Combined Vertical and Gauge Face Wear						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	18 mm 11/16 in	16.5 mm 5/8 in	13.5 mm 1/2 in	12 mm 1/2 in	8 mm 5/16 in	6 mm 1/4 in
Urgent	24 mm 15/16 in	22 mm 7/8 in	18 mm 11/16 in	16 mm 5/8 in	10.5 mm 3/8 in	8 mm 5/16 in

Note: This table identifies the wear limits when rail must be removed from the track. If rail is worn to or beyond the urgent limits in this table and must be left in track, the Director, Engineering-Track must be notified. A speed restriction may be placed and additional inspection frequency specified at the discretion of the Director, Engineering-Track.

Table G-3 Rail Wear Limits on Turnout Closures

Vertical Wear Limits						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	14.5 mm 9/16 in	13 mm 1/2 in	11 mm 7/16 in	9 mm 3/8 in	5.5 mm 3/16 in	4 mm 1/8 in
Urgent	19 mm 3/4 in	17 mm 5/8 in	14.5 mm 9/16 in	12 mm 1/2 in	7 mm 1/4 in	5 mm 3/16 in
Gauge Face Wear						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	9 mm 3/8 in		7 mm 1/4 in		6 mm 1/4 in	
Urgent	12 mm 1/2 in		9.5 mm 3/8 in		8 mm 5/16 in	
Combined Vertical and Gauge Face Wear						
Rail Size	141 lbs.	136RE	132RE	115RE	100ARA	100 lbs. HF
Increase Monitoring	18 mm 11/16 in	16.5 mm 5/8 in	13.5 mm 1/2 in	12 mm 1/2 in	8 mm 5/16 in	6 mm 1/4 in
Urgent	24 mm 15/16 in	22 mm 7/8 in	18 mm 11/16 in	16 mm 5/8 in	10.5 mm 3/8 in	8 mm 5/16 in

Table G-4 Rail End Mismatch at Bolted Joints

Class of Track	Maximum Vertical Mismatch	Maximum Gauge Face Mismatch
1	6 mm (1/4 in)	6 mm (1/4 in)
2 and 3	4.5 mm (3/16 in)	4.5 mm (3/16 in)
4 and 5	3 mm (1/8 in)	3 mm (1/8 in)

Appendix H – Rail Defect Descriptions

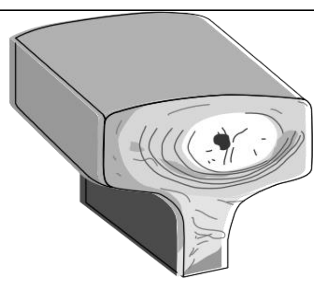
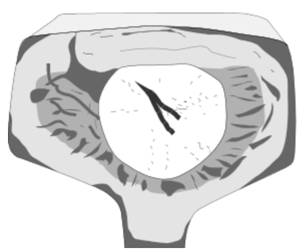
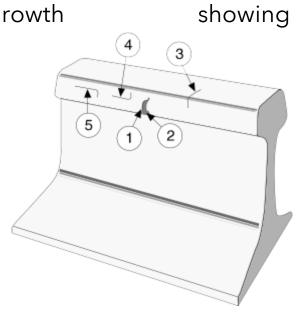
TRANSVERSE DEFECTS

Transverse Defects are any progressive fracture occurring in the head of the rail and have a transverse separation.

No evidence of a transverse defect is visible until the separation has reached the rail surface. One or more of the following may then help recognize a transverse defect:

- A crack at right angles to the running surface, usually on the field or gauge side of the head or at the fillet under the head.
- Evidence of rust around the crack.
- A crack at the gauge corner of the rail head. Numerous cracks on the gauge corner are often present but should cause no suspicion unless a single crack extends much further down the side and across the running surface.
- A horizontal crack in the side of the rail head that turns upward or downward at one or both ends with evidence of rust. A flat spot will generally be present on the running surface of the rail head.
- A crack extending down at right angles from a horizontal crack caused by shelling.

Transverse defects may be classified after the rail is broken for examination as follows:

	Transverse Fissure (TDT or TDW)
 Transverse fissure, showing rapid growth  Transverse fissure, showing sudden growth  Appearance of transverse defects on the surface of the running rail	A progressive crosswise fracture starting from a crystalline center or nucleus inside the head from which it spreads outward as a smooth, bright, or dark, round or oval surface substantially at a right angle to the length of the rail. The distinguishing features of a transverse fissure from other types of fractures or defects are the crystalline center or nucleus and the nearly smooth surface of the development that surrounds it.

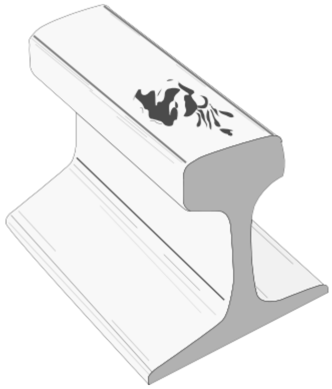
<table>
<tr><td></td><td>Compound Fissure (TDC)

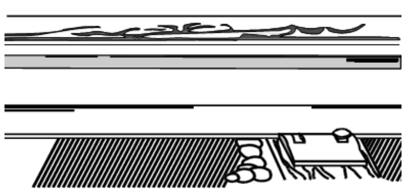
A progressive fracture originating in a horizontal split head which turns up or down in the head of the rail as a smooth, bright, or dark surface progressing until substantially at a right angle to the length of the rail. Compound fissures require examination of both faces of the fracture to locate the horizontal split head from which they originate.</td></tr>
<tr><td></td><td>Detail Fracture (TDD)

A progressive fracture originating at or near the surface of the rail head. These fractures should not be confused with transverse fissures, compound fissures, or other defects that have internal origins. Detail fractures may arise from shelly spots, head checks, or flaking.</td></tr>
<tr><td colspan="2">Engine Burn Fracture (EBF)</td></tr>
<tr><td colspan="2">A progressive fracture originating in spots where driving wheels have slipped on top of the rail head. In developing downward they frequently resemble the compound or even transverse fissures with which they should not be confused or classified</td></tr>
</table>

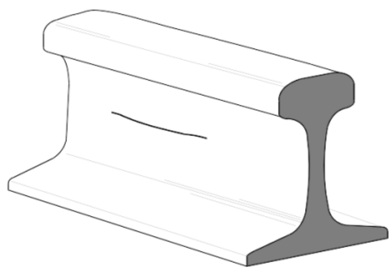
Note: Transverse defects are usually caused by imperfections in the rail steel when rolled. In non-control-cooled rail and chrome rail, a transverse defect is commonly caused by a shatter crack from hydrogen. If one crack is found, there are likely to be many others in the same rail.

Definition and appearance of rail defects are shown below:

<table>
<tr><td rowspan="2"></td><td>Engine Burn (EBF)</td></tr>
<tr><td>Damage to the rail head running surface resulting from locomotive wheel slip.

Appearance in Track:
An oval or round dark area on the rail head running surface where damaged metal breaks out forming a cavity. There are several marks with matching marks found on the adjacent rail. Spacing corresponds with the number of axles and locomotive wheels.</td></tr>
<tr><td rowspan="2"></td><td>Shelly Rail</td></tr>
<tr><td>A horizontal separation, crack out at any level on the gauge side, predominantly at the upper gauge face corner of the rail head. It extends longitudinally on the rail head at an angle related to the rail wear.

Appearance in Track:
1. Dark spots irregularly spaced on the gauge side of the running surface.
2. Longitudinal separations at levels in the upper gauge face corner
3. Most common on curved track.
4. Shelly rail does not appear until the rail head has carried substantial traffic.
Shelly Rail is not to be confused with spalling from burnt steel in chrome rail, which is a type of mill defect. Spalling from burnt steel will show up within a few days after the rail is laid.</td></tr>
</table>

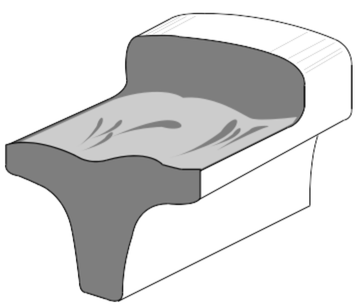


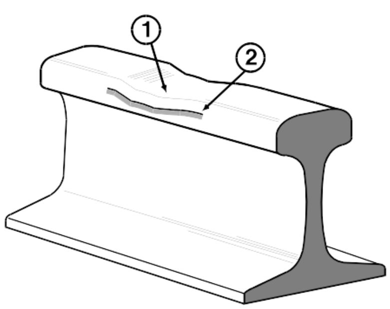
Split Web (SWJ, SWO)

A lengthwise crack along the side of the web and extending into or through it. The crack will show signs of rust.

Appearance in Track
Note: This type of failure is frequently caused by bruises on the web resulting from striking the web with a spike maul or other object.

Long splits in the web of new or nearly new rail are likely to be a manufacturing defect from roller straightening.





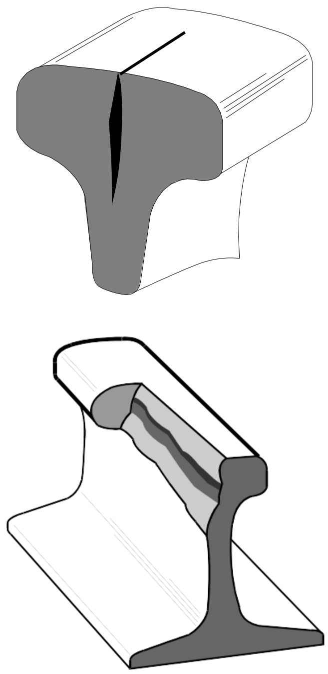
Horizontal Split Head (HSH, HSJ)

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

Appearance in Track:
1. Before cracking out, a horizontal split head will cause the appearance of a flat spot on the running surface. There may be a slight widening of the rail head.
2. After cracking out, a horizontal split head will appear as a crack on the field and/or gauge side of the rail head at least 1/3 of the depth of head below the top of the rail.

Note: This is a manufacturing defect

Vertical Split Head (VSH, VSJ)



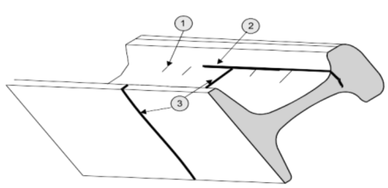
A vertical split, through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web, or pieces may split off the side of the head.

Appearance in Track:

1. A dark streak in the middle of the running surface.
2. Widening of the head for the length of the split.
3. One side of the head may show signs of sagging, causing a rust streak to appear on the fillet under the head.
4. In advanced stages, a bleeding crack will appear at the fillet under the head.

Note: The Vertical Split Head is usually caused by a defect in the rail as rolled. (Not to be confused with Piped Rail which has the defect in the web).

Head-Web Separation (HWJ, HWO)



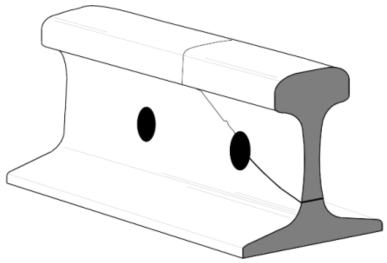
A progressive fracture longitudinally separating the head and web of the rail at the fillet under the head.

Appearance in Track:

1. In earlier stages, wrinkled lines appear along the fillet under the head.
2. In later stages, a small crack appears along the fillet under the head on either side. These cracks grow longitudinally with slight irregular turns upward and downward.
3. In advanced stages, bleeding cracks will extend downward from the longitudinal crack.

Note: This type of defect frequently occurs in rails through crossings, in tunnels and other wet locations.

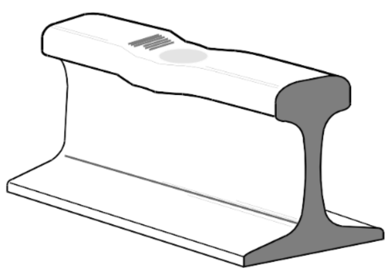
Bolt Hole Break (BHJ, BHO)



Appearance in Track:
Cracks in the web extending radially from a bolt hole.
a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward towards the rail head or downward towards the base. The crack is normally concealed by the presence of joint bars.

Note: This type of failure is frequently caused by loose bolts in the joint or inadequate anchoring of the track causing the bolts to strike the sides of the hole and damage the metal. Also commonly originates from improperly deburred holes which increases the stress applied to the bolt holes.

