Designation: F2960 – 16

Standard Practice for Permanent Amusement Railway Ride Tracks and Related Devices[1]

This standard is issued under the fixed designation F2960; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard applies to design, manufacture, installation, operation, maintenance, and inspection of permanent amusement railway ride(s) that have a track gauge greater than or equal to 12 in. (305 mm) measured between the heads of the rails and their related devices and facilities, for example, bridges, tunnels, and signal support structures, excluding rolling stock. This "track" specific standard provides requirements which are not covered in the "core" or "supporting" standards of the ASTM F24 committee.

1.2 This standard does not apply to track of rides, such as roller coasters, that may resemble railways, but may fall within the scope of Practice F2291-11 or Practice F1159-02 and does not apply to funiculars as defined in ANSI B77.2 or BS EN 1907.

1.3 This standard does not apply to Amusement Railway Rides and their associated track, devices and facilities that are manufactured and intended for use as a portable amusement ride or attraction.

1.4 This standard does not apply to permanently installed amusement railway rides and tourist railways, and their associated track, devices and facilities that are under the jurisdiction of the United States Federal Railroad Administration (FRA) in whole or part, or national equivalent.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F747 Terminology Relating to Amusement Rides and Devices

F770 Practice for Ownership, Operation, Maintenance, and Inspection of Amusement Rides and Devices

F1159 Practice for Design of Amusement Rides and Devices that are Outside the Purview of Other F24 Design Standards

F1193 Practice for Quality, Manufacture, and Construction of Amusement Rides and Devices

F2137 Practice for Measuring the Dynamic Characteristics of Amusement Rides and Devices

F2291 Practice for Design of Amusement Rides and Devices

2.2 *Industry Standards:*

AREMA Manual for Railway Engineering (2013)

AWPA U1 (American Wood Preserver's Association Standard) The Use Category System (2013)

BS EN 1907 Safety Requirements for Cableway Installations Designed to Carry Persons—Terminology (Funiculars) (2005)

Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) (2009)

3. Terminology

3.1 *Definitions:*

3.1.1 *amusement railway ride, n*—an amusement ride that may have multiple vehicles (for example, locomotive(s), coach(es), etc.) linked together, at least one of which has on board mechanical propulsion that has an on board operator(s), utilizing flanged wheels on railroad type rails with a gauge of 12 in. or greater, that is insular to national regulations, which is designated by the Designer/Engineer as an amusement railway ride.

3.1.2 *Type AP-A track, n*—active main lines; any track where the operating speed exceeds walking speed.

[1] This practice is under the jurisdiction of ASTM Committee F24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.60 on Special Rides/Attractions.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.3 *Type AP-B track, n*—active passing tracks, loading tracks, classification yard tracks, and storage tracks; all other tracks (both active and inactive) that are not previously identified as Type AP-A track; tracks having an occasional use or a foreseeable need.

3.1.4 *Type AP-C track, n*—inactive track with no current operation requirements.

3.1.5 *walking speed, n*—less than 5 ft (1.5 m) per second.

4. Significance and Use

4.1 The user of this standard shall be required to review and comply with the referenced "core" ASTM F24 Committee standards in 2.1 of this standard. Modified or alternate requirements to those standards may be required in this standard.

4.1.1 Amusement railway sub-systems may be built to various scales, that is, rolling stock maybe to one scale and the track to another but have common gauge. The railroad's documentation or maintenance manuals shall identify the railroad standards of the respective subsystems/interfaces.

4.1.2 The Designer/Engineer's requirements shall consider the track equipment manufacturer's and rolling stock manufacturer's requirements and shall determine their appropriate interfaces.

5. Design

5.1 Design of roadway (track, ties, roadbed, and roadbed shoulder) shall be performed or overseen by the Designer/Engineer knowledgeable in Railway Engineering.

5.1.1 The Designer/Engineer shall specify the preparation of the road bed and ballast to support the rail system based upon expected loads.

5.1.2 *Drains:*

5.1.2.1 *Size and Design*—Ditches and other drainage structures (culverts, drains, and drop inlets) shall be of sufficient size and construction to handle the flow of water from rain, snow, and irrigation.

5.1.3 *Ballast:*

5.1.3.1 The Designer/Engineer shall specify if ballast shall be used.

5.1.3.2 If required, the Designer/Engineer shall specify the tamping of the ballast.

5.2 *Cross Ties:*

5.2.1 A cross tie is a structure placed transversely under both rails and secured to both rails.

5.2.2 Cross ties shall maintain track gauge.

5.2.3 Cross ties shall contribute to rail alignment.

5.2.4 Cross ties shall be made of a size and material to which rail can be securely fastened and support and distribute the load from the rails to the ballast or grade.

5.2.5 *Tie Selection:*

5.2.5.1 Ties shall possess the following attributes:

(1) Made of a size and material to which rail can be securely fastened.

(2) Provide sufficient compressive size and strength to withstand and distribute rail and train loading to the ballast or grade.

5.2.5.2 *Wood Ties*—Wood ties shall meet the requirements specified in industrially recognized standard, for example, AREMA Manual for Railway Engineering, or as specified by an Designer/Engineer.

5.2.5.3 Similar ties to wood (including plastic or composite ties) may be used provided they perform the functions above, for example, rails attached to concrete tie, steel or concrete in road crossings or in streets and are designed for the loads.

5.2.5.4 The rails shall be attached to ties or the similar systems with fasteners such that the rails are adequately supported. Drilling of the rail flange is not allowed.

5.2.5.5 *Used Ties*—Ties may be reused provided they are not considered defective as described in 9.8.5.1 but may contain holes from prior use. Ties maybe flipped over to provide new spiking surfaces.

5.2.6 *Tie Spacing*—Nominal tie spacing shall be established by the Designer/Engineer and be based upon the expected load. Also, see X5.2.6 on thematic ties.

5.3 *Tie Plates*—Tie plates are not a requirement of this standard.

5.3.1 If canted tie plates are used, each shall incline the top of the rail towards the centerline of the track. If tie plates are used, flat and canted tie plates shall not be mixed in the same rail section.

5.4 *Spikes (or fasteners):*

5.4.1 Rails shall be secured at every tie. The rail shall have a sufficient number and strength of spikes (fasteners) to effectively maintain gauge and provide sufficient rail restraint.

5.4.2 *Spiking Pattern*—Reserved.

5.5 *Joints:*

5.5.1 *Joint Bars*—Joint bars, if used, shall join rail sections together and shall match the rail size.

5.5.1.1 Only metal joint bars are allowed. At insulated joints, an insulated metal bar with insulated bolt holes shall be used.

5.5.1.2 *Compromise Joints*—Rails of different size or section shall be joined with properly designed and constructed compromise bars, taper rails, or offset welds.

5.5.1.3 Welded joints are acceptable when appropriately designed for the railway installation and specific processes (for example, annealing) are specified. Aluminum rail which has been welded shall not be used.

5.5.1.4 As a minimum, the threaded end of the bolt shall be flush with or proud of the nut.

5.5.2 *Joint Gap*—A gap between rail ends shall be installed to provide for thermal expansion resulting from maximum and minimum temperature difference within the year or other means approved by the Designer/Engineer.

5.6 *Rail Anchors*—Rail anchors shall not be used on open deck bridges. An open deck bridge is a bridge with no floor.

5.7 *Gauge Rods:*

5.7.1 A gauge rod is a device threaded at its ends with features at its end that attach to opposing rails for the purpose of maintaining the gauge distance between those rails (See Fig. 1).

5.7.2 *Application*—If used, gauge rods shall be installed at right angles to the rail with the jaws firmly gripping the base of the rail.

FIG. 1 Gauge Rods (installed on rails, ties and tie plates not shown)

5.8 *Rail*—Rail shall meet the requirements of the Designer/Engineer.

5.8.1 *Short Rail*—Short rails and joint gap fillers shall provide wheel guidance to mitigate a derailment at the maximum speed stipulated by the Operator.

5.9 *Track Geometry*—One rail shall be designated as the line rail. The alignment of the track is established by this rail. Either rail may be used as the line rail on tangent track so long as the same rail is used for the entire length of the tangent.

5.9.1 In curves, the inside rail is designated as the grade rail. The grade rail is the reference from which super-elevation is applied to the outside rail of the curve.

5.9.2 The following figures define track geometry for all gauges that shall be used by the Designer/Engineer to establish the requirements for the track. These figures will be referenced in subsequent sections.

5.9.3 *Gauge*—Gauge is the distance between a point one-half the depth of the rail head below the top surface of the two rails measured at right angles to the rail or, for standard gauge, ⅝ in. (15.9 mm) below the railhead as shown in Fig. 9. The minimum and maximum gauges shall be determined using Fig. 3 and Fig. 4 respectively.

5.9.3.1 *Gauge less than standard or if the rails are canted*—Gauge is the minimum distance between the rail heads, measured at right angles to the rails at the rail head. Canted rail is the inclination of both rails towards the center line of the track, typically by the use of inclined tie plates, usually at an incline of 1 in 20. See Fig. 10.

5.9.3.2 In curves the gauge, as defined in 5.9.3, shall be adjusted for the degree of curvature, the tread width and wheel base of the rolling stock but shall not exceed the values of Fig. 4. (See X5.9.3.2 for definition of degree of curvature.)

5.10 *Cross Level:*

5.10.1 *Definition*—Cross level is the difference in elevation between the top surfaces of the two rails measured at right angles to the track, as shown in Fig. 11

5.10.2 *Designated Cross Level*—On tangent track, the cross level shall be zero ± tolerance specified by the Designer/Engineer. On curved track, the designated cross level is equal to the designated super elevation (see 5.11). Between the tangent and curved track is the transition track. Super elevation in the transition varies from level at the tangent to full super elevation at the curve.

5.11 *Super Elevation*—Super elevation is the banking of track by raising of the outside rail or lowering of the inside rail in a curve. The amount of super elevation is a function of the degree of curvature, proposed speed of the train and the location of the center of gravity of the train vehicles. The super elevation shall be designed so that the combined force vectors from the weight of the train and the centripetal forces due to the trains speed in a curve shall act as a combined force vector intersecting the tie surface between the rails (stable) versus outside the rails (unstable). The design shall use a train speed from zero to the maximum speed, including over speed conditions, to ensure overturning stability is provided.

5.12 *Turnouts:*

5.12.1 *Turnout*—The section of rail from the tip of switch points (point of switch) to the heel of the frog shall be considered the turnout.

5.12.2 General requirements for turnouts.

5.12.3 *Materials*—All materials used within the limits of a turnout shall be specified by an Designer/Engineer and not be flame cut after manufacture.

5.12.4 *Rail*—All rail used within a turnout shall be of the same weight and section. Compromise joints are not permitted within a turnout.

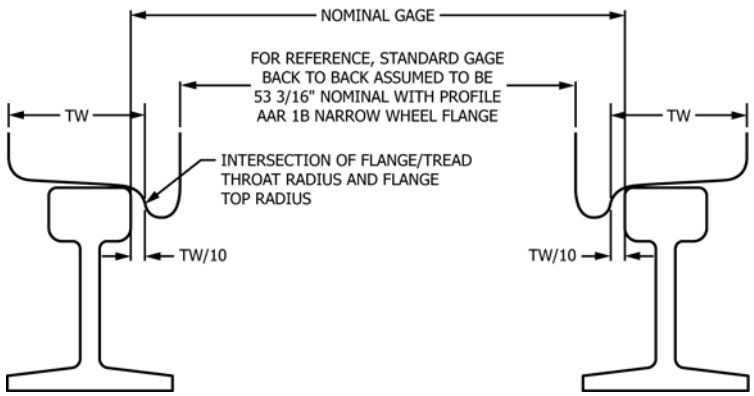

FIG. 2 Nominal Track Gauge (AAR stands for American Association of Railroads, TW stands for Tread Width)

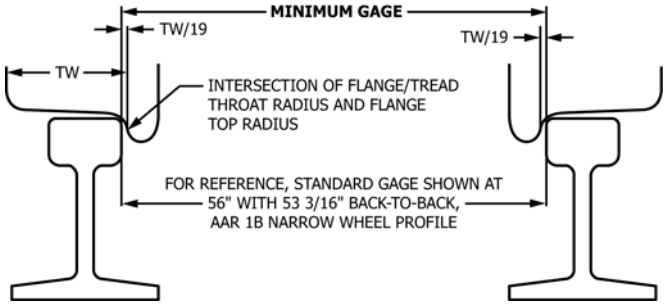

FIG. 3 Minimum Gauge for Tangent and Curved Track

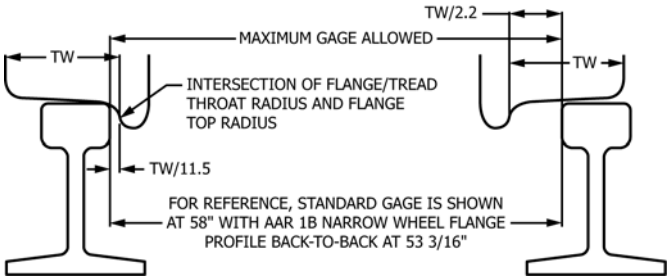

FIG. 4 Maximum Gauge for Tangent and Curved Track

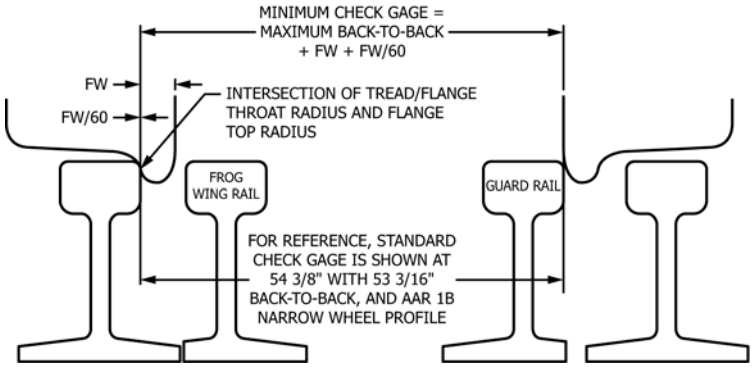

FIG. 5 Minimum Check Gauge for Guard Rails in Turnouts and Rail Crossings (FW stands for Flange Width)

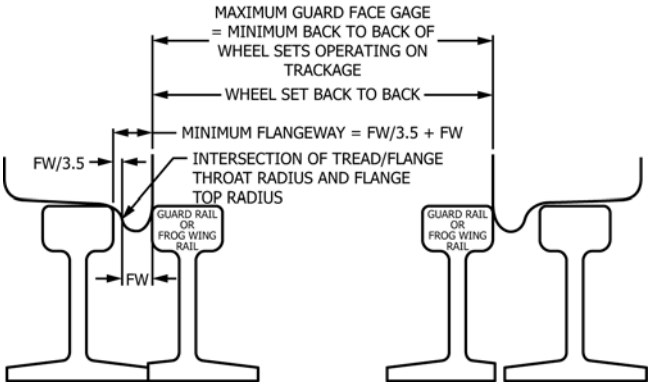

FIG. 6 Maximum Guard Face Check Gauge in Turnouts and Rail Crossings

5.12.5 *Ties*—The requirements in 5.2 of this standard shall apply to ties within the limits of a turnout.

5.12.6 *Stub Switches*—Stub switches may be used and all rules within this standard applying to turnouts shall apply to

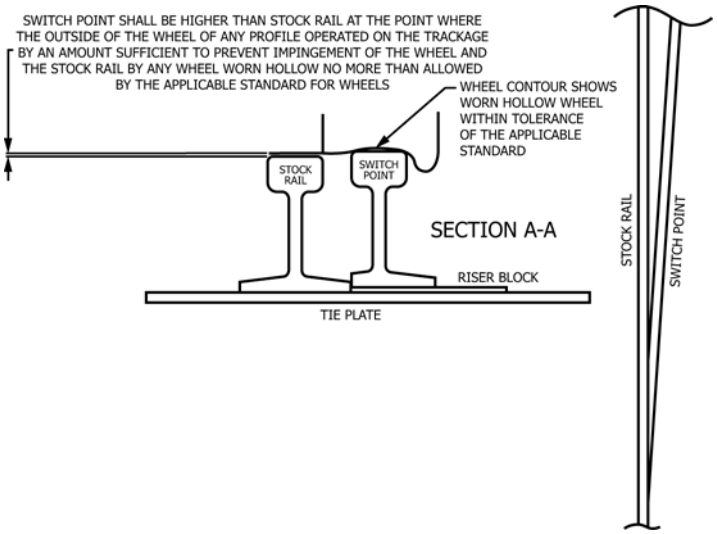

FIG. 7 Placement of Switch Point Rail to Prevent Hollow Wheels from Impinging on the Stock Rail unless it can be shown that worn hollow treads do not and will not be operated over the switch (see 5.12.9.2)

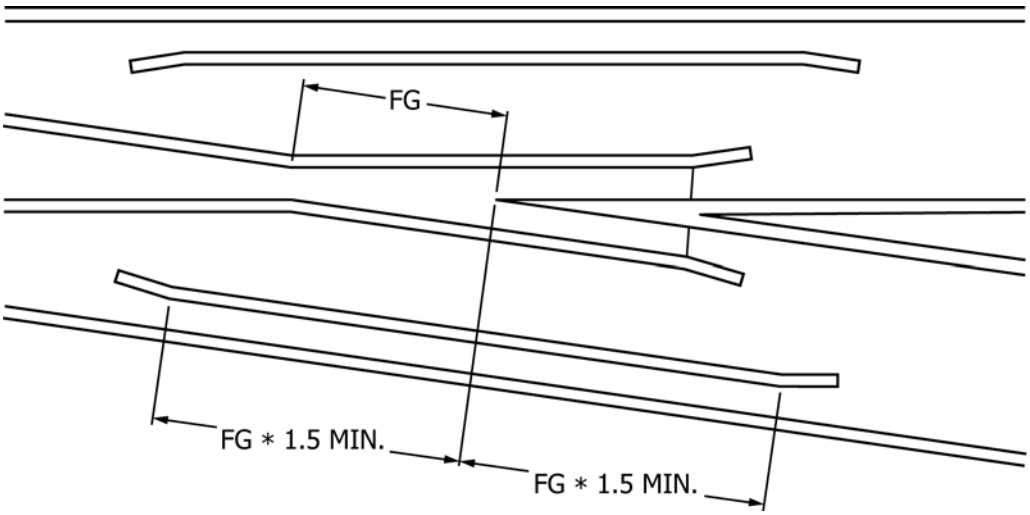

FIG. 8 Turnout Frog Minimum Guard Rail Length (FG stands for Frog Gap)

stub switches except those rules regarding the switch itself. When used, operating speed over stub switches shall be limited to twice walking speed.

