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Rail Transit Fixed Structures Inspection and Maintenance Working Group

Rail Transit Track Inspection and Maintenance

Abstract: This standard provides minimum requirements for inspecting and maintaining rail transit system tracks.

Keywords: fixed structures, inspection, maintenance, qualifications, rail transit system, structures, track, training

Summary: This document establishes a standard for the periodic inspection and maintenance of fixed structure rail transit tracks. This includes periodic visual, electrical and mechanical inspections of components that affect safe and reliable operation. This standard also identifies the necessary qualifications for rail transit system employees or contractors who perform periodic inspection and maintenance tasks.

Scope and purpose: This standard applies to transit systems and operating entities that own or operate rail transit systems. The purpose of this standard is to verify that tracks are operating safely and as designed through periodic inspection and maintenance, thereby increasing reliability and reducing the risk of hazards and failures.

This document represents a common viewpoint of those parties concerned with its provisions, namely operating/ planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any standards, recommended practices or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a transit system's operations. In those cases, the government regulations take precedence over this standard. The North American Transit Service Association (NATSA) and its parent organization APTA recognize that for certain applications, the standards or practices, as implemented by individual agencies, may be either more or less restrictive than those given in this document.

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Introduction

This introduction is not part of APTA RT-FS-S-002-02, Rev. 1*"Rail Transit Track Inspection and Maintenance".*

Sections 1 through 11 of this document describe the common track elements used on all types of track construction. Specific types of track design and track construction are described in Sections 12 through 14.

APTA rail transit safety standards represent an industry consensus on safety practices for rail transit systems (RTS) to help achieve a high level of safety for passengers, employees and the general public. This document was created by and for those parties concerned with its provisions, namely rail transit systems (operating agencies), original equipment manufacturers (OEMs), consultants, engineers and general interest groups. This standard provides procedures for inspecting and maintaining rail transit tracks.

This standard intends to meet the following objectives:

- to ensure special life/safety equipment is operational and reliable
- to help rail transit systems incorporate safety considerations during the inspection and maintenance process
- to identify inspection criteria and maintenance standards that provide a high level of passenger and personnel safety

APTA recommends the use of this document by:

- individuals or organizations that operate rail transit systems;
- individuals or organizations that contract with others for the operation of rail transit systems; and
- individuals or organizations that influence how rail transit systems are operated (including but not limited to consultants, designers and contractors).

Note on alternate practices

Individual rail transit systems may modify the practices in this standard to accommodate their specific equipment and modes of operation. APTA recognizes that some rail transit systems may have unique operating environments that make strict compliance with every provision of this standard impossible. As a result, certain rail transit systems may need to implement the standards and practices herein in ways that are more or less restrictive than this document prescribes. A rail transit system may develop alternates to APTA standards so long as the alternates are based on a safe operating history and are described and documented in the system's safety program plan (or another document that is referenced in the system safety program plan).

Documentation of alternate practices shall:

1. identify the specific APTA rail transit safety standard requirements that cannot be met;
2. state why each of these requirements cannot be met;
3. describe the alternate methods used; and

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4. describe and substantiate how the alternate methods do not compromise safety and provide a level of safety equivalent to the practices in the APTA safety standard (operating histories or hazard analysis findings may be used to substantiate this claim).

Rail Transit Track Inspection and Maintenance

1. Overview

1.1 Measuring track not under load

When unloaded track is measured to determine compliance with the requirements of this standard, the amount of rail movement, if any, that occurs while the track is loaded must be added to the measurement of the unloaded track.

1.2 Combination of conditions

Requirements as prescribed in this part are described as single conditions at a given location. When a combination of conditions at a given location exists, but none individually requires action, a qualified person (as designated in Section 2) must evaluate the condition for protection and take appropriate action. Train dynamics, track geometry and track design, location of the track, maximum speeds over the area, and any other factors that could negatively influence the severity of the conditions found must be taken into consideration when evaluating the proper action(s) to be taken, particularly in special work and curved locations.

1.3 Restoration and renewal of track

When any work is performed on the track to repair or correct conditions described herein, the work is to be under the supervision of a qualified person as designated by Section 2.

2. Qualified persons

2.1 Designation of qualified persons

Each rail transit system or operating entity shall designate qualified persons to supervise track maintenance, track renewal and inspection of track under traffic. Those designated persons shall meet the requirements described herein.

2.2 Work performed by others

Work performed by contractors or other non-agency parties on the rail transit system's track shall be inspected by a qualified person, as described herein, prior to placing the track in service.

2.3 Minimum qualifications of qualified persons

A person designated by the rail transit system as a qualified person shall:

a) Have at least:
   - two years of satisfactory related experience inspecting, constructing or maintaining track and special work; and
   - a combination of experience in track maintenance and training from a qualified course in track inspection or from a college-level educational program related to track inspection; or
   - have demonstrated sufficient knowledge or have had satisfactory supervisory experience on another transit or railroad system; and

b) Demonstrate to the rail transit system that he or she:
   - knows and understands the requirements of these standards;
   - can detect deviations from these requirements; and

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- can prescribe appropriate remedial action to correct or safely compensate for those deviations.

A list of qualified persons shall be maintained by the rail transit system.

3. Inspection

3.1 Track inspection

a. Tracks used by revenue trains shall be inspected weekly on foot, or by riding over the track in a vehicle at a speed that allows detection of noncompliance with these standards. In the unusual event that a walking or riding inspection cannot be performed, a qualified person must inspect the track from a revenue vehicle in a position that allows full view of the roadbed. Inspections must be performed by a qualified person as prescribed by Section 2. An interval of at least three but not more than 11 calendar days must elapse between inspections.
b. Non-revenue and yard tracks shall be inspected once a month.

Components of a section of track shall be inspected and their condition recorded on an inspection form, with all deviations or deficiencies recorded on the form. Remedial action for defects must be taken in accordance with the parameters set forth in this standard and as prescribed in Section 2 and Section 5. All forms shall be submitted daily to a track supervisor for review, file or remedial action. All forms shall be complete and retained on file for a minimum of one year aft.er the date of inspection. Refer to Appendix E for samples of track and switch inspection forms.

3.2 Rail inspection

Ultrasonic rail flaw detection of mainline tracks shall be performed at least once per year. Defective rails shall be clearly marked on each side of the rail web and base. Inspection records shall show the nature of defects, location of flaw and action taken. If rail defects are found during walking track inspections, use the standards listed in the rail defect remedial action chart to determine appropriate action. Broken rails must be reported using a standard form (a sample form is shown in Appendix E). Records shall be maintained for a minimum of two years aft.er inspection and one year aft.er remedial action.

3.3 Continuous welded rail inspection

Special inspections of continuous welded rail (CWR) shall occur when the ambient temperature causes the rail temperature to meet or exceed the neutral temperature of the rail. Particular attention is to be given to periods of temperature fluctuations, looking for signs of high thermal stresses in the rails. In the event that daily cycles of extreme temperature fluctuations occur, consideration shall be given to repeated inspections. Defects found shall be recorded on a track inspection form for a minimum of two years aft.er inspection and one year aft.er corrective action. See Section B.6 of Appendix B.

3.4 Geometry inspection

The geometry of mainline standard gage track shall be inspected and recorded at least once per year by an automated track inspection or measurement vehicle; this inspection will supplement the weekly visual inspection of track. Data collected in accordance with Section 8, "Track geometry," shall be maintained for three years. Defects detected shall be given to the maintenance manager for corrective action. Defects shall be reported as prescribed in Section 4. Rail transit systems with only non-ballasted revenue track shall inspect mainline tracks at least once every two years with an automated track inspection vehicle. This requirement is not applicable to embedded track; see Section 13 for inspection requirements for embedded or street-running track.

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3.5 Detailed switch and crossing inspection

a) Mainline switches, track crossings and moveable bridge lift rails shall be inspected for defects monthly.
b) Yard switches shall be inspected for defects every three months.
c) Mainline and yard track switches that are signaled or electrically controlled shall be inspected jointly by signal and track forces annually. Joint switch inspection forms shall be used, and all information shall be completed for each switch inspected. Track supervision shall be present for this inspection and sign the form. The completed form shall be forwarded to the respective track and signal maintenance managers and kept on file for a minimum of one year from the date of inspection.
d) Inspection aft.er track-related failure. Switches that failed to operate properly due to a track cause or an undetermined cause shall be inspected by both signal - and track-qualified inspectors to determine the cause and to ensure that the repair is complete.

3.6 Special inspection

In the event of fire, flood, seismic activity, severe storm or other occurrence that might have damaged the track and/or structure, a special inspection of the affected track and structure must be made as soon as possible aft.er the occurrence.

Defects reported by the public and employees shall be investigated as soon as possible. Appropriate corrective action shall be taken.

4. Condition reporting

The rail transit system shall have specific procedures for reporting defects and/or conditions, corrective action and/or mitigating measures to be taken when track conditions found by qualified personnel deviate from the standards shown herein. Either a track condition prioritization system or a speed-based track classification system shall be used. In either case, operations over deficient track conditions shall not be allowed to exceed the prescribed minimum safety requirements indicated herein. The Rail Transit System or operating entity shall follow the requirements prescribed in Section 3, ‘Inspection’, regarding the retention of records concerning the inspections performed.

4.1 Reporting of a condition’s location

Proper reporting of the location of exceptions is a necessary part of the information flow to management and others involved with follow-up and repair of conditions. When reporting a defect, all information, including track number, line stationing or other unique repeatable methodology as determined by the rail transit system must be utilized.

4.2 Classes of track

If a speed-based track classification system is used by the rail transit system, it shall conform to the following:

a) The track classes shall be as described in **Table 1**.
b) Maintenance criteria shall be established using the same speed-based track classification system.

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TABLE 1
Classes of Track

Class[1]	Maximum allowable train speed[2]
1	15 mph
2	30 mph
3	60 mph
4	80 mph
5	90 mph

1. Over track that meets all the other requirements prescribed herein.
2. The designated operating speeds of some transit systems may be determined by designed automatic train control systems or through established operating practices. The agency may alter the maximum allowable train speeds in this table to match its established train speeds if so required, provided that:
   a. the maximum allowable operating speeds shown herein to describe a class of track shall not be exceeded; and
   b. The deviations from the minimum standards shown herein are not exceeded for the specified operating speeds.

4.3 Condition prioritization

If a condition prioritization system is used, it shall conform to the following:

a) The condition prioritization system shall be as described in **Table 2**; and
b) Any rail transit system that knows or has notice that the track does not comply with the standards shown herein shall report the condition using this hierarchy and take the required corrective action.

TABLE 2
Condition Prioritization

Priority	Description[1]
1	The qualified person(s) detecting such condition shall make every effort to correct the condition immediately and must also evaluate whether to allow operations to continue under supervision, or to place the track out of service immediately. If operation is allowed to continue, then the person(s) making the decision must not leave the scene until relieved or until the defect is repaired. When "walking" trains over such a condition, each train shall be stopped short of the defect and the person on the ground shall communicate the situation to the train operator. Movements shall be made at restricted speed with extreme caution; that is, proceeding no faster than 15 mph; prepared to stop at least two car lengths short of a visible object on the roadway; ready to make a fast stop; watching rails and switches for the route; and looking for anything on the roadbed that is unsafe to pass.
2	Conditions that require inspection by a qualified person within 24 hours of the time of the detection of the condition. The investigating person shall immediately determine whether a slow speed order is necessary and what work is required, and shall base these decisions on findings and other factors, such as the type of defect, the location and permanent speed of the track in question. Every effort shall be made to correct these defects as soon as practicable.
3	Such designation alerts to a track condition that affects the ride comfort qualities of the track and that may degrade to a worse condition if left uncorrected. Work programs shall be established for the correction of these defects.
4	Conditions that do not require any immediate action. These conditions may affect ride comfort qualities of the track should they degrade to a worse condition. Uncorrected defects shall be recorded and the reports shall be used for scheduling future work.

NOTE: The rail transit system may modify the above prioritization code to meet its individual requirements; however, modifications shall be consistent with the above table and uniformly applied throughout the rail transit system's maintenance standards.

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5. Corrective action

This section describes the methods and systems that the rail transit system shall apply when it knows, or has notice, that the track does not comply with the requirements specified herein.

5.1 Required action

Any rail transit system that knows, or has notice, that the track does not comply with the requirements specified herein shall:

a) bring the track into compliance; or
b) to operate under conditions that do not meet class 1, or over priority 1 conditions, put train movements under the continuous supervision of a qualified person, subject to conditions set forth herein, at an appropriate restrictive speed not to exceed 15 mph; or
c) stop operations over that track.

5.2 Conditions detected by automated track inspection vehicles

Conditions detected by automated track inspection vehicles shall be classified according to the designations in **Table 2**. A qualified person shall perform the analysis and interpretation of those conditions, as well as any determination regarding the required corrective action. Such determination shall be made by taking into account the type of defect, its location, the type of track, the permanent speed of the track in the area and any other combination of geometry conditions that could negatively influence the severity of the conditions found. In any case, if a qualified person discovers that the condition is an exception to these standards, then the prescribed action(s) shall be taken.

6. Roadbed

This section prescribes minimum requirements for the roadbed and areas immediately adjacent to the track structure.

6.1 Drainage

Drainage is of the utmost importance in the maintenance of track. Each drain, cross-drain or other water-carrying facility under or immediately adjacent to the transit property's track must be kept free of debris and obstructions to accommodate expected water flow. Water must not be allowed to accumulate or stand around or on track and third rail (power rail) components.

6.1.1 High-water conditions

High-water conditions in track shall restrict train operations as shown in **Table 3**.

TABLE 3
High-Water Conditions[1]

Class of Track	Priority	Operating Speed	High-Water Condition
1	1	15 mph or less	Within the head of either running rail[2]
2	2	16 to 30 mph	Above the base of either running rail
3 through 5	3	31 to 90 mph	Up to the base of either rail

1. This table is not applicable for street-running track work. Rail transit systems with street-running track shall develop and adhere to specific guidelines for their conditions.
2. Only supervised operation is permitted where water is above the running surface of either rail.

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6.2 Vegetation

Vegetation found in the ballast area indicates fouled ballast and resulting poor drainage. Vegetation that is within or immediately adjacent to the roadbed must be controlled so that it does not:

1. become a fire hazard;
2. obstruct visibility of signs, highway rail crossings and signals;
3. interfere with employees performing normal trackside duties;
4. prevent proper functioning of signal and communication lines;
5. prevent employees from visually inspecting moving equipment from their normal duty stations; or
6. strike or rub the sides or tops of trains.

6.3 Storage of materials and equipment along the right-of-way

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

1. interfere with possible evacuation of passengers and personnel in an emergency;
2. interfere with possible actions of emergency personnel;
3. come in contact with rail vehicles;
4. interfere with operation of train control systems;
5. interfere with operation of switches and special track work;
6. interfere with operation of moveable bridges;
7. interfere with traction power distribution systems; or
8. contact the running or guardrails.

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

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

7. Track appliances and devices

This section prescribes minimum requirements for certain track appliances and devices.

7.1 Lift. rails

Lift. rails at moveable bridges shall be closely monitored. They are subject to all applicable standards included in this document and must be inspected monthly. During inspection, check that all fasteners are secure and holding. Check for proper lubrication, unusual wear, over-flow, mismatched joints and cracks in casting.

7.2 Derails

Each derail must be clearly visible. Switch point derails shall be maintained as per Section 11 of this standard; for other types of derails, the manufacturer's recommendations shall be followed. When in a locked position, a derail shall be free of lost motion that would prevent it from performing its intended function. Each derail should be properly installed for the rail to which it is applied

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7.3 Slip rails (expansion joints)

Particular attention shall be given to slip rails or expansion joints. Any unusual longitudinal or vertical movement must be noted. All the appropriate requirements of Section 10 of this standard shall be met, and slip rails should be inspected monthly. The sliding joint must be inspected for any loose bolts, loose hold-down devices (spikes, screws, elastic fasteners, etc.). The sliding rail shall be checked to ensure that it has been properly lubricated and is indeed moving, and the distance between the end of the free rail and the cast stop on the sliding joint must be checked to ensure that it is within tolerance.

7.4 Switch heaters

The operation of a switch heater must not interfere with the proper operation of the switch or otherwise jeopardize the safety of equipment.

7.5 Rail lubrication

a) Rail lubrication shall be used to reduce rail wear and for noise abatement purposes. Additionally, rail lubrication can help the train's wheels to negotiate sharp curves by decreasing the friction between the wheel flange and the side of the running rail and guardrail (restraining rail).
b) High-pressure, mechanical or other approved type of lubricators shall be used.
c) Rail lubricators shall be installed at the following locations:
    - Ahead of switches where the main direction of traffic is into the curved side of the turnout.
    - On all sharp curves as determined by the rail transit system. The initial applicator shall be placed ahead of the curve, prior to entering the body of the curve, at a point such that the lubricant is carried effectively throughout the curve. Additional applicators shall be placed along the curve as required.
    - Other locations deemed necessary, according to field conditions. Locations may be adjusted considering rail wear rates and train operating conditions.
d) A suitable enclosure shall be provided to house the lubricating equipment and controls as well as the lubricant.
e) Lubrication equipment shall be thoroughly inspected by trained personnel according to an approved schedule. All equipment in service is to be tested at least twice a year, especially during extreme weather changes and aft.er any repairs or adjustments have been performed. During inspections, adjustments shall be made as required based on the conditions observed.
f) Rail lubricators shall be maintained and adjusted to provide the proper amount of lubricant at all times. Excessive accumulation of lubricant at the applicators or at any other points along the track shall be avoided; the lubricant must be distributed as uniformly and evenly as possible throughout the curve. Lack of lubrication results in high rates of wear of rails and wheels, as well as an increase of friction between the flanges of the wheel and the rail, and therefore shall be avoided. The pressure shall be adjusted as required to provide the required amount of lubricant flow as determined by an inspection of the rails along the curve. If during inspection of the lubricators any conditions (such as excessive accumulation of lubricant on the rails) are found that may interfere with the safe operation of trains over the area, corrective action shall be immediately performed and the pressure adjusted accordingly.
g) The material used for lubrication shall conform to the specifications of the rail transit system. In addition, the manufacturer's recommendations regarding use, storage and handling of the product shall be followed. Lubricant sampling shall be performed at least once a year to ensure that the product does meet the required properties.

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8. Track geometry

This section prescribes the requirements for gage, horizontal alignment, surface and superelevation of track.

8.1 Track gage

8.1.1 Gage

Track gage is measured at right angles to the rail, ⅝ in. below the plane of the top of the rails. Refer to Note 1 of **Table 4**.

8.1.2 Gage limits

Track gage shall be maintained within the limits prescribed in **Table 4**.

TABLE 4
Track Gage Limits[1]

Class of Track	Priority	Operating Speed	Deviation from Design[2]	
			Minimum[3]	Maximum[4]
1	1	15 mph or less	−½ in.	+1½ in.
2 and 3	2	16 to 60 mph	−½ in.	+1¼ in.
4 and 5	3	61 to 90 mph	−⅜ in.	+¾ in.

1. This table is intended for rail transit systems using American Association of Railroads (AAR) standard wheels, regardless of the design track gage. If nonstandard wheels are used, then the agency shall perform a special evaluation of its specific conditions and set appropriate limits, in accordance with the documents listed in the section under References.
2. Where gage varies by design, for example because of sharp horizontal curvature or to reduce truck hunting on tangent, then that designed gage shall be used to determine the allowable deviations specified above. These adjustments to track gage shall be clearly designated in the rail transit system's standards.
3. No operation is permitted when loaded gage deviation is less than −½ in.
4. No operation is permitted when loaded gage deviation is more than +1½ in.

8.2 Horizontal alignment (line)

Horizontal alignment standards for curved and tangent track are based on the mid-ordinate (mid-chord offset) of a fixed chord length. Measurements shall be taken at points on the gage side of the railhead. On tangent track, both rails shall be considered; the rail with the worst alignment shall be used for the application of these standards. On curves, the outside rail shall be used. The deviation from uniformity of the mid-offset from either a 62 ft. or 31 ft. chord shall conform to that shown in **Table 5**.

TABLE 5
Maximum Allowable Horizontal Alignment Deviation

Class of Track	Priority	Operating Speed	Maximum Allowable Deviation from Design Value			
			Tangent Track		Curved Track	
			31 ft. Chord	62 ft. Chord	31 ft. Chord	62 ft. Chord
1	1	15 mph or less	3 in.	5 in.	3 in.	5 in.
2	2	16 to 30 mph	2 ½ in.	3 in.	2½ in.	3 in.
3	2	31 to 60 mph	1¼ in.	1¾ in.	1¼ in.	1¾ in.
4	3	61 to 80 mph	1 in.	1½ in.	1 in.	1½ in.
5	3	81 to 90 mph	½ in.	¾ in.	½ in.	⅝ in.

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8.3 Track surface

Rail transit systems shall maintain the surface of their track within the limits prescribed in **Table 6**. For rail transit systems with speeds enforced by train control systems, see Appendix A for corresponding track surface deviation limits.

8.4 Superelevation

Curved track shall be superelevated in accordance with each rail transit system's standards and maintained within the limits described in **Table 6**.

8.5 Superelevation runoff

Superelevation runoff shall be at a uniform rate, within the limits of track surface deviation prescribed in **Table 6**. Superelevation runoff shall extend the full length of the spirals. If physical conditions do not permit a spiral long enough to accommodate the minimum length of runoff, then part of the runoff may be on an adjacent tangent or curve. If the superelevation is run off within the curve, then the minimum superelevation in the curve shall be used to calculate the maximum operating speed. If the superelevation is run off in an adjacent tangent, then the maximum cross level on tangent track shall not exceed that shown in **Table 6**.

TABLE 6
Track Surface

	Class of Track:	**1**	**2**	**3**	**4**	**5**
	Priority:	**1**	**2**	**3**	**3**	**4**
	Operating Speed:	**15 mph or less**	**16 to 30 mph**	**31 to 60 mph**	**61 to 80 mph**	**81 to 90 mph**
Condition description	**Chord length or distance[1]**					
Runoff in any 31 ft. of rail at the end of a raise may not be more than	31 ft.	3½ in.	3 in.	2 in.	1½ in.	1 in.
Deviation from uniform profile	31 ft. chords	1½ in.	1⅜ in.	1⅛ in.	1 in.	⅝ in.
	62 ft. chords	3 in.	2¾ in.	2¼ in.	2 in.	1¼ in.
Deviation from constant cross level	See Note 2	3 in.	2 in.	1¾ in.	1¼ in.	1 in.
Deviation from desired elevation in spirals	See Note 2	2 in.	1¾ in.	1½ in.	1 in.	¾ in.
Difference in constant cross level between two points	31 ft.	2 in.	1¾ in.	1½ in.	1¼ in.	1 in.
	62 ft.	3 in.	2¼ in.	2 in.	1¾ in.	1½ in.
Variation in cross level in spirals between two points	31 ft.	2 in.	1¾ in.	1¼ in.	1 in.	¾ in.
	62 ft.	3 in.	2¼ in.	2 in.	1¾ in.	1½ in.

1. Either a 31 ft. or 62 ft. chord length or distance may be designated to be used. However, the same chord length shall be exclusively used when applying this table.
2. The chord length or distance shall be chosen to be representative of the maximum twist tolerances allowed by the rail transit system's vehicles exhibiting the largest degree of stiffness to twist conditions.

8.6 Determination of superelevation

The method(s) used by the rail transit system to determine maximum operating speeds on curves shall be maintained on file.

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8.7 Horizontal curve data

Each rail transit system shall maintain horizontal curve data for every mainline curve on its system. The data shall include the location, overall length, radii or degree of curve, superelevation, length of super elevation runoff, spiral length and maximum allowable operating speed. This data shall be readily accessible to all personnel designated as qualified herein.

9. Track structure

This section prescribes minimum requirements for ballast, crossties and rail fasteners.

9.1 Ballast

Unless it is otherwise structurally supported, all tracks shall be supported by material that will:

9. transmit and distribute the load of the track and rolling equipment to the subgrade without overloading the subgrade;
10. restrain the track laterally, longitudinally and vertically under dynamic loads imposed by rolling equipment and thermal stress exerted by the rails;
11. provide adequate drainage for the track; and
12. maintain proper track cross level, surface and alignment.

Clean, well compacted ballast must be located in the cribs around the ends of all ties at a depth equal to not less than two-thirds the height of the tie. All cribs should be filled to within 1 in. of the base of the rail. The ballast height at the center of the tie cribs (away from the running rails) may be below these limits at the discretion of the track engineer. If the top of the ballast reaches a level lower than the halfway point of the ties (for more than five cribs in a row), then a slow order should be placed on the track and speeds reduced to one-half maximum authorized speed. In any 20 ft.. of ballasted track, at least 80 percent of all cribs should be filled to within 1 in. of the top of the tie.

In ballasted track with Continuous Welded Rail (CWR), the minimum ballast shoulder width shall be 12 inches, and 10 inches for conventional jointed ballasted track (other than special work). If the ballast shoulder is less than the above specified limits, refer to Table 7 below for the condition and operating speed restriction.

When track has been disturbed, such as due to maintenance activities, the track must be examined. If the track does not conform to the requirements outlined in this section, then the maximum authorized speed must be reduced as defined herein, until a proper section has been restored.

Ballast must be kept from touching the rails aft.er compaction. A space of at least 1 in. between the ballast and the base of the rail must be maintained to provide clearance between the rail and the ballast.

Ditches, pipes, catch basins, culverts and bridge openings must be kept free of obstructions. Ditches must be kept clear of grass and weeds. All drainage facilities must be checked and cleaned (as necessary) immediately aft.er storms.

For concrete ties with center-to-center spacing of 2 ft. or more, the depth of ballast under the tie must be a minimum of 12 in. For wood or composite ties with center to center spacing of 19.5 in., the depth of ballast under the tie must be a minimum of 9 in.

See **Table 7** and **Table 8**.

TABLE 7
Ballast Guidelines for Wood & Engineered Composite Ties

Crib Ballast (below the top of the tie)	Priority Condition	Speed
3 to 6 inches.	3	40 mph
Greater than 6 inches.	2*	15 mph
Ballast Shoulder Width**		
8 to 10 inches.	3*	40 mph
Less than 8 inches.	2*	15 mph
Number of Tie Ends Exposed in 20 ft.		
3 to 5	3	40 mph
More than 5	2	15 mph

* Additional ballast should be scheduled for installation
** The minimum shoulder width for track with wood or engineered composite ties shall be 10 inches

TABLE 8
Ballast Guidelines for Concrete Ties

Crib Ballast (below the top of the tie)	Priority Condition	Speed
2 to 5 inches	3	40 mph
Greater than 5 inches	2*	15 mph
Ballast Shoulder Width**		
6 to 10 inches	3*	40 mph
Less than 6 inches	2*	15 mph
Number of Tie Ends Exposed in 20 ft.		
3 to 5 inches	3	40 mph
More than 5 inches	2	15 mph

* Additional ballast should be scheduled for installation
** The minimum shoulder width for track with concrete ties shall be 12 inches

9.2 Rail fastener requirements

9.2.1 General

a) Rail fasteners (crossties, direct fixation and other rail fasteners) shall be made of a material to which rail can be securely fastened. Fasteners must be capable of holding rails to their proper gage and alignment, preventing excessive horizontal and vertical movement and transmitting the wheel loads to the supporting structure or ballast.
b) Each segment of track shall have a sufficient number of rail fasteners that in combination provide effective support that will maintain gage, surface and alignment as prescribed herein.
c) The minimum number of non-defective rail fasteners (along a single rail) for any 39 ft. length of rail shall be as prescribed in **Table 9**.
d) The number of consecutive ineffective rail fasteners shall not be more than that prescribed in **Table 10**.

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TABLE 9

Minimum Number of Non-Defective Rail Fasteners for Any 39 ft. Length of Rail

Class of Track	Operating Speed	Priority	Minimum Effective for Any 39 ft. of Rail
1	Less than 15 mph	1	6
2 and 3	16 to 60 mph	2	8
4 and 5	61 to 90 mph	3	12

TABLE 10

Maximum Number of Consecutive Defective Rail Fasteners Per 39 ft. Length of Rail

Class of Track	Operating Speed	Priority	Tangent and Curves with Radii at or Over 2000 ft.	Curves with Radii Between 1000 and 2000 ft.	Curves with Radii of Less Than 1000 ft.
1 and 2	Less than 30 mph	1	5	4	3
3	31 to 60 mph	2	4	3	2
4 and 5	61 to 90 mph	3	3	2	1

9.2.2 Timber or engineered composite crossties

Timber or engineered composite crossties shall be considered ineffective if any of the following conditions exist:

a) There are fewer than two spikes along each rail (one on the gage side and one on the field side of each rail), except in cases of special tie plates designed otherwise;
b) The crosstie is broken through;
c) The crosstie is spike-killed to the extent that it can no longer effectively hold spikes;
d) The crosstie is split or impaired to the extent that the tie will allow the ballast to work through;
e) The crosstie is plate-cut more than 1 in.;
f) The crosstie has deteriorated such that the tie plate or base of rail can move laterally more than ½ in. relative to the crosstie.