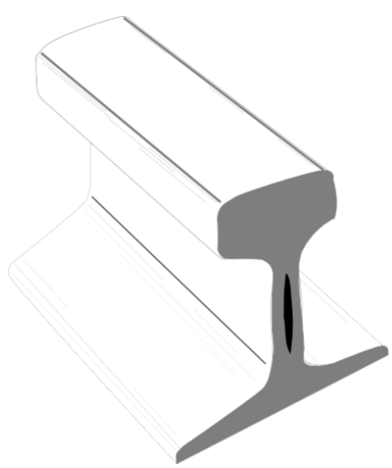
Crushed Head / Flattened Rail (CHJ, CHO)



Crushed Head - A short length of rail, not at a joint, which has sagged across the width of the rail head. Unlike a flattened rail where the depression is visible on the rail head only, the sagging is also visible in the head/web fillet area.

Appearance in Track:
1. A flattening and widening of the head with the entire head sagging,
2. Small cracks in the depression of the running surface.
3. In advanced stages, a bleeding crack may appear in the fillet under the head.
4. A short length of rail, not at a joint, which has drooped or sagged across the width of the rail head. Unlike a Localized Surface Collapse where the depression is visible on the rail head only, the sagging or drooping is also visible in the head/web fillet area.

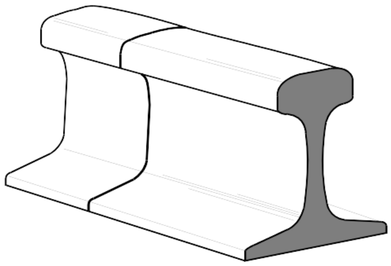
Piped Rail (PRJ, PRO)



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

Appearance in Track:
1. Bulging of the web on either or both sides. There may be shallow cracks apparent on the sides of the bulge.
2. A slight sinking of the rail head in the area above the pipe with no other deformation of the head.

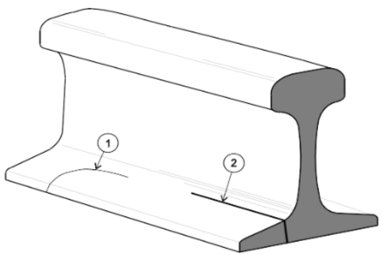
Note: This type of failure is due to a manufacturing defect.



Ordinary Break (BRJ, BRO)

A partial or complete break in which there is no sign of a fissure or other defect.

Appearance in Track:
1. A hairline crack running completely around the rail, usually accompanied by bleeding.
2. A separation of rail at the break with one or both ends battered.
3. The faces of the rail are rough and granular with no sign of a defect.

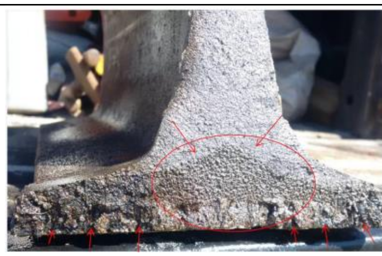


Broken Base (BBJ, BBO)

A crack or break in the rail base not extending into the lower fillet.

Appearance in Track:
1. A crack starting near the junction of the base and the web extending outward to the edge of the base.
2. A longitudinal crack along the junction of the base and the web.
3. A half-moon break in the base.

Note: This type of failure usually is due to a manufacturing defect but may be caused by uneven bearing of rail on the tie plates, as when plates are bent or plates of different slopes are mixed in track.



Hot Tear (DWF)

Appearance in Track:
1. Change in grain structure, likely near the base of the rail.
2. Discoloration

Battered End

Commonly found at a bolted joint and propagated by mismatched rail ends from differential rail head wear and/or poor support of the bolted joint.

Appearance in Track:
1. Flattening and widening of the head of the rail at the end. The rail taller of the rail heads will start to batter first, and if left long enough, both ends will experience battered ends.
2. The underside of the head is not affected in any way.

Mill Defect

Deformations, cavities, laps, seams, scabs, burnt steel, or foreign material found in any portion of the rail.
Appearance in Track:
1. A deformation of the rail head that can cause wheels to batter the rail severely.
2. Broken-out inclusions that leave cavities in the side or top of the head.
3. Inclusion of foreign material in the rail.
4. Vertical rust marks at regular intervals along the side of the rail web.

Defective Weld (DWF [field], DWP [plant])
Appearance in Track: A transverse or longitudinal crack or separation in any portion of the weld or the rail within six inches of the weld.
Defective CAD Weld (DWC)
Appearance in Track: A transverse crack across the rail head progresses down into the web, usually originating at the surface in the area of the CAD weld. The weld area will often have grinding marks from where the CAD weld has been ground off. It may appear to be a bolt-hole crack, but it originates from the CAD weld and not the bolt-hole. CAD Welds are typically used for bonding of wires to rail ends where short jumpers were employed. Note: The defect grows in the area of a heat zone created by the weld that is very brittle. Because of the brittleness, any severe blow, such as a flat spot on a wheel, can cause sudden rupture.
Defective Gas Weld (DWG)
Appearance in Track: A crack at right angles to the running surface displaying rust on the rail head side. The perpendicular crack will be vertical, unlike a transverse defect that has a 20-degree offset. Breaks will occur in the middle of the field weld without a black nucleus. Note: Welds may be in track for many years before a defect develops, but defect growth can be very rapid.
Flattened Rail (also known as Localized Surface Collapse (LSC))
A short length of rail, not at a joint, which has flattened out across the width of the rail head. Appearance in Track: 1. Flattening and widening of the head of the rail, other than at the end. 2. The underside of the head is not affected in any way.
Damaged Rail
Any rail broken or damaged by wrecks, broken, flat, or unbalanced wheels, slipping, or similar causes, as well as by track units or off-track equipment. Appearance in Track: Any rail or portion of rail with visible imperfections deep enough to cause structural concern caused by striking the rail with force to leave gouges, broken bases, broken, bent and twisted rail.
Damage by Defective Rolling Stock
Rail that has been nicked on the head, base or web by flat wheels, broken wheels, or dragging equipment. Rail defects caused by damaged rolling stock will have defect codes which reflect the type of defect the damaged rolling stock created. Appearance in Track: Rail imperfections on any part of the rail structure discovered during inspection after train operation.
Damage by Derailment
Rail that has been broken, bent, nicked or otherwise damaged by derailment of equipment. Rail defects caused by derailments will have defect codes which reflect the type of defect the derailment created. Appearance in Track: Rail that has been broken, bent, nicked or otherwise damaged by derailment of equipment. Rail defects caused by derailments will have defect codes which reflect the type of defect the derailment created (i.e., BBJ, BRO, TDT…etc.).

Appendix I – Remedial Action for Rail Defects

Table I-1 Remedial Action for Rail Surface Defect

Depth of Surface Defect		Remedial Action
Rail Wear is less than the increased monitoring limits	Rail wear is greater than the increased monitoring limits	
less than 3/16 in (4.8 mm)	less than 1/8 in (3 mm)	Monitor and repair
3/16 in (4.8 mm) to 5/16 in (7.9 mm)	1/8 in (3 mm) to 3/16 in (4.8 mm)	Limit operating speed to 30 mph and repair or replace
greater than 5/16 in (7.9 mm)	greater than 3/16 in (4.8 mm)	Limit operating speed to 10 mph and repair or replace
Corrugation		
If corrugation exists to the extent that prevents conducting a valid rail flaw test (i.e. results in a No Test Rail)		Perform corrective actions as per Track Standard Section 18.4.13.

Table I-2 Remedial Action for Joint Batter in Winter Months

Joint Batter		
>3.5 mm	> 4mm	>= 5mm
• Must be measured twice a week.	• Must be changed out or welded within 48 hours. • If rail cannot be changed, a 30-mph speed restriction must be placed until the rail is replaced.	• 30 mph if the rail wear is less than the increased monitoring limits. • 10 mph if the rail wear is greater than the increased monitoring limits. • Must be changed within 48 hours or welded with no exceptions.

Table I-3 Rail Defects on Class 1, 2, and Class 3 Track with Less Than 20 MGT Annually, No Hazardous Materials, and No Passenger Service

Defect	Percent of rail head cross-sectional area weakened by the defect	If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:
Compound Fissure	0 to 69	B and E
	70 to 99	A1
	100	A
Transverse Fissure, Detail Fracture, Engine Burn, or Defective Weld	0 to 20	C or C1
	21 to 99	D
	100	A or (E and H)
Defect	**Defect Size in (mm)**	**If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:**
Vertical or Horizontal Split Head	0 in to 2 in (0 mm to 51 mm)	H and F
	Over 2 in (>51 mm)	B and G
	Break out in rail head	A
Split Web, Piped Rail, or Head Web Separation	0 in to 1/2 in (0 mm to 12.7 mm)	H and F
	Over 1/2 in (>12.7 mm)	B and G
	Break out in rail head	A
Bolt Hole Crack	0 in to 1/2 in (0 mm to 12.7 mm)	H and F
	Over 1/2 in (>12.7 mm)	B and G
	Break out in rail head	A
Broken Rail Base	0 in to 6 in (0 mm to 152 mm)	D
	Over 6 in (>152 mm)	A or (E then B)
Defect	**If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:**	
Ordinary Break	A and E	
Damaged Rail	D	
Flattened Rail, Crushed Head, or Localised Surface Collapse	Apply Track Standard Section 4.16	

REMEDIAL ACTION APPLICABLE TO DEFECTS IN Table I-3.

A. A qualified person must visually supervise each operation over the defective rail. See Track Standard Section 4.17.

    1) After visual inspection, that person may authorize operation over the defective rail without continuous visual supervision at a maximum speed of 10 mph for up to 24 hours prior to making another visual inspection, repair or replacement of the rail.

B. Limit the operating speed over the defective rail to a speed authorized by a qualified person not exceeding 30 mph or the maximum allowable for that class of track, whichever is more restrictive.

C. In Class 1 and 2 track, apply joint bars to the defect and bolt through the outermost holes, within 10 days of being discovered.

   In Class 3 track, limit operating speed over the defective rail to a maximum of 30 mph until such time as joint bars have been applied. After joint bars have been applied, limit operating speed to 40 mph or the maximum allowable for that class of track, whichever is more restrictive. Joint bars are to be applied to the defect and bolted through the outermost holes within 10 days after discovery. When joint bars have not been applied within 10 days, speed must be limited to 10 mph, until joint bars are applied.

    2) Where the defect is identified by ultrasonic inspection, limit operating speed to a maximum of 40 mph or the maximum for the class of track, whichever is more restrictive, for a period not to exceed 4 days. If joint bars are not applied within 4 days, follow procedure in item C (where the date of defect identification is the date discovered by the ultrasonic inspection).

D. Limit operating speed over the defective rail to a maximum of 30 mph or less as authorized by a qualified person until such time as joint bars have been applied. After joint bars have been applied, limit operating speed to 40 mph or the maximum allowable operating speed for that class of track, whichever is more restrictive. Joint bars are to be applied to the defect and bolted through the outermost holes within 7 days of discovery. When joint bars have not been applied within 7 days, speed must be limited to 10 mph, until joint bars are applied.

E. Apply joint bars to the defect and bolt with the appropriate number of bolts for the class of track involved.

F. Inspect rail or remove defect within 90 days* of detecting the defect.

G. Inspect rail or remove defect within 30 days* of detecting the defect.

H. Limit operating speed over the defective rail to a maximum of 40 mph or the maximum allowable operating speed for the class of track, whichever is more restrictive, and remove defect within 90 days.

*For Rail Flaw Detected (Ultrasonic) defects that are strictly internal and not visible, perform another inspection with either rail-mounted or hand-held Rail Flaw Detection (ultrasonic) equipment. For defects that are visible and measurable, a visual or Rail Flaw Detection inspection is acceptable. For defects enclosed within the joint bar area, such as bolt-hole defects, the joint bars must be removed, and a visual re-inspection must be made. The re-inspection must be performed prior to the expiration of the 30 or 90-day interval. If the rail remains in track and is not replaced, the cycle starts over. If the defect increases in size, it may become subject to more restrictive remedial action, as described in this table.