5.12.6.1 Stock and closure rails shall be securely fastened and provide for proper alignment at the approach track end when the moveable approach track is thrown in either direction. The rail ends of both the approach track and the stock and closure rails shall bear on a common tie or contiguous bearing plate, or both. Means shall be provided to prevent misalignment between the approach and turnout tracks in all operating positions to the extent that a derailment potential is created at the speed allowed for the turnout.

5.12.6.2 Means shall be provided to prevent longitudinal movement of the approach, stock, and closure rails to the extent that they no longer bear on a common tie or bearing plate.

5.12.6.3 End gap between approach rails and closure/stock rails shall be sufficient to allow throwing the switch without binding.

5.12.6.4 End gap between approach rails and closure/stock rails shall not be large enough to present a derailment potential.

5.12.7 *Turnout Track Geometry*—Turnout track geometry shall conform to the requirements of the Designer/Engineer determined by Figs. 2-7.

5.12.7.1 Rail braces (see Figs. X1.9 and X1.10) shall be designed to provide proper lateral support to the stock rails in a turnout.

5.12.8 *Switch Stand*—A switch stand is the frame which holds the lever which moves the points of the switch and may also contain a banner or visual indicator of the direction of the points.

5.12.8.1 Switch stand lever lock or hook shall be installed on all switches. Switch point lock, when required, shall be installed in addition to lever lock or hook.

5.12.8.2 The switch stand, when required, shall be fully secured to the head block ties (see Fig. 12) to prevent any motion between the switch stand and the points and any resulting unintentional movement of the points. Head block

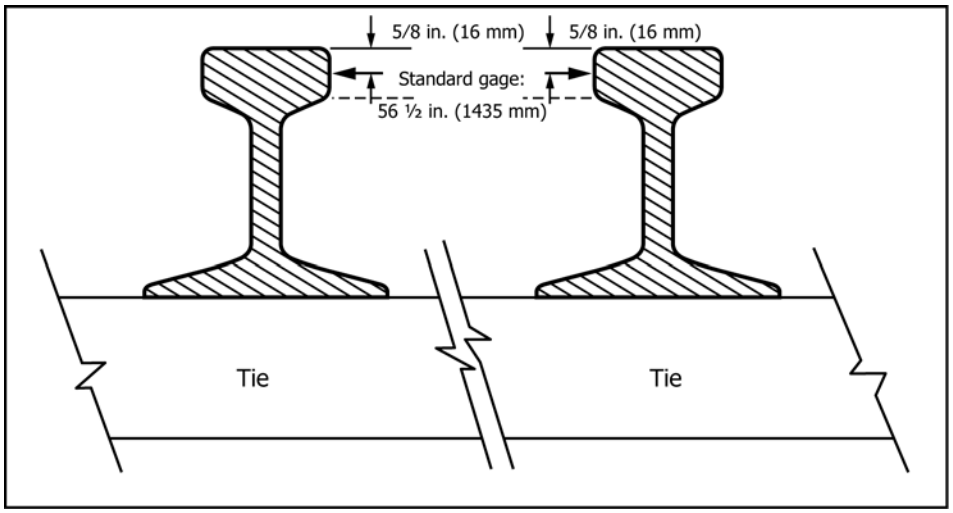

FIG. 9 Standard Railway Gauge Measurement (non canted rail)

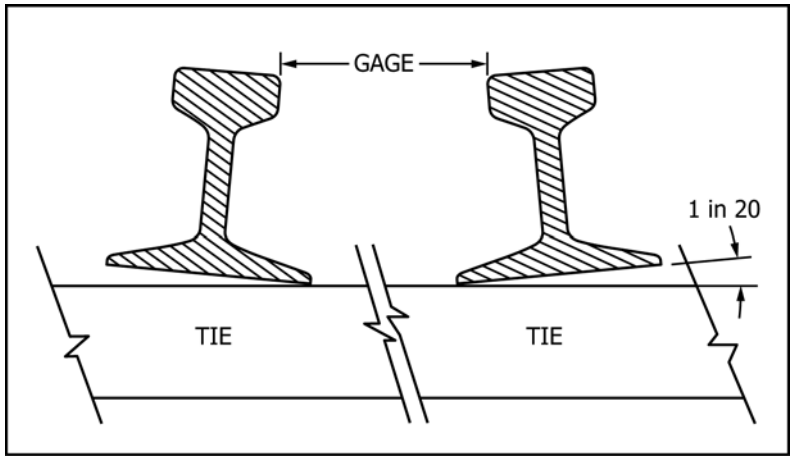

FIG. 10 Amusement Railway Gauge Measurement (canted rail)

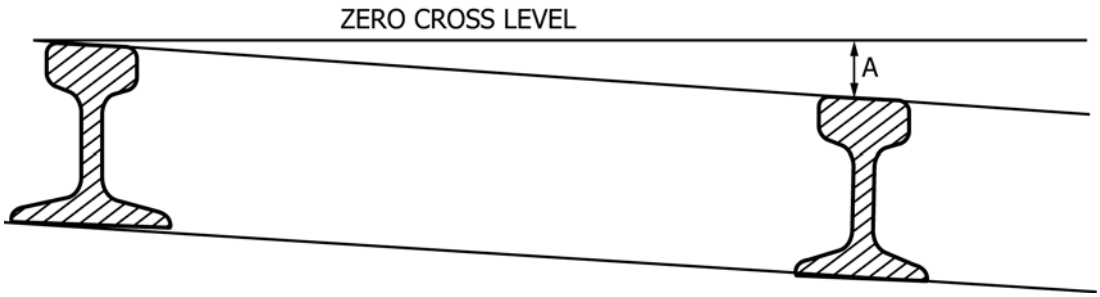

FIG. 11 Cross Level Measurement

ties are long ties that extend from under the rail points of the turnout to the switch stand.

5.12.9 *Switch Points:*

5.12.9.1 If the top surface of the milled section of the switch point is higher than the top of the stock rail, operations through the turnout shall not exceed walking speed. (See Fig. X1.13, section A-A.)

5.12.9.2 If the point rail beyond the taper is lower than the stock rail and causes wheel impingement on the stock rail, operations through the turnout shall not be permitted. See Fig. 7.

5.12.10 *Guard Rails on Turnouts:*

5.12.10.1 Guard rails shall be designed so that the straight guarding face (the portion of the guard rail parallel with and

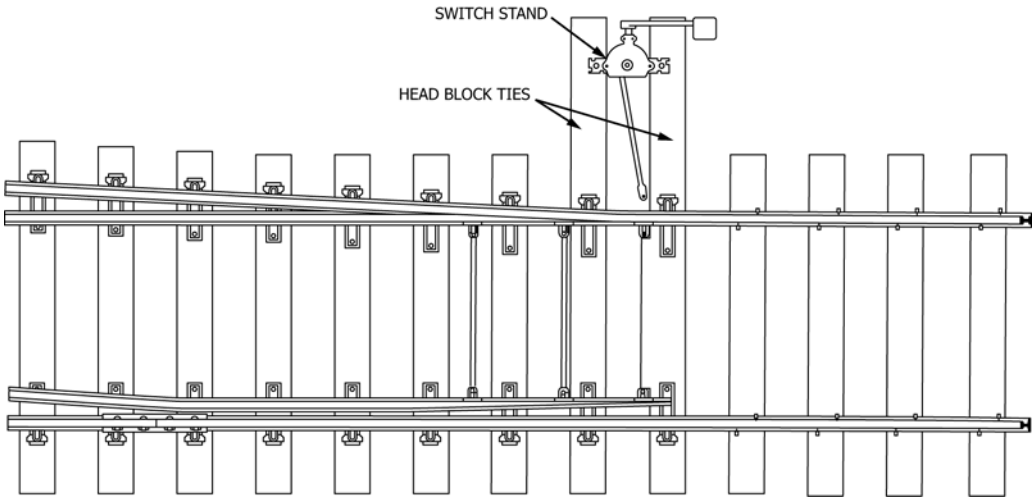

FIG. 12 Head Block Ties Supporting a Switch Stand at a Turnout

closest to the running rail) extends in advance and behind of the frog point a minimum distance equal the values given in Fig. 8.

5.12.10.2 *Check Gauge*—The minimum and maximum check gauge for guard rails in turnouts (measured to face of frog—see Fig. 13) shall be determined using Figs. 3-6; also see X5.12.10.

5.12.11 *Flangeway Width*—The minimum and maximum guard rail flangeway width shall be determined using Figs. 3-6.

5.13 *Flangeway Depth*—The minimum frog flangeway depth in turnouts shall be greater than the wheel flange height of the tallest wheel flange in service (including wear to the rolling surface of the wheels) on the line plus a margin except flangeways specifically designed to be the running surface of the wheels.

5.14 *Rail Crossings:*

5.14.1 *General*—Rail crossings are designed to carry one track across another at grade.

5.14.2 *Size*—Rail crossings shall be the proper size and section for the rails being joined.

5.14.3 *Flangeway Width*—Flangeway width at rail crossings shall be determined using Figs. 5 and 6.

5.14.4 *Flangeway Depth*—The minimum flangeway depth in a rail crossing shall be greater than the wheel flange height of the tallest wheel flange of the tallest wheel flange in service (including wear to the rolling surface of the wheels) on the line plus a margin.

5.15 *Road Crossings:*

5.15.1 *General*—Road crossings carry vehicular or patron foot traffic, or both, across rail track at grade. The roadway material that is part of the crossing and supports the rails shall be designed to withstand the permitted load over the crossing.

5.15.2 *Flangeways:*

5.15.2.1 *Flangeway Width*—Flangeway width of gauge road crossings shall not be less than the value determined using Fig. 5 increased by 33%.

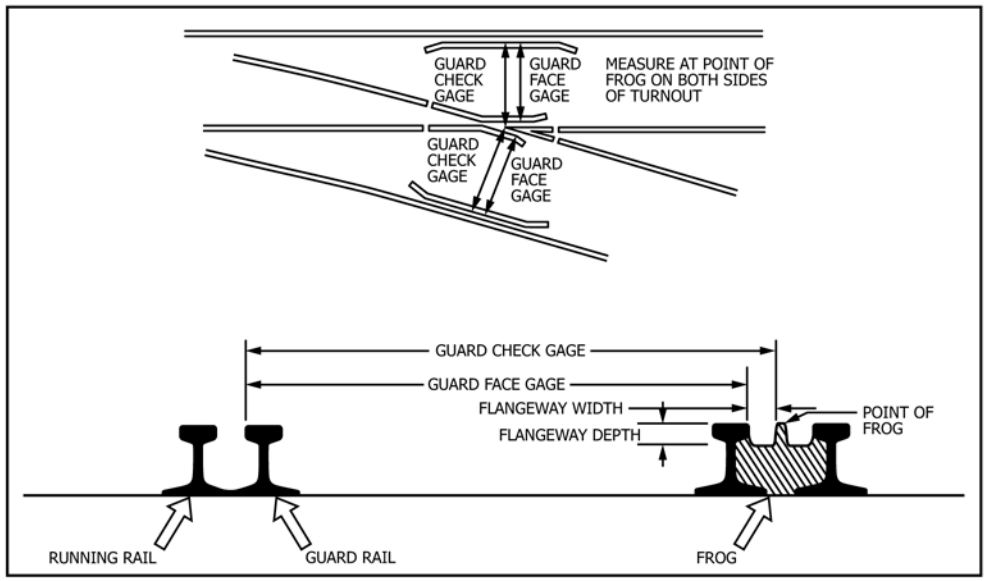

FIG. 13 Measurement of Flangeway Width & Depth, Guard Check Gauge, and Guard Face Gauge

5.15.2.2 *Flangeway Depth*—The minimum flangeway depth for road crossing shall be greater than the wheel flange height of the tallest wheel flange of the tallest wheel flange in service (including wear to the rolling surface of the wheels) on the line plus a margin.

5.15.3 *Joints*—Rail joints shall be designed to support the train loads over the maximum tie to tie pitch.

5.15.4 *Crossing Surfaces and Materials*—The crossing surface shall be designed to prevent vehicle tires from damaging or dislodging the rails. The rails may be above the crossing surface, so that the wheel running surface does not contact a hard crossing surface. Super elevation is acceptable in a curved road crossing.

5.15.5 *Crossing Protection*—Use of crossing protection shall be evaluated using the ride analysis process in Practice F2291-11, subsection 5.1.

5.15.5.1 Where track crosses public vehicular traffic at a grade crossing, signs and signals shall conform to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD).

5.15.5.2 Ride analysis shall determine if crossing signage or signals are required and the size of the warning lettering.

5.15.5.3 Where track crosses a patron (non-public) crossing, signage and signals, if used, may be reduced in size to provide for thematic size, but shall provide the same information, and function, as described in the sign manufacturer's manual and comply with the ride analysis.

5.16 Reserved.

5.17 *Clearances*—The Patron clearance envelope shall be determined by Ride Analysis per Practice F2291.

5.17.1 The envelope shall be documented in the railways records.

5.18 *Derails*—Reserved.

5.19 *Track Maps*—Reserved.

5.20 *Stations and Platforms*—Reserved.

5.21 *Bridges*—A bridge is an elevated structure for a railway to pass over.

5.21.1 Bridges shall be designed by a Licensed Professional Engineer or qualified person.

5.21.2 If the bridge is wide enough for a motor vehicle to drive over it, the bridge load rating shall be posted if it is "only for rail vehicles."

5.21.3 The bridge Licensed Professional Engineer or qualified person shall specify what inspections shall be performed by maintenance and which inspections shall be performed by a qualified person and their related frequencies.

5.21.4 *Guard Rails on Bridges and Trestles*—If guard rails are to be used, they shall be designed by the Designer/Engineer. See X5.21.1.4.

5.21.5 *Walkways*—For construction after the effective date of initial release of this standard, bridges, if longer than 15 ft (46 m) and higher than 30 in. (762 mm), shall comply with one of the following:

(1) A walkway that complies with the local Authority Having Jurisdiction and applicable accessibility codes.

(2) A means to exit from the bridge to level ground (for example, a ladder) or provide a safe means to walk longitudinally through the cars of the train.

5.21.5.1 If a handrail is required on the walkway, the handrail shall comply with Practice F2291, Section 14.

5.21.6 Open bridges with areas over patrons' heads shall have a means of catching debris from the train and bridge surface. If applicable, locomotive liquids and vapors (for example, steam) shall be diverted from contact with patrons.

5.22 *Tunnels*—A tunnel is an underground structure for a railway to pass through. Anything else not on grade is a bridge or a covered structure.

5.22.1 The tunnel shall be designed by a Licensed Professional Engineer or qualified person.

5.22.2 The tunnel Licensed Professional Engineer or qualified person shall specify what inspections shall be performed by maintenance and which inspections shall be performed by a Bridge qualified person and their related frequencies.

5.22.3 *Guard Rails in Tunnels*—If guard rails are to be used, they shall be designed by the Designer/Engineer. See X5.22.3.

6. Manufacturing

6.1 Reserved.

7. Installation

7.1 The track system shall be installed per the requirements of the Designer/Engineer.

7.2 *Sub-grade*—Sub grade, if used, during initial installation shall be compacted and crowned per the requirements of the Designer/Engineer. The sub-grade shall extend beyond the ballast.

7.3 *Ballast:*

7.3.1 If ballast is installed, it shall extend beyond the ends of the ties.

7.3.2 If specified by the Designer/Engineer, ballast shall be tamped. Tamping may be performed after installation is complete.

7.3.3 The edges of the ballast shall be profiled per the requirements of the Designer/Engineer.

7.4 *Rails:*

7.4.1 Rails shall be secured at every tie (see 5.4).

7.4.2 Serial rails shall be joined by joint bars or welded joints (see 5.5).

7.4.3 Serially joined rails shall have a gap between them as specified by the Designer/Engineer to account for thermal expansion based upon the expected temperature range over the entire year.

7.4.4 Rails shall be smooth and continuous in line and level within the tolerances specified by the Designer/Engineer. There shall be no kinks or discontinuities.

7.5 *Ties:*

7.5.1 Ties shall be initially installed perpendicular to the rails (±20°) and properly spiked and tamped. Ties shall be installed with the top of the tie (or the tie plate) in full contact with the base of the tie plate or rail and the bottom of the tie in full contact with the ballast.

7.5.1.1 Exceptions to the perpendicularity requirement are at turnouts, edges of crossings and at ballast at the edges of crossings, edges of bridges and at ballast at the edges of bridges, as required, and be properly tamped and spiked.

7.6 *Tie Plates:*

7.6.1 Tie plates, if used, shall be installed such that the bottom surface is in contact with the top of the tie and the top surface of the tie plate is in contact with the bottom of the rail.

7.6.2 Holes in tie plates for spikes or screws shall not located so close to the edge of the tie so when spikes or screws are installed they cause the tie to split.

7.7 Spikes or other fastening of rails to ties shall be installed as follows:

7.7.1 Driven vertical and square with the rail.

7.7.2 Driven or screwed such that the head of the fastener is in contact with the base of the rail, commonly known as driven "home."

7.8 *Switch Connecting Rods, Switch Rods, and Switch Clips:*

7.8.1 These parts shall be installed to allow unobstructed motion when the switch is thrown. Rod ends and clips shall not contact adjacent ties.

7.8.2 *Switch Connecting Rod Bolts, Switch Rod Bolts, and Clip Bolts*—Connecting rod and switch rod bolts shall be installed as required by the Designer/Engineer.

7.9 Super-elevation of rails shall be installed following requirements of the Designer/Engineer.

7.10 *Alignment*—Alignment or line requirements shall be installed following the requirements by the Designer/Engineer.

7.11 *Track Profile*—The elevations and gradients (profile) requirements shall be installed following requirements by the Designer/Engineer.

8. Operation

8.1 *Operating Restrictions*—Where this standard imposes operating restrictions, that operating restriction shall apply to any part of the train in the restricted speed area. In addition to the requirements of Practice F770, the Owner shall provide a fact sheet that includes: maximum and minimum gauge, maximum gauge in curves, flangeway widths and depths, track line and level tolerances, maximum and minimum cross level, maximum and minimum super-elevation, maximum tie spacing, minimum and maximum joint gap on tangent track, maximum and minimum joint gap in curves, and related operating restrictions.

8.1.1 In any case where the track structure is not in compliance with this standard, the design engineer or track supervisor may allow operation over the track in question under the following conditions:

8.1.1.1 Repair shall be made within 30 calendar days of discovery of the condition.

8.1.1.2 Operating speed or other restrictions shall be applied to the affected section of track so that the risk of derailment is no more than it would be over the same section of track at normal speed with no restrictions, in the judgment of the Designer/Engineer or track supervisor.