9.2.3 Concrete ties

Concrete ties shall be considered ineffective if any of the following conditions exist:

a) The rail clip assembly is broken, missing or impaired.
b) A rail clip bolt is stripped or broken.
c) The rail clip shoulder on the tie is damaged such that it provides no lateral support to the clips.
d) The tie is severely cracked or broken.
e) Surface spalls, chips or broken-out areas expose the pre-stressed reinforcing wire in the concrete tie.
f) The tie has a longitudinal crack running through a vertical plane that affects its structural integrity.
g) A concrete tie has a crack in the rail base area that is large enough to be easily seen.

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9.2.4 Direct fixation fasteners

Direct fixation fasteners shall be considered ineffective if any of the following conditions exist:

a) The rail clip is broken.
b) Two anchor bolts are missing, broken or so loose as to be rendered ineffective on one pad.
c) Two anchor bolt inserts are stripped or otherwise unusable on one pad.
d) The pad is corroded, deteriorated or broken such that the rail fasteners or anchor bolts no longer provide lateral or vertical support.
e) The concrete supporting the fastener is deteriorated or impaired such that it does not provide proper support.
f) The elastomer is poor or separated from any of its components, or has bulged appreciably from beneath a bearing washer.
g) Any fastener component is bent, cracked or broken.
h) The rail hold-down is defective or missing so that the gage cannot be maintained.

9.2.5 Joint ties

a) Ties under rail joints must be adequately tamped to reduce pumping and ensure proper support.
b) The center tie and one of the shoulder ties under a supported joint should be non-defective. Both ties under a suspended joint should be non-defective.
c) If the center tie in a supported joint is defective (and two shoulder ties are non-defective), or if one tie is defective in a suspended joint, then speed should be reduced to 25 mph.
d) If two of three ties in a supported joint or both ties in a suspended joint are defective, then speed should be reduced to 10 mph.
e) Each rail joint, in tracks having a maximum speed of 30 mph, should be supported by at least one crosstie whose centerline is within 48 in. of the rail end.
f) In tracks having designed speed greater than 30 mph up to 90 mph, joints should be supported by at least one crosstie whose centerline is within 36 in. of the rail end, or two crossties whose centerlines are within 24 in. of either side of each rail joint location.

9.2.6 Tie plates

a) In track where timber crossties are in use, there must be tie plates under the running rails on at least eight of any 10 consecutive ties.
b) No metal object that causes a concentrated load by solely supporting a rail should be allowed between the base of the rail and the bearing surface of the tie plate.

9.3 Clearances

a) Each rail transit system must develop a right-of-way clearance diagram based upon the car and line equipment dynamic envelopes. Right-of-way clearance envelopes cannot be violated without the approval of the agency’s chief engineer or equivalent manager. Track clearances shall be maintained as required by the car and line equipment clearance diagrams. Any indication of equipment striking wayside objects requires prompt action. Any violation to personnel clearances must be promptly communicated to the responsible manager, and marking of the affected area shall be performed as soon as possible. Clearances must be checked aft.er any work has been completed on, or in the vicinity of, the tracks.
b) Before performing horizontal or track alignment changes, the responsible manager must ensure that a physical inspection of the area to be surfaced is conducted prior to the beginning of the work. Special attention must be paid to reductions in overhead or lateral clearances caused by the installation of conduits, pipes, cables, light fixtures or any other appurtenances. Clearance measurements shall be

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made before any work has begun. Measurements of clearances before and aft.er the work is completed must be recorded and kept on file in the manager's office.

c) In station areas, care must be taken to maintain the alignment, cross level and surface of the track along the platforms in such a way to ensure compliance with ADA regulations and the rail transit system's gap and step standards.

10. Rail

This section prescribes the requirements for the maintenance of rail.

10.1 Defective rails

This section prescribes the actions required when defective rails are discovered.

10.1.1 Knowledge of defective rails

Rail transit systems that know or have notice that a rail in track contains any of the defects listed in **Table 11** shall immediately have a qualified person determine whether or not the track may continue in use unless the rail is replaced or the appropriate remedial actions described in **Table 11a**, **Table 11b** and **Table 11c** are taken.

10.1.2 Application of joint bars on defective rails

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

a) Bolts shall be applied to the defective rail through the outermost holes.
b) The minimum number of bolts that would be used for a rail joint at that same location as prescribed herein shall be used.
c) Care shall be taken not to drill bolt holes through the rail at the location of the defect.
d) At welds, if joint bars are used to protect rail defects, then precautions shall be taken to ensure that the joint bars properly fit the rail. Either special rail joint bars specifically designed for that rail section for use at weld locations, or grinding the weld upset metal, shall be used. Field-modified, torch-cut or strap protective bars shall not be used.
e) If a rail defect is found in the wing or heel rails of a frog, then the existence of two frog bolts on both sides of the defect may be considered the same as joint bars.

10.1.3 Defects within switch points and stock rails

If a rail defect is found within a switch point or stock rail adjacent to a switch point, then, at a minimum, the following action shall be taken, unless more restrictive action is required by **Table 11a**, **Table 11b** or **Table 11c**:

a) Where remedial actions C, D or E given in the notes for **Table 11c** require the use of joint bars, and joint bars cannot be placed due to the physical configuration of the switch, then remedial action B will govern, provided that there are reinforcing bars on both sides of the switch point and that there are at least two bolts or rivets on each side of the defect; or
b) A qualified person shall supervise each train movement over defective rail; and
c) The operating speed over defect location is limited as determined by a qualified person.

10.1.4 Definition of rail defects

Rail transit systems shall use the definitions of defects shown herein.

13. **Transverse fissure** means 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

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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.

14. **Compound fissure** means 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.
15. **Horizontal split head** means a horizontal progressive defect originating inside the rail head, usually ¼ in. 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.
16. **Vertical split head** means a vertical split through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web, or pieces may be split off the side of the head.
17. **Split web** means a lengthwise crack along the side of the web and extending into or through it.
18. **Piped rail** means a vertical split in a rail, usually in the web, due to failure of the shrinkage cavity in the ingot to unite in rolling.
19. **Broken base** means any break in the base of the rail.
20. **Detail fracture** means 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.
21. **Engine burn fracture** means 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.
22. **Ordinary break** means a partial or complete break in which there is no sign of a fissure, and in which none of the other defects described in this paragraph are found.
23. **Damaged rail** means any rail broken or injured by wrecks; broken, flat or unbalanced wheels; slipping; or similar causes.
24. **Flattened rail** means a short length of rail, not a joint, that has flattened out across the width of the rail head to a depth of ⅜ in. or more below the rest of the rail. Flattened rail occurrences have no repetitive regularity and thus do not include corrugations, and have no apparent localized cause such as a weld or engine burn. Their individual length is relatively short, as compared with a condition such as head flow on the low rail of curves.
25. **Bolt hole crack** means a crack across the web, originating from a bolt hole, and progressing on a path either inclined upward toward the rail head or inclined downward toward the base. Fully developed bolt hole cracks may continue horizontally along the head/web or base/web fillet, or they may progress into and through the head or base to separate a piece of the rail end from the rail. Multiple cracks occurring in one rail end are considered to be a single defect. However, bolt hole cracks occurring in adjacent rail ends within the same joint should be reported as separate defects.
26. **Defective weld** means a field or plant weld containing any discontinuities or pockets, exceeding 5 percent of the rail head area individually or 10 percent in the aggregate, oriented in or near the transverse plane, due to incomplete penetration of the weld metal between the rail ends, lack of fusion between weld and rail end metal, entrainment of slag or sand, under bead or other shrinkage cracking, or fatigue cracking. Weld defects may originate in the rail head, web or base, and in some cases cracks may progress from the defect into either or both adjoining rail ends.
27. **Head and web separation** means a progressive fracture, longitudinally separating the head from the web of the rail at the head fillet area.

- ***"Shelly Spots" or "Squats"*** means a condition where a thin (usually 3/8 inch in depth or less) shell-like piece of surface metal becomes separated from the parent metal in the rail head, generally at the

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gauge corner. It may be evidenced by a black spot appearing on the rail head over the zone of separation or a piece of metal breaking out completely, leaving a shallow cavity in the rail head. In the case of a small shell there may be no surface evidence, the existence of the shell being apparent only after the rail is broken off or sectioned. Shelling normally occurs on the upper gauge face of the rail head, extending longitudinally; shells originate under the surface of the rail head. Shelling occurs from high contact stresses from wheel-rail interaction, especially when severe non-conformal wheel-rail contact occurs. Shell propagation can develop into a transverse defect (TD); most often, they are not visible on the rail surface until they reach advance stages of development. The horizontal component of the shell can mask the detection of the transverse component of the defect that leads to a detail fracture.

- ***"Head Checks"*** means hair-line cracks which appear in the gauge corner of the rail head, at any angle with the length of the rail. When not readily visible, the presence of the checks may often be detected by the raspy feeling of their sharp edges. Head checks are a result of cold working of the metal surface due to the interaction between the wheels and the rail, usually at the gauge corner; this is also referred to as a form of rolling contact fatigue (RCF). Head checks can progress into more severe rail surface conditions such as the initiation point for detail fractures or compound defects. Severe head checking can also interfere with the detection of internal rail defects.

- ***"Flaking"*** means small shallow flakes of surface metal generally not more than 1/4 inch in length or width, that break off the gauge corner of the rail head. Flaking takes place only on the running surface of the rail, usually near its gauge corner, and it is not as deep as shelling. Flaking is the result of surface metal friction, flow and plastic deformation, caused by concentrated wheel loads, resulting in severe compressive shear deformation of the rail surface. This surface condition can progress in depth and could also become the origin point for detail fractures; severe flaking can also interfere with the detection of internal rail defects.

- ***"Spalling"*** means cracking and chipping of the rail head surface, usually at the top of the head of the rail. It is usually caused by high horizontal wheel-rail creeping forces, transverse frictional forces and extreme wheel-rail contact stresses resulting in micro-cracking and head chipping. Spalling can interfere with the detection of internal rail defects.

- ***"Corrugation"*** means cyclic, "wave-like" irregularities in the running surface of the rails, identified by an uneven wear pattern. Short wave corrugations have a wavelength of 1 to 3 inches, and a depth of less than 10 thousands of an inch, and more prevalent to be found in transit and light rail systems.

10.1.5 Definition of transverse defect size

Rail transit systems may either use percent of cross-sectional area or a size designation for determining appropriate remedial action on transverse defects as shown in **Table 11a**, as follows:

a) Only one designation shall be used.
b) That same designation shall be exclusively used and uniformly applied system-wide.
c) That same designation shall be identified in that rail transit system’s standards.

10.1.6 Torch-cut rails

Torch-cut rail ends shall be used in an emergency only. Torch-cut rails must be replaced as soon as possible and protected with a slow speed order under supervision until replaced.

10.1.7 Base-corroded rails

Rail corrosion consists of the deterioration and disintegration of the rail steel starting at its surface, due to chemical reactions, oxidation and electrolysis effects in the presence of water containing salts or other impurities. It is therefore paramount to divert any water away from the track elements (rails, fasteners and ties) so that they are not affected by electrolysis and corrosion. In addition, rail corrosion could lead to rail breaks and signal system failures. Levels of rail corrosion shall be classified as follows:

28. **Medium (moderate):** Heavy rusting and flaking of rail surfaces; surface pitting is medium-sized (approximately ⅛ in. in diameter on average) and more prevalent; loss of any section of the rail at the web or base is small (less than ¼ in.); small cracks, if present, on the deteriorated surfaces are less than ⅛ in. in length.
29. **Severe (significant):** Surface pitting is large-sized (more than ⅛ in. on average) and extensive; rail base or web have loss of section equal to or larger than ¼ in., either on a uniform basis or concentrated at point or points on the base; cracks in the deteriorated surfaces, if present, are ⅛ in. or larger in length.

Base-corroded rails must be inspected and verified by a track supervisor. The base-corroded rails shall be marked with highly visible paint in the web of the rail only, so that they can be easily monitored. The track supervisor shall inspect all base-corroded rails in the section. The track inspector of the section shall monitor and report the condition of the base-corroded rails found during each and every inspection performed in the section.

Replacement of base-corroded rails shall be scheduled as follows:

a) In general, severely based corroded rails shall be replaced within no more than 48 hrs. of their detection, or immediately if there are any cracks of any size at the location where the corrosion is most severe. If the severely base-corroded rail cannot be replaced within 48 hrs. then either joint bars, carryover bars and/or nonconductive plates shall be installed at the location of the most severe corrosion, or the rail shall be cut and joint bars installed if there are any cracks at that location.
b) Base-corroded rails of medium severity shall be replaced within 90 days of their detection. If they cannot be replaced within 90 days, then either joint bars, carryover bars and/or nonconductive plates supporting the base of the corroded rail section shall be installed in each case to the rail at the location where the base corrosion is found to be significant.
c) If there are any Priority 2 visual or track geometry defects present at locations where rails of medium or severe base corrosion do exist, then immediate action shall be taken, consisting of placement of a slow speed order, immediate replacement of the corroded rail and correction of the Priority 2 defect.

10.1.8 Required action

Rail transit systems shall either replace rail or, at a minimum, perform the actions shown in **Table 11a**, **Table 11b** or **Table 11c**.

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TABLE 11a

Rail Defect Remedial Action

Type of Transverse Rail Defect	Railhead Cross-Sectional Area Weakened by Defect		Priority	Minimum Remedial Action[1]
	Greater Than	Less Than		
Transverse fissure	5%	70%	2	B
	70%	100%	1	A2
	100%	—	1	A
Compound fissure	5%	70%	2	B
	70%	100%	2	A2
	100%	—	1	A
Detail fracture	5%	70%	2	B
	70%	100%	2	A2
	100%	—	1	A
Engine burn fracture	5%	70%	2	B
	70%	100%	2	A2
	100%	—	1	A
Defective weld	5%	25%	3	C
	25%	80%	2	D
	80%	100%	1	A2 or both E and H
	100%	—	1	A or both E and H

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TABLE 11b

Rail Defect Remedial Action

Type of Longitudinal Rail Defect	Longer Than	Shorter Than	Priority	Minimum Remedial Action[1]
Horizontal split head	1 inch	2 inches	3	H and F
	2 inches	4 inches	2	I and G
	4 inches.	—	1	B
	Breakout in railhead		1	A
Vertical split head	1 inch	2 inches	3	H and F
	2 inches	4 inches	2	I and G
	4 inches	—	1	B
	Breakout in railhead		1	A
Split web	1 inch	2 inches	3	H and F
	2 inches	4 inches	2	I and G
	4 inches	—	1	B
	Breakout		1	A
Piped rail	1 inch	2 inches	3	H and F
	2 inches	4 inches	2	I and G
	4 inches	—	1	B
	Breakout		1	A
Head web separation	1 inch	2 inches	3	H and F
	2 inches	4 inches	2	I and G
	4 inches	—	1	B
	Breakout		1	A
Bolt hole crack	½ inch	1 inch	3	H and F
	1 inch	1½ inches	2	H and G
	1½ inches	—	1	B
	Breakout		1	A
Broken base	1 inch	6 inches	2	D
	6 inches	—	1	A or both E and I

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TABLE 11c
Rail Defect Remedial Action

Other Rail Defects	Depth	Size	Priority	Minimum Remedial Action[1]
Flattened rail	Greater than or equal to ⅜ in.	Greater than or equal to 8 in.	2	H
Ordinary break	n/a	Any	1	A or E
Damaged rail	n/a	Any	2	D
Base-corroded rail	Medium (moderate)		2	A2; see section 10.1.7
	Severe (significant)		1	Replace rail; see section 10.1.7
Short wave rail corrugation	Over ⅛ inch deep		2	Grind rail
Wheel burn, "squat" or shell	Less than ⅛ inch	Less than 3 inches	2	A2
	Equal to or larger than ⅛ inch	Equal to or larger than 3 inches	1	Replace rail

1. Minimum remedial actions are coded as follows:
- A A qualified person shall supervise each operation over defective rail at a speed not to exceed 15 mph.
- A2 A qualified person shall make visual inspection. The qualified person may determine that operation may continue without continuous visual supervision at a maximum of 10 mph for up to 24 hours. If the rail is not replaced within that 24-hour period, then inspections by a qualified person shall continue, not more than 24 hours apart, until the rail is replaced or a determination is made requiring a more restrictive action.
- B Apply joint bars within 20 days aft.er it is determined to keep the track in use and limit operating speed over defective rail to a maximum of 30 mph until joint bars are applied; thereaft.er, limit speed to 60 mph. When a search for internal rail defects is conducted and defects are discovered in tracks with operating speed over 60 mph, then the operating speed shall be limited to 60 mph for a period not to exceed four days. If the defective rail has not been removed from the track or a permanent repair made within four days of the discovery, then the maximum operating speed shall be limited to 30 mph until joint bars are applied; thereaft.er, limit speed to 60 mph.
- C Apply joint bars within 10 days after it is determined by a qualified person to keep the track in use. In tracks with operating speed over 60 mph, limit operating speed over the defective rail to 30 mph or less as authorized by a qualified person, until joint bars are applied; thereaft.er, limit speed to 60 mph.
- D Apply joint bars to defect within 10 days if determined to keep the track in use with a maximum operation speed of 30 mph or less as authorized by a qualified person. Aft.er joint bars are applied, limit speed to 60 mph or less as authorized by a qualified person.
- E Apply joint bars.
- F Qualified person to re-inspect rail within three months aft.er it is determined to keep the track in use.
- G Qualified person to re-inspect rail within one month aft.er it is determined to keep the track in use.
- H Limit operating speed over defective rail to no more than 60 mph or less as determined by a qualified person.
- I Limit operating speed over defective rail to no more than 30 mph or less as determined by a qualified person.
- J Limit operating speed over defective rail as determined by a qualified person.

10.2 Rail wear

Rail wear limits should be established by each rail transit system based on rail section and wheel flange dimension. A recommended practice for 115RE rail with standard AAR wheels is provided in Appendix C as a guide.

10.2.1 Measuring rail wear

Rail gage face wear and head width shall be measured at the gage line as defined herein. Vertical wear shall be measured along the centerline of the rail web.

10.3 Rail joints and rail ends

Rail joints, joint bars applied to rail defects, and joint bars on restraining rails shall be maintained as described herein. Joint bar area condition is a function of the condition of the joint bars, bolts, insulation (for insulated

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joints) and the rail itself. The visual inspection of the joint bar area shall include a thorough examination of the condition of the area, detecting loose or missing bolts, and loose joint bar assemblies, as well as rail end defects.

10.3.1 Rail joints

a) Each rail joint, insulated joint and compromise joint shall be of a structurally sound design and dimensions for the rail on which it is applied.
b) If a joint bar on Classes 3 through 5 track is cracked, broken, or because of wear allows excessive vertical movement of either rail when all bolts are tight, then it shall be replaced.
c) If a joint bar is cracked or broken between the middle two bolt holes, then all operations over that joint must be supervised and the bars scheduled for immediate replacement.
d) In the case of conventional jointed track, each rail shall be bolted with at least two bolts at each joint in Classes 2 through 5 track and with at least one bolt in Class 1 track.
e) In the case of continuous welded rail track, each rail shall be bolted with at least two bolts in each rail at each joint.
f) Each joint bar shall be held in position by four track bolts tightened to allow the joint bar to firmly support the abutting rail ends and to allow longitudinal movement of the rail in the joint to accommodate expansion and contraction due to temperature variations. When no-slip, joint-to-rail contact exists by design, the requirements of this paragraph do not apply.
g) No rail shall have a bolt hole that is torch cut or burned in Classes 2 through 5 track.
h) No joint bar shall be reconfigured by torch cutting in Classes 2 through 5 track.
i) If bolts are broken or missing, then the following actions should be taken:
    - If less than two bolts per rail: reduce speed to 10 mph.
    - One bolt per rail: rail gap greater than 1 in.: supervise all operations.
    - For one bolt at one rail end and a rail gap greater than 3 in.: suspend operations.
j) Joint bars should fit so that they are vertical within the fishing area of the rail. A bar that is cocked causes a point stress to be introduced into the rail head, which can result in a crack forming in the head web fillet, or a broken joint bar.
k) The use of four-hole bars is acceptable only in bolted rail territory (six-hole bars are required in CWR track or where CWR joins bolted rail track) as long as the bolt heads alternate sides.
l) Joint slotting (cross-grinding) must be performed on all rail ends before chipping of the rail occurs. Particular attention should be paid to insulated joints so that corrective actions can be taken to prevent signal failure due to rail end lipping or defective insulation.

10.3.2 Rail joint and weld stagger

Bolted joints, bonded joints, insulated joints and field welds must meet the following minimum stagger distances:

10 ft., 0 in., to opposite rail joints or field welds;
11 14 ft., 0 in., to joints or field welds on the same rail.

10.3.3 Rail ends

Rail ends shall be maintained as described herein. Rail end condition is defined in terms of the depth of the defect, or lateral and vertical straightness as measured over a 36 in. length. This definition is used for both battered joints and battered welds.

10.3.3.1 Rail end mismatch

Gage face mismatch shall be measured at the gage line as described herein. Tread mismatch shall be measured along the centerline of the rail web. Rail end mismatch shall not exceed that shown in **Table 12**.

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TABLE 12
Rail End Mismatch

Class of Track	Operating Speed	Priority	Tread Mismatch	Gage Face Mismatch
1	Less than 15 mph	1	¼ inch	¼ in.
2	16 to 30 mph	2	¼ inch	$\frac{3}{16}$ in.
3	31 to 60 mph	3	$\frac{3}{16}$ inch	$\frac{3}{16}$ in.
4 and 5	61 to 90 mph	4	⅛ inch	⅛ in.

10.3.3.2 Rail end batter

Rail end batter (including battered welds) shall not exceed that shown in **Table 13**.

TABLE 13
Rail End Batter

Class of Track	Operating Speed	Priority	Tread Mismatch
1	Less than 15 mph	1	½ inch
2	16 to 30 mph	2	¼ inch
3	31 to 60 mph	3	$\frac{3}{16}$ inch
4	61 to 80 mph	4	⅛ inch
5	81 to 90 mph	4	$\frac{1}{16}$ inch

10.4 Continuous welded rail (CWR)

10.4.1 Procedures

Each rail transit system having track constructed of CWR shall have in effect and comply with written procedures that address the installation, adjustment, maintenance and inspection of CWR, and a training program for the application of those procedures. Each plan shall include, at a minimum, those shown herein.

a) Procedures for the installation of CWR that include:
   - Designation of a desired rail installation temperature range for the geographic area in which the CWR is located; in general, CWR should be laid when the rail temperature is within the temperature range specified by the following equations:

     $DRT_{MIN} = ([2Ht + Lt] / 3) + 10$
     $DRT_{MAX} = (([2Ht + Lt] / 3) + 25) \pm 5,$

     where:
     DRT_{MIN} = minimum desired rail temperature, degrees Fahrenheit
     DRT_{MAX} = maximum desired rail temperature, degrees Fahrenheit
     Ht = highest recorded rail temperature, degrees Fahrenheit
     Lt = lowest recorded rail temperature, degrees Fahrenheit

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

b) Rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and fastener movement to the extent practical. These requirements shall specifically address CWR rail

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anchoring or fastening patterns on bridges, bridge approaches and at other locations where possible longitudinal rail and fastener movement associated with normally expected train-induced forces is restricted.

c) CWR joint installation and maintenance procedures that require that:
- Each rail shall be bolted with at least two bolts at each CWR joint.
- In the case of a bolted joint installed during CWR installation, the rail transit system shall either, within 60 days:
  - weld the joint;
  - install a joint with six bolts; or
  - anchor every tie 195 ft. in both directions from the joint; and
- In the case of a bolted joint in CWR experiencing service failure or a failed bar with a rail gap present, the RTS shall either:
  - weld the joint;
  - replace the broken bar(s), replace the broken bolts, adjust the anchors and, within 30 days, weld the joint;
  - replace the broken bar(s), replace the broken bolts, install one additional bolt per rail end, and adjust anchors;
  - replace the broken bar(s), replace the broken bolts, and anchor every tie 195 ft. in both directions from the CWR joint; or
  - replace the broken bar(s), replace the broken bolts, add rail with provisions for later adjustment as per the requirements of this section, and reapply the anchors.

d) Procedures shall specifically address maintaining a desired rail installation temperature range when cutting CWR, including rail repairs, in-track welding and in conjunction with adjustments made in the area of tight track, a track buckle or a pull-apart. Rail repair practices shall take into consideration existing rail temperature so that:
- when rail is removed, the length installed shall be determined by taking into consideration the existing rail temperature and the desired rail installation temperature range; and
- under no circumstances should rail be added when the rail temperature is below that designated in paragraph a) herein, without provisions for later adjustment.

e) Procedures that address the monitoring of CWR in curved track for inward shifts of alignment toward the center of the curve as a result of disturbed track.

f) Procedures that control train speed on CWR track during maintenance work, track rehabilitation, track construction or any other event that disturbs the roadbed or ballast section and reduces the lateral or longitudinal resistance of the track, and when the difference between the average rail temperature and the average rail neutral temperature is in a range that causes buckling-prone conditions to be present at a specific location. In formulating the procedures under this paragraph, the rail transit system shall:
- determine the speed required, and the duration and subsequent removal of any speed restriction based on the restoration of the ballast, along with sufficient ballast reconsolidation to stabilize the track to a level that can accommodate expected train-induced forces (ballast reconsolidation can be achieved through either the passage of train tonnage or mechanical stabilization procedures, or both); and
- take into consideration the type of fasteners and crossties used.

g) Procedures shall prescribe when physical track inspections are to be performed to detect buckling-prone conditions in CWR track. At a minimum, these procedures shall address inspecting track to identify:
- locations where tight or kinked rail conditions are likely to occur;
- locations where track work of the nature described in Appendix B.4.3 has recently been performed;
- pull-apart prone conditions in CWR track, including locations where pull-apart or stripped-joint rail conditions are likely to occur, and

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- in formulating the procedures under this paragraph, the rail transit system shall:
  - specify the timing of the inspection; and
  - specify the appropriate remedial actions to be taken when buckling-prone conditions are found.

h) Procedures that prescribe the scheduling and conduct of inspections to detect cracks and other indications of potential failures in CWR joints. In formulating the procedures under this paragraph, the rail transit system shall:
- Address the inspection of joints and the track structure at joints, including, at a minimum, periodic on-foot inspections.
- Identify joint bars with visible or otherwise detectable cracks and conduct remedial action as indicated in the CWR Remedial Action Table shown in Appendix B.
- Specify the conditions of actual or potential joint failure for which personnel must inspect, including, at a minimum, the following items:
  - loose, bent or missing joint bolts;
  - rail end batter or mismatch that contributes to instability of the joint; and
  - evidence of excessive longitudinal rail movement in or near the joint, including but not limited to wide rail gap, defective joint bolts, disturbed ballast, surface deviations, gap between tie plates and rail, or displaced rail anchors.
- Specify the procedures for the inspection of CWR joints that are imbedded in highway-rail crossings or in other structures that prevent a complete inspection of the joint, including procedures for the removal from the joint of loose material or other temporary material.
- Specify the appropriate corrective actions to be taken when personnel find conditions of actual or potential joint failure, including on-foot follow-up inspections to monitor conditions of potential joint failure in any period prior to completion of repairs.
- Specify the timing of the inspections, which should be based on the configuration and condition of the joint. At a minimum, the rail transit system should specify that all joints in CWR track be inspected annually.
- All CWR joints that are located in switches, turnouts, track crossings, lift. rail assemblies or other transition devices on moveable bridges must be inspected on foot at least monthly, consistent with these requirements.
- The rail transit system may include in its switches, turnouts, track crossings, and lift. rail assemblies inspections, in lieu of the joint inspections required in this section, CWR joints that are located in track structure that is adjacent to switches and turnouts, provided that the rail transit system precisely defines the parameters of that arrangement in the CWR plans.

i) Rail transit systems shall have in effect a comprehensive training program for the application of these written CWR procedures, with provisions for periodic retraining for those individuals designated as qualified herein.

j) Rail transit systems shall prescribe record-keeping requirements necessary to provide an adequate history of track constructed with CWR. At a minimum, these records must include the following:
- Rail temperature, location and date of CWR installations or adjustments. This record shall be retained for at least one year.
- A record of any CWR installation or maintenance work that does not conform to the written procedures. Such record shall include the location of the rail and be maintained until the CWR is brought into conformance with such procedures.