Table I-4 Rail Defects on Class 4 and 5 Tracks, and Class 3 Tracks Carrying Passenger Traffic or Hazardous Materials

Defect[1]	Percent of rail head cross-sectional area weakened by the defect	If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:
Compound Fissure	0 to 70	1
	71 to 99	2
	100	3
Transverse Fissure, Detail Fracture, Engine Burn, or Defective Weld	0 to 19	4
	20 to 59	5
	60 to 99	6
	100	3 or 13 then 9
Defect[1]	**Defect Size in (mm)**	**If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:**
Vertical or Horizontal Split Head, or Horizontal Split Web, Piped Rail, Head-Web Separations, or Defective Weld Longitudinal	0 in to 1/2 in (0 mm – 12.7 mm)	7
	Over 1/2 in to 3 in (>12.7 mm – 76 mm)	8
	Over 3 in (>76 mm)	9
	Break out in rail head	3
Bolt Hole Crack	0 in to 1/2 in (0 mm – 12.7 mm)	7
	Over 1/2 in to 3 in (>12.7 – 76)	8
	Over 3 in (>76 mm)	9
	Break out in rail head	3
Broken Rail Base	0 in to 6 in (0 mm – 152 mm)	10 or 13 then 7
	Over 6 in (>152 mm)	11 or 10
Defect[1]	**If the defective rail is not replaced prior to train operation, take the following remedial action denoted by note:**	
Ordinary Break	3 or 10	
Damaged Rail	12	
Flattened Rail, Crushed Head, or Localised Surface Collapse	Apply Track Standard Section 4.16	

[1] Defects in special trackwork or at-grade road crossings must be protected as per the above inspected visually at the minimum frequency required by regulation for track inspections and removed within 14 days.

REMEDIAL ACTION APPLICABLE TO DEFECTS IN Table I-4

1. Inspect defects immediately. Limit operating speed to a maximum of 30 mph. Remove defect within 72 hours of being detected.
2. Assign a qualified person to make a visual inspection once every 24 hours. Limit operating speed to 10 mph. If joint bars are applied, the operating speed can be increased to 30 mph. Remove defect within 72 hours of detection.
3. Assign a qualified person to visually supervise each train movement over the defective rail. See Track Standard Section 4.17. The defect must be repaired as soon as track time permits, but not longer than 24 hours of detection.
4. Inspect defect. Limit operating speed to 30 mph until joint bars are applied. Apply joint bars and bolt through the outermost holes. Thereafter, limit operating speed to 50 mph or the maximum for the class of track, whichever is more restrictive. Remove defect within 7 days of being detected.
5. Inspect defect. Limit operating speed to 30 mph as authorized by a qualified person until joint bars are applied. Apply joint bars and bolt through the outermost holes. Thereafter, limit operating speed to 50 mph or the maximum for the class of track, whichever is more restrictive. Remove defect within 72 hours of detection.
6. Inspect defects. Limit operating speed to 10 mph until joint bars are applied. Apply joint bars to the defect. Thereafter, limit operating speed to 50 mph or the maximum for the class of track, whichever is more restrictive. Remove defect within 24 hours of being detected.
7. Inspect immediately. Limit operating speed to a maximum of 50 mph. Remove defect within 7 days of detection.
8. Inspect immediately. Limit operating speed to a maximum of 30 mph. Remove defect within 72 hours of detection.
9. Inspect immediately. Limit operating speed to a maximum of 10 mph. Remove defect within 24 hours of being detected.
10. Inspect immediately. Apply joint bars to the defect and fully bolt for a class of track. Limit operating speed to a maximum of 30 mph. Remove defect within 72 hours of detection.
11. Inspect immediately. Limit operating speed to 10 mph until repaired. Assign a qualified person to visually supervise each train movement over the defective rail until a repair has been completed. See Track Standard Section 4.17.
12. Inspect immediately. Apply joint bars within 10 days. Limit operating speed to a maximum of 30 mph until joint bars are applied. Thereafter, limit the operating speed to 50 mph.
13. Apply joint bars to the defect and bolt through outermost holes.

Table I-5 Corrective and Remedial Actions for Single Rail Surface Irregularities

Condition	Depth	Remedial Action	Corrective action
Crack in the upper fillet under the rail head	N/A	Limit train operations to not more than 10mph and visually supervise each movement until the defective rail is removed	Change out rail
Corrugation	All depths	Record Location	Grind with local welding forces, switch & crossing grinder or grinding train if possible, or change rail
Flaking	N/A	Record Location	Grind with local welding forces, switch & crossing grinder or grinding train
Spalling and Shelling	≤ 1/8 in (3 mm)	Record Location and check for escalation of defect once per month	Grind with local welding forces, switch & crossing grinder or grinding train
	> 1/8 in (3 mm) ≤ 3/16 in (4.8 mm)	Record Location and check for crack-out under head once per week	Change out rail
	>3/16 in (4.8 mm) ≤1/4 in (6.3 mm)	Limit train operation to not more than 60 mph and check for crack-out under head once per week	Change out rail
	>1/4 in (6.3 mm)	Limit train operations to not more than 30 mph and check for crack-out under head on each routine inspection	Change out rail

NOTE: If a crack-out condition exists in the upper fillet area under the rail head, trains and engines must not be allowed over this rail condition until the defective rail is changed-out, unless the person assigned to visually supervise the movement is on-site, in constant communication with the locomotive engineer, and the movement is restricted to a speed not exceeding 10 mph.

Appendix J - Speed Restrictions for Track Work

Table J-1 Speed Restrictions for Track Work

<table>
<tr><th rowspan="2">Activity</th><th rowspan="2">Forecasted Rail Temp within 24 hrs</th><th colspan="2">Speed Restriction</th></tr>
<tr><th>Without Dynamic Stabilizer</th><th>With Dynamic Stabilizer</th></tr>
<tr><td rowspan="3">• Continuous tie renewal
• Panelized turnout replacement
• Out-of-Face Surfacing
• Ballast Cleaning / Undercutting
• Lining
• Track Construction
• Crossing rehabilitation</td><td>>PRLT</td><td>• 10 mph for 8,000 tons
• Inspect
• 30 mph[2] for 100,000 tons
• Inspect
• If ok, return to track speed</td><td>• 30 mph[2] for 16,000 tons
• Inspect
• If ok, return to track speed</td></tr>
<tr><td>≤PRLT
and
≥PRLT-30°F[1]</td><td>• 10 mph for 8,000 tons
• Inspect
• 30 mph[2] for 50,000 tons
• Inspect
• If ok, return to track speed</td><td>Track Speed</td></tr>
<tr><td><PRLT-30°F[1]</td><td>• 30 mph[2] for 8,000 tons
• Inspect
• If ok, return to track speed</td><td>Track Speed</td></tr>
<tr><td>• Spot tie renewal
• Spot surfacing
• Shoulder cleaning</td><td>>PRLT</td><td>• 30 mph[2] for 8,000 tons[3]
• Inspect
• If ok, return to track speed</td><td>Track Speed</td></tr>
<tr><td>• Rail Installation (any length)
• Realignment of track
• Lifts in excess of 1 in (25 mm)</td><td>All</td><td colspan="2">When rail temperature is forecasted to have an increase greater than 40 °F or 22 °C above the RLT, a 30 mph[3] speed restriction must apply as per Track Standard Section 4.7.5</td></tr>
<tr><td colspan="4">Speed restriction must not be removed in the heat of the day (Daily between 12:00 and 18:00).
Speed restriction must not be removed prior to completing a track inspection.
[1] 30°F (16.6°C)
[2] Between the hours of 22:00 and 10:00, the speed restriction may be 40 mph. If required tonnage is not accumulated by 10:00 speed must be restricted to 30 mph.
[3] The speed restriction can be avoided by replacing up to a maximum of 2 ties per 39 ft (12 m) track section.</td></tr>
</table>

Table J-2 Speed Restrictions for Repairs to Buckled Track Without Cutting the Rail

<table>
<tr><th>Forecasted Rail Temperature</th><th>Stabilizer Used</th><th>TSO Requirement</th></tr>
<tr><td rowspan="2">Below PRLT</td><td>Yes</td><td>• 8,000 tons at 30mph</td></tr>
<tr><td>No</td><td>• 50,000 tons at 30mph</td></tr>
<tr><td rowspan="2">Above PRLT</td><td>Yes</td><td>• 16,000 tons at 30mph</td></tr>
<tr><td>No</td><td>• 16,000 tons at 10mph and inspect;
• 50,000 tons at 30mph and inspect;
• Then 50,000 tons at 40mph and inspect;</td></tr>
</table>

NOTE: Speed restriction may not be removed in the heat of the day.

Table J-3 Equipment Tonnage

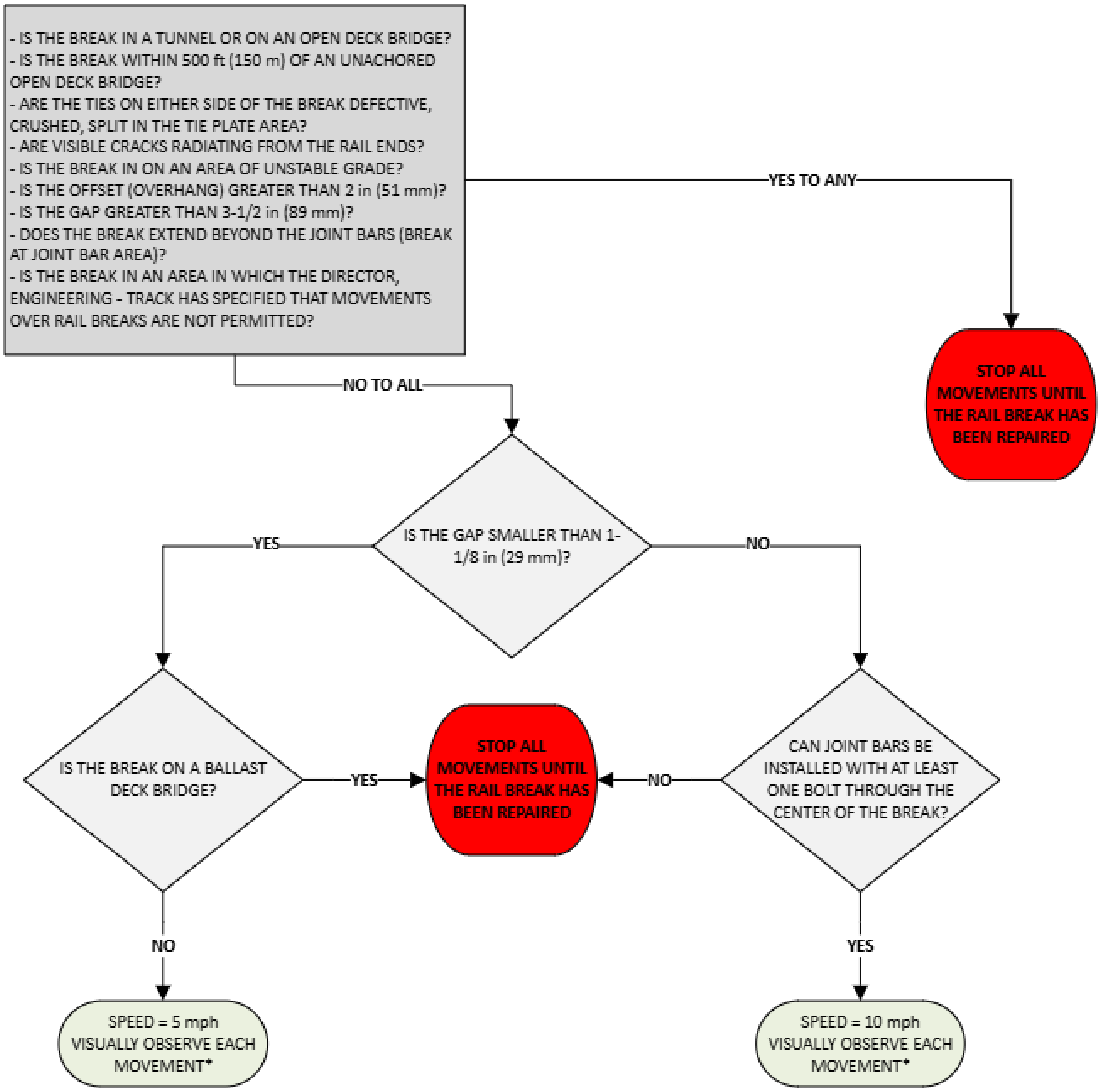
Equipment (empty / AW0 loading)	Tonnage	8,000 Tons	50,000 Tons
12-Car GO Train	800 Tons	10 Trains	62 Trains
10-Car GO Train	690 Tons	12 Trains	72 Trains
6-Car GO Train	471 Tons	17 Trains	106 Trains
3-Car UP DMU	235 Tons	34 Trains	213 Trains
2-Car UP DMU	157 Tons	51 Trains	319 Trains

8,000 tons – 1 freight train

Note: tonnage determined based on empty equipment weight.