8.1.1.3 Daily inspection shall be made of the affected section of track and measurements taken as needed to ensure that the defective condition has not worsened to a point where additional restrictions must be applied or operations ceased over the affected track section.

8.1.1.4 A daily record shall be kept of the inspections made and the restrictions applied until the affected section of track is repaired. These records shall be available for inspection for one calendar year after the affected section of track is repaired.

8.1.2 *Consecutive Defective Ties*—In the absence of requirements from the Designer/Engineer limiting the number of consecutive defective ties in types AP-A and AP-B track, operating restrictions as specified in Table 1 shall be imposed.

8.1.3 *Missing or Skewed Ties*—Missing or skewed (crooked) ties are undesirable in track. At any location where the tie is missing (tie not present for twice the nominal pitch) operations shall not exceed walking speed until additional tie support is provided. A tie is also considered missing if it is unable to perform it's structural support function as described in 5.2. At any location where the tie is skewed more than 30° from perpendicular to the rail, except where intentionally designed at turnouts, bridges or crossings, operations shall not exceed walking pace until additional tie support is provided or skewed ties are straightened to reduce the tie spacing.

8.1.4 *Joints*—If one or both joint bar(s) at a rail joint is/are cracked between the center holes, operations over that location shall not exceed walking speed.

8.1.4.1 At rail joints, where one non-defective tie is not within ½ the nominal tie spacing, operations shall not exceed walking speed.

8.1.4.2 Operations shall not be permitted over any location where one or both joint bars are broken between the center two holes of the joint bar, or where worn or loose joint bars allow movement of either rail with respect to the other that is sufficient to cause derailment.

8.1.5 *Loose and Missing Bolts:*

8.1.5.1 If all bolts at a joint are loose or if there is only one bolt through each/either rail joint, train operation shall not exceed walking speed.

8.1.5.2 Train operations shall not be permitted over locations where all bolts in one rail joint are missing except where by design and approved by the Designer/Engineer, for example, the moving end of a stub switch.

8.1.6 *Rail End Mismatch:*

8.1.6.1 At any location where rail end mismatch exceeds 1⁄16 in. per ft (5 mm per meter) of gauge not to exceed 3⁄16 in. (4.8 mm) on the tread portion or gauge side of the rail, operations shall not exceed walking speed.

8.1.6.2 At any location where rail end mismatch exceeds ⅛ in. per ft (10 mm per meter) of gauge not to exceed ½ in. (12.7

TABLE 1 Defective Ties (non thematic "functional" ties, see X5.3.4 regarding thematic ties)

Number of Consecutive Defective Ties	Operating Restrictions
0-2 ties	None
3 ties	Walking Speed
4+ ties	No operation

mm) on the tread portion or gauge side of the rail, operations shall not be permitted.

8.1.6.3 *Joint Gap*—At any location where the joint gap between rail ends exceeds the value specified by the rolling stock manufacture or the Designer/Engineer, operations shall not exceed walking speed at that location.

8.2 *Rail:*

8.2.1 *Defective Rail and Remedial Actions*—Appendix X2 provides brief descriptions of the common rail defects that may be observed in track. A list of rail defects and remedial actions for rail defects are presented in Annex A1, Table A1.1. For standard gauge, where rail defects have been identified but remedial action has not been completed, the operating restrictions presented in Annex A1, Table A1.1 shall apply. For non-standard gauge, the Designer/Engineer shall provide operational restrictions and limits for rail defects.

8.2.2 *Switch Points*—If a switch point is worn or damaged beyond the limits of 9.16, operations through the turnout shall not exceed walking speed.

8.2.2.1 If the top surface of the end of the switch point is higher than the top of the stock rail, operations through the turnout shall not exceed walking speed (see Fig. X1.13, section A-A and B-B).

8.2.2.2 If the point rail beyond the taper is lower than the stock rail, operations through the turnout shall not be permitted (see Fig. 7 and Fig. X1.13, section C-C).

8.2.2.3 Where turnout latches or locks are required per design and either are missing, damaged, insecure, or otherwise inoperative, operations through the turnout shall not be permitted unless the points are secured preventing their movement and preventing a train approach against the switch.

8.2.2.4 When switch stands are installed and operations through a non-spring switch results in visible lateral movement of the stand or opening of the switch points (point gap), operations though the turnout shall not be permitted unless the points are secured preventing their movement.

8.2.2.5 If the connecting rod, switch rod, or switch clip is insecurely fastened or is damaged, operations through the turnout shall not be permitted unless the points are secured preventing their movement.

8.2.3 *Switch Heel (bolts, fillers, and joint bars)*—The heel of the switch shall be secure according to the requirements of the Designer/Engineer.

8.2.3.1 Rail braces shall be used on turnouts as needed to maintain proper geometry for the maximum operating speed permitted over the turnout.

8.2.4 *Frog Flangeways*—The minimum and maximum frog flangeway width shall be to the requirements of the Designer/Engineer.

8.2.5 *Frog Flangeway Depth*—Frog flangeway depth shall be to the requirements of the Designer/Engineer.

8.2.5.1 *Guard Check Gauge*—Guard check gauge measured to face of frog (see Fig. 13) shall be to the requirements of the Designer/Engineer.

8.2.6 *Guard Face Gauge*—Standard guard face gauge shall be to the requirements of the Designer/Engineer.

8.2.7 *Guard Flangeway Width*—Standard gauge guard rail flangeway width shall be to the requirements of the Designer/Engineer.

8.3 *Rail Crossing Requirements:*

8.3.1 *Flangeway Width*—Flangeway width for rail crossings shall be to the requirements of the Designer/Engineer.

8.3.2 *Flangeway Depth*—Flangeway depth for rail crossings shall be to the requirements of the Designer/Engineer.

8.4 *Road Crossings:*

8.4.1 *Flangeway Width*—The minimum flange way width shall be determined by the Designer/Engineer.

8.4.2 *Flangeway Depth*—The standard flangeway depth shall be determined by the Designer/Engineer.

8.5 *Track Gauge:*

8.5.1 *Gauge*—At any location where the rail to rail gauge exceeds the required value of the Designer/Engineer, the track shall be returned to the required specifications before operation is permitted. As an alternative, equipment may be tested over the track in question and if the equipment can safely traverse the track, operations may resume but speed is limited to walking speed until the track is returned to the required dimensions. See 8.1.1.

8.6 *Allowable Cross Level Deviations and Operating Restrictions*—Deviations and operating restrictions provided by the Designer/Engineer shall be utilized for the railway.

8.7 *Alignment*—Operating speed restrictions related to track alignment, line and level shall follow the requirements of the Designer/Engineer.

8.8 *Adverse Conditions:*

8.8.1 Train operations over a bridge structure suffering from reasonably foreseeable adverse condition shall not be permitted until the bridge is examined and known to be safe.

8.8.2 Train operations in a tunnel or tunnel foundation suffering from reasonably foreseeable adverse condition shall not be permitted until the tunnel is examined and known to be safe.

8.9 Prior to the operation of a track switch, personnel operating the switch stand/switch shall complete appropriate training per Practice F770.

8.10 If the rails are covered by water, operation shall not be allowed.

9. Maintenance

9.1 Maintenance personnel shall maintain the track system per the requirements of the Designer/Engineer and this standard.

9.2 Maintenance inspections shall be performed per Practice F770 excepted as noted in the text of this document.

9.3 *Frequencies of Maintenance Inspections:*

9.3.1 As a minimum, track designated as either Type AP-A or Type AP-B shall be inspected at the intervals shown in Table 2.

9.3.2 Type AP-C track shall be inspected in accordance with 9.3.3.

TABLE 2 Minimum Track Inspection Frequencies

NOTE 1—These detailed track inspections are in addition to the daily pre-opening inspection requirements as outlined in Practice F770 and Practice F1193.

Traffic Frequency	Inspection Frequency
Daily Movement (conveying Patrons every day)	Weekly
Weekly Movement	Monthly
Less Than One Movement per Week	Every 3 Months

9.3.3 Track that has not been used for a period of 6 months or more (infrequently used track) shall be inspected prior to the first movement over the track.

9.3.4 Maintenance personel shall perform the maintenance inspections, 9.8 through 9.22.3, to the schedule prescribed by Table 2.

9.3.5 Track inspections shall be conducted in the immediate area of an incident following a derailment or accident causing damage to the track.

9.3.5.1 Track inspections shall be conducted following unusual occurances such as flood (any portion of the track or tie or ballast becomes submerged and remain submerged), fire, moderate or greater seismic event (see Appendix X9.3.5), severe storm (that is, hurricane, tornado, rain in excess of 3 in. (76 mm) in 3 hours or lightning strike to the track), or other occurrence which could have an adverse effect on the track structure.

9.3.5.2 These inspections shall be conducted prior to the first movement over the track following the unusual occurrence, and include, but not limited to, inspections of trestles, overpasses, bridges, covered bridges, overhead objects, crossing signals, tunnels, and other railway devices and equipment.

9.3.5.3 For a moderate or greater seismic event, the inspections shall also confirm that there are no visually discernible discontinuities in the line and level of the rail, no subsidence of the road bed, no recent fissures in the earth within 100 ft (30 m) of the roadbed, ballast and other support of the rails is in place. If there are bridges or tunnels as part of the track system, they shall be specifically inspected.

9.4 Track inspections shall be performed on foot or in an on-track vehicle at a speed which is conducive to effective track inspection. Track inspections of turnouts, road crossings, rail crossings, bridges, and drainage structures shall be performed on foot.

9.4.1 At intervals specified by the Designer/Engineer, at least once per year, unless a visual defect is found prior to the yearly inspections, the gauge of AP-A & AP-B track shall be measured:

9.4.1.1 At intervals of not less than at mid-rail and at rail joints and the discrepancies recorded.

9.4.1.2 In turnouts, just ahead of switch points. (See Fig. 14.)

9.4.1.3 In turnouts, at the joints.

9.4.1.4 At the point of frog on both sides of turnouts and rail crossings. (See Fig. 14.)

9.4.1.5 Wherever there is a dark streak running along the field side of the top surface of the rail head.

9.4.1.6 Wherever wear marks on a tie or tie plate indicate lateral tie plate movement.

9.4.1.7 At locations where ties are badly and non-purposely skewed.

9.4.1.8 Any place there is a kink or deviation in the track course.

9.4.1.9 In road crossings.

9.4.2 The data shall be evaluated for compliance with the gauge limits.

9.5 *Inspections of Partially Visible Track*—At locations where vegetation, dirt, debris, or other undesirable materials cover the ties or rail, or both, preventing effective track inspection, train operations shall not exceed walking speed. If debris covers the top of rail or the flangeway, the debris shall be removed prior to effective track inspection.

9.6 *Hazardous Conditions*—Reasonably foreseeable conditions presenting a hazard to the safe movement of trains shall be corrected prior to the first movement of a train over that location.

9.6.1 Any defects discovered that affect operation or operating restrictions shall be communicated to the operator.

9.7 *Drainage*—Within the watershed that includes the railroad attraction, an inspection of ditches and other drainage structures shall be performed after rains that may have adversely affected the roadway.

9.7.1 Drainage ditches and structures shall be cleared of obstructions which may interfere with the flow of water and allow proper drainage.

9.7.2 Existing drain covers shall be in place and secure.

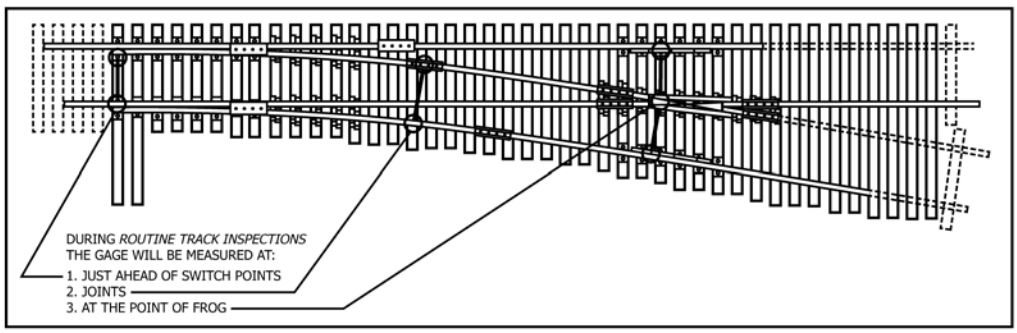

FIG. 14 Required Gauge Measurement Locations Within Turnouts

9.7.3 Particular attention shall be given to drainage conditions at turnouts, rail crossings, road crossings, bridge ends, and all locations where conditions may restrict adequate drainage.

9.7.4 An inspection of drainage structures and channels shall be performed at least annually.

9.8 *Roadway:*

9.8.1 *General*—The roadway shall be inspected for the following defects:

9.8.1.1 Ballast/sub grade pumping (significant up and down motion of the rail or tie, or both, as train passes over track section).

9.8.1.2 Erosion of embankments and cut slopes.

9.8.1.3 Embankment sliding or slippage.

9.8.1.4 Potential slope stability problems.

9.8.1.5 Settlement at approaches to bridge ends.

9.8.1.6 Washouts under the track.

9.8.1.7 If any of these are present, remedial action is required within a time frame necessary to prevent damage to the track structure.

9.8.2 Maintenance personnel shall inspect for the following:

9.8.2.1 Changes in gauge or cross-level, or both.

9.8.2.2 Settlement of the rails (changes in track level/profile).

9.8.2.3 Significant vertical or lateral movement of the rails, ties or joint bars as a train passes such that track gauge is comprised.

9.8.2.4 Settlement in the vicinity of the roadbed.

9.8.2.5 Conditions of standing water in or at the edge of the ballast.

9.8.2.6 Where applicable, settlement of the pavement in the vicinity of the track.

9.8.2.7 Where applicable, deterioration (cracking or breaking up) of the pavement in the vicinity of the track.

9.8.2.8 Flangeways shall not be blocked or clogged. Obstructions, including ice and packed snow, shall be removed prior to operation.

9.8.3 *Drains:*

9.8.3.1 *Obstructions*—Ditches and drainage structures shall be maintained to allow the free passage of water. At locations where flow is obstructed or otherwise inadequate, remedial action is required. All ditches and other drainage structures shall be kept unobstructed.

9.8.3.2 Cleaning of drainage structures and channels shall be performed at least annually.

9.8.4 *Vegetation*—Vegetation shall be maintained so that it does not:

(1) Interfere with adequate visibility at grade crossings.

(2) Obstruct visibility of location markers, switch position indicators, signs, or signals.

(3) Obstruct drainage.

(4) Interfere with the operation of trains or function of the train or track systems.

(5) Prevent proper track inspection.

(6) Present a fire hazard to timber structures.

(7) Encroach into the vertical and side patron clearance envelope (see 5.17).

9.8.5 Ballast, where used to restrain the ties:

9.8.5.1 The ballast section of rock shall be clean, free draining, and free of vegetations, soil (mud), and other foreign materials.

9.8.5.2 Ballast shall be maintained so that:

(1) It is in general contact with the ties and not less than ½ the height of the tie.

(2) It is not above the top of the ties except were use to protect the ties, for example, road crossing.

(3) Ballast materials shall be kept clear of moving components and linkages such as track switches and points, actuating linkages and actuating equipment, etc.

(4) The ballast material shall extend laterally beyond the ends of the ties sufficiently to limit the lateral motion of the ties and track from normal train operation.

(5) Ballast materials shall not interfere with the vehicle wheel flanges.

9.8.5.3 Both edges of the ballast shall be profiled per the requirements of the Designer/Engineer.

9.8.5.4 If significant vertical motion is detected in the train, as a result of loose ballast, train speeds shall be reduced in that area until the ballast is re-tamped and the track leveled in that area.

9.8.6 *Defective Ties:*

9.8.6.1 A tie is defective if it has one or more of the following conditions:

(1) Cracked from the top side to the bottom side through a spike hole.

(2) Split or otherwise impaired to the extent that it will not hold spikes or other rail fasteners.

(3) So that the tie plate, if present, can move laterally more than 0.1 in./ft of gauge (9 mm/1000 mm of gauge)

(4) Cut by the tie plate more than 25 % of the tie thickness.

(5) Cut by wheel flanges, dragging equipment, fire, etc., to a depth of more than 25 % of the tie thickness of the base of the rail, frog, or load-bearing area.

(6) Rotted, hollow, or generally deteriorated to a point where a substantial amount of the material is decayed or missing or unable to support the load of the train.

(7) Unable to adequately perform any of the functions in 5.2. See 8.1.2, Table 1 for operating restrictions related to defective ties.

9.8.7 At rail joints, one non-defective tie shall be within ½ of the nominal tie spacing from the joint.

9.8.8 Replacement ties shall meet the requirements of the Designer/Engineer.

9.8.9 If "down ties," ties that have a top surfaces not contacting the rail or tie plate, are not materially defective, the ballast shall be tamped up to fully support the rails.

9.9 *Tie Plates:*

9.9.1 Where used, replacement tie plates, rail fastenings, and other track materials shall be of the size prescribed by the Designer/Engineer.

9.9.2 Tie plates, rail fastenings, and other track materials shall not be flame cut post-manufacture.

9.9.3 Tie plates, if they are used, shall be secured to the ties and to the rails.

9.10 *Spikes or Other Fasteners of Rails to Ties shall be as follows:*

(1) Of the size prescribed by the Designer/Engineer and present in sufficient number to effectively maintain gauge and provide sufficient rail restrain.

(2) Shall not penetrate the full thickness of the tie unless used to secure the tie to a bridge or trestle.

9.10.1 *Missing and Loose Spikes*—Missing spikes shall be replaced. Loose spikes are those which protrude from the tie more than ½ their length. The Designer/Engineer shall establish the allowable number of consecutive loose spikes. If spikes are to be replaced, the tie shall be in serviceable condition.

9.10.2 *Screws and Chemical Anchors*—Screws, chemical anchors and other fastening systems are acceptable if specified by the Manufacture or accepted by the Designer/Engineer.

9.11 *Joint Bars:*

9.11.1 Joint bars which are manufactured or altered in any manner shall be smoothed and cleaned prior to installation. Bolt holes shall not be flame cut. Joint bars not meeting these requirements shall be reworked or replaced.

9.11.2 Joint bars shall be snug up against the underside of the rail head. The fasteners securing the joint bars to the rails shall be tight. When installed, split lock washers shall be flattened.

9.11.3 *Cracked or Broken Joint Bars*—Cracked or broken joint bars shall be replaced. Joint bars shall not be welded.

9.11.4 *Bolts in Track Joints*—Each joint shall be bolted with at least two bolts in each end of each rail.

9.11.5 All joint bar bolts shall be of proper size and be tightly in place. A bolt is not considered tight unless the washer or nut is flat against the joint bar, as shown in Fig. X1.5 unless specified by the Designer/Engineer.