10.4.2 Inspection of CWR

When inspecting CWR, the following areas shall be addressed:

a) Adequacy of the ballast section at curved track, sags, culverts, ballasted deck bridges and locations where vehicles may have been driven along the right-of-way or where footpaths may cross tracks.

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b) Loose, bent or broken bolts. Anchor position should be checked and anchors repositioned against the ties if necessary.
c) Evidence of rail moving through fastenings/anchors.
d) Evidence of track moving downhill or with the direction of traffic by noting if anchored ties are moving toward non-anchored ties.
e) Short flat spots in curve alignment or line kinks in tangent track, and determine if ties are floating in the ballast section by digging out one tie end at a time. All ties in welded rail track must be properly tamped.
f) Evidence of the base of rail not seated uniformly on the tie plates. Overstressed rail will have a tendency to lift. and tilt on the tie plates.

10.4.3 Maintaining and working CWR track

Before performing track work that has the potential to disturb CWR track, a qualified person must determine if the rail needs to be de-stressed or other appropriate actions taken to maintain the stability of the track. See Appendix B for further discussion of track work that constitutes disturbed track and CWR maintenance practices.

11. Restraining (guard) rails on regular track

This section describes the requirements for maintenance of restraining rails in other than special track work. Where bolt-on type guards or guarding restraining rails on regular track are used, this section shall apply. Within special track work, the requirements of Section 12 shall apply.

11.1 Restraining rail guard face gage

Where double-guarding restraining rails are used, the guard face gage shall be maintained within the limits shown in **Table 14**.

TABLE 14

Double Guarding Restraining Rails Guard Face Gage

(Difference from design)

Class of Track	Operating Speed	Priority	Double-Guarding Restraining Rails Guard Face Gage
1	Less than 15 mph	1	+½ inch
2, 3 and 4	16 to 80 mph	2	+⅜ inch
5	81 to 90 mph	2	+¼ inch

Rail transit systems shall designate where restraining rails are to be used specifically for guarding purposes. A record of these locations shall be kept on file.

11.2 Restraining rail maintenance standards

Rail transit systems shall specifically designate in their maintenance standards those maintenance requirements regarding the maintenance, application and use of restraining rails used for guarding purposes. The following shall be included:

a) where restraining rails are specifically required for safe operations
b) a specific procedure concerning the partial and complete removal of restraining rails
c) specific operating restriction(s), if any, required for the partial and complete removal of restraining rails

d) specific procedures, including mitigation measures and necessary operating restriction, required when breaks in restraining rails are found
e) specific procedures and allowable limits, including mitigation measures and necessary operating restriction, where broken or otherwise ineffective restraining rail fasteners are known to exist
f) specific numeric tables describing the allowable amounts of flare and flare length at the ends of restraining rails, including mitigation measures and required operating restriction
g) specific numeric tables for describing the allowable flange way widths on restraining rails, including mitigation measures and required operating restriction

In no case shall the minimum flange way width on restraining rails be allowed to be less than 1½ in., except as provided for in Section 11.1. For exceptions, see the “Note on alternate practices.”

12. Special track work

12.1 General requirements

In turnouts and track crossings, all fastenings shall be intact and maintained so as to keep the components securely in place. Each switch, frog and guardrail area shall be kept free of obstructions that may interfere with the passage of wheels. The rail bases must be inspected at the area of the rail fastener to determine if there is movement in the rail affecting the position of the switch points and frogs.

12.1.1 Longitudinal rail movement

Tracks shall be equipped with rail anchoring through and on each side of track crossings and turnouts to restrain rail movement affecting the position of switch points and frogs.

12.1.2 Minimum flange way

Flange way at turnouts and track crossings shall be at least 1½ in. For exceptions, see the “Note on alternate practices.”

12.2 Switches

a) Each stock rail must be securely seated in the switch plates, but care must be used to avoid canting the rail by overtightening the rail braces.
b) Each switch point shall fit and face up closely and accurately against its stock rail with the switch stand or switch machine in either of its closed positions, to allow wheels to pass the switch points without striking them. In switches with planed points (AREMA design with undercut stock rail), the point must be completely under the stock rail between the actual point of switch and the #2 track rod when the point is in the closed position. The first 6 in. of the point should not be visible when looked at from above and must not under any circumstances be higher than the top of the stock rail. Any signs of unusual wear on the first 6 in. of the point must be carefully investigated to determine and promptly eliminate the cause. Lateral and vertical movement of a stock rail in the switch plates, or of a switch plate on a tie, must not adversely affect the fit of the switch point against the stock rail.
c) Immediate protection and prompt corrective action are necessary when a switch point is found to stand open against its stock rail.
d) Any lip formation on the gage side of the stock rail along its undercut area must be promptly corrected to ensure that the switch point fits tightly against the stock rail.
e) Each switch must be maintained so that the outer edge of the wheel tread (especially in worn wheels with “false flange” conditions) cannot contact the gage side of the stock rail.
f) The heel of each switch point must be secure, and the bolts in each heel must be kept tight.
g) Each switch stand and connecting rod must be securely fastened and operable without excessive lost motion.

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h) Each hand-throw lever must be maintained so that it cannot be operated while the lock is in the keeper.
i) Each switch position indicator must be clearly visible at all times.
j) Switch points must be replaced when the raised portion of the switch point is worn down to the top of the stock rail (in general, the raised portion of the switch point starts aft.er the second track rod and ends past the heel of the switch; the maximum rise of the switch point over the top of the stock rail in this area is ¼ in.). In addition, if the tip of the switch point, with the point set against its stock rail, is higher than the top of the stock rail, then both the point and the stock rail must be replaced.
k) Unusually chipped or worn switch points must be repaired or replaced. Metal flow on stock rails must be removed by grinding to ensure proper closure.
l) Immediate protection and corrective action are necessary when a switch point is found to have an unprotected flat vertical surface of 5⁄16 in. or more in width and at a depth of ¾ in. or more below the top of the stock rail.
m) The chipping or wear along the top of the switch rail is to be investigated and a cause determined. If the chipping of the switch rail was caused by a lip on the stock rail, then the lip must be removed at once. The switch rails may be retained in place, provided that the chipping does not approach the above criterion.
n) All flange ways must be at least 1½ inches wide and not to exceed to 2⅜ in. wide in sharp radius curves.
o) Special design switches, which by design exceed maximum allowable gage limits, are permitted where operating speeds do not exceed 15 mph.

12.3 Frogs, general

12.3.1 Flange way depth

Flange way depth is measured from a plane across the wheel-bearing area of a frog. Flange way depths shall be maintained as follows:

a) Where operating speeds do not exceed 15 mph, the flange way depth shall not be less than 1⅜ in.
b) Where operating speeds exceed 15 mph, the flange way depth shall not be less than 1½ in.
c) Where frogs are designed as flange-bearing, the flange way depth may be less than the minimum prescribed herein; however, the operating speed may not exceed an appropriate restrictive speed (not greater than 15 mph).

12.3.2 Damaged frogs

a) If a frog point is chipped, broken or worn more than ⅝ in. down and 6 in. back, then the operating speed over the frog shall not exceed 10 mph.
b) If the tread portion of a frog casting is worn down more than ⅜ in. below the original contour, then operating speed over that frog shall not exceed 10 mph.
c) All fins and lips of metal flow must be ground promptly and flange way widths restored to the standard dimensions.
d) Any lateral movement in excess of ¼ in. must be corrected immediately.
e) Cracks in manganese castings must be reported immediately to a track supervisor. Frog castings with shrinkage marks or casting defects not in the wheel bearing surface should be closely monitored. All other cracked frog castings should be welded or removed from service.

12.3.3 Spring rail frogs

Spring rail frogs shall be maintained as follows:

a) The outer edge of a wheel tread shall not contact the gage side of a spring wing rail.
b) The toe area of each wing rail shall be solidly tamped and fully and tightly bolted.
c) Each frog with a bolt hole defect or head-web separation shall be replaced.

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d) Each spring shall have compression sufficient to hold the wing rail against the point rail.
e) The clearance between the hold-down housing and the horn shall not exceed ¼ in.

12.3.4 Self-guarded frogs

Self-guarded frogs shall be maintained as follows:

a) The raised guard on a self-guarded frog shall not be worn more than ⅜ in.
b) If repairs are made to a self-guarded frog without removing it from service, then the guarding face shall be restored before rebuilding the point.

12.4 Guardrail gages in frogs

The guard check and guard face gages in frogs shall be within the limits prescribed in **Table 15**.

TABLE 15
Guard Check and Guard Face Gages in Frogs

(Difference from design values)

Class of Track	Operating Speed	Priority	Guard Check Gage Shall Not Be Tighter Than	Guard Face Gage Shall Not Be Greater Than
1	Less than 15 mph	1	−½ inch	+½ inch
2	16 to 30 mph	2	−⅜ inch	+⅜ inch
3 and 4	31 to 80 mph	2	−¼ inch	+⅜ inch
5	81 to 90 mph	3	−⅛ inch	+¼ inch

12.5 Special work

Any track work in the vicinity of an electrically controlled switch that may change switch point adjustment must not start unless the signal department is notified. Any switch placed out of service for track work must not be returned to service unless proper point pressure and adjustment are provided. When working under traffic, switches shall be blocked, clamped or spiked to prevent switch point gapping.

13. Street-running track work

This section describes the inspection and minimum requirements unique to street-running embedded track. This section either modifies or adds to requirements contained within the preceding sections. Unless specifically amended by the information contained within this section, all other sections of this standard shall govern. Street-running track is commonly referred to as embedded track or paved track.

13.1 Inspection

a) Tracks used by revenue trains shall be inspected weekly on foot or by riding over the track in a vehicle at a speed that allows detection of noncompliance with standards. In the unusual event that a walking or riding inspection cannot be performed, a qualified person must inspect from a revenue vehicle in a position in full view of the roadbed. Required inspections must be performed by a qualified person as prescribed by Section 2. An interval of at least three but not more than 11 calendar days may elapse between inspections.
b) Tongue and mate switches are to be inspected weekly with at least three but not more than 11 calendar days between inspections.

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13.2 Roadbed

Street rights-of-way must be maintained in such a manner that potential hazards to train traffic, as well as to automotive traffic and to pedestrians, are minimized. Street rights-of-way may have a few special considerations that are only peripherally related to track inspection and maintenance, but that could have a detrimental effect on track performance or rail vehicle traffic. The general condition of track area and paving shall be observed, and if any of the following conditions are found, which may jeopardize the safe movement of vehicles or pedestrians, corrective actions must be taken.

1. debris in the vicinity of track, particularly in the flange way and the area of track special work
2. flange way blocked with foreign material resulting in the wheel lifting to a level such that the wheel is no longer properly riding on the designed rail profile
3. street surface higher than the top of rail that could result in equipment being stuck or damaged
4. drainage and ventilation grates, manhole covers, crosswalk pavers, passenger platform materials and other such objects found to be fouling the track or obstructing the track in any way
5. undermined track

If the conditions listed below are found, then the inspector shall identify the condition on the track inspection report:

1. loose cobblestones, pavers or bricks
2. potholes
3. low paving around rails

13.3 Track geometry

13.3.1 Gage

Measurements for track gage on girder and tram rail may vary from that outlined in Section 8.1. In the event a different measurement for gage is used, the rail transit system shall document this measurement and the corresponding gage tolerances unique to its specific design, subject to the conditions of the "Note on alternate practices."

13.3.2 Track flange way

Street track should have as much flange way depth as the type of construction will allow and in accordance with the appropriate design of the system. Flange way depth shall be monitored to ensure that rail wear or flange way debris does not create a flange-bearing condition. This is especially critical in areas that are subject to freezing temperatures, that water not be allowed to form ice in the flange ways in the fall and winter. Any obstructions to the flange way should be removed as soon as possible. If part of the track structure (i.e., elastomeric booting, rubber material, asphalt, concrete, etc.) has begun to obstruct or diminish the depth of the flange way, then the problem should be addressed on a programmed basis, in accordance with the severity of the situation. Such situations shall require periodic measurement and monitoring until corrected. Any flange way depth problem or obstruction that would result in wheel climb or potential derailments must be rectified immediately.

13.4 Track structure

Inspection of individual components is neither reasonably accomplished nor usually necessary, except for the rail. When deterioration of the track, identified by defects in gage, alignment and profiles described in Section 8, Section 10, Section 11 and Section 12 herein are found, repair of supporting structure shall be performed to correct the defects. Any temporary repairs to correct these conditions should be replaced with permanent

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structural repairs within 48 hrs. and vehicle civil speed should be adjusted as needed or supervision provided while operating over temporary repairs.

Special attention shall be given to the maintenance of track clearances as required by the car and line equipment clearance diagrams. Any street furniture or other appurtenances shall be monitored to ensure that there is not encroachment to the dynamic envelope of the vehicles, including MOW equipment.

Street or infrastructure repairs by others (DOT, contractors, any third party) must be monitored to make sure that the trackway structural integrity is not violated and that proper operating clearances are maintained during and aft.er construction.

13.5 Rail

13.5.1 Rail defects

If conditions listed below are found, then a qualified person is to identify the conditions on the track inspection report and perform the action(s) shown in **Table 16**. Rail defects such as excessive wear, engine burns, "squats," head checks, corrugation and excessive flange way shall be handled in accordance with the standards shown in Section 10 of these specifications.

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TABLE 16
Embedded Rail Defect Remedial Action

Type of Defect	Length	Maximum Speed	Priority	Minimum Remedial Action
Broken rail on guard – no movement	N/A	5 mph	2	Repair within 24 hours
Broken rail on guard – movement/pumping	N/A	Out of service	1	Repair immediately; replace rail
Missing head/rail breakout	Up to 2 inches 2 inches to 4 inches More than 4inches	10 mph 5 mph Out of service	3 2 1	Schedule repairs Repair within 24 hours Repair immediately; replace rail
Cracked rail, broken joint/or cracked weld area	Up to 4 inches 4 inches or more	10 mph 10 mph	3 2	Re-inspect in 7 days Re-inspect daily and repair within 7 days
Guard breakout	Up to 1 inch More than 1 inch	5 mph Out of service	2 1	Repair within 24 hours Repair immediately; replace rail
Cracked broken tram	Any length	Out of service	1	Schedule repairs as defect warrants

13.5.2 Rail wear

Rail gage face wear, head width and vertical wear shall be measured at the gage line, etc. as appropriate for the rail transit system's particular rail section. Limits for rail wear on girder and tram rail shall be established based on rail section and wheel flange depth. Care must be used in not allowing wheel tread to touch roadway material. Top wear is based on keeping the top of the rail above the road surface.

13.6 Special track work

Street switches, crossovers and crossings must be free of debris.

For flange-bearing areas of special work, each transit system shall develop maximum flange way wear limits. Programmed action (buildup of the frog flange way) is required if wear exceeds the limit or special work exhibits signs of excessive contact with the wheel thread.

All non-flange-bearing parts of street special work will be maintained to have a flange way as described in Section 13.3.2.

The transition area (or riser) into and out of flange-bearing special work should be maintained to provide as smooth a transition as possible and within any prescribed maintenance limits. Proper transition will usually be evidenced by a gradual takeoff and re-entry of the wheel tread on the railhead, just before and aft.er the flange-bearing special work (that is, the worn area on the railhead will taper more gently). Poor transition will also be

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evidenced on the facing side of the special work (in the normal direction of rail traffic) by excessive wear at the transition point. In the worst cases, a significant impact may be exhibited as wheels enter or exit the flange-bearing area. This would be evidence of a very poor transition and would necessitate prompt attention.

Tongue and mate switches shall be monitored, and if conditions listed below are found, a qualified person is to identify the conditions on the track inspection report and to perform the action(s) shown in **Table 17**.

TABLE 17
Tongue and Mate Switch Conditions

Condition	Required Action
Tongue vertical wear	
3⁄16 inch below casting	Schedule for replacement
¼ inch below casting	Replace within 30 days
Sharp edge	Grind within seven days to restore contour
Loose heel	Schedule to retighten within three days
Mate false grooves	
Over 3⁄16 inch	Repair within seven days
Split through risers	Repair within 24 hours
Wheel cuts in switch casting	
3⁄16 inch	Repair within 30 days

14. Elevated track

This Section describes specific elements, inspection and maintenance practices to be followed regarding elevated tracks. The term “elevated track” refers to special types of track design or construction for tracks placed on elevated structures, generally open-deck steel structures similar to open-deck bridges, as well as to tracks placed in aerial viaducts of concrete or steel structures.

14.1 Types of structures

a) **Open deck (elevated):** These are steel structures similar to typical open floor deck or through span railroad bridges, in which the track’s crossties are supported by, and fastened to, the structural steel members of the structure.
b) **Viaduct:** Typically, a concrete structure with ballasted or direct fixation track, with or without sidewalls (parapet walls).
    - Sidewalls (parapet walls): These could be structural or non-structural.
    - Without sidewalls, the edges of the structure are approximately at the same height as the top of the running rail.
c) **Through girders (trusses):** These are bridge structural members that may be present on both types of elevated structures. Typically, these may only require emergency protection rails (inner bridge guardrails) at the girder approaches, ending a few feet inside the through span.

14.2 Emergency protection rails (inner bridge guardrails)

Emergency protection rails (also called inner bridge guardrails by AREMA) are typically made of either timbers (lagged to the top surface of the crossties at their ends), steel angled members or rails laid between the two running rails in the gage of the track to prevent derailed cars from falling over the edge of the structure or to prevent a derailed car from severely damaging certain key structural members along the right-of-way.

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Installation of emergency protection rails shall be in accordance with the following:

a) Open-deck steel structures: Two emergency protection rails shall be laid in all open-deck elevated structures, except for through girder sections and in station platform areas. In station platform areas, only one emergency protection rail shall be laid adjacent to the platform edge side of the track; the other emergency protection rail shall end a minimum of one car length inside the confines of the platform.
b) Viaduct structures: If there are no structural sidewalls, then two emergency protection rails shall be installed on the tracks adjacent to the edge of the structure if the distance from the edge of the structure to the gage side of the running rail closest to the edge of the structure is less than half of the width of the rail transit's car plus 1 ft. If there are structural sidewalls (parapet walls), then emergency protection rails may be omitted. In station platform areas, only one emergency protection rail shall be laid adjacent to the platform edge side of the track; the other emergency protection rail shall end a minimum of one car length inside the confines of the platform.
c) On curves with restraining guardrails, only one line of emergency protection rails may be required, positioned closer to the low side of the curve.
d) In general, emergency protection rails shall end at least a minimum of one car length beyond the ends of the structure on which it is laid.
e) Emergency protection rails shall be continuously laid, except through switches and special track work, expansion joints and other track and signal appurtenances. The ends of the emergency protection rail shall be cut out and the rail head bent down at locations where signal equipment or other track appurtenances are located, to prevent dragging equipment from catching on it. Emergency protection rail ends should rest on a crosstie and be securely spiked. Thermal expansion and contraction of the emergency protection rails shall be addressed by adequate means.
f) Emergency protection rails shall be fastened to each crosstie with at least one spike on each side of the rail; spikes shall be offset to avoid splitting of the crosstie.
g) Emergency protection rails shall be laid at a distance from the gage of the running rail such that proper equipment clearances are maintained, enough distance from the running rail is provided for a derailed wheel not to climb over fasteners or other ancillary equipment, and enough room to install and maintain track appurtenances is provided.
h) The top of the emergency protection rails shall be not higher than the top of the running rails, and be not more than 1 in. lower than the top of the running rails.
i) Missing or ineffective emergency protection rails shall be classified as follows:
    - In subway, open cut or at-grade tracks missing or ineffective emergency protection rails shall be classified as a Priority 3 condition.
    - In elevated structures, missing or ineffective emergency protection rails shall be classified as a Priority 2 condition, except at side station platform areas in local tracks where it shall be classified as a Priority 3 condition as long as there are emergency protection rails properly installed beyond the ends of the station platform.

14.3 Spacing, fastening and type of crossties in open-deck elevated structures

a) Each rail transit system shall have a standard specifying the maximum allowable spacing of consecutive crossties on open-deck elevated structures, based on specific requirements for car weight, impact loads (dynamic and static) and maximum allowable stresses on rail, fasteners, crossties and structural members.
b) Crossties on open-deck steel elevated structures shall be fastened to the structural supporting members by two fasteners, such that the track is effectively restrained from moving laterally, vertically or longitudinally relative to the supporting structure. The transit system shall also have a standard for the maximum allowable number of ineffectively fastened (or unfastened) crossties along the track. (Curved and tangent track may have different standards.)

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c) Spacer timbers or flat steel bars shall be fastened to the top surface of the ends of the crossties on open-deck structures to ensure proper spacing and alignment of the crossties on the elevated structure.
d) On open-deck elevated structures, the rail transit system shall consider the use of retaining devices to prevent loose bolts, clips or other small track appurtenances from falling from the structure and causing potential damage to people or property below.
e) The rail transit system shall carefully analyze and document the type of material, structural characteristics, overall dimensions and environmental impact of the crossties to be used on open-deck elevated structures, to ensure that there is no potential for sudden catastrophic failure of any number of consecutive crossties due to issues directly related to their composition, manufacture, weather changes, accumulation of stresses (weather-induced or otherwise), etc.

14.4 Walkways and handrails

Each rail transit system shall have standards specifying the requirements for installation of walkways and handrails at locations where they are needed.

a) Walkways shall be installed to adequately support personnel and materials on elevated track installations. Excessive gaps or openings in slatting or walkways shall be covered adequately, where practicable; if covering cannot be performed, then the edges adjacent to the opening shall be marked as per paragraph h) below.
b) Where walkways are required, the minimum width of the walkway shall be 2 ft., 0 in., at the walking surface.
c) Where walkways are installed on the outside of a bridge or open-deck elevated structure, railings supported by posts shall be installed to provide for protection. The top of the railing shall be not less than 3 ft., 6 in., from the top of the walkway. An intermediate railing shall be placed not more than 1 ft., 9 in., above the top of the walkway. Additionally, kickplates or similar devices such as toe boards shall be installed along the surface edge of the walkway to prevent small objects placed on the walkway to fall down below. If walkways are installed between two or more tracks on open-deck steel structures, no railing may be installed.

   NOTE: As per OSHA, a standard railing shall consist of top rail, intermediate rail and posts, and shall have a vertical height of 42 in. nominal from upper surface of top rail to floor, platform, runway or ramp level. The top rail shall be smooth-surfaced throughout the length of the railing. The intermediate rail shall be approximately halfway between the top rail and the floor, platform, runway or ramp. The ends of the rails shall not overhang the terminal posts except where such overhang does not constitute a projection hazard.

d) Walkways, posts and handrails shall be designed, fastened and spaced to provide adequate support and fall protection to passengers and personnel as well as materials placed along the walkway.
e) Defective walkway shall be defined as that which is damaged, broken, split, weathered or burnt to the extent that adequate support to personnel and material is not provided.
f) A defective walkway that has been identified as such shall be clearly marked with bright red or orange paint until it is replaced or repaired.
g) A defective walkway shall be scheduled for replacement or repair as soon as practicable, within no more than 90 days of its identification as defective. If the 90 days are exceeded, then the supervisor in charge of the section will re-inspect the defective walkway with a frequency of no more than 30 days until repairs or replacements have been completed.
h) Gaps in railings on elevated tracks shall be marked with bright red or orange plastic warning barrier fence and protected with rope until permanent repairs are made.
i) Any defective railing components shall be replaced as soon as practicable, and within no more than 90 days of their identification as defective. In any case, such defective components shall be marked with bright red or orange paint and, if needed, bright red or orange ribbon and rope shall be placed around

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the area. If the 90 days are exceeded, then the supervisor in charge of the section will re-inspect the railing with a frequency not to exceed 30 days until repairs or replacements have been completed.

j) Each rail transit system shall develop adequate standards specifying the means and methods of fastening walkways and posts to crossties or other structural members, as well as standards for maintenance and inspection frequencies and procedures, including temporary removal or placement of walkways, posts and handrails.

14.5 Rail expansion joints (slip rails) on elevated structures

a) Each rail transit system shall develop standards for the application of rail expansion joints (slip rails) on elevated structures. Standards shall also include the maintenance, inspection and replacement of the rail expansion joints.
b) Typically rail expansion joints shall be used in pairs, one on each running rail, directly opposite to each other.
c) Rail expansion joints shall be assembled in such a way that they are at the approximate midpoint of their range of movement at a specified mean temperature between the extreme temperature values experienced at that location.
d) Rail expansion joints shall be designed to minimize resistance to the expansion and contraction of the structure. Typically, they should be inspected and maintained with the same frequency and level of detail required for special track work.
e) Temporary or permanent removal of rail expansion joints shall be authorized only by the chief engineer of the rail transit system.

14.6 Installation of CWR on elevated structures

a) The rail transit system shall perform an engineering study analyzing the feasibility of installing CWR on elevated structures, paying particular attention to expansion issues (both rail and structure), thermal stresses, acceleration and braking (train dynamics), need for expansion joints, transitions between elevated structure and other types of structures, connection to bolted rail and special work portions, etc.
b) The rail transit system shall develop standards for the inspection, maintenance and replacement of CWR on elevated structures, paying particular attention to thermal distressing, anchoring of CWR, need for rail expansion joints, etc.
c) Care shall be taken that CWR (or rail longer than the standard length of 39 ft.) is not installed bridging structural expansion joints unless a detailed engineering analysis is performed and the feasibility of such installation is demonstrated.

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References

Federal Railroad Administration, "FRA Track Safety Standards Compliance Manual," Chapter 5, "Track Safety Standards, Classes 1 Through 5," April 2007. https://www.hsdl.org/?view&did=15770

Federal Transit Administration, "The FTA Pocket Guide: Compilation of Rail Transit Industry Best Practices for Track Inspection and Maintenance," 2014. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjD24mgg9jPAhVnwFQKHXHfBtgQFggqMAA&url=http%3A%2F%2Fwww.bcgtrans.com%2Fwp-content%2Fuploads%2F2011%2F08%2FPocket-Guide-5-24-10.pdf&usg=AFQjCNHpdGPEiyiZ9xzNKuMo5gq-ovOJ9Q&sig2=6fvKZ6wxWXstx32qM6AEFQ

AREMA Manual for Railway Engineering, Volume 1, Chapter 5.

Definitions

The following terms are presented here to offer an understanding of the railway and roadway terminology relevant to these and other standards and documents referenced in the previous sections:

adzing machine: Portable, power-operated machine designed to adze the rail seat on ties to provide proper bearing for rail or tie plates.

aerial structure: Any system structure that carries transit tracks and spans above land or water surfaces.

alarm condition: Any abnormal condition that requires the attention or intervention of responsible personnel or an individual monitoring the transit system operation.

alignment: The horizontal location of track as described by curves and tangents.

anchor, backup: A rail anchor applied to control rail movement during anchoring procedures.

anchor bolt: A bolt or threaded rod that holds a direct fixation fastener to supporting concrete. An anchor bolt is fastened into a female insert in the supporting concrete. A threaded rod may be cast or grouted into the supporting concrete.

anchor, box: Four rail anchors on the running rails at one tie with two anchors on each rail, one on each side of the tie.

anchor, contact rail: An insulated assembly attached to both the contact rail and invert or ties to restrain the contact rail against thermal movement in the longitudinal direction.

anchor, rail: A device installed on the rail base designed to resist longitudinal rail movement due to traffic and temperature variations.

angle, frog: The angle formed by intersection gage lines of a frog.

angle, switch: The angle between the gage lines of the switch rail at its point and the stock rail.

approach slab: A concrete slab located at an aerial structure abutment or tunnel portal, to provide a transition from direct fixation track to ballasted track.