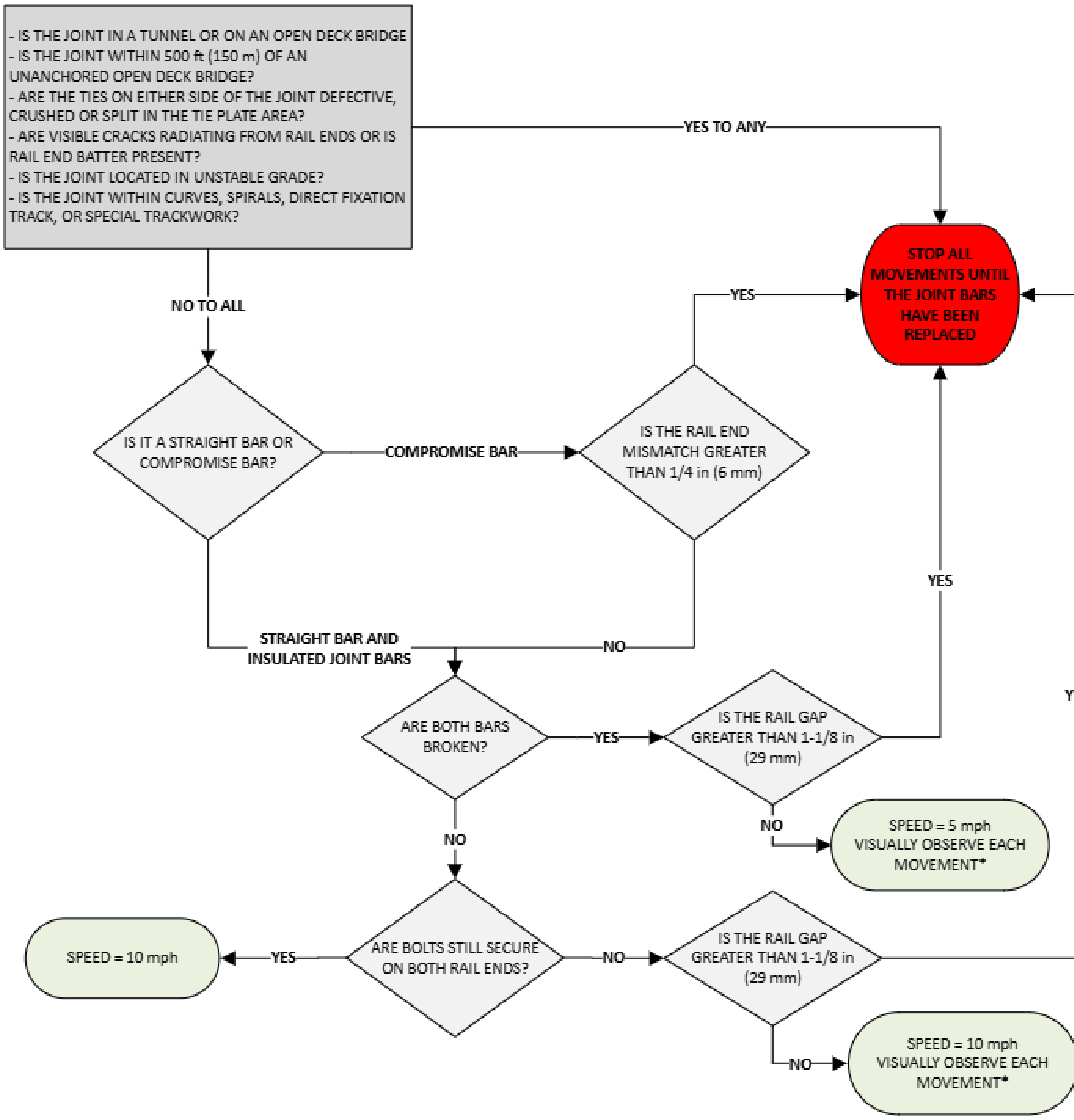
1. The limits of the speed restriction should be 500 feet (1/10 mile) (152.4 m) on either side of the work area.
2. More restrictive speed restrictions may be required depending on local conditions, such as subgrade conditions, weak ballast, insufficient anchors, poor ties, etc.
3. Prior to increasing, removing, or modifying a speed restriction, the track must be inspected to ensure the anchor pattern meets the requirements of Track Standards Section 10.2 and that there are no signs of tight rail per Track Standard Section 4.13, or any other defects. Verification must also be made that the required tonnage has actually passed over the track being restricted. Speed restrictions should not be removed in the heat of the day.

Appendix K – Authorizing Movements over Rail Breaks and Broken Joint Bars



If movements cannot be visually observed over the rail break, the track must be taken out of service.

Figure K-1 Supervised Movements over Rail Breaks



**If movements cannot be visually observed over the broken joint bar, the track must be taken out of service.*

Figure K-2 - Supervised Movements Over Broken Joint Bars

Appendix L – Continuous Welded Rail Thermal Expansion Chart

Determination of rail expansion for lengths between those shown in Table L-1 and Table L-2 must be calculated using the formula provided.

Table L-1 Length of CWR Thermal Expansion

TEMP. Difference from PRLT		LENGTH OF CWR ft (m)							
		200 (61)	400 (122)	600 (183)	800 (244)	1000 (305)	1200 (366)	1400 (427)	1482 (452)
		CWR MOVEMENT in (mm)							
°F	°C								
5	2	1/8 (3)	1/8 (3)	1/4 (6)	3/8 (10)	3/8 (10)	1/2 (13)	1/2 (13)	5/8 (15)
10	5	1/8 (3)	3/8 (10)	1/2 (13)	5/8 (15)	3/4 (20)	1 (25)	1-1/8 (29)	1-1/8 (29)
15	7	1/4 (6)	1/2 (13)	3/4 (20)	1 (25)	1-1/4 (32)	1-1/2 (38)	1-5/8 (41)	1-3/4 (44)
20	9	3/8 (10)	5/8 (15)	1 (25)	1-1/4 (32)	1-5/8 (41)	1-7/8 (48)	2-1/4 (57)	2-3/8 (60)
25	11	3/8 (10)	3/4 (20)	1-1/4 (32)	1-5/8 (41)	2 (51)	2-3/8 (60)	2-3/4 (75)	3 (76)
30	13	1/2 (13)	1 (25)	1-1/2 (38)	1-7/8 (48)	2-3/8 (60)	2-7/8 (73)	3-3/8 (84)	3-1/2 (89)
35	16	1/2 (13)	1-1/8 (29)	1-5/8 (41)	2-1/4 (57)	2-3/4 (75)	3-3/8 (84)	3-7/8 (98)	4-1/8 (105)
40	18	5/8 (15)	1-1/4 (32)	1-7/8 (48)	2-1/2 (64)	3-1/4 (83)	3-7/8 (98)	4-1/2 (114)	4-3/4 (121)
45	20	3/4 (20)	1-1/2 (38)	2-1/8 (54)	2-7/8 (73)	3-5/8 (92)	4-3/8 (111)	5 (127)	5-3/8 (137)
50	22	3/4 (20)	1-5/8 (41)	2-3/8 (60)	3-1/4 (83)	4 (102)	4-3/4 (121)	5-5/8 (143)	5-7/8 (149)
55	24	7/8 (23)	1-3/4 (44)	2-5/8 (67)	3-1/2 (89)	4-3/8 (111)	5-1/4 (133)	6-1/8 (156)	6-1⁄2 (165)
60	27	1 (25)	1-7/8 (48)	2-7/8 (73)	3-7/8 (98)	4-3/4 (121)	5-3/4 (146)	6-3/4 (171)	7-1/8 (181)
65	29	1 (25)	2-1/8 (54)	3-1/8 (79)	4-1/8 (105)	5-1/4 (133)	6-1/4 (159)	7-1/4 (184)	7-3/4 (197)
70	31	1-1/8 (29)	2-1/4 (57)	3-3/8 (86)	4-1/2 (114)	5-5/8 (143)	6-3/4 (171)	7-7/8 (200)	8-1/4 (210)
75	33	1-1/4 (32)	2-3/8 (60)	3-5/8 (92)	4-3/4 (121)	6 (152)	7-1/4 (184)	8-3/8 (213)	8-7/8 (225)
80	36	1-1/4 (32)	2-1/2 (64)	3-7/8 (98)	5-1/8 (130)	6-3/8 (162)	7-5/8 (194)	9 (229)	9-1/2 (241)
85	38	1-3/8 (35)	2-3/4 (70)	4-1/8 (105)	5-1/2 (140)	6-3/4 (171)	8-1/8 (206)	9-1/2 (241)	10-1/8 (257)
90	40	1-1/2 (38)	2-7/8 (73)	4-3/8 (111)	5-3/4 (146)	7-1/4 (184)	8-5/8 (219)	10-1/8 (257)	10-5/8 (270)
95	42	1-1/2 (38)	3 (76)	4-1/2 (114)	6-1/8 (156)	7-5/8 (194)	9-1/8 (232)	10-5/8 (270)	11-1/4 (286)
100	44	1-5/8 (41)	3-1/4 (83)	4-3/4 (121)	6-3/8 (162)	8 (203)	9-5/8 (244)	11-1/4 (286)	11-7/8 (302)
105	47	1-5/8 (41)	3-3/8 (86)	5 (127)	6-3/4 (171)	8-3/8 (213)	10-1/8 (257)	11-3/4 (298)	12-1/2 (318)
110	49	1-3/4 (44)	3-1/2 (89)	5-1/4 (133)	7 (178)	8-3/4 (222)	10-1/2 (267)	12-3/8 (314)	13 (330)

MOVEMENT (in) = RAIL LENGTH (ft.) x TEMP DIFF FROM PRLT (°F) x 0.00008
MOVEMENT (mm) = RAIL LENGTH (m) x TEMP DIFF FROM PRLT (°C) x 0.0145
The equation for CWR movement must be used for lengths of rail not mentioned in the chart.

Table L-2 CWR Required Adjustment

Temperature differential from the PRLT		Length of Rail ft (m)			
		150 (45.7)	225 (68.6)	300 (91.4)	500 (152.4)
°F	°C	Adjustment Required in (mm)			
5	2	1/8 (3)	1/8 (3)	1/8 (3)	1/8 (3)
10	5	1/8 (3)	1/4 (6)	1/4 (6)	3/8 (10)
15	7	1/4 (6)	3/8 (10)	3/8 (10)	5/8 (15)
20	9	1/4 (6)	3/8 (10)	1/2 (13)	7/8 (23)
25	11	3/8 (10)	1/2 (13)	5/8 (16)	1 (25)
30	13	3/8 (10)	5/8 (16)	3/4 (19)	1-1/4 (32)
35	16	1/2 (13)	3/4 (19)	7/8 (22)	1-3/8 (35)
40	18	1/2 (13)	3/4 (19)	1 (25)	1-5/8 (41)
45	20	5/8 (16)	7/8 (22)	1-1/8 (29)	1-7/8 (48)
50	22	5/8 (16)	1 (25)	1-1/4 (32)	2 (51)
55	24	3/4 (19)	1 (25)	1-3/8 (35)	2-1/4 (57)
60	27	3/4 (19)	1-1/8 (29)	1-1/2 (38)	2-3/8 (60)
65	29	7/8 (22)	1-1/4 (32)	1-5/8 (41)	2-5/8 (67)
70	31	7/8 (22)	1-3/8 (35)	1-3/4 (44)	2-7/8 (73)
75	33	1 (25)	1-3/8 (38)	1-7/8 (48)	3 (76)
80	36	1 (25)	1-1/2 (41)	2 (51)	3-1/8 (79)
85	38	1-1/8 (29)	1-5/8 (41)	2-1/8 (54)	3-1/2 (89)
90	40	1-1/8 (29)	1-5/8 (41)	2-1/4 (57)	3-5/8 (92)
95	42	1-1/4 (32)	1-3/4 (44)	2-3/8 (60)	3-3/4 (95)
100	44	1-1/4 (32)	1-7/8 (48)	2-1/2 (64)	4 (102)