9.11.6 Joint bar bolts which cannot be tightened shall be replaced. Missing bolts shall be replaced.

9.12 *Anchors*—Rail anchors shall not be moved by driving them along the rail (remove and re-install them at new location).

9.13 *Skewed Ties,* see 8.1.3, shall be straightened before applying rail anchors, except where the ties are designed to be skewed and there anchors shall not be used.

9.14 *Maintenance for Gauge Rods:*

9.14.1 Gauge rods, if used, shall be kept tight while maintaining the proper track gauge.

9.14.2 Bent or broken gauge rods shall be replaced.

9.15 *Rail:*

9.15.1 *Multiple Defects*—Any individual rail having two or more of the fissure or fracture type defects listed in the Annex, Table A1.1 whether they are the same or different, shall be removed and replaced. Illustrations of rail defects are shown in Appendix X2.

9.15.2 *Worn Rails*—On standard gauge rail suspected of being worn more than the allowances provided for in the Annex, wear measurements shall be taken at the center and at each end of the rail not more than 1 ft (305 mm) from the end of the joint bar. Rail wear measurements shall consist of a vertical head wear measurement and a side-wear measurement as shown in Fig. 15. For non-standard gauges, the maximum amount of wear limits shall be per the requirements of the Designer/Engineer.

9.15.2.1 *End Batter*—Rail end batter is a rail defect consisting of a depression in the rail tread at a rail joint. For standard gauge rail, end batter is measured ½ in. (13 mm) from the rail end with an 18-in. (457 mm) straight edge laid only on the rail being measured as shown in Fig. 16. For standard gauge, the maximum allowable amount of end batter is ¼ in. (6 mm). For gauges other than standard gauge, the maximum amount of end batter shall be per the requirements of the Designer/Engineer. If the maximum end batter is discovered, operation shall be reduced to walking speed until the defective rail section is removed or cropped out. See Annex, Table A1.1, Notes A1.2 and A1.3.

9.15.2.2 *Rail Running Surface Damage*—See Table A1.1 in the Annex. Rail running surface damage, such as deep engine burn, crushed head, etc., is measured at the midpoint of an 18-in. (457-mm) straightedge laid on the length of the railhead over the defect. Table A1.1 in the Annex presents limits and remedial actions for rail surface damage. For non-standard gauge, use limits from the Designer/Engineer.

9.15.2.3 *Torch Cut*—Rail shall not be flame cut in any manner. This includes cropping of the rail end, burning bolt holes, and trimming mismatched ends. Rail shall be cut using a rail saw, or other appropriate cutting tool. If a hole is required in the web of rail, it shall be drilled by a tool designed for that purpose.

9.15.2.4 *Base Corrosion on Tie Plates*—If tie plates are used, rail shall be removed from track if the base is corroded more than 1/16 in. (1.6 mm) per 25 pounds per yard (12.4 kg/m)

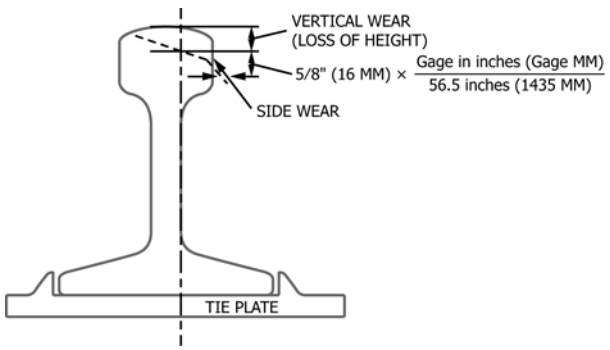

FIG. 15 Rail Wear Measurement

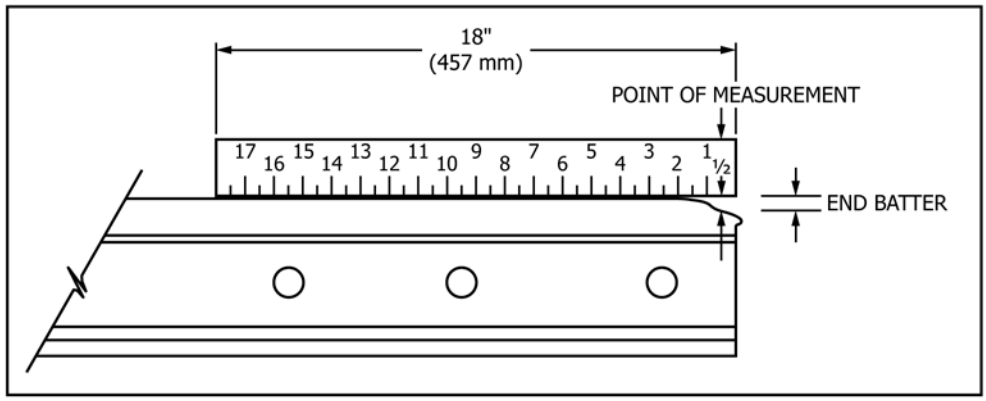

FIG. 16 Rail End Batter Measurement (Elevation View)

of rail weight and not to exceed ¼ in. (6 mm) as shown in Fig. 17. For non-standard gauge, follow the requirements of the Designer/Engineer.

9.15.3 *Used Rail*—The use of used rail is permitted as long as it meets the requirements of this standard and any additional requirements of Designer/Engineer. Transposing the rail such that the flange worn areas are moved to the opposite side or the gauge side rotated to the far side is acceptable provided the running surface condition meets the requirements of this standard.

9.16 *Turnouts, Switches and Switch Stands:*

9.16.1 *Turnouts.*

9.16.2 Inspect for loose, damaged, or missing heel bolts (if heel bolts used); cracked or improper heel filler (heel joint bars) (see Fig. X1.10).

9.16.2.1 Inspect for loose, damaged, or missing rail braces (see Fig. X1.9).

9.16.2.2 When used, rail braces shall be fully secured to the tie and tight against the outside of the stock rail on both sides of the turnout.

9.16.2.3 Inspect for loose, damaged, or missing slide plates; dirt and debris buildup on slide plates (see Fig. X1.10).

9.16.2.4 Inspect for missing cotter keys on switch rod (see Fig. X1.10) and switch clip bolts.

9.16.2.5 Inspect for debris in flangeways.

9.16.3 Inspect for debris obstructing the movement of switch rods and connecting rod.

9.16.4 *Switch Points*—A switch point shall be restored or replaced if the point is chipped, broken, or worn more than ⅛ in. per ft (10 mm per meter) of track gauge from the top surface down, and not to exceed ½ in. (13 mm) down, and not exceed 6 in. (152 mm) in length for standard gauge or 1.5 in. per ft (125 mm per meter) of track gauge back from the switch point. (See Fig. 18.) Metal flow shall be removed to ensure proper closure.

9.16.5 The portion of the point rail from its taper to its end shall be not be higher than stock rail (see Fig. X1.13, section A-A and B-B).

9.16.5.1 The point of the rail beyond the taper shall not be lower than the stock rail (see Fig. 7 and Fig. X1.13, section C-C).

9.16.6 Switches shall be inspected for the following defects:

9.16.6.1 Switch difficult to operate.

9.16.6.2 Switch stand banner/lamps, if used, miss-aligned from switch points.

9.16.6.3 The Designer/Engineer shall specify the allowable point gap. If none specified, the following shall be applied:

(1) Point Gap shall not be greater than ⅛ in. (3 mm) for rail weight greater than 80 pounds per yard (40 kg/m), and not greater than 1/16 in. (1.6 mm) for rail weight less than or equal

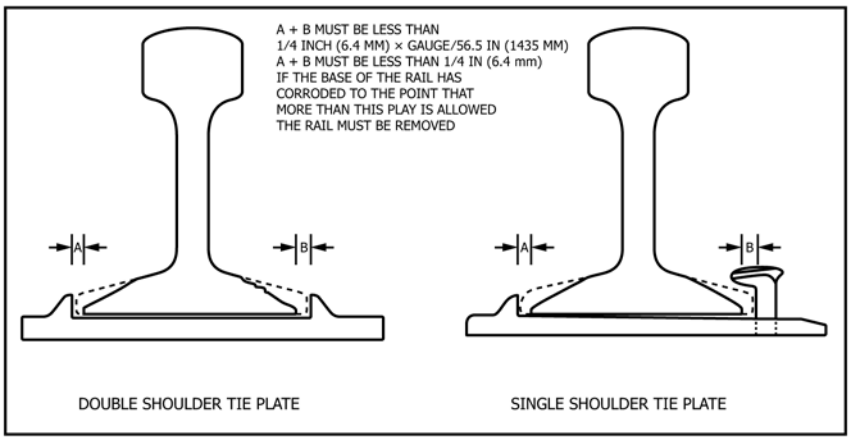

FIG. 17 Rail Base Corrosion Measurement

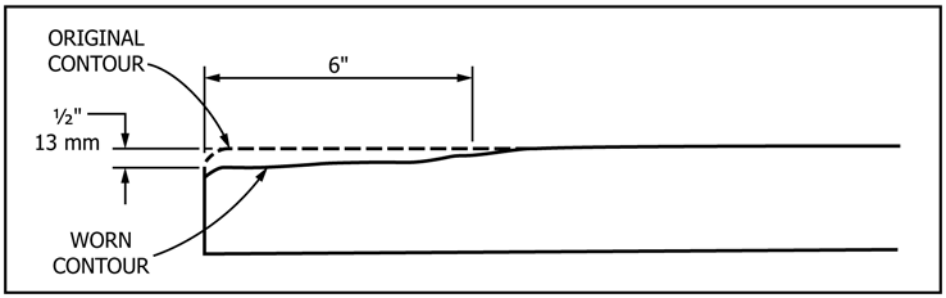

FIG. 18 Side View of Switch Point Contour for Standard Gauge

to 80 pounds per yard (40 kg/m), between a closed switch point and the stock rail shall be inspected with points in both positions.

9.16.6.4 The test spacer is only for the examination and shall not be left in place during normal operation.

9.16.6.5 If the switch can be thrown and locked in either direction with a ¼ in. (6 mm) spacer for greater than 80 pound per yard (40 kg/m) rail or ⅛ in. (3 mm) spacer for less than or equal to 80 pound rail, between the switch point and the stock rail, operations through that side of the turnout shall not be permitted. Spring loaded switches are exempt from the spacer requirement but the point gap limits shall apply.

9.16.7 *Connecting Rods, Switch Rods, and Switch Clips:*

9.16.7.1 If installed, inspect for damaged or missing switch stand lever latches or switch point lock.

9.16.7.2 Inspect for unsecure, loose, damaged, or improperly installed switch stand.

9.16.7.3 Inspect for loose, damaged, or missing jam nut, if used, at the switch stand end of the connecting rod (see Fig. X1.10).

9.16.7.4 Inspect for bent, damaged, loose, binding, or improperly installed connecting rod, switch rods, or switch clips (see Fig. X1.10). These parts shall be maintained to allow unobstructed motion when the switch is thrown. Rod ends and clips shall not contact adjacent ties. Damaged parts shall be replaced.

9.16.7.5 *Switch Stands:*

(1) Switch Stands and Related Linkages to the Swing Points—Any fasteners which affect the function or adjustment of the switch stand and related linkage shall be kept tight as specified by the Designer/Engineer.

(2) Cleaning, Lubrication, and Adjustment of Switch Stands—Switch and switch stands shall be cleaned, lubricated, and adjusted at least annually.

9.16.8 *Frogs:*

9.16.8.1 *Frog Bolts*—When used, all frog bolts shall be in place and tight.

9.16.8.2 *Frog Point*—A frog shall be restored or replaced if the point is chipped, broken, or worn down more than ⅛ in. per ft (10 mm per meter) of track gauge, and not to exceed ½ in. (13 mm), and 1.5 in. per ft (125 mm per meter) of track gauge back from the original point location unless specified by the Designer/Engineer. (See Fig. 19.)

9.16.8.3 *Frog Surface*—A frog shall be restored or replaced if the tread surface is worn more than ⅛ in. per ft (10 mm per meter) of track gauge down, and not to exceed ⅜ in. below its original contour unless specified by the Designer/Engineer. (See Fig. 19.) If the restoration is done by welding, the welding shall be done using materials and processes appropriate to the metal to be welded.

9.16.8.4 *Flangeway Depth*—Inspect the flangeway depth to ensure that flanges of the rolling stock clear the bottom of the flangeway, unless the flangeway is specifically designed for the wheel flange to run on it for example, specially made turnout frogs. Inadaquate flangeway depth can be indicated by scratches in the bottom of the flangeway left by wheel flange contact.

9.16.9 Where installed, guard rails on turnouts shall be positioned per the Designer/Engineer's requirements, and fully secured.

9.16.10 *Guarding Face of Self-Guarded Frogs*—The raised guarding face on a self-guarded frog shall not be worn more

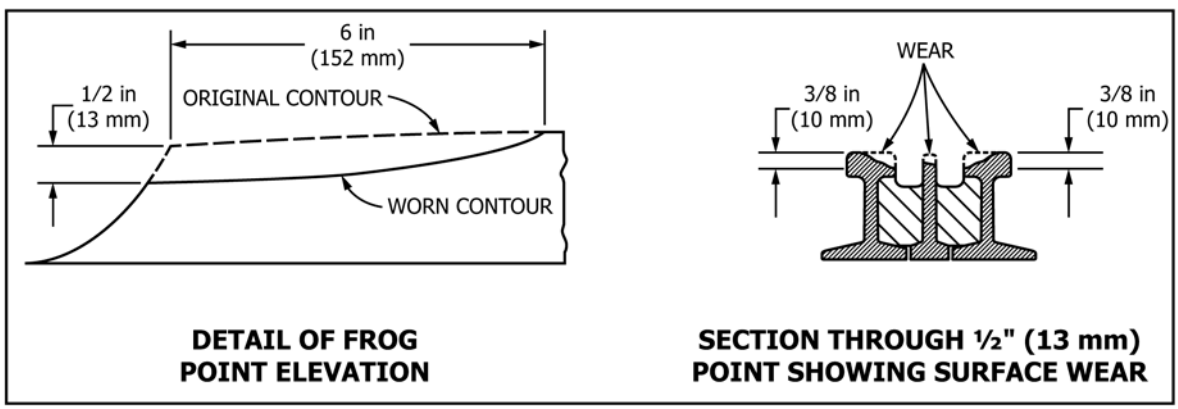

FIG. 19 Detail of Frog Point Elevation

than ⅛ in. per ft (10 mm per meter) of track gauge, and not to exceed ⅜ in. (10 mm) (see Fig. 20).

9.16.11 *Repairing Self-Guarded Frogs*—If repairs are made to a self-guarded frog the repairs shall follow the requirements and processes of the Designer/Engineer.

9.17 *Rail and Road Crossings:*

9.17.1 *Road Crossing*—During routine track inspection, any condition observed in a road crossing which would cause a hazard to vehicles or pedestrians using the crossing shall be corrected immediately or access to the crossing shall be limited accordingly.

9.17.2 The crossing surface shall be maintained to prevent vehicle tires from damaging or dislodging the rails. The rails may be above the crossing surface so that the train wheel running surface does not contact a hard crossing surface.

9.17.3 *Crossing Bolts*—All crossing bolts shall be in place and tight unless specified by the Designer/Engineer. Loose bolts shall be tightened, and bolts which cannot be tightened shall be replaced. Missing bolts shall be replaced.

9.17.4 Water shall not be allowed to pond on or near the track at a road crossing.

9.17.4.1 Catch-basins, gutters, ditches, sub drains, and culverts shall be kept free of debris that would inhibit drainage.

9.17.5 Inspect the flangeway depth to ensure that flanges of the rolling stock clear the bottom of the flangeway, unless the flangeway is specifically designed for the wheel flange to run on it, for example, specially made turnout frogs.

9.17.6 *Crossing Protection*—Crossing protection is a means that warns or provides a physical barrier to non-train crossing traffic of the possible approach of a train at designated areas. When used, crossing protection shall function as intended.

9.17.6.1 Any deficiency or defect in road crossing warning signs or signals shall be repaired prior to operation or the hazard mitigated by other means, for example, blocked off the crossing or replace the crossing protection by an attendant during movement through the crossing.

9.17.7 *Signs and Signals for Use of the Train Operator*—During routine track inspections the maintenance personnel shall maintain the intended purpose of all whistle posts, warning signs, and signals. Signs and signals shall be easily legible, clearly visible and audible at the required observation distances. Signs, signals and crossing arms are warning devices and shall not be interpreted as fences.

9.17.8 *Guard Rails*—If used, the joint bar fasteners shall be present and fastening and tightness specified by the Designer/Engineer.

9.17.8.1 The guard rails shall be secured to the ties or equivalent structure.

9.17.8.2 Guard rail head height shall not be higher than running rail.

9.18 Super-elevation requirements shall be maintained following requirements of the Designer/Engineer.

9.19 If used, derails shall be maintained in good condition, clean and painted in order to be readily visible to operating personnel.

9.19.1 If used, derails shall be locked in either in the derailing position or the non-derailing position.

9.19.2 If a derail is installed in the locking position on a section of track, a sign indicating the presence of a derail shall be posted and the sign shall be visible to operating personnel. The derail sign shall be positioned at the derail. The minimum size lettering on the sign shall be 2 in. (50 mm).

9.20 *Maintenance Activities for Type AP "C" Track:*

9.20.1 *General.*

9.20.2 Inactive track is railway track that is not used for current operations and may be dormant due to scheduling, on standby for future operations, unused due to seasonal conditions or other reasons.

9.20.2.1 *Maintenance Requirements:*

(1) Maintenance of rail, ties, and ballast may be discontinued.

(2) Damaging vegetation in the ballast, roadbed, and ditches should be controlled.

(3) Switches shall be serviced, properly adjusted, and operational or spiked preventing switch movement prior to operation or any movement through the switch.

9.21 *Clearances,* shall comply with the Patron clearance envelop. See 5.17.

9.22 *Track Geometry:*

9.22.1 During routine track inspections, track geometry measurements shall be taken as a minimum at the following locations:

(1) Wherever there are visual indications of track geometry deviations.

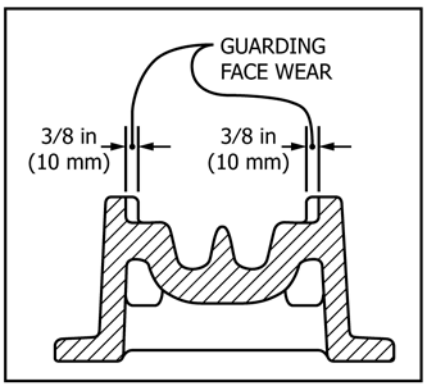

FIG. 20 Allowable Wear on Guarding Face of Self-Guarded Frog

(2) Wherever track geometry deviations were previously detected, unless the deviation has been corrected.