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asphalt cement: A fluxed or un-fluxed asphaltic material, specially prepared as to quality and consistency, suitable for direct use in the manufacture of asphaltic pavements, and having a penetration of between 5 and 250.

at-grade section: Roadbed, generally at the same level as the surrounding area, on which ballasted track is constructed.

average ambient temperature: The average of temperature readings taken every three hours for a 24-hour period immediately preceding the work.

ballast: Granular material placed in the track bed to support and restrain the track, and to provide drainage.

ballast impedance: See *impedance, ballast*.

ballast leakage: The leakage of current from one rail of a track circuit to the other through the ballast, ties, etc.

batter: The deformation of the surface of the head of the rail in the immediate vicinity of the rail end.

bolted fastener system: Any fastener system containing a bolt (exclusive of anchor bolts) to hold the elastic rail clip in position.

bond, impedance: An iron core coil of low resistance and relatively high reactance, used to provide a continuous path of the return propulsion current around insulated joints and to confine the alternating current signaling energy to its own track circuit.

bond, inductive coupled impedance: A device of low resistance and high reactance, used with jointless audio frequency track circuits to couple inductively and to confine the signaling energy to its own track circuit and to equalize the return propulsion current between rails without impeding its flow.

bond, propulsion: A conductor of low resistance providing a path for the return propulsion current at non-insulated joints.

bond, signal: Conductor of low resistance providing a path for track circuit current across bolted rail joints.

bonded fastener: A resilient fastener in which the elastomeric material is bonded to a steel top plate and a steel bottom plate. A common manufacturing practice is to apply an adhesive to the steel plates, place the plates in the mold with the compounded but uncured elastomer, and then conduct the elastomer curing. Bonding and curing occur in the same process.

bonded joint: A rail joint that uses high-strength adhesives in addition to bolts to hold the rails together.

bonding (rail): The connection of rail or frogs to provide a continuous path for signal or propulsion current by use of bonds.

book of rules: A set of codified regulations and procedures by which operating personnel are governed.

bridge, ballasted: A bridge on which ballasted track is constructed.

bridge, non-ballasted: A bridge having a steel or concrete surface on which direct fixation track is constructed.

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bridge tie: A transverse timber resting on the stringers and supporting the rails.

bumping post: A device attached to the rail designed to stop a rail vehicle at the end of a track.

bumping post signal: See *signal, bumping post*.

burrs: The rough edges left. at the end of a rail when sawed, or on the side of the web when drilling bolt holes.

cant: The inward inclination of a rail, affected by the use of inclined-surface or tie plates, usually expressed as a rate of inclination, such as 1 in 40.

carbon steel (or plain steel): Steel containing only the elements carbon, manganese, phosphorus, sulfur and silicon in addition to iron, the properties of which are due essentially to the percentage of carbon in the steel.

catenary: An overhead contact wire system from which a transit vehicle collects propulsion and auxiliary power.

central control: That place from which train control or train supervision is accomplished for the entire transit system; the train command center.

clearance diagram: A diagram that establishes the minimum safe distance between all points on a moving vehicle and fixed wayside structures or appurtenances.

clearance: The distance between specified points along the tracks and specified points on moving vehicles.

clip: See *elastic rail clip, rigid rail clip*.

closure rails: The rail between the heel of a switch and the toe of a frog in a turnout.

compound fissure: 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.

compromise joint (bar): Joint bars designed to connect rails of different fishing height and section, or rails of the same section but of different joint drilling.

construction, fire resistant non-combustible: Non-combustible construction that has a fire resistance rating through application of a protective fire-resistive membrane such as masonry or concrete to supporting steel.

construction, non-combustible: Construction minimizing the hazards of fire by the use of non-combustible materials for structural elements or assemblies, and by limiting the amount of combustible materials that are incorporated into the building construction.

contact rail: See *third rail*.

continuous welded rail (CWR): A number of rails welded together into various lengths.

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controlled cooling: A method of controlling the cooling rate of steel products. For rails, this is accomplished by placing 75 to 100 rails in an insulated container.

corrosion: The dissolving or eating away of the surface of metal through chemical action, either regularly or slowly as by rusting, or irregularly and rapidly as by pitting and grooving.

corrugated rail: A wear condition on the railhead of alternate peaks and hollows, which may develop in service under certain conditions.

cover board: A fiberglass cover over the contact rail to protect personnel from accidental contact with the rail.

cover board bracket: A fiberglass bracket attached to the base of the contact rail to support the cover board.

creosote: As used in wood preserving, a distillate of coal tar produced by high-temperature carbonization of bituminous coal. It consists principally of liquid and solid aromatic hydrocarbons and contains appreciable quantities of tar acids and tar bases; it is heavier than water and has a continuous boiling range of at least 257 °F beginning at about 392 °F.

crib: The space between two adjacent ties.

cropping: Cutting metal from the end of an ingot, bloom or rail during the process of rail manufacture. Also, cutting of the ends of used rails to eliminate battered or damaged portions.

cross level: The vertical relationship of the top of one running rail to that of the opposite running rail at the same location on the track.

crossing at grade: An intersection of two or more tracks at the same elevation.

crossover: A pair of turnouts with track between them, connecting two nearby and usually parallel tracks.

crushed head: A flattening or crushing down of the head of a rail.

current, foreign: Stray electrical currents that may affect a signaling system but that are not a part of the system.

current, leakage: An electric current that flows through or across the surface of insulation when a voltage is impressed across the insulation.

curve, circular: A horizontal curve, formed by a portion of a circular arc specified by its radius or degree of curve and length, with the following points:

1. **PC:** Point of curve.
2. **PT:** Point of tangent.
3. **PI:** Point of intersection of the tangents

curve, spiral: A transition curve connecting a tangent to a circular curve.

1. **ST:** Spiral to tangent.
2. **TS:** Tangent to spiral

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curve, vertical: A parabolic curve connecting different profile grades.

1. **PIVC:** point of intersection of the grades

cut and cover: A method of constructing an underground structure, mostly tunnels, by excavating from the surface, placing the structure, and then backfilling and restoring the original surface.

dap: A recess cut into a tie.

de-energize: To deprive an electro receptive device of its operating current.

degradation: Falling from an initial level to a lower level in quality or performance.

depth: The depth of the wheel flange passageway, or the vertical distance from the top of the tread portion and guard portion of a track structure.

derail: A device designed to cause rolling equipment to leave the rails.

derailment: The condition of rolling equipment leaving the rails.

design safety: Safety achieved by integration of safety features into the system designed characteristics to prevent operation except in the manner intended to be safe.

designated authority: The titled position charged with responsibility of supervising, authorizing, directing and/or controlling train movements and other facets of operations, often from a central location. The local company title should be used in place of "designated authority."

detail fracture: A progressive fracture originating at or near the surface of the railhead. These fractures should not be confused with transverse fissures, compound fissures or other defects, which have internal origins. Detail fractures usually have their origins in the following types of defects, and progress crosswise into the head of the rail:

2. shell where a thin shell of metal becomes separated from the head, usually at the gage corner
3. head checks usually at or close to the gage corner where movement or flow of the surface metal is sufficient to start a hairline crack

detector, ground: A device for detecting a ground on an electrical circuit.

detector, point: A circuit controller that is part of a switch operating mechanism and operated by a rod connected to a switch, derail or movable point frog, to indicate that the point is within a specified distance of the stock rail.

detector track circuit: A track circuit within an interlocking that, when occupied by a train, prevents the position of a train switch from being changed.

diamond: A special track work assembly consisting of two end frogs and two center frogs, which comprise the central portion of a double crossover.

direct fixation fastener: A sub-category of elastic fastener in which the rail fastener attaches immediately to a rigid support (concrete, invert, concrete deck, floating slab, open-deck structure). Direction fixation systems are systems used on other than ballasted track. Resilient fasteners and embedded concrete blocks with

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elastomeric boots (embedded in invert concrete pockets) fall within the general definition of direct fixation fasteners.

direction, normal: The designed predominant direction of train traffic as specified by the rules.

direction, reverse: Train movement against the normal direction of traffic.

double crossover: A combination of a crossing with two right-hand and two left.-hand switches and curves between them within the limits of the crossing and connecting the two intersecting tracks on both sides of the crossing and without the use of separate turnout frogs.

dress: To shape and trim the ballast to the required cross-section.

elastic fastening system: Any rail fastening system that includes an elastic rail clip.

elastic rail clip: A mechanical spring designed to hold a rail to its support (tie plate, elastomer plate, tie, etc.) providing continuous contact with the rail and the rail support during restraint or rail rotation and longitudinal rail movement. Equivalent terminology: rail clip, elastic clip.

elastomer: Any member of a class of synthetic polymeric substances that, in the vulcanized state, can be stretched repeatedly to at least twice its original length and, upon release of the external load, will immediately return to approximately its original length.

elastomer pad: An assembly placed in the contact rail at approximately 1000 ft. intervals to accommodate thermal expansion and contraction of the rail.

elastomer plate: See *bonded fastener*.

embedded wood block systems (in concrete inverts): A type of track is used generally in subway or viaduct track construction in which each rail is supported by short tie blocks embedded directly in a monolithic concrete slab. Some systems also use a long crosstie every fourth or fifth block in order to connect both rails and ensure proper track gage during construction. Elastic or resilient fasteners are generally used with this type of track.

end chipping: The loosening of metal at the top of gage side at the end of a rail.

end flow: Projection of metal into the end gap at the railhead.

end hardening: Heat treatment of the top of rail ends, to minimize batter.

facing movement: See *movement, facing*.

facing point lock: A mechanical lock, for a switch, derail or movable pint frog, comprised of a plunger stand and a plunger, which engages a lock rod attached to the switch point to lock the operated unit.

facing point, switch: See *switch, facing point*.

fastener body: An elastomeric plate; a bonded fastener; the rail support component of a resilient fastener system. The term “fastener body” refers to a single component of bonded steel and elastomer. The fastener body provides the rail support in a resilient fastener system.

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fastener vertical spring rate: Also called vertical static stiffness, represents the slope of the load-vs.-deflection curve of the fastener over a prescribed range of loads (usually 1000 lbf to 12,000 lbf). Modern resilient fasteners achieve good results regarding noise and vibration attenuation, as well as a track modulus similar to that of good ballasted track, by limiting the static vertical stiffness of the fasteners to no more than 100,000 lbf/in.

fastenings: Clips, pads, insulators, joint bars, bolts and spikes.

female insert: An internally threaded component that is designed to anchor a threaded fastener such as an anchor bolt into a concrete support.

field side: The side of the rail farthest from the center of track.

fixed way: All wayside appurtenances.

flaggers: Personnel assigned to control the movement of trains by the display of hand signals, flags or lights.

flange way: The space between the running rail and the guardrail or restraining rail adjacent to it that provides a passageway for wheel flanges.

floating slab: A concrete slab supported by a resilient foundation and designed to support direct fixation track and special track work in a manner that will dampen vibrations.

flowed head: A rolling out of the metal on the head of the rail toward the sides without showing any indication of breaking down of the head structure.

fouling point: The location near a turnout marking the safe passing clearance with another track.

frog: A track structure used at the intersection of two running rails to provide support for wheels and passageways for their flanges, thus permitting wheels on either rail to cross the other.

frog, movable point: A frog equipped with points, which are movable in the same manner as the points of a switch.

gage (gauge): The distance between rail gage lines, measured at right angles.

gage line: A line ⅝ in. below the top of the centerline of head of running rail along that side that is nearer the center of the track.

gage (of track): The distance between the gage lines, measured at right angles thereto. Standard gage in North America is 56½ in.

gage side: The side of the rail nearest the center of track.

grade: The amount of rise or fall of the track in a specified length, usually 100 ft.. For example, a rise of 2 ft. in elevation along 100 ft. of track constitutes a 2 percent grade.

guard check gage: The distance between guard line and gage line, measured across the track at right angles to the gage lines.

guard face gage: The distance between guard lines, measured across the track at right angles to the gage lines.

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guard line: A line along that side of the flange way that is nearer the center of the track and at the same elevation as the gage line.

guard rail: A rail laid parallel with the running rails to prevent wheels from being derailed, or to hold wheels in correct alignment to prevent their flanges from striking the points of frogs or switches and to reduce the wear of the high rail in curves.

guard rail (track): A rail or other structure laid parallel with the running rails of a track to control a derailed train. . Also called *emergency protection rail*.

guideway: That portion of the transit line included between the outside lines of curbs, or shoulders, underground tunnels, cut or fill slopes, ditches, channels, waterways and including all appurtenant structures.

hand-signal: See *signal, hand*.

hand-throw switch: See *switch, hand-throw*.

hazard: Any existing or potential condition that can cause injury or death, or damage to or loss of equipment or property.

hazard level: A qualitative measure of hazards stated in relative terms:

Category I, Negligible: Will not result in personal injury or system damage.

Category II, Marginal: Can be counteracted or controlled so that no injury to personnel or major system damage will be sustained.

Category III, Critical: xx

Category IV, Catastrophic: Will cause death to personnel.

heartwood face: The side of a timber tie about which the growth rings are concave.

heel length: The distance between the ½ in. point of a frog and the heel, measured along the gage line.

heel of frog: The end of a frog farthest from the point of switch.

heel of switch: That end of a switch rail farther from the point and nearer the frog.

heel spread: The distance between gage lines at the heel.

helicoidal spring lock washer: A washer design with one or more coils within the general class of springs that accommodate compression loading (as compared with springs designed for tension loading or torsional loading). Some lock washers incorporate a bolt or nut engagement protrusion (a sharp edge or serrations) intended to supplement bolt/nut back-out friction resistance.

hi-rail: Attachments that make rubber-tired vehicles (trucks, autos, special work equipment) capable of operating on rails.

high-restraint fastener: Elastic fastener systems with maximum longitudinal rail restraint allowed by the particular fastener design. Generally, the term is invoked in projects that use both a low and/or zero restraint system and a normal, maximum restraint fastener. The term distinguishes between the normal fastener and the low-restraint fastener or zero-longitudinal restraint systems deployed on that project.

horizontal split head: A horizontal progressive defect originating inside the railhead, usually ¼ in. 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 railhead.

impedance, ballast: The impedance shunting of a track circuit due to the condition of the ballast.

impedance bond: See *bond, impedance*.

in-house maintenance: The repair, overhaul and testing services provided to an operating property by its own employees in its own facilities.

incident: An unforeseen event or occurrence that does not result in injury or property damage.

inner guardrail: A longitudinal member, usually a metal rail, secured on top of the ties inside the running rail to guide derailed car wheels. Also called *emergency protection rail*.

inspection: The checking or testing for condition, performance and safety of equipment against established standards.

Insulated joint: A rail joint designed to arrest the flow of electric current from rail to rail by means of insulation so placed as to separate rail ends and other metal parts connecting them.

insulated rail joint: See *joint, insulated rail*.

insulator, contact rail: A non-conducting body of porcelain or fiberglass that supports the contact rail.

insulator, rail fastener: An insulating component between the elastic clip and the top of the rail base, overlapping the rail base edge and interlocking with the fastener's body or shoulder. Same as *rail insulator*. See also *shoe*.

insulator base: The base of the insulator assembly attached to the invert or ties.

insulator cap: The top of the insulator assembly where the contact rail sits.

interlocked switch: See *switch, interlocked*.

interlocking: An arrangement or signals and signal appliances, so interconnected that their movements must succeed one another in proper sequence.

interlocking, automatic: An interlocking controlled by circuit log so that movement succeed one another in proper sequence without need for manual control.

joint, rail: A mechanical fastening for rails, composed of steel bars and bolts.

joint, insulated rail: A rail joint in which electrical insulation is provided between adjoining rails.

junction: A location where train routes converge or diverge.

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ladder track: A track connecting successively the body of consecutive tracks of a yard.

lead: The distance between the actual point of the switch and the ½ in. point of the frog.

lead curve: The curve rail (also called the closure rail) in a turnout placed between the switch point and the frog.

line: Condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in change of direction over short distances on curves.

line end: The end of any tie from which all measurements are made.

line side: The side of the track along which the line ends of all the crossties are evenly located in a line parallel to the centerline of the track.

lining track: Shifting track laterally to conform to the established alignment.

locomotive: A prime mover for towing work cars or moving transit vehicles, generally in the 50-ton and less-than-100-horsepower class.

low-restraint fastener: Elastic fastener systems designed with less longitudinal rail restraint than potentially available from the fastener design. Low-restraint fasteners are applicable on tall aerial structures to reduce longitudinal load transfer to piers, thereby reducing structure construction costs. See also *zero longitudinal restraint systems*.

lubrication: The application of lubricants, generally on a scheduled basis, to equipment and machinery.

machine: A device for power operation of switches, usually dual controlled for power or hand operations.

machine, interlocking: An assemblage of manually operated levers or equivalent devices for the control of signals, switches or other units, including mechanical or electric locking or both to establish proper sequence of movements.

main track: See *track, main*.

maintenance: The upkeep of vehicles, plant, machinery and equipment. It may be scheduled, planned, progressive or periodic based on pre-established intervals of time, hour or mileage and employing pre-printed checklists, or it may be unscheduled or corrective, generally not interval based.

maintenance-of-way department: That functional unit within a maintenance organization that generally has responsibility for track, guideways or structures. It sometimes includes responsibility for maintenance of all transit plants and equipment other than rolling stock.

maintenance-of-way shop: A transit facility expressly designed for maintenance of the plant and equipment within the jurisdiction of a maintenance-of-way department.

maintenance planning system: A system of cost, work and manpower planning, scheduling and control, either manual or automated and generally part of a total management information system.

malfunction: Any anomaly wherein a system, subsystem or component fails to function as intended.

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manganese steel insert: A crossing in which a manganese steel casting is inserted at each of the four intersections, being fitted into rolled rails and forming the points and wings of the crossing frogs.

mid-ordinate (mid-chord offset): The perpendicular distance between the gage line of a rail and the midpoint of a string pulled taut and straight between two points on a curved rail.

monument: A permanent marker accurately defining a point from which the track work geometry may be plotted (i.e., elevation and centerline of the track).

movable point: A crossing of small angle in which each of the two center frogs consist essentially of a knuckle rail and two opposed movable center points with the necessary fixtures.

number, frog: One-half the cotangent of one-half the frog angle or the number of units of centerline length, of which the spread is one unit.

original equipment manufacturer (OEM): The enterprise that initially designs and builds a piece of equipment.

other track material (OTM): Miscellaneous materials required to complete track construction, other than rail, special track work ballast and ties.

out of face (referring to track work): A track maintenance operation that is performed on an entire segment of the track without skipping over any portion of that track segment.

personal protective equipment (PPE): All clothing and other work accessories designed to create a barrier against workplace hazards. Examples include safety goggles, blast shields, hard hats, hearing protectors, gloves, respirators, aprons and work boots.

piped rail: A rail with a vertical split, usually in the web, due to failure of the sides of the shrinkage cavity in the ingot to unite in rolling.

pit: A depressed area below floor level mainly between running rails or guideway for under-car lubrication, inspection and maintenance and equipped with all necessary utilities.

pitting: Localized corrosion.

plate, gage: A steel plate installed on the switch tie at the switch points to secure the stock rails at the correct gage.

plate, riser: A steel plate welded to a special switch plate for the purpose of raising the switch rail slightly above the stock rail.

plates, special: Plates for use in special track work, designed to replace the AREMA standard gage, switch, heel and hook twin tie plates, commonly used under switches and frogs.

point, actual: That end of the switch rail farther from the frog, where the spread between the gage lines of the switch rail and the stock rail is sufficient for a practicable switch point.

point detector: See *detector, point*.

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point, half-inch: A point located at a distance from the theoretical point toward the heel equal in inches to one-half the frog number, and at which the spread between gage lines is ½ in. It is the origin from which measurements are usually made.

point of frog, theoretical: The point of intersection of the gage lines of a frog

point of switch, theoretical: The point where the gage line of the switch rail, if produced, would meet the gage line of the stock rail.

point: See *switch point*.

rail anchorage appliance, fixed: Often used with zero- or low-restraint direct fixation fasteners on elevated structures to prevent longitudinal movement of the rail by fixing it at one point using a special device that has a robust, usually bolted connection to the structure and the rail, similar to the "deadman" used to fix crane rails. The anchorage is placed strategically to transfer the least longitudinal load to the structure while still preventing any rail movement; often used to prevent the rail from "running" into a switch or other sensitive track appliance such as a diamond crossing or expansion joint.

rail anchor, general railroad applications: A drive-on, single piece clip that develops high longitudinal rail restraint.

rail brace: A device that provides lateral support on the field side of stock rails to maintain the track gage.

rail brace backing block: The part of a rail brace that is welded to the special switch plate.

rail brace wedge: The part of a rail brace that is driven between the backing block and the stock rail, thereby securing the rail at the desired gage.

rail clamp: A device for securing rails and frogs to special plates. Generally, this term means rigid rail clip. Colloquial use varies.

rail clamp block: The portion of the rail clamp that is welded to the special plate.

rail clamp spring: The portion of the rail clamp that holds the rail or frog to the special plate and is bolted to the rail clamp block.

rail clip: See *elastic rail clip*, *rigid rail clip*.

rail, composite contact: An electrical conductor made of a steel rail section mounted adjacent to the running rail with an aluminum extrusion secured to each side of the steel rail web for supplying DC traction power to the transit vehicles. Sometimes referred to as "third rail."

rail, continuous welded: A number of rails welded together into a single length.

rail, control-cooled: Rail cooled during manufacture at a controlled rate in an insulated container to prevent the formation of internal defects that may later result in rail breakage.

rail fastening system: A system of components designed to resist lateral and longitudinal rail movement and to restrain rail rotation while providing vertical support. In resilient fastener assemblies, the design provides electrical insulation and filtering vibrations from the rail.

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rail, field welded: Rail welded in track using an aluminothermy exothermic (thermite) process.

rail, fully heat-treated: Control-cooled rail specially processed to produce a desired hardness throughout the rail.

rail insulator: An insulating component between the rail clip and other rail fastener components. Atypically used to describe the component that is placed between the toe of the rail clip and the rail base top; the rail insulator usually overlaps the rail edge and insulates the rail laterally between the rail and fastener shoulders or other lateral restraint protuberances.

rail, jointed: Rails joined together by means of joint bars and bolts, usually composed of individual rails.

rail rapid transit system: An electrified fixed-guideway transportation system, using steel rails, usually operating on an exclusive grade-separated right-of-way for the mass movement of passengers within a city or a metropolitan area and consisting of its fixed-way, transit car vehicles and other rolling stock, power system, maintenance facilities, and other stationary and movable apparatus and equipment and its operating practices and personnel.

rail contact, resistance: The contact rail's electrical resistance to ground, measured in ohms per track length (usually the unit for track length is 1000 track feet).

rail, restraining: Rail added to the inside running rail on curves to reduce the possibility of derailments attributed to the leading outside wheel climbing the outside rail and to reduce outside rail wear. Sometimes referred to as guardrail.

rail, running: Rail that supports and guides the flanged wheels of the rail vehicle.

rail seat: The portion of the supporting fastener (fastener body, tie pad, tie plate) that is in direct contact with the bottom of the rail base. The context of this term's usage can refer to the area below the fastener that is within the footprint of the rail base, such as the fastener bearing surface of the concrete slab within the rail seat area.

rail section: The shape of the cross-section of a rail at right angles to its length.

rail, shop welded: Rail pressure butt-welded into continuous lengths by means of electric flash welding, using special machines to align and hold the rail during the welding process.

rail, standard contact: An electrical conductor mode of a steel rail section mounted adjacent to the running rail for supplying DC traction power to the transit vehicles, sometimes referred to as the "third rail."

rail stop: A steel plate welded to a special plate to provide lateral restraint to the rail.

rail transit system: The organization or portion of an organization that operates rail transit service and related activities. Also called the operating agency, operating authority, transit agency, transit authority or transit system.

railbound manganese steel: A frog consisting essentially of a single manganese steel body casting fitted into and between rolled rails and held together with bolts.

resilient fastener: A fastener, often used in direct fixation track construction, that uses an elastomer between the rail and the support of the fastener.

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retaining wall section: A portion of track roadbed elevated or depressed from the surrounding area and located between retaining walls.

right-of-way: Lands or rights used or held for operation.

rigid rail clip: A rail clip design that does not deflect under load; an inelastic rail clip. Rigid rail clips are typically cast steel or iron blocks held by a bolt to a support base or plate. The block bottom face has locking serrations that engage mirror serrations in the surface of the support base or plate. Also called a rigid clamp or rigid rail clamp.

roadbed: The earth bed that supports the ballast, ties and rail of a track structure.

runoff: That part of the precipitation that is carried off from the land upon which it falls. Also refers to the transition zone in lifting track, between track that has been raised and track that has not been raised.

section, dead: A section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit.

semaphore: A signal in which day indications are given by the position of a movable arm.

shatter cracks: Minute cracks in the interior of railheads, seldom closer than ½ in. from the surface, and visible only aft.er deep etching or at high magnification. They may extend in any direction. They are caused by rapid (air) cooling and may be prevented from forming by control-cooling the rail. Shatter cracks also occur in other steel products.

shim: A small piece of wood or metal placed between two members of a structure, or between the rail fastener and its support, to bring them to a desired relative elevation.

shoe: A cast steel or elastomer (or combination of steel and elastomer) component between the top of the rail base and an elastic rail clip. The shoe shape conforms to the rail base top and side, with interlocking shapes (dogs) to the fastener body, shoulder or plate design. See also *rail insulator*.

shoulder: That portion of the ballast between the end of the tie and the toe of the ballast slope.

shunt: A by-path in an electrical circuit.

siding: A track auxiliary to the main track for meeting, passing or storing trains.

slip switch: A combination of a crossing with one right-hand and one left.-hand switch and curve between them within the limits of the crossing and connecting the two intersecting tracks without the use of separate turnout frogs.

solid manganese steel: A frog consisting essentially of a single manganese steel casting.

solid manganese steel crossing: A crossing in which the frogs are of the solid manganese steel type.

spiral (when used with respect to track): A form of easement or transition curve in which the change of curvature is proportional to its length.

split web: A longitudinal or diagonal transverse crack in the web of a rail.

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spot board: A sighting board placed above and across the track at the proposed height, to indicate the new surface and to ensure its uniformity.

spring: In a switch, the operating mechanism incorporating a spring device so arranged as to automatically return the points to their original or normal position aft.er they have been thrown over by the flanges of the trailing wheels passing along the other track from that for which points are set for facing movements.

spring clamp: See *elastic rail clip*.

spring rate: Equivalent to stiffness.

spring switch: A track switch equipped with a spring mechanism arranged to restore points to normal position aft.er having been trailed through.

spring-rail, right-hand and left.-hand: Starting at the toe end of a spring-rail frog and looking toward its point, a right-hand frog has the movable wing rail located on the right-hand side, and a left.-hand frog has the movable wing rail located on the left.-hand side.

stand: A device for manual operation of switches.

standard times: The average times required to perform a given maintenance or operations task. These times are usually estimated originally and constantly refined to reflect experience and progress. They are a measure of production and most useful in estimating personnel, material and budget requirements, as well as for cost control.

station: A place designated for the purpose of loading and unloading passengers.

station, above ground: A station in which the track and platform are either located on an aerial structure or rest directly on grade.

station, underground: A station in which the major portion of the structure is located below the finished grade subway station.

stinger: An electrical device, usually on an overhead trolley used for applying traction power to vehicles in a shop for testing or moving these vehicles. Some shops use external means of moving vehicles, such as locomotives, track mobiles or hi-rail vehicles.

stock rail: The rail against which the point of a switch, derail, expansion joint or movable point frog rests.

sub-ballast: A granular material, superior to most subgrade materials, that is spread on the finished subgrade before top ballast is applied, to provide drainage, to prevent frost heaving and to distribute the load over the top of the subgrade.

sub-drain: A covered drain below the roadbed or ground surface, receiving water along its length through perforations or joints, for the control and removal of excess water.

subgrade: The finished roadbed surface upon which are laid the ballast and the track structure.

superelevation (of curves): The vertical distance that the outer rail is above the inner rail.

switch: A track device used to divert rolling stock from one track to another.

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switch and lock movement: A device, the operation of which performs the functions of unlocking, operating and locking a switch, movable point frog or derail.

switch, electro-pneumatic: A track switch operated by an electro-pneumatic switch and lock movement.

switch, facing point: A track switch, the points of which face toward traffic approaching.

switch, hand-throw: A non-interlocked switch that can only be operated manually.

switch, indicator: xx

switch, interlocked: A track switch within the interlocking limits, the control of which is interlocked with other functions of the interlocking.

switch, point: A movable tapered track rail, the point of which is designed to fit against the stock rail.

switch position, normal: The position of a track switch and its controls when opposite to the defining track layout.

switch position, reverse: The position of a track switch and its controls when opposite to the defining track layout.

switch rod: A rod that connects two switch rails.

switch, track: A pair of switch points with their fastenings and operating rods providing the means for establishing a route from one track to another.

switch, trailing point: See *trailing point switch*.

tangent: The straight portion of railway alignment.

test track: A length of track usually separated from a main line, or of sufficient length to safely operate a car or train through a performance cycle (start, accelerate, run at maximum speed, decelerate, stop). The track is equipped with all the system safety features and, in addition, with automatic train control, if the operation is automatic.

third rail: A conductor rail mounted on insulators alongside the running rail that provides traction power for train operation.

third rail shoe: A truck-mounted power pickup device, which slides on top of, on the side of or under the third rail.

thread: The top surface of the head of a rail that contacts the wheels.

threaded fastener system: See *bolted fastener system*.

throat: That portion of a yard that connects the storage areas to the mainline lead tracks or, in an automatic system, to the transfer zone.

throw: The distance through which the switch points are moved laterally, measured at the No. 1 switch rod.