Appendix M – Effective Length Added for Curves Chording Inward

Table M-1Effective Length Added for Curves Choring Inward

DEGREE OF CURVE	DISTANCE CURVE HAS CHORDED INWARD in (mm)											
	1/2 (13)	1 (25)	1-1/2 (38)	2 (51)	2-1/2 (64)	3 (76)	3-1/2 (89)	4 (102)	4-1/2 (108)	5 (127)	5-1/2 (140)	6 (152)
	EFFECTIVE RAIL LENGTH ADDED TO CURVE PER 1000 ft OF CURVE in (mm)											
0°30′	0	1/8 (3)	1/8 (3)	1/8 (3)	1/4 (6)	1/4 (6)	1/4 (6)	3/8 (10)	3/8 (10)	3/8 (10)	1/2 (13)	1/2 (13)
1°00′	1/8 (3)	1/8 (3)	1/4 (6)	3/8 (10)	1/2 (13)	1/2 (13)	5/8 (16)	3/4 (19)	3/4 (19)	7/8 (22)	1 (25)	1 (25)
1°30′	1/8 (3)	1/4 (6)	3/8 (10)	1/2 (13)	5/8 (16)	3/4 (19)	7/8 (22)	1 (25)	1-1/8 (29)	1-1/4 (32)	1-1/2 (38)	1-5/8 (41)
2°00′	1/8 (3)	3/8 (10)	1/2 (13)	3/4 (19)	7/8 (22)	1 (25)	1-1/4 (32)	1-3/8 (35)	1-1/2 (38)	1-3/4 (44)	1-7/8 (48)	2-1/8 (54)
2°30′	1/4 (6)	3/8 (10)	5/8 (16)	7/8 (22)	1-1/8 (29)	1-1/4 (32)	1-1/2 (38)	1-3/4 (44)	1-7/8 (48)	2-1/8 (54)	2-3/8 (60)	2-5/8 (67)
3°00′	1/4 (6)	1/2 (13)	3/4 (19)	1 (25)	1-1/4 (32)	1-5/8 (41)	1-7/8 (48)	2-1/8 (54)	2-3/8 (60)	2-5/8 (67)	2-7/8 (73)	3-1/8 (79)
3°30′	1/4 (6)	5/8 (16)	7/8 (22)	1-1/4 (32)	1-1/2 (38)	1-7/8 (48)	2-1/8 (54)	2-1/2 (64)	2-3/4 (70)	3-1/8 (79)	3-3/8 (79)	3-5/8 (92)
4°00′	3/8 (10)	3/4 (19)	1 (25)	1-3/8 (35)	1-3/4 (44)	2-1/8 (54)	2-1/2 (64)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-7/8 (98)	4-1/4 (108)
4°30′	3/8 (10)	3/4 (19)	1-1/8 (29)	1-5/8 (41)	2 (51)	2-3/8 (60)	2-3/4 (70)	3-1/8 (79)	3-1/2 (89)	3-7/8 (98)	4--3/8 (111)	4-3/4 (121)
5°00′	1/2 (13)	7/8 (22)	1-1/4 (32)	1-3/4 (44)	2-1/8 (54)	2-5/8 (67)	3 (76)	3-1/2 (89)	3-7/8 (98)	4-3/8 (111)	4--3/4 (121)	5-1/4 (133)
5°30′	1/2 (13)	1 (25)	1-1/2 (38)	1-7/8 (78)	2-3/8 (60)	2-7/8 (73)	3-3/8 (86)	3-7/8 (98)	4-1/4 (108)	4--3/4 (121)	5-1/4 (133)	5-3/4 (146)
6°00′	1/2 (13)	1 (25)	1-5/8 (41)	2-1/8 (54)	2-5/8 (67)	3-1/8 (79)	3-5/8 (92)	4-1/8 (105)	4-5/8 (117)	5-1/4 (133)	5-3/4 (146)	6-1/4 (159)
6°30′	5/8 (16)	1-1/8 (29)	1-3/4 (45)	2-1/4 (57)	2-7/8 (73)	3-3/8 (86)	4 (102)	4-1/2 (114)	5 (127)	5-5/8 (143)	6-1/4 (159)	6-3/4 (172)
7°00′	5/8 (16)	1-1/4 (32)	1-7/8 (48)	2-1/2 (64)	3 (76)	3-5/8 (92)	4-1/4 (108)	4-7/8 (124)	5-1/2 (140)	6-1/8 (156)	6-3/4 (172)	7-3/8 (187)
7°30′	5/8 (16)	1-1/4 (32)	2 (51)	2-5/8 (67)	3-1/4 (83)	3-7/8 (98)	4-5/8 (117)	5-1/4 (133)	5-7/8 (149)	6-1/2 (165)	7-1/4 (184)	7-7/8 (200)
8°00′	3/4 (19)	1-3/8 (35)	2-1/8 (54)	2-3/4 (70)	3-1/2 (89)	4-1/4 (108)	4-7/8 (124)	5-5/8 (143)	6-1/4 (159)	7 (178)	7-5/8 (194)	8-3/8 (213)
8°30′	3/4 (19)	1-1/2 (38)	2-1/4 (57)	3 (76)	3-3/4 (95)	4-1/2 (114)	5-1/4 (133)	5-7/8 (149)	6--5/8 (168)	7-3/8 (187)	8-1/8 (206)	8-7/8 (225)
9°00′	3/4 (19)	1-1/2 (38)	2-3/8 (60)	3-1/8 (79)	3-7/8 (98)	4-3/4 (121)	5-1/2 (140)	6-1/4 (159)	7 (178)	7-7/8 (200)	8-5/8 (219)	9-3/8 (238)
9°30′	7/8 (22)	1-5/8 (41)	2-1/2 (64)	3-3/8 (86)	4-1/8 (105)	5 (127)	5-3/4 (146)	6-5/8 (168)	7-3/8 (187)	8-1/4 (210)	9-1/8 (232)	10 (254)
10°00′	7/8 (22)	1-3/4 (45)	2-5/8 (67)	3-1/2 (89)	4-3/8 (111)	5-1/4 (133)	6-1/8 (156)	7 (178)	7-3/4 (197)	8-3/4 (222)	9-5/8 (245)	10-1/2 (267)

Example:
A 2000 ft (610 m), 4-degree curve is found to have shifted inwards an average of 3 in (76 mm). What is the effective amount of rail added to the curve?

Per the Table, for a 4-degree curve and 3 inches (76 mm) of movement, it is equivalent to adding 2-1/8 in (54 mm) of rail per 1000 ft (305 m) or a reduction in the Rail Neutral Temperature by 30°F (13°C). For a 2,000 ft (610 m) curves the effective rail length added would therefore be 4-1/4 in (108 mm).

Refer to Track Standard section 12.1.22 for applicable speed restrictions due to effective steel added. Speed restrictions per Track Standards Section 16.2 also apply.

Appendix N – Curve and Vmax Tables

Degree of Curvature	Equilibrium (Balanced) Superelevation (Eq)																			
	Speed (mph)																			
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0° 15''	0	0	0	1/8	1/8	1/8	1/4	1/4	3/8	1/2	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 5/8	1 3/4
0° 30''	0	0	1/8	1/8	1/4	3/8	3/8	1/2	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 7/8	3 1/8	3 1/2
0° 45''	0	0	1/8	1/4	3/8	1/2	5/8	7/8	1 1/8	1 3/8	1 5/8	1 7/8	2 1/4	2 5/8	3	3 3/8	3 3/4	4 1/4	4 3/4	5 1/4
1° 0''	0	1/8	1/8	1/4	1/2	5/8	7/8	1 1/8	1 3/8	1 3/4	2 1/8	2 1/2	3	3 3/8	4	4 1/2	5	5 5/8		
1° 30''	0	1/8	1/4	3/8	5/8	1	1 1/4	1 5/8	2 1/8	2 5/8	3 1/8	3 3/4	4 3/8	5 1/8	5 7/8					
2° 0''	0	1/8	3/8	1/2	7/8	1 1/4	1 3/4	2 1/4	2 7/8	3 1/2	4 1/4	5	5 7/8							
2° 30''	0	1/8	3/8	3/4	1 1/8	1 5/8	2 1/8	2 3/4	3 1/2	4 3/8	5 1/4									
3° 0''	0	1/4	1/2	7/8	1 3/8	1 7/8	2 5/8	3 3/8	4 1/4	5 1/4										
3° 30''	0	1/4	1/2	1	1 1/2	2 1/4	3	3 7/8	5											
4° 0''	1/8	1/4	5/8	1 1/8	1 3/4	2 1/2	3 3/8	4 1/2	5 5/8											
4° 30''	1/8	3/8	3/4	1 1/4	2	2 7/8	3 7/8	5												
5° 0''	1/8	3/8	3/4	1 3/8	2 1/4	3 1/8	4 1/4	5 5/8												
5° 30''	1/8	3/8	7/8	1 1/2	2 3/8	3 1/2	4 3/4													
6° 0''	1/8	3/8	1	1 5/8	2 5/8	3 3/4	5 1/8													
6° 30''	1/8	1/2	1	1 7/8	2 7/8	4 1/8	5 5/8													
7° 0''	1/8	1/2	1 1/8	2	3 1/8	4 3/8	6													
7° 30''	1/8	1/2	1 1/8	2 1/8	3 1/4	4 3/4														
8° 0''	1/8	1/2	1 1/4	2 1/4	3 1/2	5														
8° 30''	1/8	5/8	1 3/8	2 3/8	3 3/4	5 3/8														
9° 0''	1/8	5/8	1 3/8	2 1/2	4	5 5/8														
9° 30''	1/8	5/8	1 1/2	2 5/8	4 1/8	6														
10° 0''	1/8	3/4	1 5/8	2 3/4	4 3/8															
10° 30''	1/8	3/4	1 5/8	3	4 5/8															
11° 0''	1/4	3/4	1 3/4	3 1/8	4 7/8															
11° 30''	1/4	3/4	1 3/4	3 1/4	5															
12° 0''	1/4	7/8	1 7/8	3 3/8	5 1/4															
12° 30''	1/4	7/8	2	3 1/2	5 1/2															
13° 0''	1/4	7/8	2	3 5/8	5 3/4															
13° 30''	1/4	1	2 1/8	3 3/4	5 7/8															
14° 0''	1/4	1	2 1/4	3 7/8																
14° 30''	1/4	1	2 1/4	4																
15° 0''	1/4	1	2 3/8	4 1/4																

$Eq=0.0007\ D\ V^2$

Eq = Equilibrium Superelevation (in)
D = Degree of Cruvature (decimal degrees)
V = Speed (mph)

Degree of Curvature	Vmax 3 Measured Superelevation (in)																								
	0	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5	5 1/4	5 1/2	5 3/4	6
0° 15"	131	136	141	146	151	156	160	165	169	173	177	181	185	189	193	196	200	204	207	210	214	217	220	224	227
0° 30"	93	96	100	104	107	110	113	116	120	122	125	128	131	134	136	139	141	144	146	149	151	154	156	158	160
0° 45"	76	79	82	85	87	90	93	95	98	100	102	105	107	109	111	113	115	118	120	121	123	125	127	129	131
1° 0"	65	68	71	73	76	78	80	82	85	87	89	91	93	94	96	98	100	102	104	105	107	109	110	112	113
1° 30"	53	56	58	60	62	64	65	67	69	71	72	74	76	77	79	80	82	83	85	86	87	89	90	91	93
2° 0"	46	48	50	52	53	55	57	58	60	61	63	64	65	67	68	69	71	72	73	74	76	77	78	79	80
2° 30"	41	43	45	46	48	49	51	52	53	55	56	57	59	60	61	62	63	64	65	67	68	69	70	71	72
3° 0"	38	39	41	42	44	45	46	48	49	50	51	52	53	55	56	57	58	59	60	61	62	63	64	65	65
3° 30"	35	36	38	39	40	42	43	44	45	46	47	48	49	51	52	52	53	54	55	56	57	58	59	60	61
4° 0"	33	34	35	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	53	54	55	56	57
4° 30"	31	32	33	35	36	37	38	39	40	41	42	43	44	45	45	46	47	48	49	50	50	51	52	53	53
5° 0"	29	30	32	33	34	35	36	37	38	39	40	41	41	42	43	44	45	46	46	47	48	49	49	50	51
5° 30"	28	29	30	31	32	33	34	35	36	37	38	39	39	40	41	42	43	43	44	45	46	46	47	48	48
6° 0"	27	28	29	30	31	32	33	34	35	35	36	37	38	39	39	40	41	42	42	43	44	44	45	46	46
6° 30"	26	27	28	29	30	31	31	32	33	34	35	36	36	37	38	39	39	40	41	41	42	43	43	44	44
7° 0"	25	26	27	28	29	29	30	31	32	33	34	34	35	36	36	37	38	38	39	40	40	41	42	42	43
7° 30"	24	25	26	27	28	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	39	40	40	41	41
8° 0"	23	24	25	26	27	28	28	29	30	31	31	32	33	33	34	35	35	36	37	37	38	38	39	40	40
8° 30"	22	23	24	25	26	27	28	28	29	30	30	31	32	32	33	34	34	35	36	36	37	37	38	38	39
9° 0"	22	23	24	24	25	26	27	27	28	29	30	30	31	31	32	33	33	34	35	35	36	36	37	37	38
9° 30"	21	22	23	24	25	25	26	27	27	28	29	29	30	31	31	32	32	33	34	34	35	35	36	36	37
10° 0"	21	22	22	23	24	25	25	26	27	27	28	29	29	30	30	31	32	32	33	33	34	34	35	35	36
10° 30"	20	21	22	23	23	24	25	25	26	27	27	28	29	29	30	30	31	31	32	32	33	34	34	35	35
11° 0"	20	21	21	22	23	23	24	25	25	26	27	27	28	28	29	30	30	31	31	32	32	33	33	34	34
11° 30"	19	20	21	22	22	23	24	24	25	26	26	27	27	28	28	29	29	30	31	31	32	32	32	33	33
12° 0"	19	20	20	21	22	22	23	24	24	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33

$$V_{max} = \sqrt{\frac{(E_a+3)}{0.0007 \times D}}$$

Ea = Actual Superelevation (in)
D = Degree of Cruvature (decimal degrees)
Vmax = Maximum Speed (mph)