9.22.1.1 Cross level requirements shall be inspected following the requirements of the Designer/Engineer.

9.22.2 *Alignment*—Alignment or line requirements shall be inspected following the requirements of the Designer/Engineer.

9.22.3 *Profile*—Track profile requirements shall be inspected following the requirements of the Designer/Engineer.

9.23 *Bridges, Tunnels, and Other Structures:*

9.23.1 Bridges, tunnels and other track structures shall be maintained in structurally sound condition.

9.23.2 *Bridges:*

9.23.2.1 Debris built up around piers or pilings in streams or drainage channels shall be removed. Wood structures and wood connections to the foundations shall be kept above grade.

9.23.2.2 Any rail anchors (see Fig. X1.6) found on track over an open deck bridge shall be removed immediately.

9.23.2.3 Any reasonable foreseeable condition in a bridge, bridge foundation, or other track structure that might adversely affect train operations shall be reported immediately, operations restricted accordingly, until a detailed inspection can be performed by a qualified person.

9.23.3 *Tunnels and Other Structures*—See 10.1.4.2.

10. Inspection and Record Keeping

10.1 Inspections shall follow the requirements of the track Designer/Engineer and this standard.

10.1.1 Inspection shall be performed by a qualified person.

10.1.2 Any defects discovered that affects operation or operating restrictions shall be communicated to the operator.

10.1.3 *Responsibilities of Inspectors*—The qualified person is responsible for the following:

10.1.3.1 Assuring that inspections are performed in accordance with this standard and other referenced standards or documents.

10.1.3.2 The owner/operator of the railway shall maintain a copy of inspection reports per Practice F770.

10.1.4 *Bridges, Tunnels, and Other Structures:*

10.1.4.1 *Bridges*—An annual inspection shall be performed to look for deformation or deterioration in the structure, such as, rotting wood, concrete cracking or spalling, steel rusting or loose or missing fasteners. If any of these conditions exist, they need to be repaired or analyzed by a person qualified to ascertain their ability to continue in service. The qualified person shall provide a written report.

10.1.4.2 *Tunnels*—An annual inspection shall be performed to look for deformation or deterioration in the structure, such as, concrete cracking, steel rusting, or fasteners loose or missing. If any of these conditions exist, they need to be repaired or analyzed by a person qualified to ascertain their ability to continue in service. The qualified person shall provide a written report.

10.1.4.3 *Other Track Structures*—Structures which are not bridges or tunnels are other structures. This includes structures that are under, on, over or adjacent to the track. These structures are to be inspected by the appropriate qualified person at an interval specified by the Designer/Engineer.

ANNEX

(Mandatory Information)

A1. RAIL DEFECTS, OPERATING RESTRICTIONS, AND REMEDIAL ACTION FOR STANDARD GAUGE

TABLE A1.1 Rail Defects, Operating Restrictions, and Remedial Action for Standard Gauge

Defect Type	Operating Restrictions Until Repairs are Completed (Maximum Operating Speed)	Remedial Action – Replace Entire Defective Rail	Remedial Action – Crop Defect (Note A1.2 and Note A1.3)	Remedial Action – Apply Joint Bars (Fully Bolted)
Bolt Hole Crack	Walking Speed	Allowed	Allowed	–
Broken Base	Walking Speed	Allowed	Allowed	Not Allowed
Corrosion – Greater than 1/16 in., depth per ft (5.2 mm per meter) of track gauge	Walking Speed	REQUIRED	Not Allowed	Not Allowed
Complete Break – Clean & Square	CLOSE TO TRAFFIC	Preferred	–	Allowed (Note A1.3)
Complete Break – Rough or Angled	CLOSE TO TRAFFIC	Preferred	Allowed	Not Allowed (Note A1.4)
Crushed Head	CLOSE TO TRAFFIC	Preferred	Allowed	Not Allowed
Defective Weld	Walking speed	Preferred	Allowed	Allowed
End Batter – See 9.15.2.1	Walking Speed	Allowed	Allowed	Not Applicable
Fissure – compound (Note A1.5)	CLOSE TO TRAFFIC	Preferred (Note A1.1)	Allowed	Not Allowed (Note A1.4)
Fissure – Transverse (Note A1.5) – Size less than 40% of height or width of rail	Walking Speed	Allowed (Note A1.1)	Allowed	Allowed
Fissure – Transverse (Note A1.5) – Size greater than 40% of height or width of rail	CLOSE TO TRAFFIC	Preferred (Note A1.1)	Allowed	Allowed
Fracture – Detail (Note A1.5) – Size less than 40% of height or width of rail	Walking Speed	Allowed (Note A1.1)	Allowed	Allowed
Fracture – Detail (Note A1.5) – Size greater than 40% of height or width of rail	CLOSE TO TRAFFIC	Preferred (Note A1.1)	Allowed	Allowed
Fracture – Engine Burn (Note A1.5) – Size less than 40% of height or width of rail	Walking Speed	Allowed (Note A1.1)	Allowed	Allowed
Fracture – Engine Burn (Note A1.5)– Size greater than 40% of height or width of rail	CLOSE TO TRAFFIC	Preferred (Note A1.1)	Allowed	Not Allowed (Note A1.4)
Head / Web Separation/fissure	CLOSE TO TRAFFIC	REQUIRED	Not Allowed	Not Allowed
Piped Rail	Walking Speed	REQUIRED	Not Allowed	-
Short Rail (less than 3 times the nominal gauge long)	NO RESTRICTION	REQUIRED	-	Not Allowed
Split Rail – horizontal	Walking Speed	REQUIRED	Not Allowed	Not Allowed
Split Head – vertical	CLOSE TO TRAFFIC	REQUIRED	Not Allowed	Not Allowed
Split Web	Walking Speed	REQUIRED	Not Allowed	Not Allowed
Torch Cut – rail ends or bolt holes	Walking speed	Preferred	Allowed	Not Allowed
Wear on 90 lb. or larger rail – Side wear greater than 1/2 in. (13 mm)	Walking Speed	REQUIRED (Note A1.6)	Not Allowed	Not Allowed
Wear on 90 lb. or larger rail – Vertical wear greater than 3/8 in. (10 mm)	Walking Speed	REQUIRED	Not Allowed	Not Allowed
Wear on rail less than 90 lb. – Side or vertical wear greater than 3/8 in. (10 mm)	Walking Speed	REQUIRED	Not Allowed	Not Allowed

NOTE A1.1—If two or more of these defects are found in any individual rail, that rail shall be replaced.

NOTE A1.2—Rails may be cropped by cutting the rail with a rail saw or other appropriate cutting tool, at least 6 in. (152 mm) either side of the defect.

NOTE A1.3—Not allowed if results in a rail length of less than 3 times the nominal gauge (See "Short Rail" below).

NOTE A1.4—May be allowed as an emergency measure until defect is removed provided operations are restricted to walking speed and a qualified individual other than the operator is present to observe operations through the defect area.

NOTE A1.5—If broken through or cracked out, rules for rough or angled complete break apply.

NOTE A1.6—Rail with wear on one side only may be transposed to the other side of the track, thus extending its life.

NOTE A1.7—For non-standard gauge, see 8.2.1.

APPENDIXES

(Nonmandatory Information)

X1. GOOD PRACTICES

NOTE X1.1—The following is a description of good practices and additional information (not requirements). The "X" section numbers mirror the section numbers in the body of the standard. Not all section numbers are referenced.

X1. *Scope*—No Additional Information.

X2. *Referenced Documents*

CFR 49 Part 213 (DOT/FRA Track Standards) (2012)

X3. *Terminology*—No Additional Information.

X4. *Significance and Use*—No Additional Information.

X5. *Design*

X5.1.3 *Ballast*—Ballast is a select material placed on the sub-grade to:

(1) Restrain the ties laterally, longitudinally, and vertically under the dynamic loads imposed by trains and the thermal stresses induced in the rails by changing temperature.

(2) Provide adequate drainage of the track.

(3) Withstand and distribute the load of the track, cross ties, and trains to prevent overstressing the sub-grade.

If ballast is used, both edges of the ballast should be profiled at a slope of approximately 2:1 (run to rise). Ballast should be flush with the top of the tie and extend beyond the end of the tie amount equal to the width of the tie.

Ballast should be cleaned crushed rock not rounded rock or fines.

X5.2 *Cross Ties:*

The preferred species for wood ties are the following hardwoods: Red Oak, White Oak, Hickory, Ash, Beech, and Gum. Where softwoods are used, the Pine and Fir species are preferred.

Ties should be resistant to decay, dry rot and insect infestation. Pressure treated wood ties should be treated in accordance with the most current version of American Wood-Preserver's Association (AWPA) Standard U1 or as specified by the Designer/Engineer.

Wood ties which are cut post treatment should have the cut end treated.

Non-wood ties or similar systems should be in conformance with the AREMA Manual for Railway Engineering or the requirements of the Designer/Engineer. *Caution with use of plastic ties:* There have been reports of longitudinal slippage of rail on plastic ties. Fully secure the rails to these ties and consider the use of rail anchors.

Ties may contain "spike" holes from prior use and are to be properly filled and preserved with specifically designed fillers/adhesives/preservatives to prevent accelerated tie deterioration of the tie prior to use.

X5.2.6 Additional ties may be added for thematic appearance (for show or creative look). The Designer/Engineer should define what is the required tie spacing for "functional" ties and how to differentiate these ties from thematic ties and their spacing.

X5.3 *Tie Plates:*

Use—Tie plates, when used, distribute the applied loads from the rail to the tie as well as assist in keeping the rail in position. Their use is especially important on curves where they can provide additional lateral restraint.

Type—Tie plates may be of either the single shoulder type (see Fig. X1.1) or the double shoulder type (see Fig. X1.1) or maybe either the flat or canted (inclined) type (not shown).

X5.4 *Spikes:*

Spikes should be installed as shown in Fig. X1.2.

On curves of 4° and greater and on the curved side of turnouts, the use of an additional spike as shown in Fig. X1.3 is preferred.

Spikes in Angle Bars—If angle bars are used, spikes shall be installed such that the body of the spike is on the edge of the angle plate and not installed through the slots in skirted-type slotted joint bars (angle bars) as shown in Fig. X1.4 (such fastening would prevent the longitudinal movement of the rail).

X5.5 *Joints:*

Bolts should be installed with spring lock washers. It is recommended that joint bar fastener thread extend beyond the nut by two threads. Nuts shall be installed against the spring (lock) washer as shown in Fig. X1.5. Other styles of bolts, washers, or nuts may be used if approved by the Designer/Engineer.

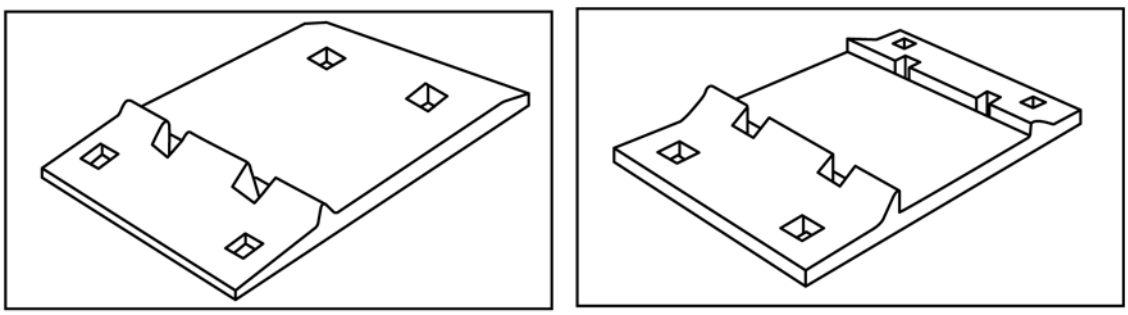

FIG. X1.1 Single Shoulder Tie Plate and Double Shoulder Tie Plate

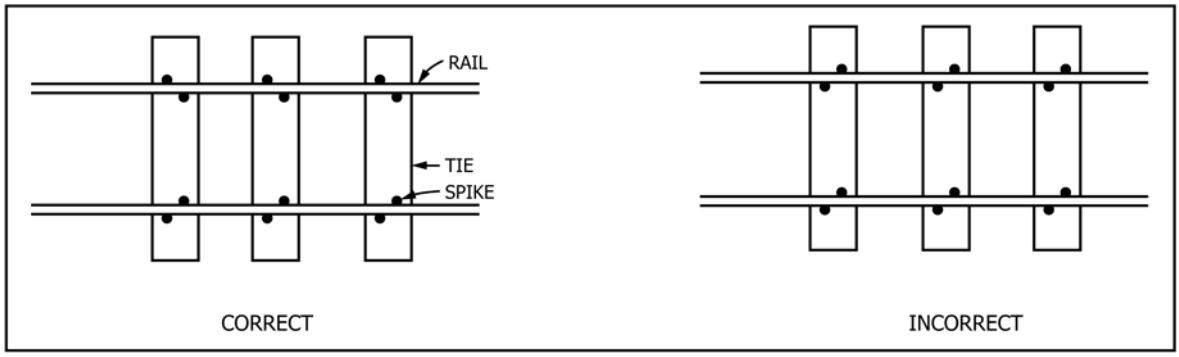

FIG. X1.2 Spiking Pattern

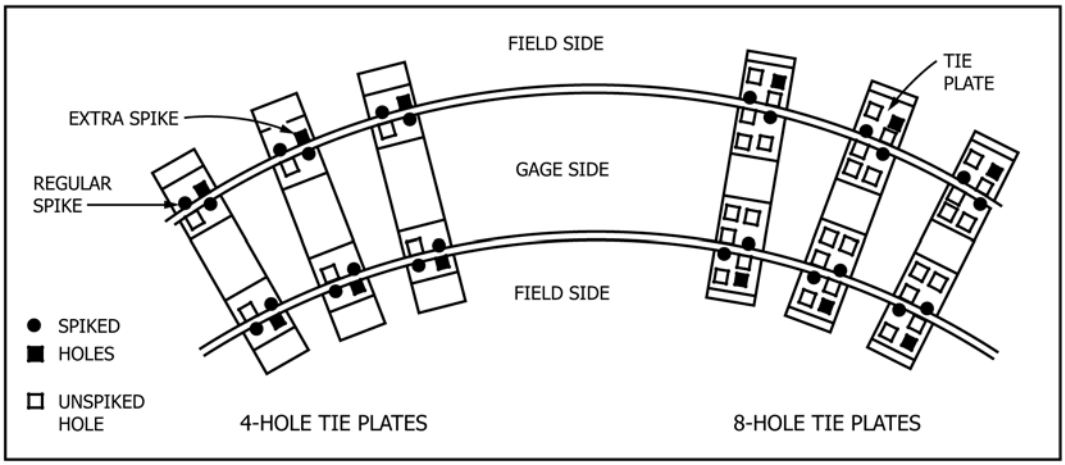

FIG. X1.3 Preferred Spiking Pattern for Curves Greater Than or Equal to 4°

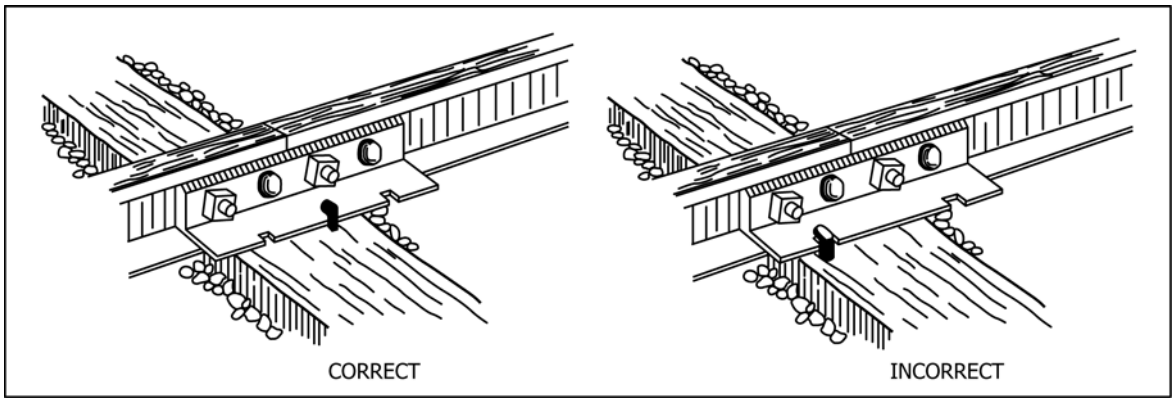

FIG. X1.4 Spiking through Angle Bars

It is preferred that bolts be installed so that the nuts will be alternately on the inside and outside of the rail as shown in Fig. X1.5. Smaller gauge (36 in. (91 mm) or less) and light weight rails (less than 70 lbs per yard (35 Kg/m)) may install bolts with all nuts to the outside, away from wheel flange, contact area on the inside of the rails if required by the equipment manufacture or the Designer/Engineer.

X5.6 *Rail Anchors:*

Rail anchors should be used at locations where the track is subject to significant movement from rail expansion or traffic conditions to inhibit longitudinal movement of rails.

Rail anchor is a device attached to the foot of a rail adjacent to a tie to resist the longitudinal movement of the rail relative to the tie. See Fig. X1.6. When used, rail anchors shall be installed following the requirements of the Designer/Engineer.