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tie, contact rail: The transverse member of the track structure that functions as a crosstie, but is longer and supports the contact rail.

tie, crosstie: The transverse member of a track structure to which the running rails are fastened, which is centered on the track and designed to cushion, distribute and transmit the stresses of traffic from the rail to the ballast.

tie, switch: The transverse member of a track structure that functions as a crosstie, but is longer and supports a crossover or turnout.

toe: The end of a frog nearest the switch point.

toe length: The distance between the ½ in. point of a frog and the toe, measured along the gage lines.

toe load: The clamping load generated by an elastic rail clip on a rail base.

toe spread: The distance between gage lines at the toe.

tolerance: An allowable variation from dimensions or requirements specified.

track, ballasted: Track constructed of rail, ties and ballast.

track, direct fixation (DF): Track constructed of rail and direct fixation rail fasteners attached by means of anchor bolts to a concrete slab a plinth or a steel surface.

track layout: An organized assemblage of track; the depiction thereof for control purposes.

track, main: A track extending through yards and between stations, upon which trains are operated by timetable or train order or both, or the use of which is governed by signals.

track, main line: A track designated by route name and direction for the purpose of carrying revenue passengers.

track mobile: A self-powered road-rail vehicle.

track relay: A relay receiving all or part of its operating energy through conductors, of which the track rails are an essential part.

track, reversible: A section of track on which the prescribed direction of running can be reversed if it is unoccupied and the opposing home signal is at stop.

track, single: A main track on which trains are operated in both directions.

track switch: See *switch, track*.

track, transfer: A track in a yard area where the transfer between main track and manual yard modes or operation takes place.

track, yard and secondary: Track constructed for the purpose of switching, storing or maintaining rail vehicles and not used for carrying revenue passengers.

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trailing movement: The movement of a train from the frog toward the point of switch.

trailing point switch: A track switch, the points of which face away from traffic approaching.

train orders: Instructions used to govern trains manually, usually written and hand-delivered.

transverse defect: For defects found by detector cars, a tentative group classification, applied prior to the breaking of the rails, of all types of rail defects that have transverse components, such as transverse fissures, compound fissures and detail fractures.

transverse fissure: A progressive crosswise fracture starting from a crystalline center or nucleus inside the head, from which it spreads outward as a smooth, light 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.

trolley wire: See *catenary*.

truck: A major transit vehicle assembly of structural members, wheels and axles, motors, gearboxes, brakes, collectors, cable, piping, etc.

turnout: An arrangement of a switch and a frog, together with closure rails, by means of which rolling stock may be diverted from one track to another.

turnout number: The number corresponding to the number of the frog used in the turnout.

unbonded fastener: A resilient fastener where the elastomeric material is not bonded to a steel top plate or a steel bottom plate. See also *bonded fastener*.

unsafe condition: Any condition that endangers human life or property.

vertical split head: A split along or near the middle of the head of a rail and extending into or through it. A crack or rush streak may show under the head close to the web, or pieces may be split off the side of the head.

vertical stiffness (elastomeric fasteners): The stiffness of an elastomeric fastener from loads and deflections measured in the rail's vertical axis. If not stated explicitly otherwise, this stiffness value is measured with no rail cant.

water pocket: A depression in the roadbed, filled with ballast or other porous material, wherein water collects, to the detriment of track stability. Also described as a "ballast pocket."

water table: The underground water level.

width: The distance between the gage line and the guard line of a track structure, which provides a passageway for wheel flanges.

work train: A train composed of work cars pulled by a prime mover, generally a locomotive.

wye (y): A track or guideway arrangement allowing a car or train to be turned by a series of moves; requires much yard space.

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yard: A system of tracks within defined limits provided for making up trains, storing cars and other purposes over which movements not authorized by timetable or by train order may be made, subject to prescribed signals and rules or special instructions.

yard: A system of tracks within defined limits for making up trains and storing cars.

yard control tower: An airport-like structure overlooking as much of a yard and mainline as possible and housing the personnel and equipment required to control movement of trains and work vehicles throughout the yard, transfer zones and lead tracks.

yard master: A Transportation Department employee, generally the supervisor for a yard's transportation activity.

yard speed: The safe operating speed of railway vehicles over yard trackage.

zero longitudinal restraint (ZLR) systems: A special category of direct fixation fastener that is designed to have zero longitudinal restraint. In general, zero restraint is achieved by placing a formed rigid steel plate between the rail clip and the top of the rail base such that there is no contact with the top of the rail base. This device is generally used for long bridges and requires the installation of rail expansion joints at or near the bridge structural expansion joints. Zero longitudinal restraint systems are virtually all-resilient fasteners but may be of other designs under this definition.

zero thermal stress temperature: The temperature at which a string of continuous welded rail that has been restrained will not be stressed due to thermal expansion or contraction.

Abbreviations and acronyms

AREMA	American Railway Engineering and Maintenance-of-Way Association
ATC	automatic train control
CWR	continuous welded rail
DC	direct current
DF	direct fixation
DRT	desired rail temperature
Ht	highest rail temperature
Lt	lowest rail temperature
NATSA	North American Transit Services Association
NRT	neutral rail temperature
OEM	original equipment manufacturer
OTM	other track material
PPE	personal protective equipment
PRLT	preferred rail-laying temperature
SJ	standard joint
ZLR	zero longitudinal restraint

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Summary of document changes

1. Document has been formatted to the new APTA standard format.
2. Sections have been renumbered and moved.
3. Definitions, abbreviations and acronyms have been moved to the back of the document.
4. Two new sections added: "Summary of document changes" and "Document history."
5. Some global changes to section headings and numberings resulted when sections dealing with references and acronyms were moved to the end of the document, along with other cosmetic changes, such as capitalization, punctuation, spelling, grammar and general flow of text.
6. Revised wording and sections have been added to better match these standards with the contents of "FTA Pocket Guide: Compilation of Rail Transit Industry Best Practices for Track Inspection and Maintenance" (2014) and the "FRA Track Safety Standards Compliance Manual," Chapter 5, Track Safety Standards, Classes 1 through 5, Office of Safety Assurance and Compliance, Track and Structures Division (2014).
7. Added new sections dealing with rail base corrosion defects, elevated track and track lubrication standards.
8. Section 3.1, "Track inspection": Revised wording to add "track supervisor" and a reference to new Appendix E for samples of track and switch inspection forms.
9. Section 3.2, "Rail inspection": Added wording regarding defects found during walking inspections, and a reference to Appendix E for sample inspection form.
10. Section 3.3, "Continuous welded rail inspection": Revised wording to match it closely with FTA and FRA standards, and to reference section B.6 of Appendix B.
11. Section 3.4, "Geometry inspection": Added the words "mainline tracks" to the fourth sentence.
12. Section 3.5, "Switch and crossing inspection": Added "track crossings and moveable bridge lift. rails" to paragraph a). Also added the words "and kept on file for a minimum of one year from the date of inspection" at the end of paragraph c). These changes were made to match it closely with the requirements of FTA and FRA standards.
13. Section 4, "Condition reporting": Added the words "defects and/or conditions" to the first sentence.
14. Section 5.1, "Required action": Wording was revised in paragraph b) for better grammatical structure.
15. Section 6.1, "Drainage": Wording was revised to match it closely with FTA standards' wording.
16. Section 6.2, "Vegetation": The words "highway rail crossings" were added to paragraph b) to match it closely with FTA standards' wording.
17. Section 7.2, "Derails": Wording was added to match it closely with FTA standards' wording.
18. Section 7.3, "Slip rails (expansion joints)": Wording was added to match it closely with FTA standards' wording.
19. Section 7.5, "Rail lubrication" section was added to ensure that proper rail lubrication was performed where applicable.
20. Section 8.1.2, "Gage limits," Table 4: The deviation from design values for classes of track 4 and 5 were revised to match them closely with the FTA and FRA standards' values. Also corrected wording of Note 1 to reference Section 14.
21. Section 8.2, "Horizontal alignment (line)": Table 5, the values for class of track 2 for the maximum allowable deviation from design value on 31 ft. chords were corrected to match the FTA and FRA standards' values.
22. Section 8.3, "Track surface," Table 6: The values for deviation from uniform profile for 31 ft. chords were corrected. Also, Note 2 was rewritten.
23. Section 9.1, "Ballast": Wording was added to match it closely with FTA and FRA standards. In addition, Table 7 and Table 8 were added to follow FTA standards.
24. Section 9.2.2, "Timber crossties": The words "or engineered composite" were added to take into account this type of crossties.
25. Section 9.2.3, "Concrete ties": Wording was added to match it closely with FTA standards.

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26. Section 9.2.4, "Direct fixation fasteners": Wording was added to match it closely with FTA standards.
27. Section 9.2.5, "Joint ties": Section was added to match FTA standards.
28. Section 9.2.6, "Tie plates": Section was added to match FTA standards.
29. Section 9.3, "Clearances": Paragraph c) was added to account for the need to ensure that at platform boarding areas the ADA, gap and step standards are maintained.
30. Section 10.1.4, "Definition of rail defects": Section was updated and rewritten to match it closely with FTA and FRA standards.
31. Section 10.1.7, "Base-corroded rails": This is a new section that was added by the working group to this standard.
32. Table 11c, "Rail Defect Remedial Action": Values were added for base-corroded rails and wheel burn, "squat" or shell.
33. Section 10.3, "Rail joints and rail ends": Wording was added to match it closely with FTA and FRA standards.
34. Section 10.3.1, "Rail joints": Paragraph c) was revised to specify that operations must be supervised and the bars immediately replaced when a joint bar is cracked or broken between the middle two bolt holes. In addition, paragraphs i), j), k) and l) were added to match it closely with FTA and FRA standards.
35. Section 10.3.2 "Rail ends": Section was renamed "Rail joint and weld stagger" to introduce joint stagger standards to match FTA standards.
36. Section 10.3.3, "Rail ends": Wording was added to match it closely with FTA standards.
37. Section 10.4.1, "Procedures": Paragraph a), the words "degrees Fahrenheit" and "recorded" were added to the definitions of different rail temperatures. Paragraph c) was added to match it closely with FTA and FRA standards. Paragraph f) was modified to add instances when the difference between the average rail temperature and the rail neutral temperature are in range that could cause buckling-prone conditions. The words "and crossties" were added to the second bullet. Under paragraph g) the third and fourth bullets were added to match it closely with FTA and FRA standards. Paragraph h) was also added to this section in order to match it closely with FTA and FRA standards.
38. Section 12.1, "General requirements," Special track work: The last sentence was added to match it closely with FTA standards.
39. Section 12.2, "Switches": Paragraphs k), l), m) and n) were added to match it closely with FTA and FRA standards. Section 12.2.1 "Special design switches," was reformatted as paragraph o) of Section 12.2.
40. Section 12.3.2, "Damaged frogs": Paragraphs c), d) and e) were added to match it closely with FTA and FRA standards.
41. Section 13.3.2, "Track flange way": The third sentence was added to emphasize the need to clear ice from flange ways in areas subject to freezing temperatures.
42. Section 13.4, "Track structure": The last sentence of the first paragraph was added to emphasize that temporary repairs must be promptly followed by permanent repairs, and that speeds need to be adjusted accordingly. The words "vehicles, including MOW equipment" were added to the last sentence of the second paragraph. The third paragraph was also added to specify that infrastructure repairs performed by others must be monitored.
43. Section 13.5.1, "Rail defects": A sentence was added to the end of the first paragraph to indicate that specific types of rail defects shall be handled in accordance with the standards shown in Section 10, "Rail."
44. Section 13.5.2, "Rail wear": The last two sentences were added to indicate that the wheel tread must not be allowed to touch the roadway material and that the top wear is based on keeping the top of the rail above the road surface.
45. Section 14, "Elevated track": Section was added by the working group to deal with elevated track structures, including: types of structures; emergency protection (inner bridge) rails; spacing, fastening

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and type of crossties in open-deck elevated structures; walkways and handrails; rail expansion joints (slip rails); and installation of CWR on elevated structures.

46. References: "The FTA Pocket Guide: Compilation of Rail Transit Industry Best Practices for Track Inspection and Maintenance 2014," was added as a reference, as well as "The FRA Track Safety Standards Compliance Manual."
47. Definitions: The first paragraph was rewritten. Some definitions were revised.
48. Appendix B, Section B.1.1.1: The coefficient of expansion for steel rail value was corrected to 0.0000065. Also R_L was redefined as the unrestrained rail length. The values in Table B1 were revised in accordance with the change in the coefficient of expansion for steel rail value.
49. Appendix B, Section B.1.1.3: The constant derived from Young's modulus was revised to 19.015 in account of the revision of the coefficient of expansion of steel rail. Consequently, the values on Table B2 were also revised.
50. Appendix B, Section B.2: The words "cross-section and condition" were added to the end of the first paragraph. The words "for practical purposes" were added to the end of the second paragraph. In the third paragraph, the words "per joint" were added aft.er "100,000 lbs. of restraining force." The last sentence of the fourth paragraph was changed to read, "The vertical restraint capacity of a well-maintained elastic fastening system is approximately 5000 lbs. per rail seat." The third sentence of the sixth paragraph was changed to read, "Well-maintained ballast with well-maintained fastening systems provide approximately 1300 lbs. of resistive longitudinal force per anchored tie."
51. Appendix B, Section B.5.2: The title was changed to read "Effect of repairing surface and alignment of the track on the neutral temperature of the rail." The third sentence of the first paragraph was changed to read, "On rough track with surface deviations, the rail covers a longer distance than on smooth track."
52. Appendix B, under Section B.6.4 a CWR "Remedial Action Table" was added as a guide to determine appropriate action to take when indications of track under high thermal forces have been found.
53. Appendix B, Section B.12, "Benefits of CWR": The first two sentences of the section were deleted.
54. Appendix B, Section B.13, "References": The sentence "Another good source is FTA's "Pocket Guide: Compilation of Rail Transit Industry Best Practices for Track Inspection and Maintenance" was added at the end of the paragraph.
55. Appendix B, Section B.14, "Thermal rail adjustment table": The coefficient of expansion of steel rail value was changed to 0.0000065.
56. Appendix C, Table C1: The values for running rail side and vertical wear were revised to match more closely those given by FTA standards.
57. "Appendix E (informational): Typical track and switch inspection forms" was added by the working group to this standard.

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	Rail CEO Approval	Rail Standards Policy & Planning Approval	Publish Date
First Published	June 25, 2002	—	—	Sept. 22, 2002	September 2002
First Revision	Feb 11, 2016	Jan 31, 2017	Feb 22, 2017	March 15, 2017	April 7, 2017

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Appendix A (informational): Track surface table

Table A1 is a guideline for maximum allowable speeds based on individual track geometry parameter deviations.

TABLE A1
Maximum Allowable Speeds on Various Track Conditions

	Parameter							
Max. Allowable Speed	**62 ft. Twist, Spirals**	**31 ft. Twist, Spirals**	**62 ft. Twist, Curves and Tangent**	**31 ft. Twist, Curves and Tangent**	**Crosslevel**	**62 ft. Surface**	**31 ft. Surface**	**31 ft. Runoff**
Class 1 Track								
15	3 in.	2 in.	3 in.	1½ in.	3 in.	3 in.	⅞ in.	3½ in.
Class 2 Track								
20	2¾ in.	1⅞ in.	2¾ in.	1⅜ in.	2⅝ in.	2⅞ in.	⅞ in.	3⅜ in.
25	2½ in.	1⅞ in.	2½ in.	1¼ in.	2⅜ in.	2⅞ in.	¾ in.	3⅛ in.
30	2¼ in.	1¾ in.	2¼ in.	1⅛ in.	2 in.	2¾ in.	¾ in.	3 in.
Class 3 Track								
35	2¼ in.	1⅝ in.	2¼ in.	1⅛ in.	2 in.	2⅝ in.	¾ in.	2⅞ in.
40	2⅛ in.	1⅝ in.	2⅛ in.	1⅛ in.	1⅞ in.	2⅝ in.	⅝ in.	2⅝ in.
45	2⅛ in.	1½ in.	2⅛ in.	1⅛ in.	1⅞ in.	2½ in.	⅝ in.	2½ in.
50	2⅛ in.	1⅜ in.	2⅛ in.	1 in.	1⅞ in.	2⅜ in.	⅝ in.	2⅜ in.
55	2 in.	1⅜ in.	2 in.	1 in.	1¾ in.	2⅜ in.	½ in.	2⅛ in.
60	2 in.	1¼ in.	2 in.	1 in.	1¾ in.	2¼ in.	½ in.	2 in.
Class 4 Track								
65	2 in.	1¼ in.	2 in.	1 in.	1⅝ in.	2¼ in.	½ in.	1⅞ in.
70	1⅞ in.	1⅛ in.	1⅞ in.	1 in.	1½ in.	2⅛ in.	½ in.	1¾ in.
75	1⅞ in.	1⅛ in.	1⅞ in.	⅞ in.	1⅜ in.	2⅛ in.	⅜ in.	1⅝ in.
Class 5 Track								
80	1¾ in.	1 in.	1¾ in.	⅞ in.	1¼ in.	2 in.	⅜ in.	1½ in.
85	1⅝ in.	⅞ in.	1⅝ in.	⅞ in.	1⅛ in.	1⅝ in.	⅜ in.	1¼ in.
90	1½ in.	¾ in.	1½ in.	¾ in.	1 in.	1¼ in.	¼ in.	1 in.

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Appendix B (informational): Continuous welded rail (CWR) recommended practices

This appendix provides recommended practices for rail transit systems that maintain continuous welded rail (CWR) track. These recommended practices are not intended to supersede any rail transit system's existing practices. This appendix is intended as a guide for rail transit systems that do not have existing practices and is intended to be modified by individual rail transit systems for their specific needs, requirements and situations.

B.1 CWR

Continuous welded rail is defined herein as any rail 400 ft. or more in length, although a rail transit system can designate any length as CWR. Some define CWR as any rail greater than a standard 78 ft. length. Rail transit systems should clearly define what they consider as CWR.

B.1.1 Thermal expansion

Nearly all materials, including rail, expand and contract with temperature changes. When the temperature of the rail increases, the rail attempts to grow in length, and when the temperature of the rail decreases, the rail attempts to shorten. If rail is free to change length with changes in rail temperature, then it will behave in a predictable manner.

B.1.1.1 Formula for expansion of unrestrained rail

The amount that unrestrained rail will expand or contract can be determined with the following formula:

$$\Delta R_L = R_L \times \Delta T \times 0.000078,$$

where
ΔR_L = change in rail length (in inches)
R_L = unrestrained rail length (in feet)
ΔT = change in rail temperature (in Fahrenheit degrees). The change in rail temperature from when it was originally measured.
0.000078 = coefficient of expansion for steel rail

$$\Delta R_L = R_L \times 12 \times \Delta T \times 0.0000065,$$

where:
ΔR_L = change in rail length (in inches)
R_L = unrestrained rail length (in feet)
12 = conversion of rail length from feet to inches
ΔT = change in rail temperature (in Fahrenheit degrees). The change in rail temperature from when it was originally measured.
0.0000065 = coefficient of expansion for steel rail

The effect that temperature has on unrestrained rail length is shown in **Table B1**.

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TABLE B1
Longitudinal Rail Expansion vs. Temperature Change

ΔT Change in Rail Temperature	Rail Length				
	100 ft.	**1320 ft.**	**2640 ft.**	**3960 ft.**	**5280 ft.**
10 °F	1⁄16 in.	1 in.	2 1⁄16 in.	3 1⁄16 in.	4⅛ in.
20 °F	⅛ in.	2 1⁄16 in.	4⅛ in.	6 3⁄16 in.	8¼ in.
30 °F	¼ in.	3 1⁄16 in.	6 3⁄16 in.	9¼ in.	1 ft., ⅜ in.
40 °F	5⁄16 in.	4⅛ in.	8¼ in.	1 ft., ⅜ in.	1 ft., 4 7⁄16 in.
50 °F	⅜ in.	5⅛ in.	10 5⁄16 in.	1 ft., 3 7⁄16 in.	1 ft., 8 9⁄16 in.
60 °F	7⁄16 in.	6 3⁄16 in.	1 ft., ⅜ in.	1 ft. 6½ in.	2 ft., ¾ in.
70 °F	9⁄16 in.	7¼ in.	1 ft., 2 7⁄16 in.	1 ft., 9⅝ in.	2 ft., 4 13⁄16 in.
80 °F	⅝ in.	8¼ in.	1 ft., 4 7⁄16 in.	2 ft., ¾ in.	2 ft., 8 15⁄16 in.
90 °F	11⁄16 in.	9¼ in.	1 ft., 6½ in.	2 ft., 3 13⁄16 in.	3 ft., 1 1⁄16 in.
100 °F	¾ in.	10¼ in.	1 ft., 8 9⁄16 in.	2 ft., 6⅞ in.	3 ft., 5 3⁄16 in.

B.1.1.2 Rail size and amount of rail movement

The size or weight of the rail has no effect on the amount that the rail will expand or contract. Only the unrestrained length of the rail affects rail movement. For a given change in rail temperature, the amount of expansion and contraction is the same on 60 lbs./yd. or 136 lbs./yd. rail sections.

B.1.1.3 Longitudinal rail stresses from temperature changes

CWR attempts to change rail length with changes in temperature. Rail is installed such that this expansion and contraction cannot occur; hence large stresses can build up along the rail, and these forces are called longitudinal forces.

There are three force states for rail installed in track: compression, tension and neutral. When the temperature of the rail increases, the rail attempts to grow in length. This is prevented, so the rail pushes against itself, creating compressive forces. When the temperature decreases, the rail attempts to shorten itself. Again this is prevented, and the rail pulls against itself, creating tension forces. When the rail temperature is equal to that where no expansion or contraction will occur, the rail is at "neutral" temperature. Since rail has only one temperature at which it is at "neutral," odds are that some longitudinal forces do exist.

While size or weight does not affect the amount that rail expands or contracts, it does affect the forces generated. The larger the rail size, the greater the force generated with a temperature change. The forces can be calculated using the following formula:

$$\Delta L_F = R_W \times \Delta T \times 19.015,$$

where:
ΔL_F = longitudinal force (in pounds)
R_W = rail weight (in pounds per yard)
ΔT = change in rail temperature (in degrees Fahrenheit)
19.015 = constant derived from Young's modulus (29.85×10^6 psi) × Coefficient Expansion of Steel (6.5×10^{-6} °F^{-1}) × Ratio of Rail Cross-Section to Weight per Yard (0.098)

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The effect that rail size has on these longitudinal rail forces is shown in **Table B2**.

TABLE B2
Longitudinal Rail Forces vs. Temperature Change (in pounds)

ΔT Change in Temperature	Rail Size (rail weight, in pounds per yard)				
	60	**90**	**100**	**115**	**136**
0 °F	0	0	0	0	0
25 °F	28,523	42,784	47,538	54,668	64,651
50 °F	57,045	85,568	95,075	109,336	129,302
75 °F	85,568	128,351	142,613	164,004	193,953
100 °F	114,090	171,135	190,150	218,673	258,604

B.1.1.4 Longitudinal rail stresses from train traffic

In addition to the longitudinal stresses induced by changes in rail temperature, train traffic can generate large longitudinal forces. When trains accelerate or brake, the momentum of the train is translated into longitudinal forces in the rail. These forces can be very high. For rail transit systems, the effects of these forces can be compounded, since train stops and starts occur nearly at the same locations, in the same directions with every train. Locations such as stations, street crossings, speed changes and interlockings are particularly impacted. Automatic train control (ATC) systems further exacerbate these effects, since the system will automatically brake and accelerate all trains at exactly the same locations every time; whereas with manually controlled trains each train operator will brake/accelerate trains at slightly different locations and rates. While the adverse effects of, for example, a station stop, will still be present with or without an ATC system, the ATC system could make these effects more prominent.

B.2 Longitudinal rail restraint

This section discusses the large forces that can be generated in CWR. When CWR is installed in the track, these forces are offset with four restraints: tie plate/rail seat friction, joint bar restraint, fastening system, and the ballast cross-section and condition.

The friction from tie plates is negligible and can be discounted for practical purposes.

At properly maintained rail joints, the longitudinal restraint of the rail is approximately equal to the clamping force of each bolt. A properly torqued bolt provides about 25,000 lbs. of restraining force. For a rail joint with four bolts installed, this equates to 100,000 lbs. of restraining force per joint, 150,000 lbs. for six-hole joint bars. Note that this is for a “properly maintained” rail joint. Loose rail joints do not provide as much restraint as is possible.

The fastening system provides the primary resistance to longitudinal rail forces and movement. The cut spike/rail anchor fastening system can provide significant longitudinal restraint, if properly maintained. Loose or missing rail anchors can greatly reduce restraining capacity. With many resilient fasteners, the rail alignment and longitudinal restraint are combined, such that no rail anchors are required. The vertical restraint capacity of a well-maintained elastic fastening system is approximately 5000 lbs. per rail seat.

Direct fixation (DF) fastening systems can provide significantly large restraining forces. This is also true of street-running track where the rail is somewhat shielded from the sun’s energy, in addition to providing large restraining forces. Great care shall be taken not to rely solely on these additional restraining forces. Rail should be maintained at proper thermal adjustment, regardless of the type of track construction. Sudden failure of the

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fastening systems can occur if the rail is not properly adjusted. The high forces will also be transferred to the structure, causing permanent damage. Sun kinks and pull-aparts can also occur on these track forms, and the results usually take more resources to repair, with symptoms such as loss of gage and failed DF fasteners; on street-running track the rail can lift. out of the roadway.

On ballasted track, the longitudinal forces from the thermal rail expansion and contraction are transmitted from the rail fastening system to the ties. The ties then transmit these loads to the ballast. Well-maintained ballast with well-maintained fastening systems provide approximately 1300 lbs. of resistive longitudinal force per anchored tie. This can be significantly reduced if there is insufficient ballast, if the ballast is not well-consolidated, if ballast with poor interlocking properties is used, or if the track is not firmly tamped. The resistance of ballast to lateral movement is broken down by approximately 40 percent provided by the bottoms of the tie, 40 percent by the ballast cribs, and 20 percent by the ballast shoulders. Frozen or dry ballast fouled with dirt can increase the restraining capacity of ties; however, this restraint capacity is not to be relied upon. In the case of frozen ballast, it can quickly thaw; with dirty ballast, a rain can cause a significant loss of restraint.

In some cases, CWR is purposely installed with no longitudinal restraint. This is done to prevent the large forces generated in the rail by temperature changes from transferring to bridges or other similar structures. In these circumstances, special "slip joints" are installed in the track to allow the rail to freely expand and contract. These slip joints are also installed at approaches to moveable bridges to ensure that any rail movement does not adversely affect the operation of the bridge.

B.3 Determining rail temperatures

Each rail transit system needs to designate the temperature ranges for installing and maintaining CWR rail. These designations need to be made for each geographic region. Even on fairly short rail transit systems, the tracks can pass through numerous microclimates; separate calculations should be made for each region where CWR is used. Even if the climate is fairly uniform throughout a rail transit system's property, consideration should be given to different track forms, such as at-grade, elevated (aerial) and subway; the rail temperatures can vary considerably along these different types of track. For example, a bridge over a river or raised trackway that is subjected to a constant breeze may react differently from ballasted track in a cut in the same area. Knowledge and familiarity with local weather patterns and what effects they have on the track should be used when dividing temperature range for each of these geographic areas in which the CWR is located. The experience and knowledge of *local* personnel should be relied upon in making these geographic determinations.

Some rail transit systems may choose not to thermally adjust rail in subway areas. Since the temperature in tunnels and subways is typically constant and not subject to extreme and sudden changes in temperature, this can be safely done. However, consideration should be given to controlling the rail installation temperature during construction at portal areas, stations and ventilation ducts. While the temperature in subways may be "on average" constant, these special areas may be subjected to sudden temperature swings.