Degree of Curvature	Vmax 4 Measured Superelevation (in)																								
	0	1/4	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5	5 1/4	5 1/2	5 3/4	6
0° 15''	151	156	160	165	169	173	177	181	185	189	193	196	200	204	207	210	214	217	220	224	227	230	233	236	239
0° 30''	107	110	113	116	120	122	125	128	131	134	136	139	141	144	146	149	151	154	156	158	160	163	165	167	169
0° 45''	87	90	93	95	98	100	102	105	107	109	111	113	115	118	120	121	123	125	127	129	131	133	135	136	138
1° 0''	76	78	80	82	85	87	89	91	93	94	96	98	100	102	104	105	107	109	110	112	113	115	116	118	120
1° 30''	62	64	65	67	69	71	72	74	76	77	79	80	82	83	85	86	87	89	90	91	93	94	95	96	98
2° 0''	53	55	57	58	60	61	63	64	65	67	68	69	71	72	73	74	76	77	78	79	80	81	82	83	85
2° 30''	48	49	51	52	53	55	56	57	59	60	61	62	63	64	65	67	68	69	70	71	72	73	74	75	76
3° 0''	44	45	46	48	49	50	51	52	53	55	56	57	58	59	60	61	62	63	64	65	65	66	67	68	69
3° 30''	40	42	43	44	45	46	47	48	49	51	52	52	53	54	55	56	57	58	59	60	61	61	62	63	64
4° 0''	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	53	54	55	56	57	57	58	59	60
4° 30''	36	37	38	39	40	41	42	43	44	45	45	46	47	48	49	50	50	51	52	53	53	54	55	56	56
5° 0''	34	35	36	37	38	39	40	41	41	42	43	44	45	46	46	47	48	49	49	50	51	51	52	53	53
5° 30''	32	33	34	35	36	37	38	39	39	40	41	42	43	43	44	45	46	46	47	48	48	49	50	50	51
6° 0''	31	32	33	34	35	35	36	37	38	39	39	40	41	42	42	43	44	44	45	46	46	47	48	48	49
6° 30''	30	31	31	32	33	34	35	36	36	37	38	39	39	40	41	41	42	43	43	44	44	45	46	46	47
7° 0''	29	29	30	31	32	33	34	34	35	36	36	37	38	38	39	40	40	41	42	42	43	43	44	45	45
7° 30''	28	28	29	30	31	32	32	33	34	35	35	36	37	37	38	38	39	40	40	41	41	42	43	43	44
8° 0''	27	28	28	29	30	31	31	32	33	33	34	35	35	36	37	37	38	38	39	40	40	41	41	42	42
8° 30''	26	27	28	28	29	30	30	31	32	32	33	34	34	35	36	36	37	37	38	38	39	39	40	40	41
9° 0''	25	26	27	27	28	29	30	30	31	31	32	33	33	34	35	35	36	36	37	37	38	38	39	39	40
9° 30''	25	25	26	27	27	28	29	29	30	31	31	32	32	33	34	34	35	35	36	36	37	37	38	38	39
10° 0''	24	25	25	26	27	27	28	29	29	30	30	31	32	32	33	33	34	34	35	35	36	36	37	37	38
10° 30''	23	24	25	25	26	27	27	28	29	29	30	30	31	31	32	32	33	34	34	35	35	35	36	36	37
11° 0''	23	23	24	25	25	26	27	27	28	28	29	30	30	31	31	32	32	33	33	34	34	35	35	36	36
11° 30''	22	23	24	24	25	26	26	27	27	28	28	29	29	30	31	31	32	32	32	33	33	34	34	35	35
12° 0''	22	22	23	24	24	25	26	26	27	27	28	28	29	29	30	30	31	31	32	32	33	33	34	34	35

$$V_{max} = \sqrt{\frac{(E_a+4)}{0.0007 \times D}}$$

Ea = Actual Superelevation (in)
D = Degree of Cruvature (decimal degrees)
Vmax = Maximum Speed (mph)

Appendix O – Minimum Construction Standards

Table O-1 Minimum Construction Standards

Description	Class 4 and Above	Class 2 and 3	Class 1, Yard
Rail Weight	Per Appendix P or as specified by the Director, Engineering-Track		
Rail (CWR or Jointed)	CWR	CWR	Jointed or CWR
Tie Plates	100% ties plated per Track Standards Section 10 and Appendix S		
Rail Anchors	Improved Fair Type Anchors or approved equivalent per Tack Standards Section 10.2		
Fasteners	Elastic Fasteners (Rail Clips) 6 in (152 mm) Cut Spikes GTS-1322		
Joint Bars	6-hole bars, punched for alternating oval-head bolts per Standard Plan GTS-1202†		
Track Ties	Concrete	Concrete or Hardwood**	Concrete, Insulated Steel, or Hardwood
Turnout/Crossing Ties	Hardwood Grade 1, or Concrete**		Hardwood Grade 1 or Insulated Steel
Track Tie Spacing			
Concrete	24 in (609 mm) (2640/mile)		
Hardwood Grade 1	20-3/8 in (518 mm) (3110/mile)		21-3/4 in (552 mm) (2980/mile)
Insulated Steel (M10, M12, H10, H12) As Directed by the Director, Engineering–Track	N/A		Tangent and Curves <4° - 24 in (609 mm) (2640/mile) Curves 4° to <12° - 22 in (559 mm) (2880/mile) Curves >12° - 20 in (508 mm) (3168/mile)

* Where walking ballast is required, it shall be applied in a minimum 4 in (102 mm) thick layer.
** Only when authorized in writing by the Director, Engineering – Track
† Legacy 4-hole joint bars are permitted to remain as approved in writing by the Director, Engineering-Track

Description	Class 4 and Above	Class 2 and 3	Class 1, Yard
Ballast			
Crushed Rock	Metrolinx Class 1 – Main Track (Crushed Rock Track Ballast Specification)		Metrolinx Class 1 – Main Track Metrolinx Class 2 – Non-main Track Only AREMA Class 4A for Steel Ties
Minimum Depth Below Bottom of Tie	12 in (305 mm) (GTS-2205)		9 in (229 mm)
Shoulder Width (CWR)	12 in (305 mm)		
Shoulder Width (Jointed)	N/A		6 in (152 mm)
Sub-ballast			
Material	Granular B Type II (OPSS 1010) The % passing No. 200 Sieve must be limited to less than 5%		
Minimum Depth	12 in (305 mm) (GTS-2204)		
Top Width	22 ft (6.7 m) – Single Track		
Turnouts†			
Hardwood Tie Turnouts	#20 RBM 136RE (GTS-0278) #16 RBM 136RE (GTS-0251) #12 RBM 136RE (GTS-0271)		#12 RBM (GTS-0271) #10 RBM (GTS-0267) #8 RBM (GTS-0009)**
Steel Tie Turnouts	N/A		Narstco #12 RBM Narstco #10 RBM Narstco #8 RBM**
Concrete Tie Turnouts	#20 RBM 136RE (GTS-2108) #24 MPF 136RE (GTS-0245)		
Frogs	RBM with low impact heel, Jump Frogs**, Movable Point Frog (MPF) for #24 turnouts/crossover.		
			SGM Frogs** SGM Frogs are not preferred for new construction

* Where walking ballast is required, it shall be applied in a minimum 4 in (102 mm) thick layer.

** Only when authorized in writing by the Director, Engineering – Track.

† All turnout points must be Sampson-type points.

Construction and Rehabilitation Tolerances

Tolerances must meet or exceed the measurements in the table below for all new track construction and track rehabilitation projects.

This table applies to all classes of main track and non-main tracks.

Table O-2 Construction and Rehabilitation Tolerances

Defect	Description	Tolerance
Gauge*	The deviation from the standard gauge for track measured between the running rails at right angles to the alignment of the track 5/8 in (16 mm) below the top of rail.	± 1/8 in (3 mm)
Track Centers*+	The tolerance distance between the center lines of two adjacent tracks.	+ 1/4 in (6 mm) - 0 mm
Horizontal Position*+	Horizontal track centerline from the design requirements.	± 1/4 in (6 mm)
Alignment*	The deviation of the mid-ordinate from a 62 ft (18.9 m) chord.	± 1/4 in (6 mm)
Surface*	The deviation from uniform profile on either rail at the mid-ordinate of a 62 ft (18.9 m) chord	± 1/4 in (6 mm)
Runoff	The runoff in any 31 ft (9.5 m) of rail at the end of a raise or track lift	± 1/2 in (13 mm)
Warp	The difference in cross-level between any two points less than 62 ft (18.9 m) apart	± 1/4 in (6 mm)
Cross-level	The deviation from the designed cross-level at any point on a tangent or curve	± 1/4 in (6 mm)
Tie Spacing*	Horizontal spacing tolerance between adjacent ties, applying to all tie types.	± 1 in (25 mm)
Tie Plate Placement*	Applicable to hardwood ties, the difference of plate to edge of tie on both field sides of tie. A measure of how center the ties are between the rails.	± 1/2 in (13 mm)

* Does not apply to maintenance activities which do not involve new track panel construction or if a track design is not available but must still comply with priority defect tolerances as per Appendix C.
+ Must be met if a design is available for proposed maintenance activities.