If rail anchors are used, the general rules are:

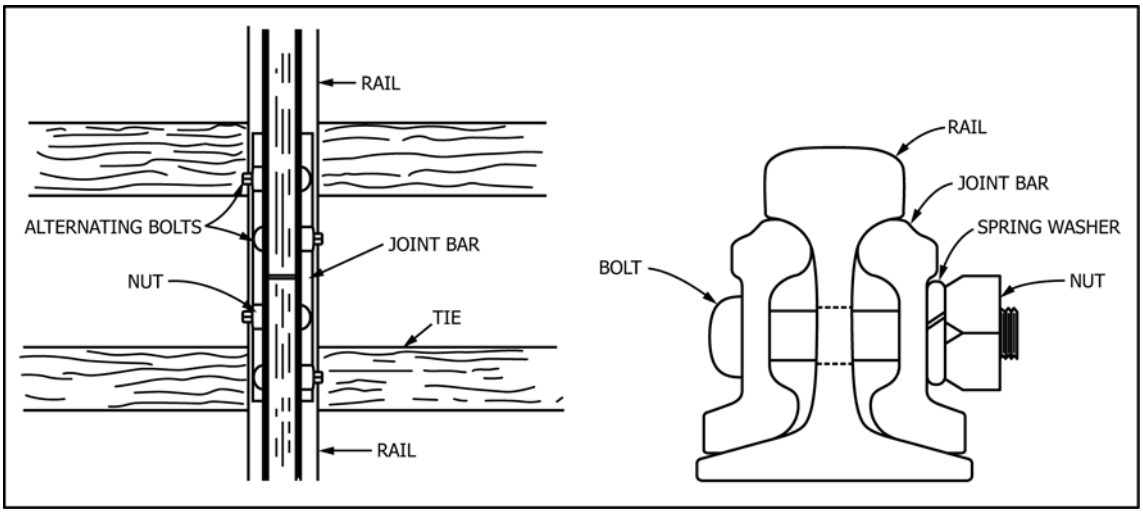

FIG. X1.5 Joint Bar Bolt Installation

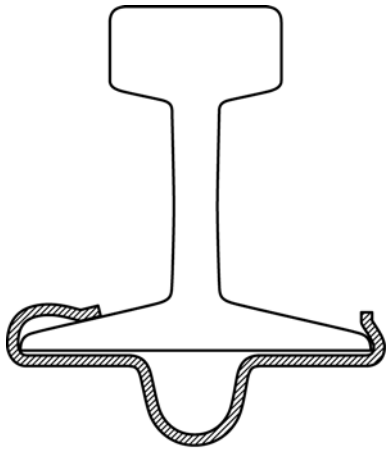

FIG. X1.6 Typical Rail Anchor

(1) The head or large end of the anchors shall be applied to the gauge side of the rail against the same tie face on opposite rails.

(2) Anchors shall grip the base of the rail firmly and have full bearing against the face of the tie.

(3) When the bearing of the rail anchor against the tie has been disturbed by removal of the tie, the anchor shall be removed and reset.

Anchor Locations:

Where used, eight anchor locations (see Fig. X1.7) per 39 ft (11.9 m) of rail for standard gauge or, for lesser gauges, a scale of this distance should be used. If a train normally circulates only in one direction anchors can be use only on the lead-in side of the tie.

Additional anchor locations should be used as needed, and they should be installed four anchors per tie with approximately uniform spacing along the rail.

At Open Deck Bridges—Where anchors are used on track approaching open deck bridges, every third tie should be box anchored (four anchors per tie) for at least one rail length off each end of the bridge.

At Rail Crossings—Where anchors are used on track approaching rail crossings, every third tie should be anchored for at least one rail length in all directions from the crossing, 4 anchors per every third tie if trains travel in both directions and 2 anchors (anchors on the leading side of the tie) if the train normally travels only in one direction.

X5.7 *Gauge Rods:*

Use—When used, gauge rods help maintain proper track gauge but are not a substitute for good track maintenance and good tie conditions. Gauge rods are sometimes used at the following locations:

(1) On sharp curves where there is difficulty holding the gauge.

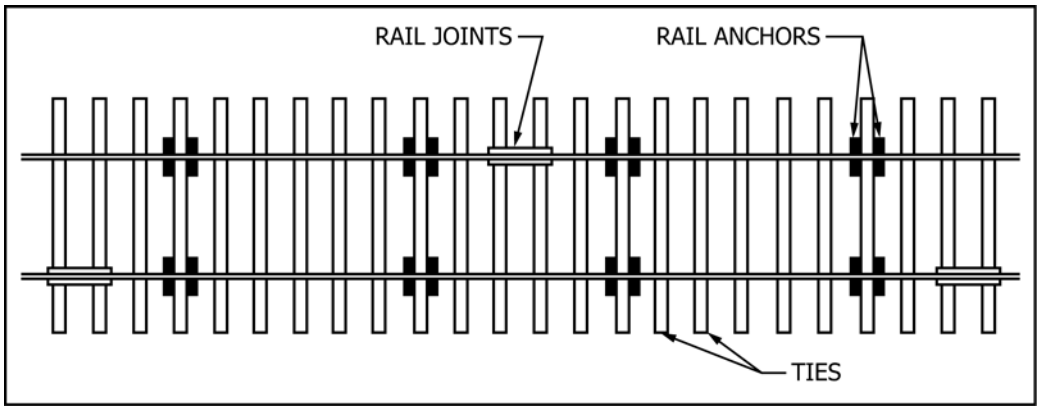

FIG. X1.7 Recommended Minimum Anchoring Pattern

(2) In turnouts just ahead of the switch points and on the curved closure rails.

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

X5.8 No Additional Information.

X5.9.2 *Track Geometry*—See also X5.12.10

X5.9.2.1 No Additional Information.

X5.9.3.2 *Degree of Curvature:*

Curvature Measurement—The degree of curvature (for standard and non-standard gauge) is the amount of the central angle of a track curve in degrees subtended by a chord of 100 ft (30.5 m). If the degree of curvature is not known, it can be determined as follows: degree of curvature (in degrees) is equal to 5729.7/*R*, where *R* equals the radius of the curve in feet (1746.4/*R*, where *R* equals the radius of the curve in meters). A

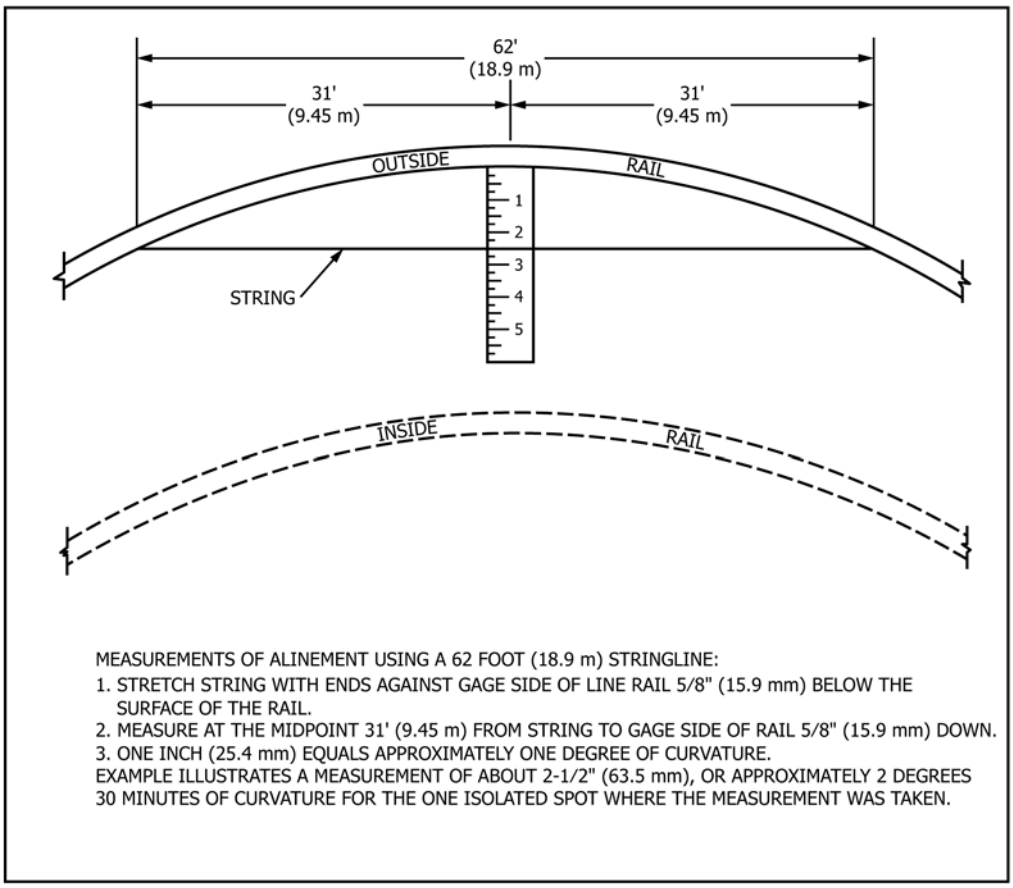

FIG. X1.8 Measurement of Curve

practical way to estimate curvature is that 1 in. (25.4 mm) distance from a 62 ft (18.9 m) string-line to the line rail equals approximately 1° of curvature, as shown in Fig. X1.8.

It is strongly recommended to provide a transition curve or spiral between a tangent track and a fixed radius track.

Beginning at a point near the center of the curve, mark at least two stations spaced 31 ft (9.45 m) apart in both directions along the line rail.

Measure the alignment at each station, including the beginning point, and average the measurements. This average measurement is the approximate degree of curvature.

X5.12 *Turnouts*—Turnouts are designed to divert trains from one track to another. Major components of a turnout are the switch, frog, and guard rails. Fig. X1.10 shows a typical turnout with the various parts identified.

X5.12.4.1 *Rail Braces Rail Braces*—It is recommended that rail braces, when used, be installed on each tie from the point of switch to within two ties of the switch heel. Rail braces are designed and manufactured for the specific turnout. See Figs. X1.9 and X1.10.

X5.12.8 *Switch Stands*—A colored banner or switch lamp/reflector, or both, should be considered based upon on the ride analysis.

Switch Stand Placement—If used, switch stands with banner indicators of switch position should be used on main line track switches and that they be located outside the reach of riders per the Patron clearance envelop (see 5.17). The Patron clearance envelope should be determined by ride analysis per Practice F2291. The envelope should be documented in the railway records.

The switch stand should be installed so that when the switch is lined for the normal (main) route, the connecting rod keeps the points closed with a pulling (rather than a pushing) force. In most cases this will mean installing the stand on the diverging side of the turnout as shown in Fig. X1.11.

X5.12.10 *Guard Rails, Flangeways, and Check Gauges*—Flangeway width is the distance between the gauge side of the running rail and the guard face of the guard rail. This width is limited to a minimum width in order to have enough clearance for the flanges of the wheels to pass freely through without any binding.

Check gauge is distance measured at right angles to the running rail between the gauge side of a switch frog and the guard side of the frog's guard rail. This dimension is limited to a minimum in order to prevent the wheel on the frog side from hitting the point of the frog.

Guard gauge is the distance measured at right angles to the running rail between the guard side of the guard rail and the guard side of the frog wing rail. This dimension is limited to a maximum so that the inside surfaces of the wheel rims do not pinch on the guard faces.

When considering a turnout, all three dimensions are to be looked at together as well as the actual track gauge at the point of the frog. If any one of these dimensions is out of tolerance, derailment is more likely.

The Federal Railroad Administration has requirements for standard gauge trackage in 49 CFR, Part 213. These requirements are based upon standard wheel profile dimensions required by the Association of American Railroads. Miniature railways cannot always scale these larger dimensions down because there is no universal standard for wheels. In other words, wheel profiles may differ from one gauge railroad to another.

FIG. X1.9 Rail Brace

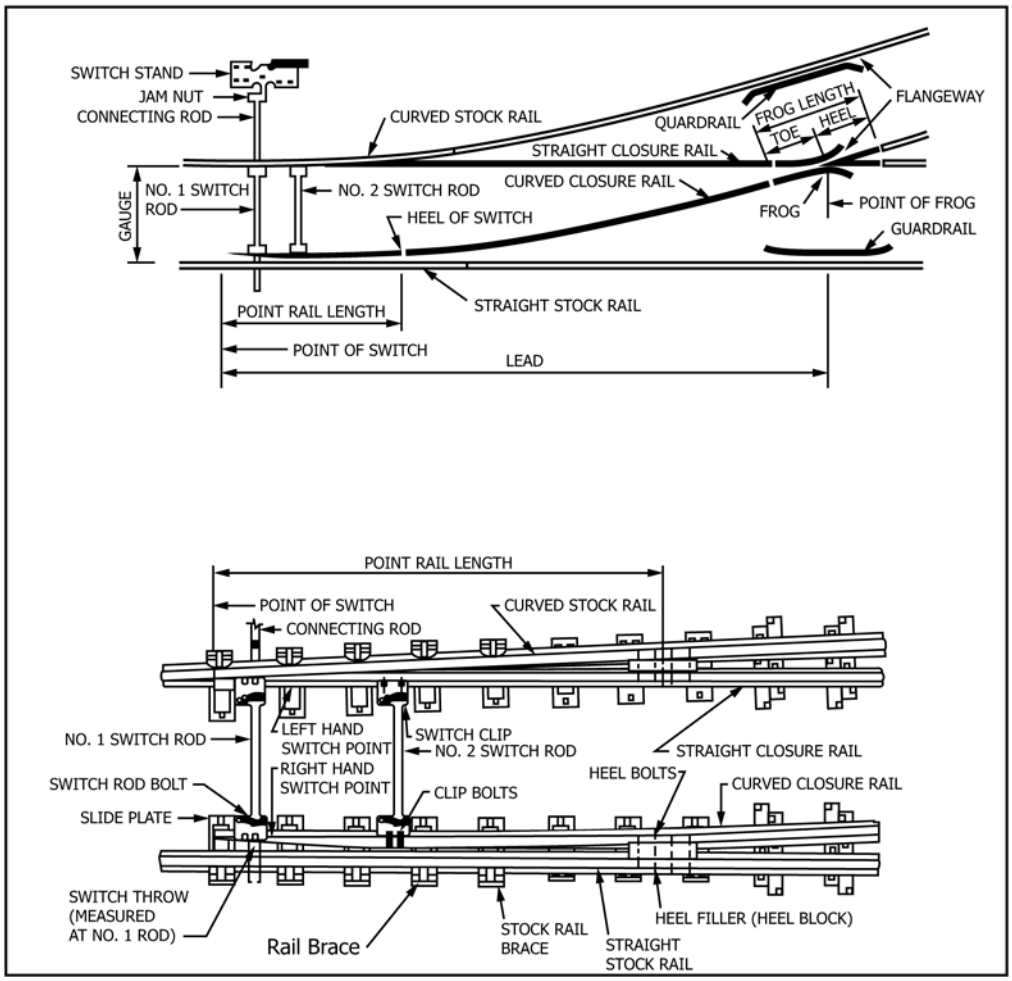

FIG. X1.10 Components of a Turnout

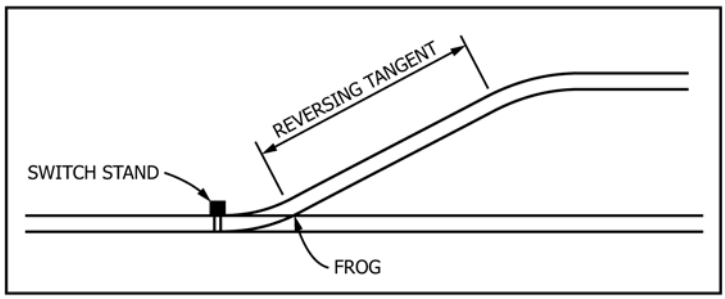

FIG. X1.11 Reversing Tangent Length and Switch Stand Placement

For the greatest reliability, wheel profiles should be consistent on any given railway system. More variation in wheel profile will require greater tolerances in the track system. The varied wheel profiles and looser tolerances can lead to a greater chance of a single wheel-to-rail mismatch that could lead to a derailment.

The first step in designing, inspecting, and maintaining an amusement railway system is to know the dimensions of the wheelsets operating on that system. Once known, the extremes need to be taken into account when gaging track. Typically considered are maximum flange width, tread width, minimum back-to-back of the wheel or tire rims, and maximum gauge. Additionally, the longest rigid wheel base with more than two axles are to also be considered. Sometimes these can be in all sorts of combinations such as wide tread/narrow flange, wide tread/wide flange, narrow flange/narrow gauge, and so on. Tracking reliability and simplification of the track system will be increased with fewer variations in wheelsets and it may be necessary to modify some of the wheelsets in order to maintain a standard set of track specifications.

The track gauge is the first item to consider. If a turnout has a sharp enough curve and at least one piece of equipment has a long enough rigid wheelbase, the track gauge may need to be widened slightly through the diverging leg of the turnout.

Typically, the frog area of a turnout is straight on both legs, but in miniature railways curves are often continued through the frog area. Whatever the case, the gauge is to be wide enough to pass the widest gauge, longest wheelbase piece of equipment without binding on the flanges.

Once gauge is established, the check gauge is determined in order to place the guard rail in a position to prevent any wheelset flange from striking the point-of-frog. Check gauge will be equal to the wheelset with the greatest distance between the gauge point of one wheel and the back of the rim of the opposite wheel. Essentially, that dimension becomes the check gauge. If this distance was lessened, the wheelset in question would most likely strike the point-of-frog and possibly derail.

Once the guard rail is in place, the flangeway width is checked to ensure it is wide enough to easily pass the widest flange operating on the system. If it is not wide enough, it may be possible to widen the track gauge a bit unless there is another wheelset that has a narrow enough tread to prohibit widening the gauge. If this be the case, the offending wheelset(s) is altered to more closely match the majority that operate on the system.

Assuming check gauge is established and the flangeway is wide enough, the guard gauge between the guard rail and the frog wing rail is to be established. This distance will be no wider than the smallest back-to-back dimension of any wheelset operating on the system and typically should be a bit less so there is no chance of binding on the back side of the rims. The flangeway width between the frog running rail and the frog wing rail is to be wide enough to pass the widest flange on the system. Widening the flangeway of the frog wing rail will have no negative affect on gauge issues however as the flangeway widens, the longitudinal distance between the point-of-frog and the closure rail where it diverges to become the wing rail will lengthen which can result in smaller diameter wheels dropping vertically in this gap and will lead to damaging the top of both the frog point and the closure rail, and could also damage wheels.

As a final note, the depth of the flangeways is to be a bit deeper than the highest flange operating on the system, accounting for maximum allowable tread wear. Flanges are not to be allowed to bottom out and raise the tread off the rail unless a turnout is specifically designed for this. This condition is hard on the flanges and track, and can lead to an increased possibility for derailment.

When considering guard rails at road crossings, only guard gauge and flangeway width need be considered in the same manner as a turnout. Excessively wide flangeways will have no impact on the tracking ability of rail equipment, but may pose a safety hazard to traffic crossing the tracks.

X5.12.10.1 The track guard rail(s) may be directly attached to the ties or similar systems without tie plates.

X5.12.10.2 The frog is the portion of a turnout that provides support for the wheels and a passageway for the wheel flanges as they cross from one track to another.

Good turnout maintenance is essential for the safe and efficient operation of trains.

Reversing Tangent—It is recommended that the tangent between the frog and any reverse curve past the frog be no less than the length of the longest vehicle in the train as shown in Fig. X1.11. It is also advisable to have a tangent between any reverse curves.

X5.12.11 See X5.12.10.

X5.14 *Rail Crossing*—The track guard rail(s) may be directly attached to the ties or similar systems without tie plates.

Anchors—Where rail anchors are used on track approaching rail crossings, every third tie should be box anchored (four anchors per tie if the train travels in both directions or two anchors per tie if the train only travels in one direction) for at least one rail length in all directions from the crossing.