CWR should be laid when the rail temperature is within the temperature range specified by the following equations. See **Table B5**.

$$DRT_{MIN} = ([2Ht + Lt] / 3) + 10$$
$$DRT_{MAX} = (([2Ht + Lt] / 3) + 25) \pm 5,$$

where:
DRT_{MIN} = minimum desired rail temperature, degrees Fahrenheit;
DRT_{MAX} = maximum desired rail temperature, degrees Fahrenheit;
Ht = highest recorded rail temperature, degrees Fahrenheit
Lt = lowest recorded rail temperature, degrees Fahrenheit.

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Rail temperature is not directly related to ambient or air temperature. At night, or when there are heavy clouds, the rail temperature closely follows the ambient temperature. However, the rail temperature will lag behind the ambient, since it takes time for the rail temperature to change; the faster the ambient temperature changes, the greater the lag in the rail temperature. This is also true for rail size. The larger the rail size, the greater the lag, since it takes more time for a given amount of thermal energy to heat up a larger mass of rail. When the rail is in direct sunlight, its temperature can significantly increase over the ambient. It is not unusual for the rail temperature to be as much as 40 °F or more higher than ambient when it is in direct sunlight.

Two calculations should be made for each geographic region, one for a minimum and one for the maximum. As can be seen, the "DRT_{MAX}" formula includes a plus or minus 5 °F. Which end of the range is appropriate for each rail transit system should be determined by experience. If a system experiences extremely low rail temperatures in winter and high temperatures in summer, it may be appropriate to use the minus 5 °F, whereas if the temperatures are more temperate or high temperature spikes are common, then the plus 5 °F may be appropriate. Again, the experience of railroad qualified personnel should be relied upon.

The minimum and maximum temperatures to be used in these formulas can be easily obtained from various sources. Many university libraries have books showing historical weather data; this information can sometimes be obtained on the internet. Other excellent sources are government weather agencies. If research time is unavailable, then this data can be obtained, for a fee, from professional weather services. Historical weather data will be for ambient. While the ambient temperature can be used for the minimum rail temperature, the maximum historical ambient temperature should be increased to that experienced by a rail transit system. Experience should be used in determining the maximum possible rail temperature.

Once the DRT_{MIN} and DRT_{MAX} (minimum and maximum) rail temperatures are determined for each geographic area, the preferred rail-laying temperature (PRLT) can be determined. The PRLT should be within the range provided by the DRT_{MIN} and DRT_{MAX}. Again, experience should be used; however, it is far better to err on the high side than low, as a sun kink could be far more dangerous than a rail pull-apart. A pull-apart will typically show up as a false occupancy in the signal circuit, while a sun kink is typically found by a train, and many times can occur under a train. With the PRLT determined, it is not unusual for a rail transit system to provide a plus and minus range of a few degrees. This allows maintenance personnel a range to work within, without having to expend excessive resources. This range should be a few degrees only, not so large as to allow sloppy workmanship.

When making the PRLT determination, it is advisable for rail transit systems to be aware that the neutral rail temperature (NRT) changes over time. The NRT differs from the PRLT. The PRLT is the temperature that rail is installed at or adjusted to when rail is thermally adjusted. The NRT is the actual adjusted temperature of the rail. This tends downward from the PRLT due to maintenance activities and rail creep. The longer the rail has been installed, the lower the NRT tends to be. It is better to err to the higher temperature when making the determinations as to what the PRLT should be, with experience being the guide.

B.4 Maintenance activities on CWR track

Rail transit systems should develop specific direction for track construction and maintenance personnel describing what actions should be taken when disturbing track with CWR. These policies should include what specific actions are required for temperature ranges above and below the PRLT. These policies should include what speed restrictions are required and what precautions should be taken and what can be done to minimize or eliminate the need for speed restrictions. Rail transit systems should in no way limit their ability to efficiently and productively perform maintenance and construction activities with existing resources. However, the developed policy should provide enough direction to guide personnel in what changes they can make to their existing work methods to ensure that the work is safely performed and will remain safe for traffic aft.er the work is completed.

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If the track is disturbed when the rail temperature is above or below the NRT, then the track can become unstable. By disturbing the tracks, resistance to longitudinal rail movement and lateral restraint can be significantly diminished. It is important to keep in mind that problems can be encountered when disturbing the track at temperatures below the NRT. So much emphasis is placed upon dealing with CWR track in hot weather that cold-weather problems are often ignored. CWR track can be easily and safely disturbed within median temperature ranges. Precautions need to be taken only when it is disturbed at temperatures above or below this range.

The following maintenance activities are examples of work that would constitute disturbing CWR track:

- undercutting track
- tie replacement
- track surfacing and alignment
- field welding rail
- track gaging
- replacement of rail fasteners or rail anchors
- track or switch panel installation
- track shimming
- disturbing the ballast section

These are common maintenance activities and do not exclude additional activities that are commonly performed by a specific transit system or activities that are unique to a specific transit system with unique types of track. It is not mandated that each of these specific activities should have a special detailed policy or procedure. These types of activities should be considered when developing policies or procedures. Whenever possible, generic policies and procedures should be developed.

B.4.3 Maintenance operations that disturb track structure

The following maintenance work on CWR track should be performed when the rail temperature is equal to or lower than the installation or latest adjusted rail temperature:

- out-of-face track raising and lining
- rail renewal
- tie renewals (with or without raising)
- disturbing the ballast section

B.5 Surfacing and aligning CWR track

B.5.1 General

When surfacing and aligning CWR track, there should be sufficient ballast prior to surfacing. When the work is complete, with the cribs and any gaps at the tie ends filled, the ballast section should be completely restored.

B.5.2 Effect of repairing surface and alignment of the track on the neutral temperature of the rail (NRT)

Surfacing and aligning CWR track can greatly affect the NRT. Where the surface of the track is in extremely poor condition, resurfacing will reduce the neutral temperature of the rail. On rough track with surface deviations, the rail covers a longer distance than on smooth track. The worse the track surface and alignment prior to surfacing, the greater the reduction in neutral temperature. Serious consideration should be given to thermally readjusting the rail throughout.

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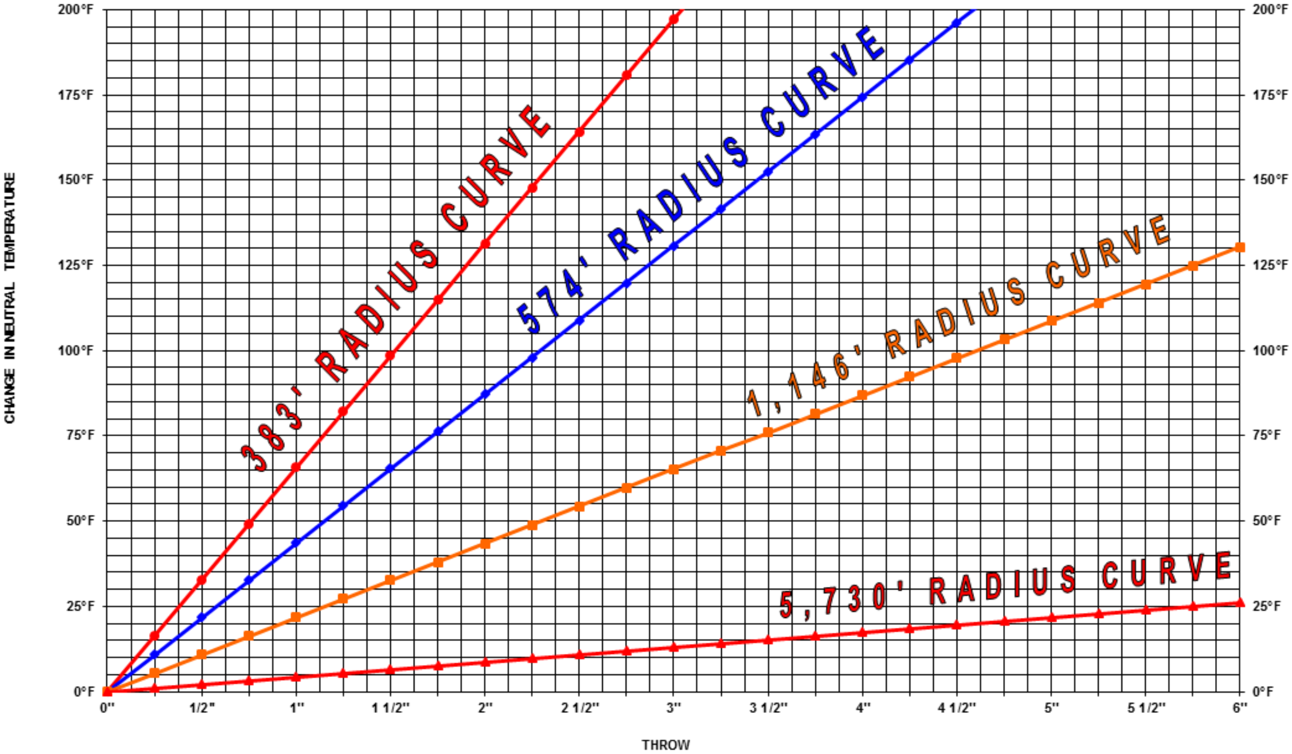
B.5.3 Curve alignment and neutral temperature

When curved track is realigned, the throws should be balanced. For every inch of outward throw, there should be an inch of inward throw. If the curve is thrown outward, the track is made longer, raising the neutral temperature. If thrown inward, the track is then shorter and the neutral temperature is reduced. Neither of these is desirable. If the neutral temperature is too high, either by incorrect adjustment or by aligning the curve outward, then the track will tend to move inward, usually not uniformly, creating a misalignment "flat spot" in the curve. Where the neutral temperature is too low, through misadjustment or by aligning the track inward, a sun kink is risked. The sharper or longer a curve, the larger the impact to the neutral temperature. This is illustrated in **Figure B1**, which shows the changes for selected curve radii for curves 100 ft. long.

FIGURE B1

Effects of Throws on Neutral Temperature, 100 ft. Long Curves



When realigning curves, where large throws are required, it is good to consider thermally readjusting the rail in the curve. When the throws are quite large, even if the throws are balanced, localized stretching and bunching of the rail can occur. Large surfacing and lining machines do help somewhat, since they vibrate the entire track structure, which helps the rail slide through fasteners. On cut spike track, the rail anchors can be removed prior to aligning the track. With resilient fasteners, thermal readjustment may be the only option.

B.6 CWR special inspection

B.6.1 Why special inspections are performed

With extremes in ambient temperatures, special inspections should be made on CWR track. While hot weather typically provides a greater risk for sun kinks, extremely cold weather can also create problems on CWR with pull-aparts. Greater stress is usually placed upon hot-weather special inspections, but cold-weather inspections should also be considered. Some rail transit systems do not perform specific cold-weather inspection, but rather rely upon signal circuits to provide broken rail and pull-apart detection. It should be taken into consideration

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that signal circuits do not provide 100 percent reliability for pull-apart detection. Rail joints, special track work, restraining rails, turnouts and crossings can provide an alternate path for the signal circuits, negating detection of a pull-apart on the running rails.

The neutral or force-free temperature of the rail tends to reduce with time. Since the rail temperature is usually artificially increased during installation and maintenance, any disturbance without readjustment will cause the neutral temperature to decrease. Since there is no easy way to determine the neutral temperature of CWR, inspection of CWR track is critical to ensure uninterrupted train operations.

Inspections for potential problems in CWR track should not be limited to extremes in weather; there are many indicators of unstable track that are evident to diligent inspectors. These indicators should be watched for during regular track inspections, so problems can be identified in advance of failure or weather extremes and repairs can be made on a programmed basis.

B.6.2 Methods of performing special inspections

Special inspections on CWR during temperature extremes can be made using the normal methods used for regular track inspections. One of the hardships of maintenance personnel in rail transit systems is the restriction to track access due to the high frequency of trains. Frequent trains can be beneficial for special inspections. Personnel making special inspections can cover large territories in a short time by riding the trains. The person making the inspection should ride in the trailing or leading end of the train, positioned where he or she has full view of the track. If possible, the trailing end of the trains is preferred, so the person performing the inspection will not interfere with those operating the train. Even though the train may be traveling at high speeds, many of the indicators of a pending or potential problem can be readily identified. If necessary, a more detailed visual inspection can be made. It is not unusual for personnel performing special inspections to make multiple passes over the same track. This allows maintainers persons performing inspections to see if changes have occurred or if problems have developed since the last pass.

During temperature extremes, train operation control centers are a good resource for information concerning adverse effects of temperature extremes. Problems such as false occupancies in CWR track with track circuits and problems with the operations of switches and movable bridges should be investigated. Patterns and repeated complaints are excellent indicators of pending problems. Good communication with personnel who are operating the trains is an excellent tool for determining where to take a closer look for potential problems.

B.6.3 When special inspections should be performed

Rail transit systems should specify when special inspections should be performed on CWR. The “trigger level” can be as simple as when the ambient temperature is above or below a certain temperature. Another method is to perform special inspections when the temperature is above or below the PRLT by a certain amount. Others perform special CWR inspections when there is a sudden change in temperature within a certain time period. Some rail transit systems perform special inspections on CWR track only as determined by inspectors or management staff.

Any of these, a combination of these, or other methods can be used for determining a trigger level for when special inspections are made. Rail transit systems should have specific guidelines in place to guide those persons who perform and/or manage the special inspections. The methods and determinations should be based primarily on the knowledge and experience of the rail transit system. The key is to ensure that sufficient thought has gone into the decision-making process so guidelines are developed to cover possible scenarios and maintain safe, reliable and economical train operations.

Along with the guidelines for when and how special inspections should be made, rail transit systems should include what inspection reports or other documentation, if any, is required when special inspections are made.

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B.6.4 Items to watch for during special inspections of CWR

The following are examples of items that should be watched for when special inspections are made on CWR during temperature extremes. Persons performing regular track inspections should also be vigilant for these same conditions during regular track inspections.

Rail

- canting or tipping of the rail
- the rail crowding the shoulders of fastening systems
- rail lifting or riding up in tie plates and rail fasteners
- scrape marks on the rail indicating longitudinal rail movement
- uneven wear patterns on the rail gage face or running surface
- excessive longitudinal rail movement at slip joints, switch points and stock rails
- misaligned switch points

Rail joints

- pull-aparts
- track bolts that are bent, broken or worn
- heavily worn fishing surfaces
- frozen joints (rail end gaps at rail joints that are open when the rail is hot and closed when the rail is cold)

Rail fasteners

- tearing, lifting or separating of direct fixation fasteners
- missing rail anchors
- rail anchors that are away from the edge of the tie
- lifted spikes
- resilient fasteners that are loose, missing or broken along one side of the rail
- skewed gage rods

Ties

- skewed ties
- tie movement or bunching (uneven tie spacing)
- hanging or swinging ties, particularly at approaches to bridges or direct fixation track
- clusters of defective ties

Track geometry

- misalignment, kinks, buckles in the track, in particular at fixed objects such as road crossings, bridge or subway approaches, and special track work
- changes in alignment with temperature changes
- irregular gage
- pumping track (excessive up-and-down movement under load)

Ballast

- churned (freshly disturbed) ballast
- displaced ballast
- gaps in the ballast at the end or sides of the ties

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- bunched up or piled ballast at the end or sides of the ties
- insufficient ballast shoulder

Other areas

- track that has been recently worked on
- new track
- past derailment locations
- past washout locations
- steep grades
- locations subjected to heavy acceleration and braking (stations, speed changes, interlockings) locations with soft. subgrades and drainage problems

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CWR Remedial Action Needed

The following "**Remedial Action Table**" may be used as a guide to determine appropriate action to take when indications of track under high thermal forces have been found.

Sub-standard item detected	Repair required
RAIL:	
Rail tilting on tie plates	Destress
Crowding the shoulder of the tie plates on curves	Destress (can be a normal condition), additional information needed.
Riding up or out of the tie plates	Destress
Marks on the base of the rail where the rail is moving through the spikes	Destress (check anchor condition)
Uneven wear on the rail surface, or welds, under traffic	Determine cause and correct
Poor weld alignment	Replace weld, check for track movement
Severe corrugation in curves	Remove corrugation, check for rail run
Longitudinal movement of switch point to the stock rail	Destress both sides of turnout as needed.
JOINT AREAS:	
Bars: broken, bent, cracked	Replace
Not fully bolted or bolts that are loose	Fully bolt, check bolt condition tighten replace as necessary
Bolts: Missing, bent	Replace
Battered rail ends	Slot, weld or replace
Mismatched rail ends	Weld, compromise, or replace
Gap between tie plate and rail	Nip up and tamp joint ties
Not closed 40° F above PRLT	Check drilling, bent bolts, frozen joint destress
Missing/broken/flattened insulating post (insulated joint)	Replace post (armored) or replace joint (glued)
Missing/broken rail fasteners	Check for rail run, replace fastener
Cracked/shattered epoxy on glued joints	Check integrity, (bars, bolts, insulation, electrical resistance), and compromised, replace.
Pull-aparts	Repair as outlined in Maintenance Standards
Frozen (standard or compromise) joints	Oil and check bolt condition
Location where rail repairs were made in the winter	Check to see if destressing is required or eliminate joint
Joint elimination areas that may have had rail added	Check to see if destressing is required

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Sub-standard item detected	Repair required
Missing/broken washers	Replace
More than one washer or nut	Check bolt size and replace with proper size complete with one washer and one nut only
Improper torque	Check bolt condition and re-torque
Disturbed ballast, and/or Surface deviation, and/or Displaced rail anchors	Check for excessive rail movement at joint bar (fishing surface), tighten bolts/replace joint, tamp up joint ties and adjust anchors
FASTENINGS	
Spikes: high, missing, bent	Plug and re-spike, if condition persists, destress as needed
Improper pattern of spikes	Re-spike to RTS specifications
Anchors: missing, loose, damaged	Replace, check for rail run
Anchors away from tie or plate	Tighten and check for rail run
Improper pattern of anchors	Re-set to RTS specifications
Elastic fasteners: missing, loose, damaged	Replace, and check for rail run. Destress as needed
Area of heavy brake application	Check for rail run and install additional anchors as needed
TIES:	
Defective	Replace in accordance with RTS specifications
Skewing	Check ballast and anchors. Destress
Moving and bunching from longitudinal movement	Check ballast and anchors. Destress as needed
Clusters of poor ties	Never leave more than two adjacent defective ties
Hanging ties	Surface and check for rail run
BALLAST:	
Inadequate shoulder	Check cause, destress, or slow order until reinstated
Cribs not full, narrow shoulder	Regulate or add ballast, check for rail run. Destress if needed
Pumping	Undercut, destress if needed

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Sub-standard item detected	Repair required
TRACK GEOMETRY:	
Misalignment	Slow order to RTS compliance and reline.
Lateral or vertical movement when temperature is more than 20° F above the PRLT	Slow order may be required, notify the Track Supervisor, destress as needed
Poor surface	Surface and line, check for rail run
Spike killed ties	Plug and respike. Check adequate tie contact with anchor
Anchors on shimmed ties	Remove
Poor cross level	Check cause, slow order to RTS compliance and surface
Gauge irregularities	Regauge, check tie condition. If cause is tight rail, may require destressing
Blocked ditches or culverts	Repair
Slide/washout areas	Stabilize, destress
Where the rail moves under traffic causing ties to skew and bunch up such as wet low lands, poor subgrade, etc.	Stabilize, destress

B.7 Slow orders/speed restriction on CWR track

While CWR track may be stable and able to withstand thermal expansion and contraction forces, the dynamic loads imposed on the track by trains can reduce the track's ability to maintain alignment. Train braking, increases in rail temperature from the friction of the train wheels, and the up-and-down movement of the track that occurs as trains pass all work to degrade the track's ability to maintain stability. The following are some of the dynamic factors that can affect CWR track's ability to remain stable:

1. train speed
2. axle loads (the heavier the axle loads, the worse the effects)
3. train length (longer trains disturb the track more with a cumulative effect; typically the longer the train, the greater the track displacement, and the temperature increase from rolling friction is greater)
4. train frequency
5. sharp curves (the sharper the horizontal curvature, the greater the translation of longitudinal rail forces to lateral track forces)
6. steep grades (the steeper the grade, the greater the effect of train braking and acceleration forces)

With higher train speeds, larger forces are generated from dynamic loading all around. This includes larger track displacement, greater friction-related temperature increases to the rail, and significantly larger longitudinal forces from braking/acceleration and larger lateral loads on the track from truck hunting and the effects of minor (typically acceptable) geometry deviations.

These dynamic forces alone can increase the risk factors to the stability of the track. These, combined with freshly disturbed track, can lead to even higher risk factors for continued high-speed train operations.

As with other items related to CWR maintenance practices, the need for and the level of speed restrictions should be determined on a case-by-case basis by rail transit systems. Experience and knowledge of the individual property and types of operations should weigh heavily in the decision-making process. Many look

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to the policies and procedures of heavy haul freight railroads for examples of what should be done. It should be kept in mind that these policies are based upon experience and research based upon what can be vastly different circumstances, such as heavier and longer trains and less-frequent inspections during temperature extremes. Whatever policy is used, the rail transit system should weigh all the affecting factors and develop uniform procedures for placing speed restrictions under the following situations:

- extreme high temperatures
- extreme low temperatures
- after maintenance work is performed
- after maintenance work is performed where temperature extremes are expected

It should be noted that different speed-restriction scenarios are required for different maintenance tasks. In some cases, various different types of CWR track maintenance tasks can be lumped together to simplify the process but still provide the needed safety measures. A clear, easy-to-understand policy may be better than a detailed, complex policy that may be hard for personnel to interpret and apply. It may be that for a particular rail transit system, no special speed restrictions are required. However, whatever the policies and procedures are, they should be clearly identified.

It may be appropriate to have speed restrictions on one type of track but not another, or in one area but not another. For example, a rail transit system may determine that temperature and/or maintenance-related speed restrictions are not needed in subways or on DF track but are on ballasted track. Another scenario is where a rail transit system may require speed restrictions on older ballasted wood tie track but not on newer ballasted track. Again, the recommendations provided here are not intended to compel a rail transit system to certain practices, only to recommend that certain scenarios be included in the decision-making process.

If it is determined that speed restrictions are required in some circumstances, then what those speeds will be is another factor in the decision-making process. Again, many look to the policies and practices of heavy haul freight railroads or those of other rail transit systems. But each rail transit system is unique. Many operate using ATC systems, and these systems may provide only for certain speed restrictions to be placed. For example, it does no good to adopt a policy requiring a 25 mph speed restriction if only 15 and 30 mph speed restrictions are possible. Existing operational rules, realistically possible operational rule changes, and ATC system design should weigh heavily upon what speeds are used when placing speed restrictions. This is in no way inferring that no speed restriction should be placed when one is needed, only that the speeds used should be obtainable.

B.8 Rail temperature measurement

Reliable pyrometers (thermometers) should be used to determine the rail temperature. Numerous styles are available, any of which is sufficient for determining the temperature of the rail.

If mechanical or liquid type rail thermometers are used, then at least two thermometers should be used simultaneously; the average of the temperatures shown on the thermometers should be used for determining the rail temperature. The thermometers should be placed on the shaded side rail web and left there for at least 10 minutes.

When using non-contact infrared or laser type pyrometers, multiple readings should be taken in at least three locations along the rail. The pyrometer should be aimed at a shaded portion of the rail and the reading taken close enough to the rail to ensure that only the rail temperature, and not that of ballast, ties and fasteners, is measured. Ensure that OEM recommendations and instructions are followed.

The accuracy of rail pyrometers should be occasionally checked and calibrated. An easy method of checking pyrometers is to measure the temperature of an ice water solution, which should provide 32 °F, and that of

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boiling water (212 °F). While variations in elevation and air pressure will affect these temperatures, this method can provide an easy check between calibrations.

B.9 Thermal rail adjustment methods

Five methods are commonly used for thermally adjusting the rail:

Rail pullers: This method uses powerful hydraulic cylinders that are clamped to the rail, then manually or power operated hydraulic pumps. These types of rail pullers can generate as much as 120 or more tons of pulling power. It should be noted that these rail pullers might not work on rails next to an electric third rail. The size of the pulling unit and third rail clearances should be investigated. Some rail transit systems may require special electrical safety procedures if this tool is used on the running rail on the same side as the third rail.

Rail heaters: This method uses equipment that rides along the rail that heats the rail using an exposed flame or infrared heating unit. Propane has historically been used for rail heaters; however, units are available that use diesel fuel, which can be more desirable in some cases due to easier resupply and a lower fire hazard. If not properly used, this method can damage plastic or rubber components of fastening systems and can set fire to wood ties. These drawbacks can be overcome if the equipment is properly used and if sufficient precautions are taken. It should be noted that because of the possible fire risk, some rail transit systems are not allowed to take propane or large amounts of flammable gases and fuels into subway areas. Heating the rail using electrical heaters has also been explored.

Burn ropes: This method uses diesel fuel–soaked ropes that are stretched out along the rail base and then lit. The resultant heat from the wicking off of the fuel heats the rail. Before these are used, it would be wise to discuss their use with fire protection agencies that have jurisdiction. Many times when these are used, concerned citizens will call emergency personnel when they see the smoke and fire. Prior coordination with local emergency agencies and advance notification immediately prior to use is one method of preventing problems. A modified version of this method is available that uses a smokeless chemical process that does not have an open flame.

Natural air temperature: This method relies upon the effects of the air temperature to heat or cool the rail. This method can be somewhat inconvenient, since work must be scheduled depending on the weather. When the rail temperature is too low to perform work such as repair of a pull-apart or a rail renewal, the rail will have to be readjusted at a later date. Great care should be taken so the locations that require readjustment are promptly readjusted. The risk is that a hot weather spell could occur before the locations are readjusted. Good record-keeping and communication are the keys to preventing impacts to train operations. Speed restrictions and/or track outages may be necessary when early heat spells occur. Special care shall be taken to protect these areas during hot weather. The greatest problem with this method is that major impacts to train operations will eventually occur, in addition to the additional resources required for readjustment.

Water spray: This method is used exclusively for cooling the rail; it relies upon water sprayed on the rail. The rail is typically cooled using both the heat transfer from the rail, which is typically warmer than ambient, and the evaporative energy of the water sprayed on the rail. Using refrigerated water or ice water can speed up this process.

B.10 Practical CWR maintenance applications

The following are some recommended methods for dealing with specific common CWR maintenance tasks. These are provided only as examples to guide rail transit systems. It is acceptable for rail transit systems to use

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other methods to perform CWR maintenance tasks. It is important to provide adequate direction and understanding to maintenance personnel as to what is required to leave the track fit aft.er work is performed.

Rail transit systems should include thermal rail adjustment methods and procedures not only for running rail, but also on restraining rails and the guardrails used to guide derailed cars on bridges or placed to protect wayside structures. These rails also expand and contract and can cause problems or affect train operations. In some cases, the equipment normally used for thermal rail adjustment, such as rail heaters and rail pullers, will not work. Methods should be developed and used by the rail transit systems that require them. Rail transit systems should include these methods and practices in their procedures.

B.10.1 Rail adjustment distance

Rail transit systems should determine how much distance should be thermally adjusted along the rail when it is disturbed. Some rail transit systems use as little as 200 ft. in each direction; others use as much as 500 ft.. Whatever the distance a system uses, it should be clearly defined. This distance policy should include some direction concerning what it determines as fixed objects. Items such as frogs, crossing diamonds, etc., can be used as an end-to-rail adjustment. For example, if the rail is cut 100 ft. from a frog (along the same rail), it may not be necessary to adjust the rail 200 ft. back on that end, just up to the frog. Again, the rail transit system's practice should be clearly defined. To reduce confusion, 200 ft. is used in the following recommended procedures. This distance may not be appropriate for a particular rail transit system. Each transit system should assess the required distance and make its own determination.

B.10.2 New construction of CWR track

a) Prior to performing any thermal rail adjustment, all surface and alignment should be completed.
b) Remove rail clips and/or rail anchors. On cut spike track, the rail should slide through the plates. The rail should be vibrated to bring it to a relaxed condition.
c) Create adjustment stations by creating match marks on the rail, at least every 200 ft., on the rail base and tie or tie plates. Ensure that the match marks on the tie or tie plates cannot be disturbed by possible movement of the tie and/or plate.
d) Measure the rail temperature.
e) Determine the difference between the current rail temperature and the PRLT.
f) Using the temperature difference, determine the amount of rail movement required at each adjustment station. The movement should be accumulative. For example, if ½ in. of movement is required at the first station, then 1 in. will be required at the second, 1½ in. at the next and so on. Do not use the same rail movement calculated for 200 ft. repeatedly; rather use the amount individually calculated for 200 ft., 400 ft., 600 ft., etc. This will eliminate any accumulative errors created by rounding. This is particularly important when long strings of CWR are adjusted.
g) Adjust the temperature of the rail until the desired movement of the rail is obtained at the first adjustment station, and anchor the rail up to that station.
h) Continue until the desired rail movement has occurred at all the adjustment stations.
i) At the end point of previous track construction or at tie-in locations on existing track, the existing track should be readjusted at least 200 ft. back. Ends of track tend to pull back in the same way, as it is easier to pull a chain than to push it. This lowers the neutral rail temperature.