Appendix P – Rail Usage Guidelines

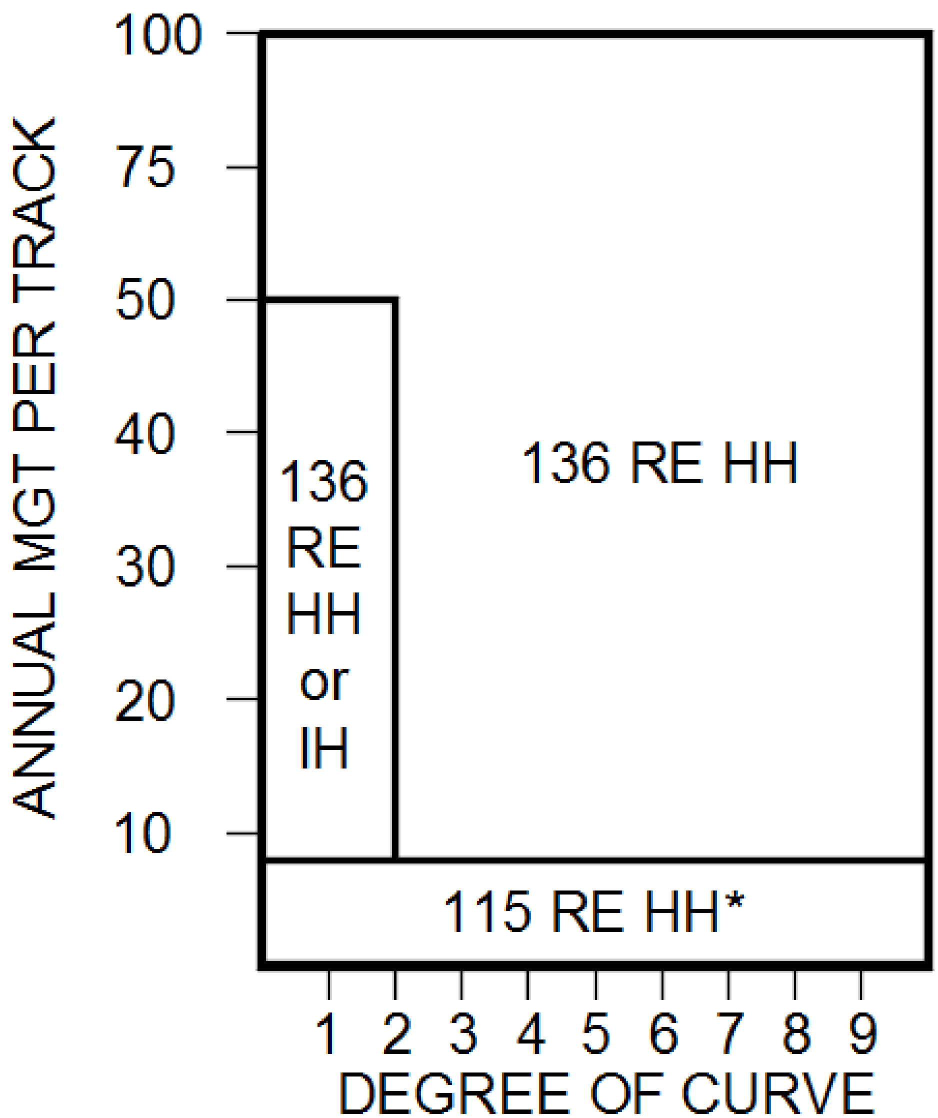


Figure P-1 Rail Usage Guideline Chart

* 100 ARA and 132 RE rail may be used for maintenance only to match existing rail in track. All mainline 100 ARA rail must be scheduled for upgrade to the appropriate rail section above.

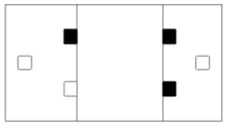
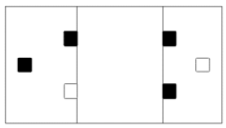
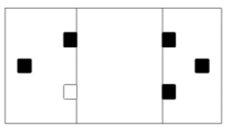
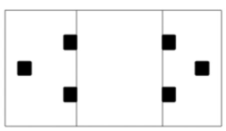
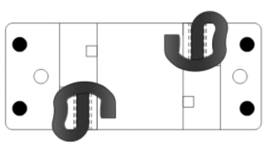
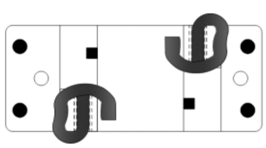
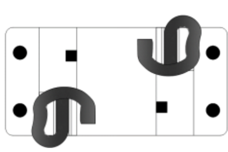
Note: Any rail section smaller than 100 ARA must be scheduled for upgrade to the appropriate rail size.

Appendix Q – Standard Rail Head Profiles

Rail grinding and rail milling profiles must be submitted prior to any grinding or milling activities for review and approval by Metrolinx E&AM-Track.

Appendix R – Tie Plate Fastening Patterns

Table R-1 Spiking Patterns

Spiking Pattern			MGT Per Year	Degree of Curve			
	Field	Gauge		0°-2°	>2°-4°	>4°-6°	>6°
A			Non-main Track	X	X	X	X
			0-20	X			
B			0-20		X	X	
			>20	X			
C			0-20				X
			>20		X	X	
D			>20				X
			Applied to turnouts per Track Standards Section 10.4 Figure 10-1				
E			18″ cast plates for use on tangent portions of timber deck bridges				
F			18″ cast plates for use on curved portions of timber deck bridges				
G			For 16″ cast plates				

Notes:
- When 8-hole plates are re-installed into track, only the 4 gauge spike holes must be filled. Pin spike holes must be replaced with standard 6-hole or forged plates.
- ■ indicates cut spike ● indicates screw spike

Appendix S – Recommended Tie Plate Usage

Table S-1 Recommended Tie Plate Usage

<table>
<tr><th rowspan="2">Annual Tonnage (MGT)</th><th rowspan="2">Class of Track</th><th colspan="3">5½″ (140mm) Rail Base, 1:40 Canted Rail Seat*</th></tr>
<tr><th colspan="3">14″ (356mm) Double Shoulder (DS) plate
Cast 16″ (406mm) and 18″ (457mm) Plates</th></tr>
<tr><td>All</td><td>Yard</td><td colspan="3">All
(Existing 11″ DS Tie plates and Rolled Plates* shall be replaced through routine maintenance)</td></tr>
<tr><td>All</td><td>1 - 5</td><td colspan="3">All</td></tr>
<tr><th colspan="2" rowspan="3"></th><th colspan="3">6″ (152mm) Rail Base, 1:40 Canted Rail Seat*</th></tr>
<tr><th>14″ (356mm) DS Plate with 1:40 Cant</th><th>16″ (406mm) DS Plate</th><th>16″ (406mm) Cast</th></tr>
<tr><th colspan="3">Degree of Curve</th></tr>
<tr><td>≤5</td><td>1 - 5</td><td>0° - 6°</td><td>> 6°</td><td>N/A</td></tr>
<tr><td>>5 - 20</td><td>1 - 5</td><td>0° - 4°</td><td>>4° - 6°</td><td>> 6°</td></tr>
<tr><td rowspan="2">>20 - 40</td><td>1 - 2</td><td>0° - 4°</td><td>>4° - 6°</td><td>> 6°</td></tr>
<tr><td>3 - 5</td><td>0° - 2°</td><td>>2° - 4°</td><td>> 4°</td></tr>
<tr><td>>40</td><td>3 - 5</td><td>N/A</td><td>0° - 2°</td><td>>2°</td></tr>
</table>

NOTE: See Standard Plan GTS-501 for details

*1:20 Canted Rail Seat is permitted for Galt Sub Maintenance only

Appendix T – Typical Ballast Profiles

See Standard Plan GTS-2205 for details.

Also, refer to the Metrolinx Crushed Rock Track Ballast Specification

For use with Steel Ties, see the manufacturer-recommended instructions.

Appendix U – Crossing Surfaces

Table U-1 Crossing Surface Life Span

Crossing Surface Type	Average Life Span (Years)
Bituminous (Asphalt)	6
Treated Sectional Timber	10
Precast Concrete Panels	15
Poured in Place Concrete	15*
Full-Depth Recycled Rubber	15*
Sectional Steel Panels	18*
Full Depth Virgin Rubber	20
Steel Reinforced Virgin Rubber	20*

The above-average crossing surface life spans are based on 3,000 to 5,000 vehicles per day and 120 to 175 GO trains per day over the crossing.
* Not typically used on Metrolinx-operated corridors.

The following chart for selection of crossing surfaces should be used as follows:

1. Obtain from the road authority the average daily vehicle counts for the crossing involved. This count should include separate counts for the number of trucks and cars using the crossing on a daily basis;
2. Multiply the average number of trucks per day by 100 and add to this number the average number of cars per day to obtain the number of car equivalents;
3. Determine the number of million gross tons over the crossing annually;
4. Enter the chart using the calculated car equivalents and the MGTs to determine the numbered area; and
5. From the number area obtained from the chart, select a recommended crossing surface from those listed.

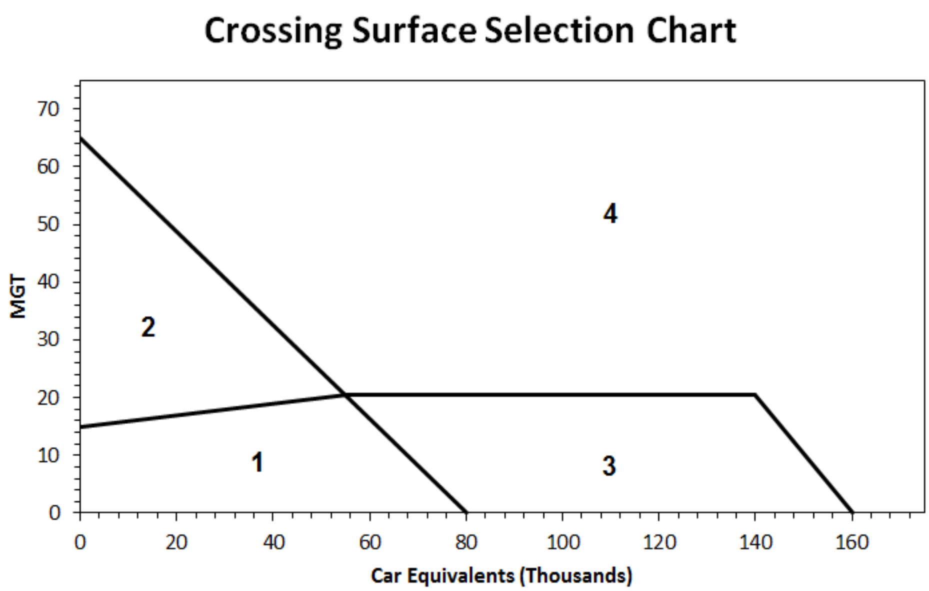


Figure U-1 Crossing Surface Selection Chart

Table U-2 Crossing Surface Selection

Area 1	• Treated sectional timber • Full-depth bituminous with rubber flange-ways • Full depth (virgin) rubber • Precast concrete panels with rubber flange-ways
Area 2	• Full depth (virgin) rubber • Precast concrete panels with rubber flange-ways
Area 3	• Full depth (virgin) rubber • Full-depth bituminous with rubber flange-ways
Area 4	• Full-depth bituminous with rubber flange-ways

* Other crossing surfaces may be used under the written permission from the Director, Engineering - Track;

** Crossings located in curves may not be able to meet the requirements for crossing surfaces above. In this case, the Director, Engineering–Track must be informed in writing, and the crossing surface must be full-depth bituminous with rubber flange-ways; and

***For tangent track crossings in Area 1 and Area 2, the preference is to use concrete crossing panels.

Appendix V - Track Inspection Checklist

Table V-1 Track Inspection Checklist

ITEM TO CHECK	WHAT TO LOOK FOR		
	HI-RAIL	WALKING	TRAIN
Rail	Broken, vertical split heads, crushed heads, engine burns, discoloration, wear.	Broken, vertical or horizontal split heads, rail head surface collapse, crushed heads, corrugation, wear, spalls, shelling, engine burns, rail end batter, discoloration, rust streaks, rail wear, underside of rail head, damage by equipment.	Broken, rough
Bars	Broken.	Broken, bent, cracked.	-
Bolts	Loose, missing.	Loose, missing, bent.	-
Washers	-	Missing.	-
Tie Plates	Broken, missing.	Broken, bent, badly corroded, missing, skewed, installed backwards, improper cant.	-
Track Spikes	High, missing.	High, missing, bent, loose.	-
Rail Anchors	Off, damaged, insufficient.	Off, loose, away from tie or plate, damaged, insufficient.	-
Timber Ties	Broken, damaged by equipment.	Broken, split, spike killed, plate cut, damaged by equipment, clusters.	-
Concrete Ties	Broken, damaged by equipment.	Broken, cracked, center-bound, loose, worn, or damaged shoulders, skewed, abraded rail seat, damaged by equipment. Walk along the field side noting the condition of clips, pads, insulators, and cast shoulder or outward rail movement or other signs of Rail seat abrasion.	-
Steel Ties	Broken, damaged by equipment.	Broken, cracked, bent, loose or damaged clips, heavy corrosion, worn shoulders, skewed, damaged by equipment. Check inspection holes for sufficient ballast.	-
Elastic fasteners	Missing, damaged.	Missing, damaged, loose, corroded.	-
Insulators	Missing.	Missing, worn, damaged, out of position.	-
Pads	-	Missing, worn, out of position.	-
Ballast Section	Ballast low in cribs or shoulder.	Cribs not full, low shoulder, narrow shoulder.	-
Ballast	Pumping, fouled.	Pumping, fouled, hanging ties.	-
Line	Misalignment.	Misalignment.	Misalignment, ride quality.