X5.15 *Road Crossing*—The track guard rail(s) may be directly attached to the ties or similar systems without tie plates.

Road Crossing Flangeways—Pedestrian road crossings should consider the use of rubber “flangeway fillers”. It is recommended that the type of flangeway filler have a flat or slightly curved top that comes to the height of the railhead and is pushed away by passing wheel flanges. If flangeway fillers are used, they shall be secured in place. Periodic inspection should confirm they are secure.

X5.15.5.1 Road crossing warning signage lettering should not be less than 2 in. (51 mm) in height.

X5.17 *Clearances*—No further information.

X5.19 *Track Maps:*

Track maps shall identify and locate the track data listed below. The Owner of the railroad or designated person shall maintain a complete, accurate, representative and up-to-date set of track maps for use by maintenance and Designer/Engineering personnel.

Legend—Track maps shall contain a legend identifying all symbols used in the track map.

Track Data—Data presented on track maps should include the following:

(1) All track, active and inactive.
(2) Track name or identification for each track.
(3) Speed limitations.
(4) Track type for each area of track.
(5) Track Gauge.
(6) Buildings, loading docks, bridges, culverts, and other structures on or adjacent to the railroad roadway.
(7) Highway and road crossings and their traffic load ratings or capacity.
(8) Rail weight.
(9) Turnout identification.
(10) Grades and profile information.
(11) Location of signage where to whistle.
(12) If used, location of signals and crossing arms.

X5.21.1.4 *Guard Rails on Bridges and Trestles:*

Track Guard Rails—Track guard rail(s) on bridges are rails or similar structure set within the gauge of the rails that hold the wheels of a vehicle in lateral position via the back rim face of the wheels.

The track guard rail(s) may be directly attached to the ties or similar systems without tie plates.

Bridges and trestles are recommended to have guard rails that start prior to the bridge a sufficient distance to prevent the

rolling stock from leaving the track while on such structures. The gauge of the guard rails shall be determined by Fig. X1.12.

X5.22.3 *Guard Rails in Tunnels:*

Track Guard Rails—Track guard rail(s) on bridges are rails or similar structure set within the gauge of the rails that hold the wheels of a vehicle in lateral position via the back rim face of the wheels.

The track guard rail(s) may be directly attached to the ties or similar systems without tie plates.

The guard rail(s) should not be taller than the installed running rail. The ends of the guard rail(s) shall be turned in towards the centerline of the track so to guide a derailed train between the running rail and the guard rail. Track guard rail(s) may be used or worn rails. Track guard rail(s) may be different weight and shape rail than running rails.

Tunnels are recommended to have guard rails that start prior to the bridge a sufficient distance to prevent the rolling stock from leaving the track while on such structures. The gauge of the guard rails shall be determined by Fig. X1.12.

X6. *Manufacturing*—No Additional Information.

X7. *Installation*

Ties should be initially installed perpendicular to the rails (±20°) except at turnouts, edges of crossings and at ballast at the edges of crossings, edges of bridges and at ballast at the edges of bridges, as required, and be properly tamped and spiked. Also see 8.1.3 for allowable skew ties after installation.

Drilled holes of appropriate size in ties prior to driving of spikes may reduce the tendency for the spikes to come lose.

Spikes should not penetrate the full thickness of the tie.

Switches—Washers or similar spacers should not be permitted between the switch clip and the switch point.

X8. *Operation*—See Fig. X1.13.

X9. *Maintenance*

X9.3.5.1 *Seismic Events:*

The indicators of a moderate or greater seismic event in the immediate vicinity of the railroad are any of the following:

(1) That it was felt by all persons,

(2) Windows broken, things have fallen off of shelves,

(3) Props or furniture moved,

(4) Plaster or bricks or tiles have fallen.

X9.8.3 *Vegetation*

Vegetation should not be allowed to penetrate the ballast.

Desirable Vegetation—Vegetation may be planted and grown on the slopes of cuts and fills and in other locations within the roadway to prevent erosion. The growth of desirable vegetation should be controlled to meet the requirements of 9.8.3.

X9.8.4 *Ballast*—During major maintenance or track rehabilitation, dirty or fouled crushed stone or slag ballast meeting the requirements herein may be cleaned or reconditioned and reused.

X9.13 *Cross Ties*—Ties should be maintained perpendicular to the rails (±30°) except at turnouts, edges of crossings, bridges, as required, and be properly tamped and spiked. Skewed ties maybe necessary at turnouts where converging rails meet, for example, at a turn out or where the edge of a bridge or road/rail crossing is not perpendicular to the track and shall be allowed.

Skewed ties (ties skewed more than 30°) except where intentionally designed to be skewed should be straightened during the next track rehabilitation.

X9.15.1 *Internal Defect Inspection*—An internal rail defect inspection, if performed, should be conducted using accepted railroad industry practice and the results recorded and preserved. If a defect is found, the manufacturer or Designer/Engineer should supply appropriate accept/reject criteria for evaluating internal defect indications.

X9.17 *Ties, Tie Plates, and Spikes in Crossings*—When crossings are rebuilt with ties, all ties within the crossing limits and for a distance of at least five (5) times the track gauge, beyond each end of the crossing should be replaced, fully tie plated (when used), and spiked with eight rail-holding spikes on each tie (see Fig. X1.14) or as specified by the Designer/Engineer.

X10. *Inspection and Record Keeping*—Reserved.

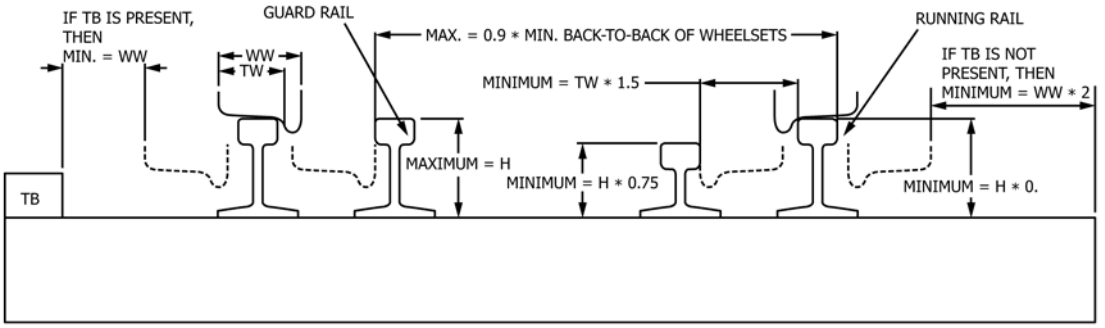

FIG. X1.12 Bridge and Tunnel Guard Rails Recommended Maximum and Minimum

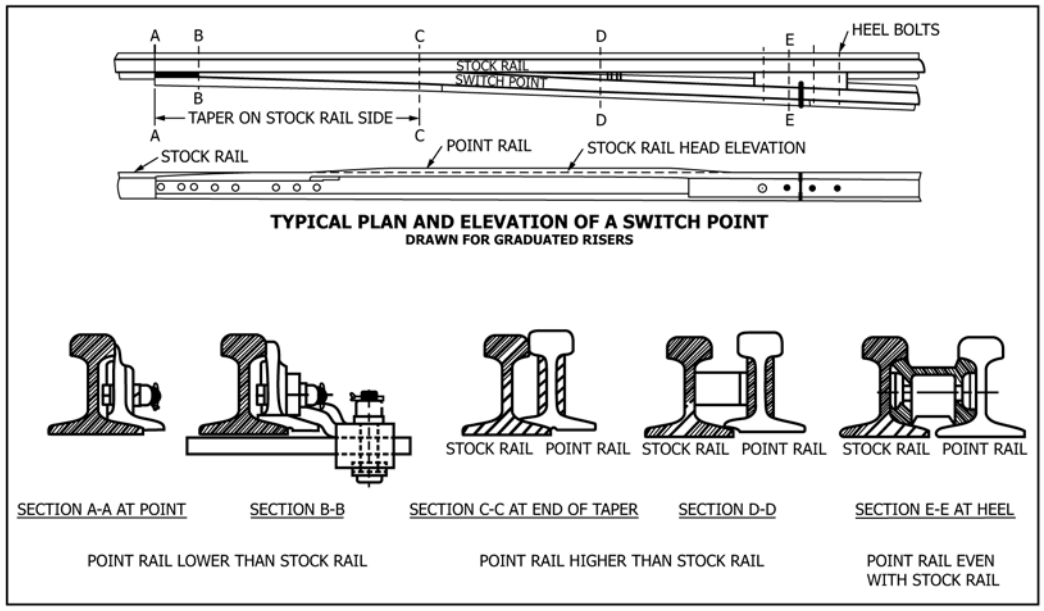

FIG. X1.13 Example of Switch Point Plan and Elevation

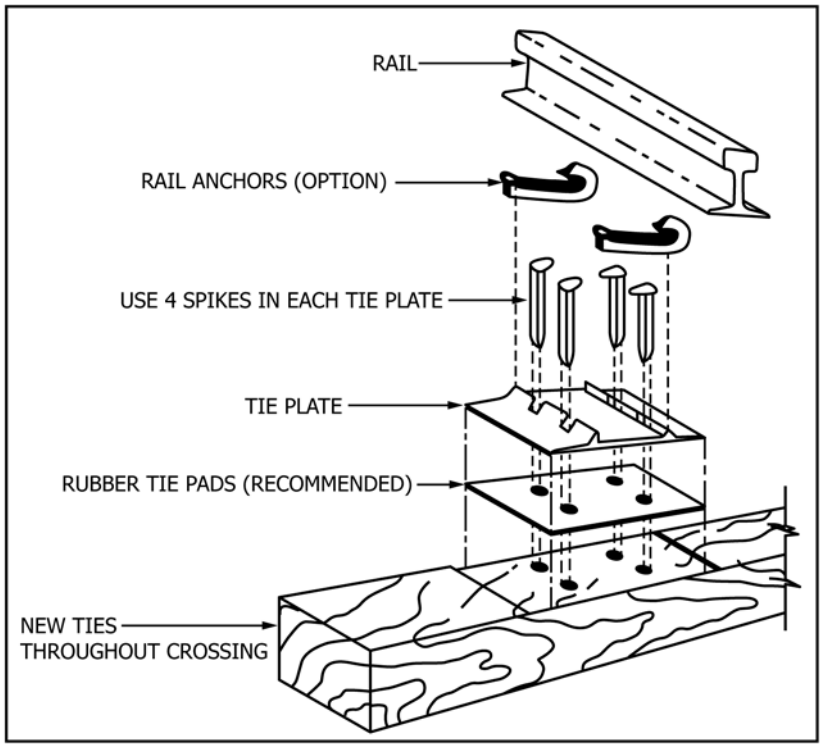

FIG. X1.14 Track Construction for Road Crossing

X2. INSPECTIONS

INTRODUCTION

The following identify inspections for the defects listed in X2.1, X2.2, and X2.3 can be performed visually without disassembly except for embedded track, for example, track encased in concrete or asphalt. In the case of embedded track, inspect the visible areas.

X2.1 Field Identification of Rail Defects

X2.1.1 *Rail Defects may be Observed in Track*—This appendix presents definitions relating to rail and brief descriptions of the common rail defects observed in track. Fig. X2.1 presents common rail nomenclature, and Fig. X2.2 shows the relative positions of planes through the rail.

X2.1.2 *Not All Rail Defects are Critical*—A critical defect is a rail defect that will effect the safety of train operations. Noncritical defects are defects that occur in the rail but do not effect the structural integrity of the rail or the safety of the trains operating over the defect. Noncritical defects are identified in the defect descriptions presented in this appendix. Table A1.1 of these standards presents a listing of rail defects, operating restrictions, and remedial actions.

X2.1.3 *Field Identification of Rail Defects*—These descriptions are presented in alphabetical order to assist in identifying defective rails in track.

X2.1.3.1 *Bolt Hole Crack:*

(1) Description—A progressive fracture originating at a bolt hole.

(2) Appearance in Track—Bolt hole cracks are not visible until a bolt or a joint bar has been removed unless the defect has progressed beyond the bar. They may be recognized by a hairline crack extending from the bolt hole (Fig. X2.3).

X2.1.3.2 *Broken Base:*

(1) Description—Any break in the base of the rail.

(2) Appearance in Track—Gently appears as a half-moon crack break in the rail base. Fig. X2.4 illustrates three different appearances of broken bases.

X2.1.3.3 *Complete Break (broken rail):*

(1) Description—A complete transverse separation of the head, web, and base of the rail.

(2) Appearance in Track—May appear as a hairline crack running completely around the rail, usually accompanied by bleeding or a separation of the rail at the break with one or both of the broken ends battered down (see Fig. X2.5).

X2.1.3.4 *Compound Fissure*—See “transverse defects.”

X2.1.3.5 *Corrosion:*

(1) Description—The decaying or corroding of the metal in the web or base of the rail.

(2) Appearance in Track—Pits or cavities in the upper base or the web of the rail. In advanced stages, a significant loss of material is evident.

X2.1.3.6 *Corrugation:*

(1) Description—A repeated wavelike pattern on the running surface of the rail. Corrugations develop over a long period of time. A number of factors contribute to the development of corrugations with the actual cause dependent on the track and operating conditions. Corrugations are not a critical defect.

(2) Appearance in Track—Small, hard, bright, short-pitch ridges along the running surface of the rail varying anywhere from 2 to 18 in. apart and usually less than 1⁄16 (0.0625) in.

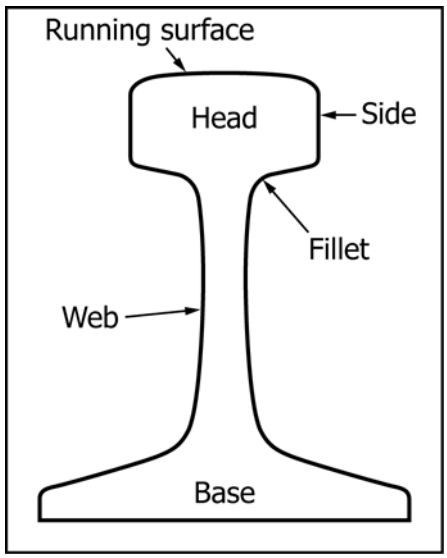

FIG. X2.1 Rail Nomenclature

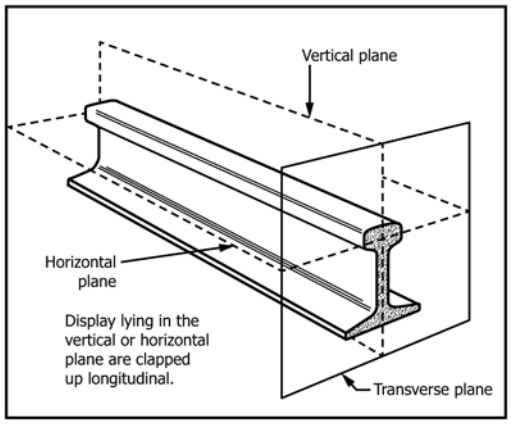

FIG. X2.2 Relative Positions of Planes through a Rail

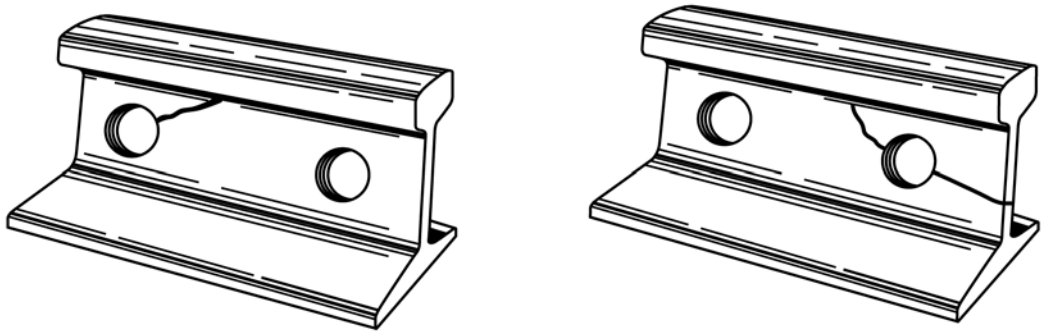

FIG. X2.3 General Appearance of Bolt Hole Cracks

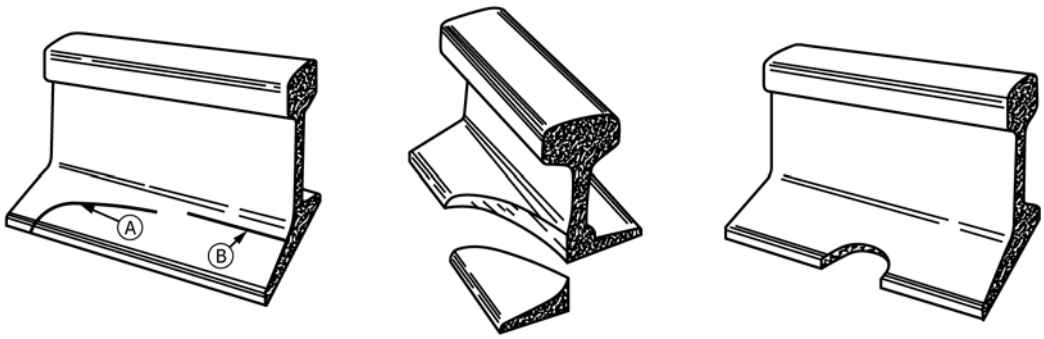

FIG. X2.4 General Appearance of Broken Base

deep. Although the individual waves (ridges) are usually only a short distance apart, the corrugations may extend over a considerable distance (see Fig. X2.6).

X2.1.3.7 *Crushed Head:*

(1) Description—The flattening of several inches of the rail head, usually accompanied by a crushing down of the metal but with no signs of cracking in the fillet under the head.

(2) Appearance in Track—Generally appears as:

(a) Flattening and widening of the head for several inches with the entire head sagging.

(b) Small cracks in a depression on the running surface.

(c) In advanced stages, a bleeding crack may be present at the fillet under the head (see Fig. X2.7).

X2.1.3.8 *Defective Weld:*

(1) Description—A progressive transverse separation within an area where two rails have been joined by welding or a rupture at a weld where improper fusion has occurred.

(2) Appearance in Track—No outward sign is visible until the separation reaches the rail surface. A defective weld may then be recognized by a vertical bleeding crack at the welded portion of the rail joint where the separation has reached the surface.

X2.1.3.9 *Detail Fracture*—See “transverse defects.”

X2.1.3.10 *End Batter:*

(1) Description—Damage caused by wheels striking the rail ends.