Note

The temperature of the rail should be constantly monitored throughout the adjustment process. If the rail temperature changes, then the amount of rail movement at subsequent stations should be recalculated.

During rail adjustment, the rail should be vibrated to aid rail movement through the rail seats. Do not hit the rail with hammers, as this will damage the rail. If a rail vibrator is not available, then use special brass or rubber-faced hammers for knocking the rail. If special hammers are not available, then tap on the tie plates or tie shoulders with a sledgehammer.

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If the CWR is to be field welded, gaps should be left for the field weld. The OEM of the field weld kit should determine the amount of gap; typically the gap required is 1 in. Some choose to use a short piece of rail to maintain this gap. If the rail is to be field welded at a later date, this protects the rail ends from batter and other damage from construction equipment moving over the track. Others choose to cut the required gap when the actual field weld is made. In no case should the rail be allowed to move back to create the gap needed for a field weld. If this is done, then the NRT will be reduced.

If the track has to be repaired after the rail adjustment is completed, then the CWR should be readjusted. For example if CWR track has to be resurfaced and/or realigned, beyond spot work, then both rails of the CWR track through the disturbed track should be readjusted. Another example would be a weld that is found to be defective or an insulated rail joint that needs to be added. In this case the disturbed rail should be readjusted in the same manner as a pull-apart or a broken rail.

Both rails should be simultaneously adjusted. When one rail at a time is to be adjusted, then the adjustment of one rail should not proceed too far ahead of the other. This will prevent any undue stress on the ties and fasteners and prevent slewing of the ties.

B.10.3 Installing CWR in existing track

a) Prior to cutting the existing rail, place match marks ahead of the beginning and end locations to ensure that normal movement occurs on the existing track. If necessary, readjust the rail anchors on each side of the beginning and ending location to keep the existing rail from being disturbed.
b) If no rail movement occurs aft.er the cut is made, then no further adjustment is required to the existing rail. If rail movement occurs, then the existing rail should be adjusted at least 200 ft. back.
c) Aft.er the new rail is placed and gagged, measure the rail temperature.
d) Determine the difference between the current rail temperature and the PRLT.
e) Using the temperature difference, determine the amount of rail movement required at each adjustment station. The movement should be accumulative. For example, if ½ in. of movement is required at the first station, then 1 in. will be required at the second, 1½ in. at the next and so on. Do not use the same rail movement calculated for 200 ft. repeatedly; rather use the amount individually calculated for 200 ft., 400 ft., 600 ft., etc. This will eliminate any accumulative errors created by the rounding. This is particularly important when long strings of CWR are adjusted.
f) Adjust the temperature of the rail until the desired movement of the rail is obtained at the first adjustment station, and anchor the rail up to that station.
g) Continue until the desired rail movement has occurred at all the adjustment stations.

Note

The temperature of the rail should be constantly monitored throughout the adjustment process. If the rail temperature changes, then the amount of rail movement at subsequent stations should be recalculated.

During rail adjustment, the rail should be vibrated to aid rail movement through the rail seats. Do not hit the rail with hammers, as this will damage the rail. If a rail vibrator is not available, then use special brass or rubber-faced hammers for knocking the rail. If special hammers are not available, then tap on the tie plates or tie shoulders with a sledgehammer.

If the CWR is to be field welded, gaps should be left for the field weld. The OEM of the field weld kit should determine the gap; typically the required gap is 1 in. Some choose to use a short piece of rail to maintain this gap. If the rail is to be field welded at a later date, this protects the rail ends from batter and other damage from construction equipment moving over the track. Others choose to cut the required gap when the actual field weld is made. In no case should the rail be allowed to move back to create the gap needed for a field weld. If this is done, then the NRT will be reduced.

Where both rails are replaced at the same time, both should be simultaneously adjusted. When one rail is to be adjusted at a time, the adjustment of one rail should not proceed too far ahead of the other. This will prevent any undue stress on the ties and fasteners and prevent slewing of the ties.

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B.10.4 Repair of broken rails and pull-aparts in CWR track

a) If the rail temperature is hot, or is expected to rise during the repair process, then the rail ends should be bypassed to ensure that the rail ends will not jam.
b) Remove the rail anchors and/or fasteners for 200 ft. on each side of the gap in the rail, along the disturbed rail. Remove the anchors or fasteners beginning at the gap in the rail, working away from the gap. Otherwise, the last few ties or fasteners near the gap will become overstressed when the remaining anchors or fasteners have been removed.
c) Vibrate the rail to ensure that it is at its natural length.
d) Measure the rail temperature.
e) Determine the difference between the current rail temperature and the PRLT.
f) Using the temperature difference, determine the amount of rail movement required for 400 ft.. If the gap is more than the required rail movement, then additional rail is required, and a rail will need to be cut in.
g) If the rail temperature is less than the PRLT, then cut the rail ends to provide the required gap. If the rail temperature is above the PRLT, then cut the rail ends to provide the required overlap. If the rail temperature is equal to the PRLT, then no gap is required. If the rail is to be field welded, then provide the additional gap required for the field weld. Where the rail temperature is more than the PRLT, then the gap required for the field weld should be subtracted from the overlap.
h) Thermally adjust the rail until the rail ends match.
i) Join the rail, using rail joint(s) or field welding as required.

Note

During rail adjustment, the rail should be vibrated to aid rail movement through the rail seats. Do not hit the rail with hammers, as this will damage the rail. If a rail vibrator is not available, then use special brass or rubber-faced hammers for knocking the rail. If special hammers are not available, then tap on the tie plates or tie shoulders with a sledgehammer.

Rail transit systems should determine the minimum length of rail that can be used for making repairs. This minimum rail length should be reiterated in the rail transit system's rail adjustment procedure, where instructions are given for installing rail.

Some rail transit systems drill only the holes furthest from the rail ends on rail joints that are to be welded at a later date. The policies and procedure for securing rail joints should be reiterated in the rail transit system's rail adjustment procedure, where instructions are given for creating rail joints in CWR track.

B.10.5 Repair of sun kinks or suspected improperly adjusted rail in CWR track

a) Carefully cut the rail(s). If the rail is to be cut with a rail saw, then the stress can be relieved by removing the rail from its rail seats and aligning it away from the rail seats or snaking the rail to allow its length to increase. Great care should be taken when cutting the rail when it is under compression; the rail should be secured so it cannot jump out of place. Personnel should position themselves out of harm's way.
b) Remove the rail anchors and/or fasteners for at least 200 ft. on each side of the gap in the rail, along the disturbed rail. Remove the anchors or fasteners beginning at the cut previously made in the rail, working away from the gap. Otherwise, the last few ties or fasteners near the gap will become overstressed when the remaining anchors or fasteners have been removed.
c) Vibrate the rail to ensure it is at its natural length.
d) Measure the rail temperature.
e) Determine the difference between the current rail temperature and the PRLT.
f) Using the temperature difference, determine the amount of rail movement required for the distance that the rail anchors or fasteners were removed. If the gap is more than the required rail movement, then additional rail is required and a rail will need to be cut in.
g) Thermally adjust the rail until the rail ends match.

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h) Join the rail, using rail joint(s) or field welding as required.
i) The track should be realigned and resurfaced as required. Prior to releasing the track to unrestricted train movement, the ballast section should be restored as required.

Note

Typically, both rails should be adjusted at a location of a sun kink. Unless there is specific information, such as a known maintenance procedure that had previously taken place without proper rail adjustment, then both rails should be adjusted. In any case, the safe course should be taken; if there is any doubt, then both rails should be adjusted.

The distance that the rail needs to be adjusted should be determined on a case-by-case basis. The cause of the sun kink should be determined. In newly constructed track, adjacent rail segments should be considered suspect, and if not adjusted, they should be carefully watched. Where surface and alignment has recently been performed on a curve, then the track may have been aligned inward, reducing the adjustment of the rail. If this is the case, then both rails on the entire curve should be thermally readjusted or the curve realigned. If a defective rail was repaired or a weld made, then that should be looked to as the cause. Where rail has been relayed with CWR, then the adjustment made when the renewal was made should be suspect. Whatever the problem, careful thought should be made as to the cause and appropriate action taken to prevent another sun kink nearby. In no case should the adjustment distance be less than that required by the rail transit system.

If the rail is to be cut with a torch, first cut away approximately 3 in. of the railhead, and then cut away approximately 3 in. of the rail base, then through the web. If this does not relieve the compressive forces in the rail, then repeat the process. Personnel should position themselves out of harm’s way while the cut is being made. Many rail transit systems have policies concerning torch-cut rails. Some rail transit systems forbid torch-cut rail ends; in these cases, the torch-cut rail ends will need to be cut off. How far back the cuts need to be made generally varies from 3 to 6 in. to eliminate shatter cracks caused by the torch cutting and the potential of rail breaks. Some rail transit systems allow torch-cut rail ends to be field welded if the weld is made within an hour of when the cut was made. Whatever the policies of the rail transit system, they should be reiterated in its rail adjustment procedure, where instructions are given for cutting rail in CWR track.

During rail adjustment, the rail should be vibrated to aid rail movement through the rail seats. Do not hit the rail with hammers, as this will damage the rail. If a rail vibrator is not available, then use special brass or rubber-faced hammers for knocking the rail. If special hammers are not available, then tap on the tie plates or tie shoulders with a sledgehammer.

Rail transit systems should determine the minimum length of rail that can be used for making repairs. This minimum rail length should be reiterated in the rail transit system’s rail adjustment procedure, where instructions are given for installing rail.

Some rail transit systems drill only the holes furthest from the rail ends on rail joints that are to be welded at a later date. The policies and procedure for securing rail joints should be reiterated in the rail transit system’s rail adjustment procedure, where instructions are given for creating rail joints in CWR track.

B.10.6 Cutting in a rail or rail joint in CWR track

a) Cut the rail at the desired location, taking the necessary precautions (see Notes below).
b) Remove the rail anchors and/or fasteners for at least 200 ft. on each side of the cut in the rail, along the disturbed rail. Remove the anchors or fasteners beginning at the cut, working away from the cut. Otherwise, the last few ties or fasteners near the gap will become overstressed when the remaining anchors or fasteners have been removed.
c) Vibrate the rail to ensure that it is at its natural length.
d) Measure the rail temperature.
e) Determine the difference between the current rail temperature and the PRLT.
f) Using the temperature difference, determine the amount of rail movement required for the distance that the rail anchors or fasteners were removed. If the gap is more than the required rail movement, then additional rail is required and a rail will need to be cut in.
g) Thermally adjust the rail until the rail ends match.
h) Join the rail, using rail joint(s) or field welding as required.

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Note

If the current rail temperature is higher than the neutral rail temperature, then expect the rail to bind when cut. If the rail is to be cut with a rail saw, then the stress can be relieved by removing the rail from its rail seats and aligning it away from the rail seats or snaking the rail to allow its length to increase. Great care should be taken when cutting the rail when it is under compression; the rail should be secured so it cannot jump out of place. Personnel should position themselves out of harm's way.

If the rail is cut with a torch and it is under compression, first cut away approximately 3 in. of the railhead, and then cut away approximately 3 in. of the rail base, then through the web. If this does not relieve the compressive forces in the rail, then repeat the process. Personnel should position themselves out of harm's way while the cut is being made. Many rail transit systems have policies concerning torch-cut rails. Some rail transit systems forbid torch-cut rail ends. In these cases, the torch-cut rail ends will need to be cut off. How far back the cuts need to be made generally varies from 3 to 6 in. to eliminate shatter cracks caused by the torch cutting and the potential of rail breaks. Some rail transit systems allow torch-cut rail ends to be field welded if the weld is made within an hour of when the cut was made. Whatever the policies of the rail transit system, they should be reiterated in its rail adjustment procedure, where instructions are given for cutting rail in CWR track.

If the rail temperature is significantly lower than the neutral rail temperature, then precautions should be taken to prevent the rail from tearing when the cut is partially made. The rail anchors facing the location where the cut is to be made should be tightly adjusted against the ties. Where direct fixation fasteners or resilient fasteners are used, a sufficient number of fasteners should be loosened to prevent damage to the ties, fasteners or anchor bolts. In the case of ties, expect some of the ties to be skewed when the rail is cut. In extreme cases, the ties may lift. out of the tamp beds and need to be dug back down.

During rail adjustment, the rail should be vibrated to aid rail movement through the rail seats. Do not hit the rail with hammers, as this will damage the rail. If a rail vibrator is not available, then use special brass or rubber-faced hammers for knocking the rail. If special hammers are not available, then tap on the tie plates or tie shoulders with a sledgehammer.

If the CWR is to be field welded, then gaps should be left. for the field weld. The OEM of the field weld kits should determine the gap, typically 1 in. Some choose to use a short piece of rail to maintain this gap. If the rail is to be field welded at a later date, this protects the rail ends from batter and other damage from construction equipment moving over the track. Others choose to cut the required gap when the actual field weld is made. In no case should the rail be allowed to move back to create the gap needed for a field weld. If this is done, then the NRT will be reduced.

Rail transit systems should determine the minimum length of rail that can be used for making repairs. This minimum rail length should be reiterated in the rail transit system's rail adjustment procedure, where instructions are given for installing rail.

Some rail transit systems drill only the holes furthest from the rail ends on rail joints that are to be welded at a later date. The policies and procedure for securing rail joints should be reiterated in the rail transit system's rail adjustment procedure, where instructions are given for creating rail joints in CWR track.

B.11 Communication and record keeping

Good communication among the different people working on, disturbing and maintaining CWR track is a key element in preventing problems. This communication can be an extensive effort, particularly when the number of people, shifts and divisions increases. For example, if a repair crew from another section is called in on a holiday to repair a pull-apart, it is critical for the personnel who normally maintain and inspect the track to know and understand what was done to repair the CWR track. Questions that need to be answered include the following: Where was the repair made? Was the rail readjusted? If so, to what temperature? Which rail?

One of the key elements to maintaining a given stretch of track is knowing exactly where something has been done and what has been done to it. Even in smaller organizations, communicating and record keeping are equally important. In these situations, the entire maintenance and work history can easily be kept in the collective memory of the few maintenance personnel; however, others that follow along later have no access to this information. Construction and contract management groups also affect CWR track. It is not uncommon for

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the contracts that they manage to be written for new construction, not for maintenance activities. Those managing contractors may be unaware or unable to compel contractors to provide the information required by maintenance personnel due to contractual limitations. These challenges must be overcome.

The record kept when maintaining CWR track should, at a minimum, provide the rail temperature, location, which rail and date of CWR installations. This same information should be recorded when CWR track is disturbed by maintenance or construction activities that can disturb the rail temperature. It is especially important to record locations where the rail installation or track work does not conform to the rail transit system's procedures, in particular when rail is added by these tasks. These records should be made available in a timely manner to those responsible for maintaining and inspecting the track. Special effort should be made by rail transit systems to ensure that crews return as soon as possible to properly readjust the rail. If these records are not maintained, the usual effect is later impacts to the operations of trains.

The Rail Transit System or operating entity shall follow the requirements prescribed in Section 3, 'Inspection', regarding the retention of records concerning inspections performed.

An example of a CWR disturbance report is shown in **Figure B2**.

FIGURE B2
Example CWR Disturbance Report

Date CWR was disturbed: ____________________

Division or line: __________ **Track:** __________ **Milepost or engineering station:** __________

Rail: ☐ North ☐ South ☐ East ☐ West

Weather: ____________________

Type of work performed: ☐ Rail replacement ☐ Pull-apart ☐ Broken rail ☐ Sun kink

☐ Other (explain): ____________________

Amount of rail added or removed: __________ **Distance rail was adjusted or moved:** __________

Was rail properly adjusted? ☐ Yes ☐ No

Was rail cut? ☐ Yes ☐ No **Temperature rail was adjusted to**: __________

Reason rail was not properly adjusted: ____________________

____

____

Person completing report: ____________________ **Date report completed:** __________

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B.12 Benefits of CWR

CWR eliminates the need for rail end welding, battered rail joints, cracked angle bars, broken joint bolts, retorquing rail joints, and surfacing and gaging at rail joints. It decreases resistance for traction power ground return and improves signal circuit reliability. Tie life is also increased, along with the life of the rail. In addition to all of this, surfacing and aligning cycles are greatly lengthened. Another benefit is a reduction in noise from passing trains.

B.13 References

There is a large amount of published material available concerning the maintenance of CWR. Much research has been performed, and more is underway. Different predictive models and various versions of computer software are available for predicting the effects of temperature changes on CWR track. An excellent resource is the AREMA "Manual for Railway Engineering" In particular, reference Volume 1, Chapter 5. Another good source is FTA's "Pocket Guide: Compilation of Rail Transit Industry Best Practices for Track Inspection and Maintenance."

B.14 Thermal rail adjustment table

Table B3 details the changes in unrestrained rail length for given rail lengths and temperature changes, using the following formula:

$\Delta R_L = R_L \times \Delta T \times 0.000078$, where

ΔR_L = change in rail length (in inches)
R_L = rail length (in feet)
ΔT = change in rail temperature (in Fahrenheit degrees)

TABLE B3
Change in Rail Length

		R_L Rail Length							
		100 ft.	**200 ft.**	**300 ft.**	**400 ft.**	**500 ft.**	**600 ft.**	**700 ft.**	**800 ft.**
ΔT = Change in Rail Temperature	**5 °F**	1/16 in.	1/16 in.	1/8 in.	1/8 in.	3/16 in.	1/4 in.	1/4 in.	5/16 in.
	10 °F	1/16 in.	1/8 in.	1/4 in.	5/16 in.	3/8 in.	7/16 in.	9/16 in.	5/8 in.
	15 °F	1/8 in.	1/4 in.	3/8 in.	7/16 in.	9/16 in.	11/16 in.	13/16 in.	15/16 in.
	20 °F	1/8 in.	5/16 in.	7/16 in.	5/8 in.	3/4 in.	15/16 in.	1 1/16 in.	1 1/4 in.
	25 °F	3/16 in.	3/8 in.	9/16 in.	3/4 in.	1 in.	1 3/16 in.	1 3/8 in.	1 9/16 in.
	30 °F	1/4 in.	7/16 in.	11/16 in.	15/16 in.	1 3/16 in.	1 3/8 in.	1 5/8 in.	1 7/8 in.
	35 °F	1/4 in.	9/16 in.	13/16 in.	1 1/16 in.	1 3/8 in.	1 5/8 in.	1 15/16 in.	2 3/16 in.
	40 °F	5/16 in.	5/8 in.	15/16 in.	1 1/4 in.	1 9/16 in.	1 7/8 in.	2 3/16 in.	2 1/2 in.
	45 °F	3/8 in.	11/16 in.	1 1/16 in.	1 3/8 in.	1 3/4 in.	2 1/8 in.	2 7/16 in.	2 13/16 in.
	50 °F	3/8 in.	3/4 in.	1 3/16 in.	1 9/16 in.	1 15/16 in.	2 5/16 in.	2 3/4 in.	3 1/8 in.
	55 °F	7/16 in.	7/8 in.	1 5/16 in.	1 11/16 in.	2 1/8 in.	2 9/16 in.	3 in.	3 7/16 in.
	60 °F	7/16 in.	15/16 in.	1 3/8 in.	1 7/8 in.	2 5/16 in.	2 13/16 in.	3 1/4 in.	3 3/4 in.
	65 °F	1/2 in.	1 in.	1 1/2 in.	2 in.	2 9/16 in.	3 1/16 in.	3 9/16 in.	4 1/16 in.
	70 °F	9/16 in.	1 1/16 in.	1 5/8 in.	2 3/16 in.	2 3/4 in.	3 1/4 in.	3 13/16 in.	4 3/8 in.
	75 °F	9/16 in.	1 3/16 in.	1 3/4 in.	2 5/16 in.	2 15/16 in.	3 1/2 in.	4 1/8 in.	4 11/16 in.
	80 °F	5/8 in.	1 1/4 in.	1 7/8 in.	2 1/2 in.	3 1/8 in.	3 3/4 in.	4 3/8 in.	5 in.

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TABLE B3
Change in Rail Length (continued)

		Rail Length							
		900 ft.	**1000 ft.**	**1100 ft.**	**1200 ft.**	**1300 ft.**	**1400 ft.**	**1440 ft.**	**1500 ft.**
ΔT = Change in Rail Temperature	**5 °F**	3/8 in.	3/8 in.	7/16 in.	7/16 in.	1/2 in.	9/16 in.	9/16 in.	9/16 in.
	10 °F	11/16 in.	3/4 in.	7/8 in.	15/16 in.	1 in.	1 1/16 in.	1 1/8 in.	1 3/16 in.
	15 °F	1 1/16 in.	1 3/16 in.	1 5/16 in.	1 3/8 in.	1 1/2 in.	1 5/8 in.	1 11/16 in.	1 3/4 in.
	20 °F	1 3/8 in.	1 9/16 in.	1 11/16 in.	1 7/8 in.	2 in.	2 3/16 in.	2 1/4 in.	2 5/16 in.
	25 °F	1 3/4 in.	1 15/16 in.	2 1/8 in.	2 5/16 in.	2 9/16 in.	2 3/4 in.	2 13/16 in.	2 15/16 in.
	30 °F	2 1/8 in.	2 5/16 in.	2 9/16 in.	2 13/16 in.	3 1/16 in.	3 1/4 in.	3 3/8 in.	3 1/2 in.
	35 °F	2 7/16 in.	2 3/4 in.	3 in.	3 1/4 in.	3 9/16 in.	3 13/16 in.	3 15/16 in.	4 1/8 in.
	40 °F	2 13/16 in.	3 1/8 in.	3 7/16 in.	3 3/4 in.	4 1/16 in.	4 3/8 in.	4 1/2 in.	4 11/16 in.
	45 °F	3 3/16 in.	3 1/2 in.	3 7/8 in.	4 3/16 in.	4 9/16 in.	4 15/16 in.	5 1/16 in.	5 1/4 in.
	50 °F	3 1/2 in.	3 7/8 in.	4 5/16 in.	4 11/16 in.	5 1/16 in.	5 7/16 in.	5 5/8 in.	5 7/8 in.
	55 °F	3 7/8 in.	4 5/16 in.	4 3/4 in.	5 1/8 in.	5 9/16 in.	6 in.	6 3/16 in.	6 7/16 in.
	60 °F	4 3/16 in.	4 11/16 in.	5 1/8 in.	5 5/8 in.	6 1/16 in.	6 9/16 in.	6 3/4 in.	7 in.
	65 °F	4 9/16 in.	5 1/16 in.	5 9/16 in.	6 1/16 in.	6 9/16 in.	7 1/8 in.	7 5/16 in.	7 5/8 in.
	70 °F	4 15/16 in.	5 7/16 in.	6 in.	6 9/16 in.	7 1/8 in.	7 5/8 in.	7 7/8 in.	8 3/16 in.
	75 °F	5 1/4 in.	5 7/8 in.	6 7/16 in.	7 in.	7 5/8 in.	8 3/16 in.	8 7/16 in.	8 3/4 in.
	80 °F	5 5/8 in.	6 1/4 in.	6 7/8 in.	7 1/2 in.	8 1/8 in.	8 3/4 in.	9 in.	9 3/8 in.
	85 °F	5 15/16 in.	6 5/8 in.	7 5/16 in.	7 15/16 in.	8 5/8 in.	9 5/16 in.	9 9/16 in.	9 15/16 in.
	90 °F	6 5/16 in.	7 in.	7 3/4 in.	8 7/16 in.	9 1/8 in.	9 13/16 in.	10 1/8 in.	10 1/2 in.
	95 °F	6 11/16 in.	7 7/16 in.	8 1/8 in.	8 7/8 in.	9 5/8 in.	10 3/8 in.	10 11/16 in.	11 1/8 in.
	100 °F	7 in.	7 13/16 in.	8 9/16 in.	9 3/8 in.	10 1/8 in.	10 15/16 in.	11 1/4 in.	11 11/16 in.
	85 °F	11/16 in.	1 5/16 in.	2 in.	2 5/8 in.	3 5/16 in.	4 in.	4 5/8 in.	5 5/16 in.
	90 °F	11/16 in.	1 3/8 in.	2 1/8 in.	2 13/16 in.	3 1/2 in.	4 3/16 in.	4 15/16 in.	5 5/8 in.
	95 °F	3/4 in.	1 1/2 in.	2 1/4 in.	2 15/16 in.	3 11/16 in.	4 7/16 in.	5 3/16 in.	5 15/16 in.
	100 °F	3/4 in.	1 9/16 in.	2 5/16 in.	3 1/8 in.	3 7/8 in.	4 11/16 in.	5 7/16 in.	6 1/4 in.

B.15 Desired rail laying temperature range table

Table B4 provides desired rail-laying temperature ranges for selected high and low rail temperatures. The PRLT used by a rail transit system should be within the ranges shown in **Table B4**, given the high and low rail temperatures that the system experiences. For more information, see Section B.3.