ITEM TO CHECK	WHAT TO LOOK FOR		
	HI-RAIL	WALKING	TRAIN
Icing Conditions	Ice build-up between base of rail and tie plate, raised spikes, churned ice.	Ice build-up between base of rail and tie plate, raised spikes, churned ice chunks, wide gauge.	Churned Ice, rough ride.
Surface	Poor surface.	Poor surface.	Poor surface, ride quality.
Cross Level	Poor cross-level.	Poor cross-level.	Ride quality.
Gauge	Wide/Irregularities, wheel flange marks, raised or tipped spikes, plate cutting or movement Irregularities. Change in location of running band on the rail.	Wide / Irregularities, wheel flange marks, raised or tipped spikes, plate cutting or movement. Change in location of running band on the rail.	Irregularities, ride quality.
Turnouts	Misalignment, components damaged, loose, missing, worn.	As per Track Standards Section 17.	Ride quality.
Railway Crossings (Diamonds)	Misalignment, components damaged, loose, missing, worn.	As per Track Standards Section 17.7.	Ride quality.
Vegetation	Contacting equipment, restricting visibility, fire hazard, Restricting drainage, contacting wires, fouling ballast, Impeding inspection of fasteners, encroaching bridge structure.	Contacting equipment, restricting visibility, fire hazard, Restricting drainage, contacting wires, fouling ballast, Impeding inspection of fasteners, encroaching bridge structure.	Contacting equipment, restricting visibility, fire hazard, Restricting drainage, contacting wires, fouling ballast, and encroaching bridge structure.
Drainage	Ditches or culverts blocked, beaver activity, high water.	Ditches or culverts blocked, beaver activity, high water.	High water.
Land Slides, Slope Failures	Slope failures, slides, rock falls.	Slope failures, slides, rock falls.	Slope failures, slides, rock falls.
Fencing	Damaged, open gates, livestock on ROW.	Damaged, open gates, livestock on ROW.	Damaged, open gates, livestock on ROW.
Clearances	Restricted clearances.	Vertical & horizontal restricted clearances.	-
Highway and Farm Crossings	Missing or high planks or other surface material, high spikes, obstructed flange-ways, restricted sight lines. Warning devices – damaged or missing gates, lenses, bulbs, signs, masts, 1-800 number label Power light.	Loose, missing or high planks or other surface material, high spikes, obstructed flange-ways, restricted sight lines. Warning devices: damaged or missing gates, lenses, bulbs, signs, masts, 1-800 number labels, and power "off" or "on" lights.	Ride quality, restricted visibility. Warning devices – damaged or missing gates, inoperable.
Track Signs	Defective, missing, obstructed, loss of reflectivity.	Defective, missing, obstructed, loss of reflectivity.	Defective, missing, obstructed, loss of reflectivity.

Appendix W – Temporary Excavation Limits for Intrusive Works Adjacent to a Railway

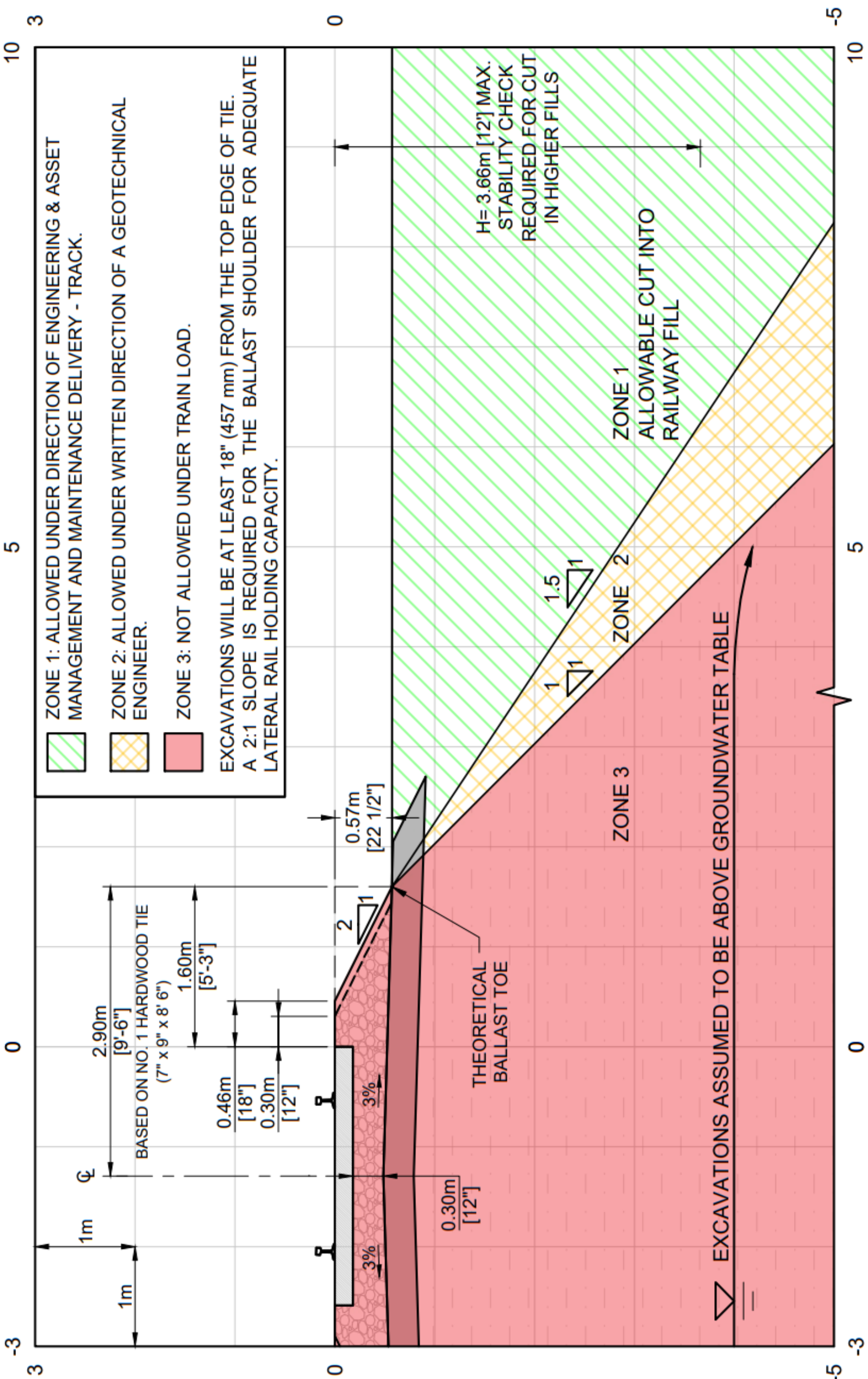


Figure W-1 Excavation Zones

Appendix X – Metrolinx Heavy Rail Clearance Envelope

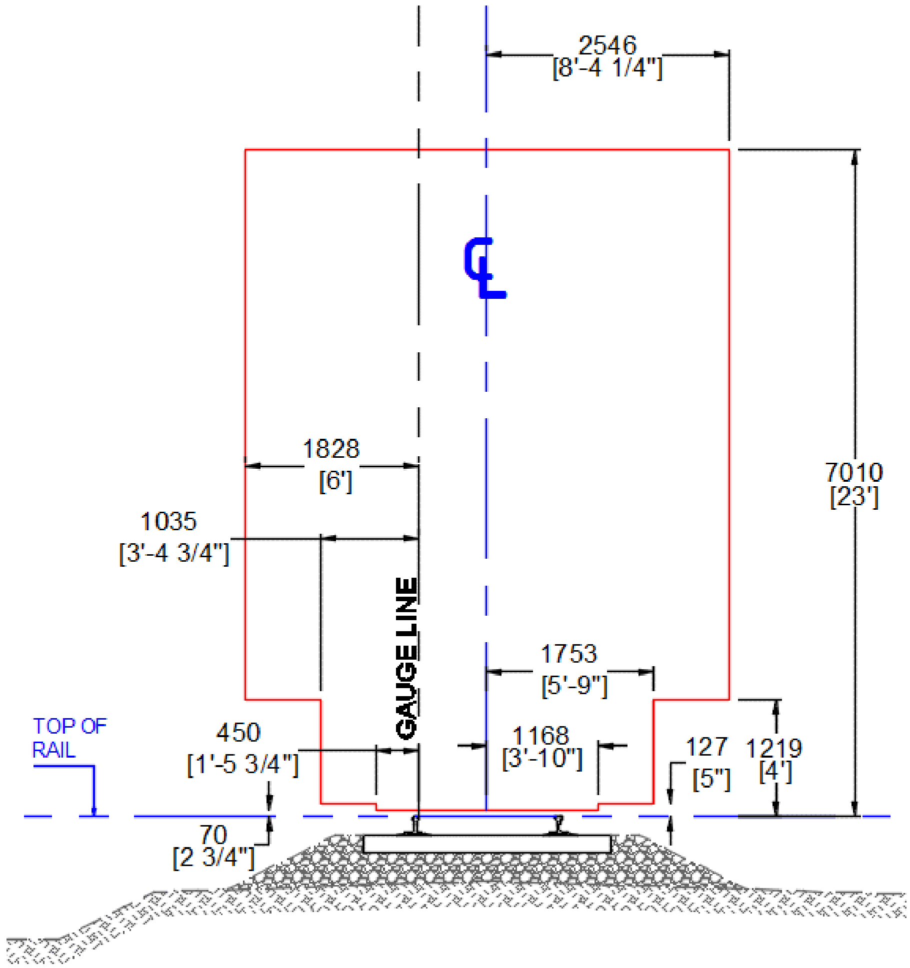


Figure X-1 Standard Train Envelope on Tangent Track

See Standard Plans GTS-3003, GTS-3004 for additional clearance envelopes.

Appendix Y – Grapple Ability by Make and Model

Table Y-1 Grapple Ability by Make and Model

Make / Model	Ability to Handle Ties (wood)	Ability to Handle Rail by Tine Tips	Ability to Handle Rail Grasped in Grapple Arms	Maximum Allowable Load on Grapple (lbs)	Maximum Length of 136RE Rail Approved for Handling ft (m)
Heiden HC20-B3	yes	yes	no	6000	39
Heiden HC20-B4	yes	yes	no	6000	39
Heiden HC20-A3	yes	yes	no	6000	39
Heiden HC20-AHR3	yes	yes	yes	6500	39
Heiden HC20-AHR4	yes	yes	yes	6500	39
Heiden HC20-BP-3	yes	yes	no	6000	39
Heiden HC20-BLT-3	yes	yes	no	6000	39
Kinshofer 632-2-R	yes	yes	yes	6600	50
Kinshofer 632-R	yes	yes	yes	6600	50
Kinshofer C12VE	yes	yes	yes	9900	50
Kinshofer C25VE	yes	yes	yes	9900	50
Moley MPB1	yes	yes	yes	4400	50
Moley MPB2	yes	yes	yes	4400	50
Moley MPB3	yes	yes	yes	4400	50
Moley MPB 1C	yes	yes	no	4400	50
Moley MPB 2C	yes	yes	no	4400	50
Moley MPB 3C	yes	yes	no	4400	50
Rotobec 4550RA-RT252	yes	yes	yes	32000	60
Rotobec 4642-RT252	yes	no	yes	25000	N/A
Rotobec 4642RA-RT252	yes	yes	yes	25000	60
Rotobec 6007BT-RT142	yes	yes	no	14000	60
Rotobec 6007RA-RT222	yes	yes	yes	14000	60
Rotobec 6606HDRA-RT252	yes	yes	yes	21000	60
Rotobec 6806RA-RT142	yes	yes	yes	14000	60
Rotobec 5805BT- A	yes (individual)	yes	no	8800	60
Rotobec 5805RA	yes	yes	yes	8800	60
Rototilt MG60	yes	no	yes	18250	N/A
Rototilt MG80	yes	no	yes	26460	N/A
Serco 5006137	yes (individual)	yes	yes	16000	39
Serco 5006139	yes	yes	no	9000	39
Serco 5006141	yes	yes	no	16000	39
Serco 5013215	yes	yes	yes	16000	39
Serco 5013329	yes	yes	no	9000	39
Serco 5206 C/R S/P Log	yes	yes	no	32000	39
Serco 680A899	yes	yes	no	32000	39
Serco 5006143	yes	yes	no	9000	39
Serco 5006145	yes	yes	no	9000	39
Serco 5013255	yes	yes	no	9000	39