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TABLE B4

Desired Rail Laying Temperature Ranges

	Highest Rail Temperature (Ht)							
	80 °F	**90 °F**	**100 °F**	**110 °F**	**120 °F**	**130 °F**	**140 °F**	**150 °F**
−40 °F	50.0 °F to 65.0 ±5 °F	56.7 °F to 71.7 ±5 °F	63.3 °F to 78.3 ±5 °F	70.0 °F to 85.0 ±5 °F	76.7 °F to 91.7 ±5 °F	83.3 °F to 98.3 ±5 °F	90.0 °F to 105.0 ±5 °F	96.7 °F to 111.7 ±5 °F
−35 °F	51.7 °F to 66.7 ±5 °F	58.3 °F to 73.3 ±5 °F	65.0 °F to 80.0 ±5 °F	71.7 °F to 86.7 ±5 °F	78.3 °F to 93.3 ±5 °F	85.0 °F to 100.0 ±5 °F	91.7 °F to 106.7 ±5 °F	98.3 °F to 113.3 ±5 °F
−30 °F	53.3 °F to 68.3 ±5 °F	60.0 °F to 75.0 ±5 °F	66.7 °F to 81.7 ±5 °F	73.3 °F to 88.3 ±5 °F	80.0 °F to 95.0 ±5 °F	86.7 °F to 101.7 ±5 °F	93.3 °F to 108.3 ±5 °F	100.0 °F to 115.0 ±5 °F
−25 °F	55.0 °F to 70.0 ±5 °F	61.7 °F to 76.7 ±5 °F	68.3 °F to 83.3 ±5 °F	75.0 °F to 90.0 ±5 °F	81.7 °F to 96.7 ±5 °F	88.3 °F to 103.3 ±5 °F	95.0 °F to 110.0 ±5 °F	101.7 °F to 116.7 ±5 °F
−20 °F	56.7 °F to 71.7 ±5 °F	63.3 °F to 78.3 ±5 °F	70.0 °F to 85.0 ±5 °F	76.7 °F to 91.7 ±5 °F	83.3 °F to 98.3 ±5 °F	90.0 °F to 105.0 ±5 °F	96.7 °F to 111.7 ±5 °F	103.3 °F to 118.3 ±5 °F
−15 °F	58.3 °F to 73.3 ±5 °F	65.0 °F to 80.0 ±5 °F	71.7 °F to 86.7 ±5 °F	78.3 °F to 93.3 ±5 °F	85.0 °F to 100.0 ±5 °F	91.7 °F to 106.7 ±5 °F	98.3 °F to 113.3 ±5 °F	105.0 °F to 120.0 ±5 °F
−10 °F	60.0 °F to 75.0 ±5 °F	66.7 °F to 81.7 ±5 °F	73.3 °F to 88.3 ±5 °F	80.0 °F to 95.0 ±5 °F	86.7 °F to 101.7 ±5 °F	93.3 °F to 108.3 ±5 °F	100.0 °F to 115.0 ±5 °F	106.7 °F to 121.7 ±5 °F
−5 °F	61.7 °F to 76.7 ±5 °F	68.3 °F to 83.3 ±5 °F	75.0 °F to 90.0 ±5 °F	81.7 °F to 96.7 ±5 °F	88.3 °F to 103.3 ±5 °F	95.0 °F to 110.0 ±5 °F	101.7 °F to 116.7 ±5 °F	108.3 °F to 123.3 ±5 °F
0 °F	63.3 °F to 78.3 ±5 °F	70.0 °F to 85.0 ±5 °F	76.7 °F to 91.7 ±5 °F	83.3 °F to 98.3 ±5 °F	90.0 °F to 105.0 ±5 °F	96.7 °F to 111.7 ±5 °F	103.3 °F to 118.3 ±5 °F	110.0 °F to 125.0 ±5 °F
5 °F	65.0 °F to 80.0 ±5 °F	71.7 °F to 86.7 ±5 °F	78.3 °F to 93.3 ±5 °F	85.0 °F to 100.0 ±5 °F	91.7 °F to 106.7 ±5 °F	98.3 °F to 113.3 ±5 °F	105.0 °F to 120.0 ±5 °F	111.7 °F to 126.7 ±5 °F
10 °F	66.7 °F to 81.7 ±5 °F	73.3 °F to 88.3 ±5 °F	80.0 °F to 95.0 ±5 °F	86.7 °F to 101.7 ±5 °F	93.3 °F to 108.3 ±5 °F	100.0 °F to 115.0 ±5 °F	106.7 °F to 121.7 ±5 °F	113.3 °F to 128.3 ±5 °F
15 °F	68.3 °F to 83.3 ±5 °F	75.0° F to 90.0 ±5 °F	81.7 °F to 96.7 ±5 °F	88.3 °F to 103.3 ±5 °F	95.0 °F to 110.0 ±5 °F	101.7 °F to 116.7 ±5 °F	108.3 °F to 123.3 ±5 °F	115.0 °F to 130.0 ±5 °F
20 °F	70.0 °F to 85.0 ±5 °F	76.7 °F to 91.7 ±5 °F	83.3 °F to 98.3 ±5 °F	90.0 °F to 105.0 ±5° F	96.7 °F to 111.7 ±5 °F	103.3 °F to 118.3 ±5 °F	110.0 °F to 125.0 ±5 °F	116.7 °F to 131.7 ±5 °F
25 °F	71.7 °F to 86.7 ±5 °F	78.3 °F to 93.3 ±5 °F	85.0 °F to 100.0 ±5 °F	91.7 °F to 106.7 ±5 °F	98.3 °F to 113.3 ±5 °F	105.0 °F to 120.0 ±5 °F	111.7 °F to 126.7 ±5 °F	118.3 °F to 133.3 ±5 °F
30 °F	73.3 °F to 88.3 ±5 °F	80.0 °F to 95.0 ±5 °F	86.7 °F to 101.7 ±5 °F	93.3 °F to 108.3 ±5 °F	100.0 °F to 115.0 ±5 °F	106.7 °F to 121.7 ±5 °F	113.3 °F to 128.3 ±5 °F	120.0 °F to 135.0 ±5 °F
35 °F	75.0 °F to 90.0 ±5 °F	81.7 °F to 96.7 ±5 °F	88.3 °F to 103.3 ±5 °F	95.0 °F to 110.0 ±5 °F	101.7 °F to 116.7 ±5 °F	108.3 °F to 123.3 ±5 °F	115.0 °F to 130.0 ±5 °F	121.7 °F to 136.7 ±5 °F
40 °F	76.7 °F to 91.7 ±5 °F	83.3 °F to 98.3 ±5 °F	90.0 °F to 105.0 ±5 °F	96.7 °F to 111.7 ±5 °F	103.3 °F to 118.3 ±5 °F	110.0 °F to 125.0 ±5 °F	116.7 °F to 131.7 ±5 °F	123.3 °F to 138.3 ±5 °F

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Appendix C (informational): Rail wear recommended practices

Rail wear shall be monitored for prioritization in terms of when to replace it (including a cautionary stage for close monitoring). Worn rail, per se (in the absence of defects related to shelling, contact stresses, wheel flanges hitting joint bars or other objects, etc.) is not inherently a safety issue. **Table C1**, applicable to 115RE rail, is provided as a guide for maintenance practices. FTA's *Pocket Guide: Compilation of Rail Transit Best Practices for Track Inspection and Maintenance*, Section 2.2. Rail Wear, offers recommended limits for maximum rail wear for other rail sizes.

TABLE C1
Rail Wear Limits

Rail Wear	Monitor	Change Rail
Running rail vertical wear	>⅜ in.	>½ in.
Running rail side wear	>5⁄16 in.	>½ in.
Guardrail side wear	>¼ in.	>7⁄16 in.

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Appendix D (informational): Special track work recommended practices

a) Special attention is necessary when renewing stock rails to provide a full rail "seat" and to avoid any canting of rails before they are placed in service.
b) When renewal of worn switch points or stock rails is necessary, as a rule both the point and stock rail should be changed out simultaneously. Under no circumstances shall a new switch point be placed against a worn stock rail. When renewal of the unguarded point is required, the housetop, the guardrail preceding the housetop and the straight stock rail shall also be replaced. Special attention to stock rail slide plates is necessary to prevent any lateral or vertical movement. Worn slide plates shall be renewed when changing out stock rails.
c) When renewing frogs, care shall be exercised to provide frog point protection by checking guardrail gage and adjusting it as necessary.

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Appendix E (informational): Typical track and switch inspection forms

Following are examples of typical track and switch inspection forms used by rail transit systems. These are included here for the benefit of transit systems that may be considering the use of similar forms for their inspections of track and switches.

Track Inspector Reporting Form

Name (please print)____________________

Date		
M	D	Y

Page _____of_____

Employee Pass No.	Section	Inspection Type			Title Code	Total Inspection Lines	Total Complaint(s)	Total Defect Lines
		14 Day	Sp	Trk				

Inspection				Complaints												
Sequence Number		Time		Complaint #	Sequence Number		Stationing Markers				Switch Number	Com-ponent	Defect	Status	Rail E/W/B	Complaint Reference Number
							From		To							
From	To	HH	MM		From	To	Primary Marker	2nd ary	Primary Marker	2nd ary						

Compl. #	General Comments and Repairs (Include Line, Track, Location and Column Numbers)	Material Usage	
		Description / Commodity #	Qty

____________________ Employee Signature

____________________ Supervisory Certification

CODES FOR TRACK INSPECTOR REPORTING FORM

DEFECT CODES

DEFECTS

D01	BATTERED
D02	BLOCKAGE
D03	BROKEN / SHEARED
D04	BURNT (LUMBER)
D05	CHIPPED / PITTED ***(Discontinued)***
D06	CORRODED
D07	CORRUGATED
D08	CRACKED / SPLIT
D09	CROSS LEVEL IMPROPER
D10	DETERIORATING
D11	DISHED (WHEEL BURN)
D12	FLANGEWAY IMPROPER
D13	FOULED (BALLAST CEMENTED)
D14	FROZEN / SEIZED / JAMMED
D15	GROOVED
D16	HARDWARE MISSING
D17	HIGH SPIKES
D18	ICE CONDITION
D19	LATERAL MOVEMENT
D20	LOOSE / SLACK
D21	MISSING
D22	MISMATCH
D23	MUD CONDITION
D24	OUT OF GAUGE
D25	OUT OF LINE
D26	OUT OF RISER
D27	OUT OF SURFACE
D28	POOR SUPPORT
D29	PLATE CUT (TIES, TIE BLOCKS)
D30	PUMPING
D31	ROTTED
D32	RUNNING
D33	SETTLED
D34	SHELLED
D35	SHOULDER WORN (PLATES)
D36	SKEWED
D37	SNOW CONDITION
D38	SPIKED KILLED (POOR HOLDING)
D39	TIGHT
D40	WATER CONDITION
D41	BAD WELD
D42	SIDE WORN (RAIL)
D43	TOP WORN (RAIL)
D44	WORN (as per Standards)
D45	WRONG PART
D46	FIRE
D47	NO HOLES
D48	DEBRIS
D49	COMBINED CONDITIONS (Reactivated)
D50	TRACK / RAIL SHORED
D51	VEGETATION
D52	PULL APART / GAP
D53	INSULATING PAINT REQUIRED
D54	IMPROPER PATTERN (SPACING)
D55	IMPROPER TYPE / SIZE
D56	IMPROPER STAGGER
D57	CHIPPED
D58	PITTED
D59	GOUGED
D60	SCORCHED
D61	BASE CORRODED (ONLY)
D62	PROPERLY STORED/PLACED
D63	IMPROPERLY STORED/PLACED
D64	HEAD CHECKED

NOTE: SHADED AREA INDICATES NEW CODES

COMPONENT CODES

FASTENERS

F01	BRIDGE ANCHOR
F02	MACHINE BOLT BRIDGE ANCHOR
F03	RAIL ANCHOR
F04	TIE SPACER BAR
F05	'C' BOLT
F06	GAUGE ROD (TURNBUCKLE)
F07	'C' CLAMP
F08	BOLTS
F09	CUT SPIKES
F10	SCREW LAGS
F11	'E' CLIPS
F12	MODIFIED 'E' CLIPS
F13	HEAVY DUTY 'E' CLIPS
F14	'J' CLIP (115 lb.)
F15	FENCE POST BOLT
F16	HAND RAIL 'U' BOLT
F17	LOCK SPIKES
F18	REINFORCEMENT BOLT

INVERT

I01	BALLAST
I02	CONCRETE

JOINTS (RUNNING RAIL)

J01	INSULATED RAIL JOINT
J02	BONDED INSULATED JOINT
J03	END POST, INSULATED JOINT
J04	'G' RAIL JOINT BAR
J05	'F' RAIL JOINT BAR
J06	OTHER MECHANICAL JOINTS
J07	CONTINUITY BOND (SIGNAL)
J08	CONTINUITY BOND (NEGATIVE)
J09	BOUTET WELD
J10	FACTORY WELD

LUMBER

L01	TIES
L02	TIE BLOCKS
L03	SLATTING
L04	GUARD TIMBER
L05	WEDGES
L06	EVEVATION BLOCKS
L07	CLAMPS, ELEVATION BLOCKS
L08	MISCELLANEOUS LUMBER
L09	PROTECTION BOARD (WOOD)
L10	TAPERED TIES

MISCELLANEOUS

M01	DRAINS
M02	PAPER CATCHER
M03	HANDRAIL
M04	GIRDER
M05	WIRE BASKET
M06	SEPARATOR BLOCK
M07	FENCE POST
M08	LADDER / STAIRWAY
M09	EMERGENCY EXIT
M10	MAN HOLE
M11	FIBER WALKWAY
M12	NO CLEARANCE SIGNS
M13	RAIL LUBRICATOR
M14	GUARD RAIL NOSING
M15	DRIP PANS
M16	3RD RAIL INSULATOR
M17	PROTECTION BOARD (FIBERGLASS)
M18	RUBBING BOARD

PLATES

P01	14" 'A' PLATE
P02	'B' PLATE
P03	14" 'C' PLATE
P04	'D' PLATE
P05	ABRASION PLATE
P06	CONTAINER PLATE
P07	RUBBER RAIL SEAT
P08	FILLER PLATE (SHIM)
P09	8" PLATE
P10	TWIN HOOK PLATE
P11	PANDROL PLATE
P12	' B ' BRACE (for EPR)
P13	SENECA / 'Y' PLATE
P14	RESILIENT 'A' PLATE
P15	RESILIENT 'B' PLATE
P16	RESILIENT 'D' PLATE

RAIL

R01	RUNNING RAIL
R02	GUARD RAIL
R03	CONTACT RAIL
R04	EMERGENCY PROTECTION RAIL
R05	CONTINUOUS WELDED RAIL (CWR)
R06	WING RAIL
R07	SCRAP RAIL
R08	SPARE RAIL
R09	DEFECTIVE RAIL

SWITCH (SPECIAL WORK)

S01	SWITCH PLATE
S02	SWITCH CHAIR
S03	HOUSETOP
S04	STOCK RAIL
S05	SWITCH POINT
S06	FROG
S07	SWITCH ROD
S08	SWITCH STAND (HAND THROW)
S09	SWITCH BRACES
S10	MALLEABLE RAIL STOP
S11	LIFT RAIL
S12	EXPANSION RAILS
S13	CLOSURE RAILS
S14	'P' BOLT
S15	THRU BOLTS / LAGS
S16	SHOULDER BOLT
S17	KINK BAR
S18	HEEL BLOCK
S19	DERAILER
S20	HEEL BOLTS
S21	GUARDED SWITCH POINT
S22	UNGUARDED SWITCH POINT
S23	FOOT GUARD
S24	FROG RISER
S25	FROG POINT

TRACK

T01	TRACK
T02	PORTAL AREA
T03	ABUTMENT

COMPLAINT STATUS CODES

P1 = REPORTED **PRIORITY 1** DEFECT

P2 = REPORTED **PRIORITY 2** DEFECT

P3 = REPORTED **PRIORITY 3** DEFECT

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JOINT SWITCH and FROG INSPECTION FORM

DATE: ____/____/____

GENERAL INFORMATION	SUPERINTENDENT ☐ MONTHLY ☐ QUATERLY ☐ SPECIAL INSP. ____________ ☐		
Division:	Line:	Track:	Switch #:
Location:	Classification: Mainline ☐ Yard ☐	Type of Switch: Standard ☐ Special ☐	
Configuration: Turnout ☐ Single X-over ☐	Double X-over ☐ Equilateral ("Y") ☐	Turnout Size (Frog #):	Point Length:
Switch Hand: LH ☐ RH ☐ "Y" ☐	Train Traffic: Facing ☐ Trailing ☐ Both ☐	Rail: 100 # ☐ 115 # ☐	Track Type:
Point Type: A.R.E.M.A. ☐ KNUCKLE: ½" ☐ 3/8" ☐ KNIFE ☐ LAP ☐		Environment: Dry ☐ Wet ☐ Other:	
TRACK SUB-DIVISION: SECTION: ZONE:		SIGNAL MAINTAINER's SECTION:	

SWITCH COMPONENTS		GOOD / POOR	DEFECT	REMARKS
Front Rod				
Lock Rods / Lock Dogs				
7/8" Pin				
Cap Screws / Lags				
SWITCH CONDITION & TEST		**OK / ADJ.**	**MEASUREMENT**	**REMARKS**
Straight Stock	Switch Point Facing Up			
	Switch Throw			
	Switch Locking/Adj. Test			
Curved Stock	Switch Point Facing Up			
	Switch Throw			
	Switch Locking/Adj. Test			
Test Operation of Switch (performed at completion of the Joint Switch Inspection): YES ☐				
PRINT NAME:		TITLE:	PASS #:	SIGN:

CONDITION of SWITCH

		CODE P3	CODE P2	CODE P1	NO DEFECT	MEASUREMENT AND/OR DESCRIPTION & REMARKS (ALSO INDICATE ANY ADJUSTMENTS MADE)
Left Switch Point	Switch Point Gap (at Point Tip)		☐	☐	☐	________ In.
	Switch Point End Condition (first 5")		☐	☐	☐	
Right Switch Point	Switch Point Gap (at Point Tip)		☐	☐	☐	________ In.
	Switch Point End Condition (first 5")		☐	☐	☐	
Left Stock Rail	Switch Braces		☐	☐	☐	
Right Stock Rail	Switch Braces		☐	☐	☐	
Left Housetop	"P" Bolt		☐	☐	☐	
	Housetop Bolts		☐	☐	☐	
	Housetop Chairs		☐	☐	☐	
	Chair Fasteners	☐	☐	☐	☐	
	Housetop Wear		☐	☐	☐	________ In.
Right Housetop	"P" Bolt		☐	☐	☐	
	Housetop Bolts		☐	☐	☐	
	Housetop Chairs		☐	☐	☐	
	Chair Fasteners	☐	☐	☐	☐	
	Housetop Wear		☐	☐	☐	________ In.
Switch Rods		☐	☐	☐	☐	
Switch Ties		☐	☐	☐	☐	
Closure Ties		☐	☐	☐	☐	
Frog Bolts		☐	☐	☐	☐	
Frog Point			☐	☐	☐	

TRACK GEOMETRY MEASUREMENTS		CODE P3	CODE P2	CODE P1
Left Stock	Top Wear: ________	☐	☐	☐
	Side Wear: ________	☐	☐	☐
Left Point	Top Wear: ________	☐	☐	☐
	Side Wear: ________	☐	☐	☐
Right Stock	Top Wear: ________	☐	☐	☐
	Side Wear: ________	☐	☐	☐
Right Point	Top Wear: ________	☐	☐	☐
	Side Wear: ________	☐	☐	☐
"S" Plate	Track Gauge: ______	☐	☐	☐
	Crosslevel: ______	☐	☐	☐
	E. Flangeway: ______		☐	☐
	W. Flangeway: ______		☐	☐
# 1 Track Rod, Turnout Side	Track Gauge: ______	☐	☐	☐
# 1 Track Rod, Straight Side	Track Gauge: ______	☐	☐	☐
# 4 (*) Track Rod, Turnout Side	Track Gauge: ______	☐	☐	☐
	Crosslevel: ______	☐	☐	☐
	Flangeway: ______		☐	☐

TRACK GEOMETRY MEASUREMENTS		CODE P3	CODE P2	CODE P1	REMARKS
# 4 (*) Track Rod, Straight Side	Track Gauge: ________	☐	☐	☐	
	Crosslevel: ________	☐	☐	☐	
	Flangeway: ________		☐	☐	
Heel of Switch Point, Turnout Side	Track Gauge: ________	☐	☐	☐	
	Crosslevel: ________	☐	☐	☐	
	Flangeway: ________		☐	☐	
	Guard Rail Gauge: ________		☐	☐	
Heel of Switch Point, Straight Side	Track Gauge: ________	☐	☐	☐	
	Crosslevel: ________	☐	☐	☐	
	Flangeway: ________		☐	☐	
	Guard Rail Gauge: ________		☐	☐	
Point of Frog, Turnout Side	Track Gauge: ________	☐	☐	☐	
	Crosslevel: ________	☐	☐	☐	
	Guard Rail Gauge: ________		☐	☐	
	Back-to-Back Gauge: ________		☐	☐	
Point of Frog, Straight Side	Track Gauge: ________	☐	☐	☐	
	Crosslevel: ________	☐	☐	☐	
	Guard Rail Gauge: ________		☐	☐	
	Back-to-Back Gauge: ________		☐	☐	

TRACK SUPERVIS.	PRINT NAME:		TRACK SUPT.	PRINT NAME:	
	PASS #:	Sign:		PASS #:	Sign:

(*): Use the #3 Track Rod for switches with 13 ft. points.

CODE: P3 = "Priority 3"; P2 = "Priority 2"; P1 = "Priority 1"

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<u>**GENERAL:**</u>

- **Line:** name of the Line where the switch is located.
- **Track:** actual letter and track number where the switch is located (e.g. E-1, A-2, MM-3, etc.)
- **Type of Switch**: Standard: as per Rail Transit System's standards; Special :anything else.
- **Switch Hand:** standing in front of the switch points looking at the switch: LH if the turnout is to the left, RH if the turnout is to the right, "Y" for equilateral switches (see sketch below).
- **Train Traffic:** Facing: normally the train approaches the switch point from its head panel; Trailing: normally the train approaches the switch from the frog end; Both: for traffic in both directions (middle tracks, Yard leads).
- **Point Type:** A.R.E.M.A.: tapered tip, with undercut stock rail; KNUCKLE: ½" offset on stock rail to accommodate the ½" point; KNIFE: knife-type switch points resting against a standard rail without undercut; LAP: two offset knife-type points, with standard rails used for stock rails.

<u>**SWITCH COMPONENTS and SWITCH CONDITION & TEST**</u>**:** For **Switch Components**, denote the condition of the component as either "Good" or "Poor". If the condition is "Poor" write the defect in the "Defect" column. Perform corrective action and enter it in the "Remarks" column. For **Switch Condition & Test, if the condition needs to be corrected or adjusted** write "ADJ" in the appropriate column (otherwise write "OK"). In the "Remarks" column record the action performed to correct the condition.

- **Switch Front Rod**: Signal personnel must inspect the condition of the front rod, switch feet, foot bolts and all connection points for mechanical security and wear.
- **Signal Lock Rods / Locking Dog:** Locking edges of the opening in lock rods and bars must be square before the obstruction test is performed. Plungers and locking dogs must be full size and corners square at the locking end. Rod and bar must be clear of the locking dog or plunger (when unlocked) and must move freely when operated without binding in its guides. Bolts, nuts and jam nuts must be in place and in good condition.
- **7/8" Pin**: check for excessive lost motion and wear of the 7/8" connecting holes and pin. Ensure that the 7/8" pin is effectively secured with its cotter pin.
- **Switch Machine Cap Screws / Lags**: Signal personnel must inspect the condition of the Cap Screws / Lags for mechanical security and wear.
- **Switch Point Facing Up (both sides)**: indicate if the switch point is firmly placed against its stock rail when the point is closed, by entering "OK" in the appropriate column. If the point is open, write the size of the opening in the measurement column and take immediate corrective action to close the switch point.
- **Switch Throw (both sides)**: record the actual throw measurement found, i.e. 3 ¾". This measurement shall be taken at the number 1 track rod. If the measurement is between 3 ½ and 4 inches write "OK" in the appropriate column. If the measurement is less than 3 ½ inches or greater than 4 inches perform immediate corrective action to correct the throw opening.
- **Switch Locking and Adjustment Test**: Interlocked switches must be tested with the standard 1/4-inch gauge placed between the switch point and the stock rail, 6 inches back from the tip of the point. Switch point detection must also be checked. Non-interlocked switches equipped with electric locks shall be tested and reported in the same manner as interlocked switches. If the switch DOES NOT LOCK when the standard obstruction gauge is inserted, write "OK". If the switch LOCKS with the standard obstruction gauge inserted, corrective action must be taken immediately. **Under no circumstances shall a switch that does not pass the locking test be left unattended. The switch must be properly secured for train movements until the condition is corrected. Signal Supervision, Track Supervision and Operations must be notified immediately of any switch that must be secured.**
- **Switch Test Operation**: the switch machine **must** be tested, operated under power a minimum of two times upon completion of the Joint Switch Inspection. The "YES" box must be checked, indicating that the test operation has been completed.

DURING INSPECTION IF CONDITION WARRANT REMOVAL OF SWITCH FROM SERVICE RTO SUPERVISION AND MOW CONTROL MUST BE NOTIFIED. IF SWITCH IS OUT OF SERVICE NOTE THE REASON IN REMARKS AND DISCONTINUE THE INSPECTION.

RH:  **LH:**  **EQUILATERAL ("Y"):** 

Report of Rail Failure in Mainline Track

Report date:	Sub-division report #:	Report #:
Found by:	Date found:	Time found: am ❑ pm ❑
Date new rail installed:	Date of temporary repair:	Date of Last UT Run:

1. Location and General Information

Division:	Line name:	Letter & track #:	
Location: N/O ❑ S/O ❑	Track Sub.-Div.:	Sta.#:	Switch#:
Signal indication? Yes ❑ No ❑ N/A ❑		Rail affected: Negative ❑ Signal ❑	
Slow speed needed? Yes ❑ No ❑	Rail Length:	Rail Date:	Rail Temp.: °F

2. Track Design

Track type: Ballasted ❑ Open Deck ❑ DF/Slab ❑ Jointed ❑ CWR ❑	Rail section: 115-lb ❑ Other ❑
Geometry: Tangent ❑ Ungrd. Curve ❑ Guarded Curve ❑ Special Work ❑	Rail type: OH ❑ CC ❑ HT ❑ HH ❑
Tie plates: Single shoulder ❑ 14" cut spikes ❑ Pandrol (rolled steel) ❑ Resilient ❑ Other ❑	
Fasteners: Screw lags ❑ Rubber rail seats ❑ Cut spikes ❑ Pandrol ❑ Other ❑	Curve Radius (ft.):

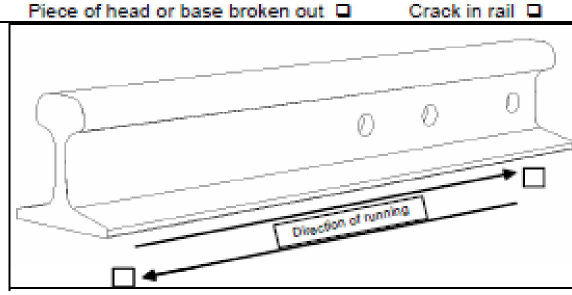
3. Likely Causes of Break

Nicks & Chips	❑ Any evidence that crack started at a nick or chip or gouge on the rail?	Cadweld Bond	❑ Did the crack run through or from a Cadweld bond?
Wear on Rail Bottom	❑ Was the rail worn on the base from rubbing on the steel plate?	Water	❑ Standing water ❑ Dripping on rail ❑ Wet (moisture)
Corrosion	❑ Was the base of the rail corroded?	Pumping	❑ Was the track pumping? ❑ Were tie blocks loose in the concrete?
Wheel Burns	❑ Did the break start from a wheel burn or, ❑ a repaired wheel burn?	Corrugation	❑ Did the rail show a wave along the top – maybe with alternating dark/light patches?
Head Checks	❑ Did the break start from cracks or spalls on the rail head?	Joint Condition	❑ Open ❑ Rail Mismatch ❑ Loose Bolts ❑ Pumping
Track Geometry	❑ Anything unusual about track geometry? Specify:	Rail Weld	❑ Field (Thermite) ❑ Factory (Plant)
Compression (Neg.) Bonds	❑ Specify:	Other	❑ Specify:

4. Description of Rail Break

Type of break: Rail broken in two or more pieces ❑ Piece of head or base broken out ❑ Crack in rail ❑

Comments: Add anything you think may be significant.



- Crack location: Mark the position of the crack and the direction of traffic.
- Crack start position: Mark where the crack likely started – this is often where rust is heaviest on the fracture surface.
- Plates: Is the break: Over a plate ❑ Between plates ❑ At edge of plate ❑
- Distance from closest joint or weld:

Report submitted by: ____________________ **Title:** ______ **Signed:** ________________

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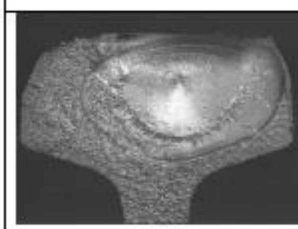
Type of defect: Tick the box that best describes the defect.

	**Bolt hole cracks BH ❑** These start at bolt holes and mostly grow in the web to form a "star" pattern. If left to grow they cause the rail to break up and the head to break away.		**Broken rail BR ❑** **(Head-web-base break)** This is used if there is no clear cause of the break. In this picture the rail has failed from wear on the base caused as the rail rubs against the plate. It's a good idea to look closely at the fracture to see if there are any "thumbnail" fatigue cracks.
	**Base of web BW ❑** This crack runs along the bottom of the web. It is more likely to be seen at a rail end. If it is not at a joint it might be due to manufacturing defects in older rail.		**Head of web HW ❑** This crack runs along the top of the web and is dangerous because the head can detach. It is another defect that is more likely to occur at a rail end.
	**Split web SW ❑** This defect runs along the center of the web. It is often seen at a weld, as shown in the picture.		**Vertical split head VSH ❑** This defect is more common in older rail and when there is a lot of vertical wear.
	**Defective field weld DWF ❑** This is easily recognized from the weld metal on the web and base. The fracture usually is very shiny. Often it is possible to see blow holes on the fracture – these show moisture was present when the weld was made. **Defective plant weld DWP ❑**		**Engine burn, welded TDW ❑** The dark area towards the top of the head of the rail shows that the break started on the rail top from a weld repair. A break from an engine burn will look just the same. You can tell the two apart by looking to see if there is weld metal on the rail top. **Engine burn, fracture EBF ❑**
	**Transverse fissure TD ❑** This is a break that starts in the center of the head. It is usually found in old rail. **Detail fracture TDD, also known as SF ❑** This is a break that starts from a shell at the gage corner of the outer rail in curves. They are not often seen on passenger track.		**Welded bond WB ❑** These cracks start at Cadweld bonds. They have become more common in the last few years. They can be clearly identified by the nearby copper deposits left by bond application.
	**Broken base BB ❑** This refers to any break in the base of the rail. In this photograph the crack runs from A to B on top of the rail foot.		**Horizontal split head HSH ❑** These also usually occur at a rail end, especially if the rail joint is dipped or if there is a step between the two rails. The horizontal crack can turn up or down in the rail.

Note: When the broken rail is replaced, the damaged section plus 6 inches on either side <u>**must**</u> be cut out and brought to the Track Division's offices **AND** detailed pictures <u>**must**</u> be taken of the broken rail at the field with a label indicating location, track No. and date of break.

Please fill this report in as well as you can. **IT'S IMPORTANT.**

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