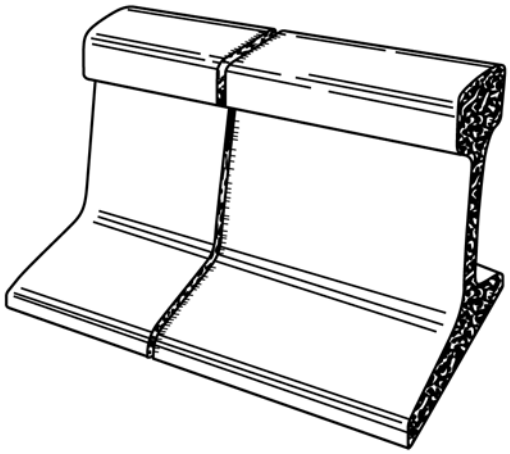

FIG. X2.5 General Appearance of Broken Rail

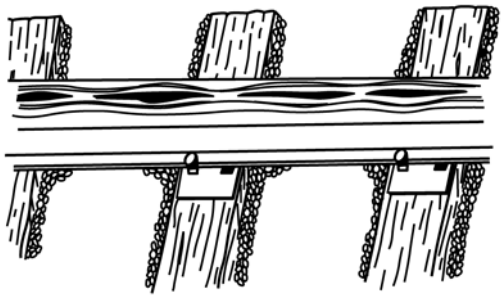

FIG. X2.6 General Appearance of Corrugation

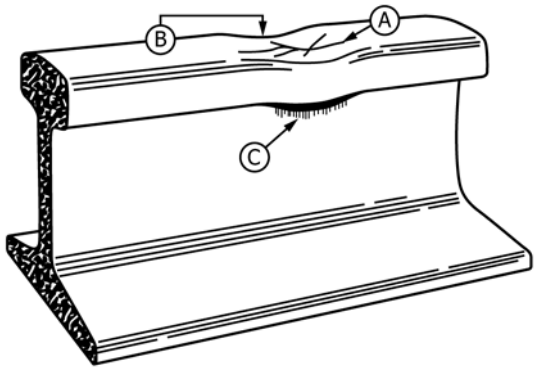

FIG. X2.7 General Appearance of Crushed Head

(2) Appearance in Track—Appears as damage to or a depression in the top surface of the rail head at the ends of the rail (see Fig. X2.8).

X2.1.3.11 *Engine Burns (burned rail):*

(1) Description—Rail that has been scarred on the running surface by the friction of slipping locomotive wheels. An engine burn is not a critical defect; however, an engine burn may lead to an engine burn fracture.

(2) Appearance in Track—Round or oval rough spots or holes on the tread of the running surface. Often the source of engine burn fractures. Engine burns may be deep (see Fig. X2.9).

X2.1.3.12 *Engine Burn Fracture:*

(1) Description—A progressive fracture in the rail head starting from a point where engine wheels have slipped and burned the rail.

(2) Appearance in Track—No sign of transverse separation is visible until the defect reaches the rail surface (cracks out). An engine burn fracture may then be recognized by one or more of the following characteristics.

(a) A hairline crack on the side of the head in the immediate vicinity of an engine burn and at right angles to the running surface. The crack may be visible on either the field or gauge side of the head.

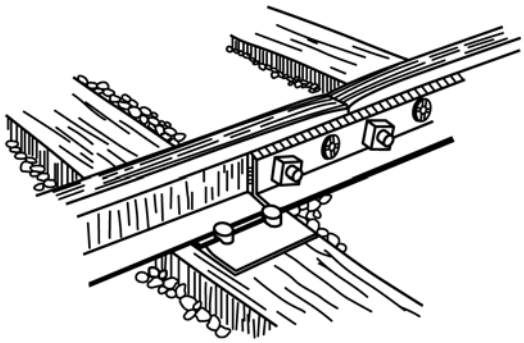

FIG. X2.8 Rail End Batter

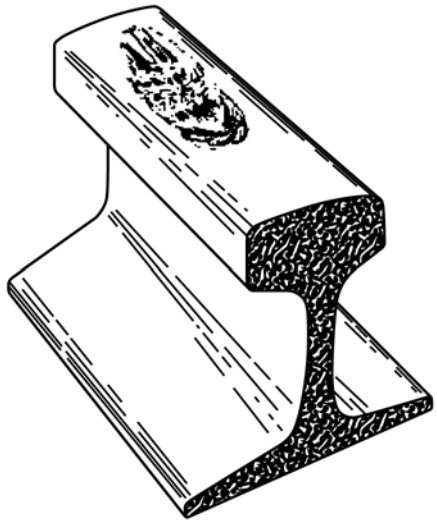

FIG. X2.9 Typical Appearance of an Engine Burn

(b) Transverse thermal cracks extending from the burn to the gauge corner and down the side of the head for at least ⅛ (0.125) in.

(c) A cracked out horizontal separation on the field side of the rail head under the burned area often accompanied by one or more thermal cracks extending transversely to the gauge corner (see Fig. X2.10).

X2.1.3.13 *Flaking:*

(1) Description—A progressive horizontal separation on the running surface near the gauge corner often accompanied by scaling or chipping. Flaking should not be confused with shelling as flaking occurs only on the running surface near the gauge corner and is not as deep as shelling. Flaking is not a critical defect.

(2) Appearance in Track—Can be recognized by one or more of the following characteristics:

(a) Shallow depressions with irregular edges occurring on the running surface near the gauge corner. Generally flaking will occur within ¼ (0.25) in. of the corner of the rail.

(b) Horizontal hairline cracks along the running surface near the gauge corner of the rail head, resembling small slivers (see Fig. X2.11).

X2.1.3.14 *Flowed Rail:*

(1) Description—A rolling out of the tread metal beyond the field corner with no breaking down of the underside of the head. Flow is not a critical defect.

(2) Appearance in Track:

(a) Surface metal on the head flowed toward the field side giving a creased appearance on the running surface near the field corner.

(b) A protruding lip extending along the length of the rail.

(c) In the advanced stage, flow becomes bladelike, jagged, or nonuniform and may hang down or separate from the rail head (see Fig. X2.12).

X2.1.3.15 *Head/Web Separation:*

(1) Description—A progressive fracture separating the head and web of the rail.

(2) Appearance in Track—Can be recognized by one or more of the following characteristics.

(a) In earlier stages, wavy lines appearing along the fillet under the head.

(b) As the condition develops, a small crack will appear along the fillet on either side progressing longitudinally with slight irregular turns upward and downward.

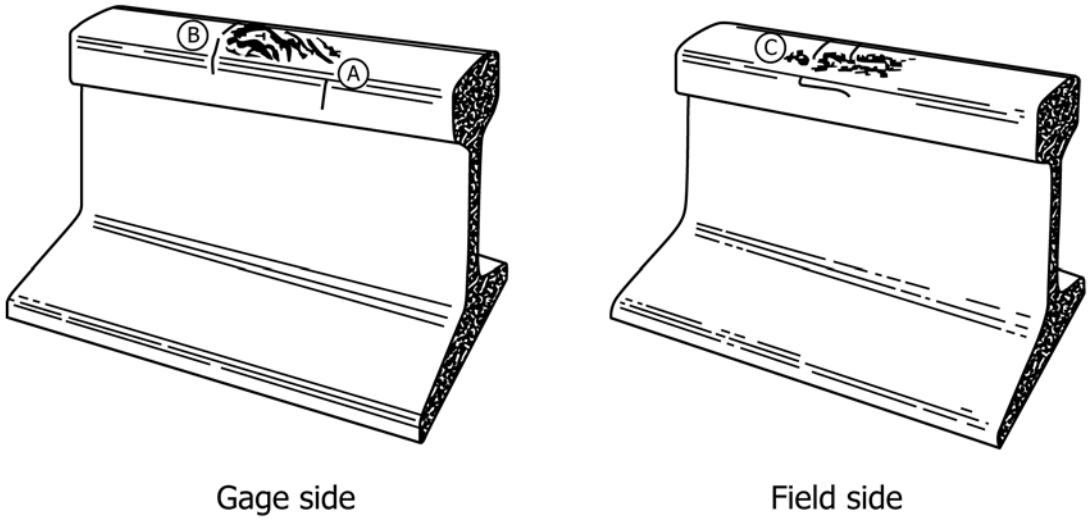

FIG. X2.10 General Appearance of an Engine Burn Fracture

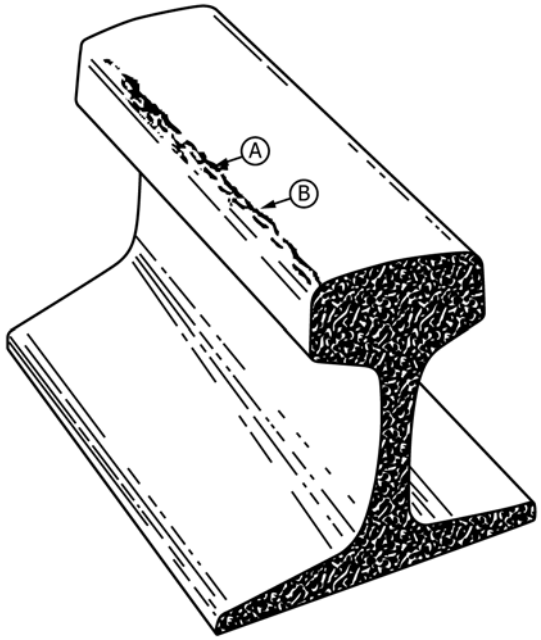

FIG. X2.11 General Appearance of Flaking

(c) In advanced stages, bleeding cracks will extend downward from the longitudinal separation through the web and may extend through the base (see Fig. X2.13).

X2.1.3.16 *Horizontal Split Head:*

(1) Description—A progressive longitudinal fracture in the rail head parallel to the running surface.

(2) Appearance in Track:

(a) Before cracking out, a moderate size horizontal split head will appear as a flat spot on the running surface often accompanied by a slight widening or dropping of the rail head. The flat spot will be visible as a dark spot on the bright running surface.

(b) After cracking out, the horizontal split head will appear as a hairline crack in either side or both sides of the rail head usually ¼ (0.25) in. or more below the top of the rail head (see Fig. X2.14).

X2.1.3.17 *Mill Defects:*

(1) Description—Deformations, cavities, seams, or foreign material found in the head, web, or base of the rail. Mill defects are not critical defects.

(2) Appearance in Track—Any deformation in the rail, broken out area, or inclusion (see Fig. X2.15).

X2.1.3.18 *Piped Rail:*

(1) Description—A progressive longitudinal fracture in the web of the rail with a vertical separation or seam, forming a cavity in the advanced states of development.

(2) Appearance in Track:

(a) A bulging of the web on either or both sides. Shallow cracks due to distortion may be found in the bulging surface.

(b) A slight sinking of the rail head may exist above the pipe (see Figs. X2.16 and X2.17).

X2.1.3.19 *Rail Wear:*

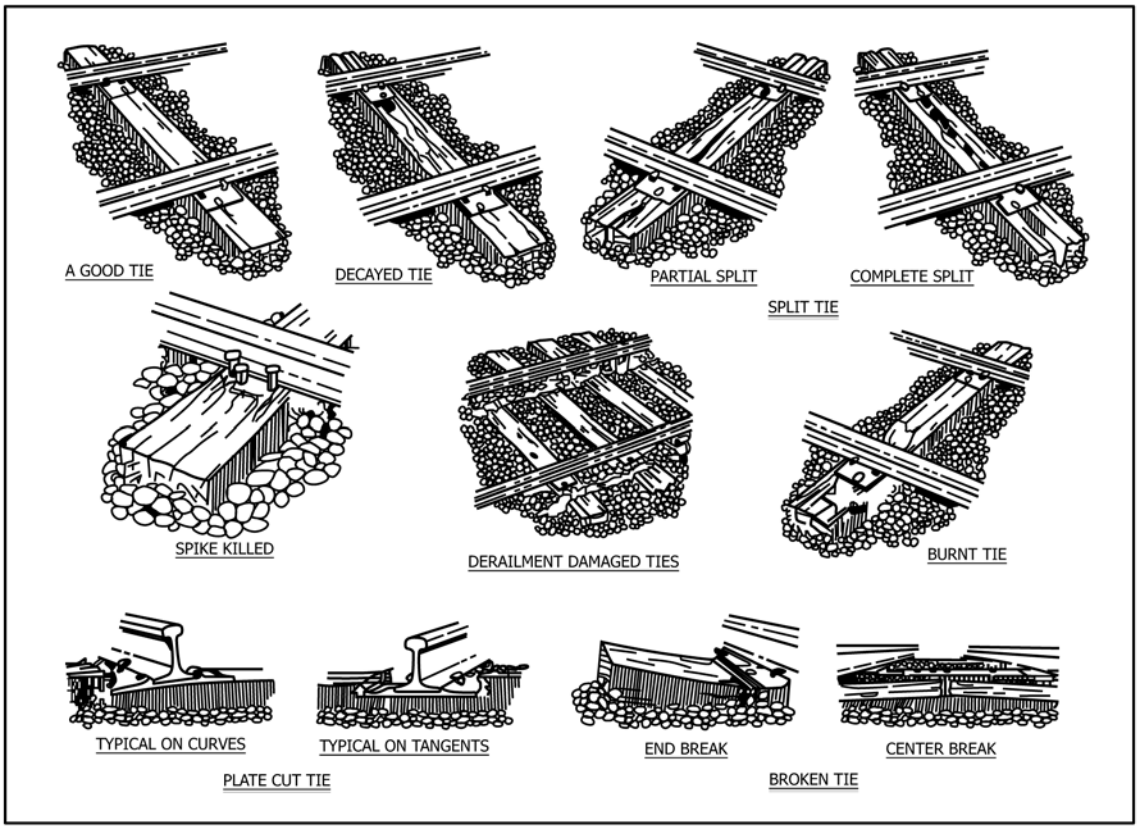

FIG. X2.12 General Appearance of Flow

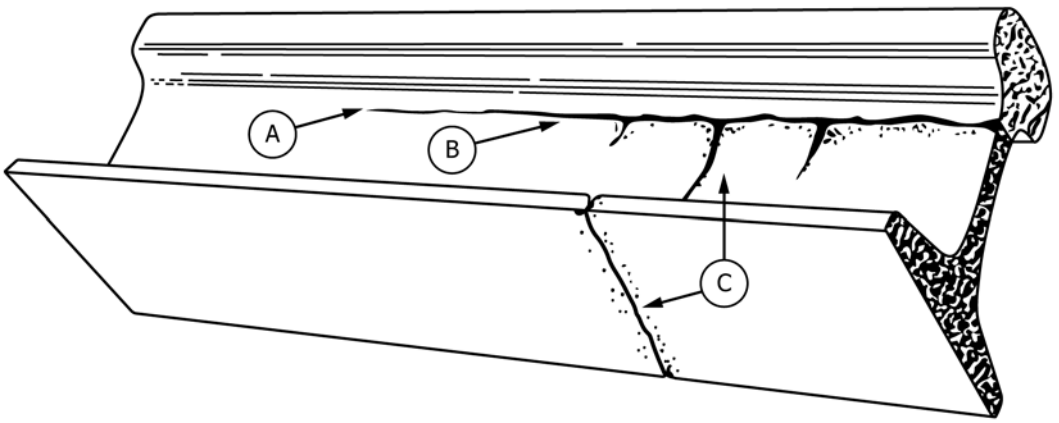

FIG. X2.13 General Appearance of Head/Web Separation

(1) Description—The loss of material from the running surface and side of the rail head due to the passage of wheels over the rail.

(2) Appearance in Track—Rail wear appears as a rounding of the running surface of the rail head, particularly on the gauge side (see Fig. X2.18).

X2.1.3.20 *Shelling:*

(1) Description—A progressive horizontal separation which may crack out at any level on the gauge side but generally at the gauge corner. It extends longitudinally not as a true horizontal or vertical crack, but at an angle related to the amount of rail wear. Shelling is not a critical defect.

(2) Appearance in Track—Appears as one or more of the following:

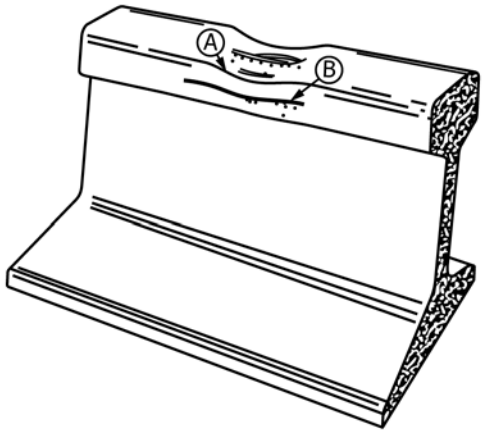

FIG. X2.14 General Appearance of Horizontal Split Head

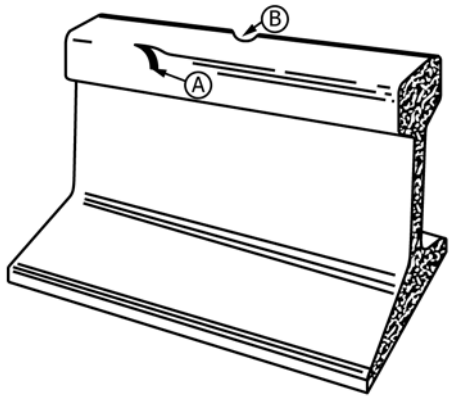

FIG. X2.15 General Appearance of Mill Defects

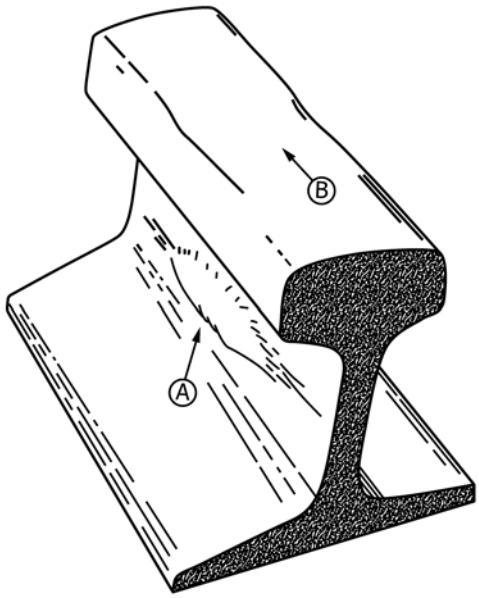

FIG. X2.16 General Appearance of Piped Rail

(a) Dark spots irregularly spaced on the gauge side of the running surface.

(b) Longitudinal separation at one or several levels in the upper gauge corner with discoloration from bleeding.

(c) If the rail has been turned, the shelly spots will appear on the field side with an irregular overhanging lip of metal similar to flowed rail (see Fig. X2.19).

X2.1.3.21 *Slivers:*

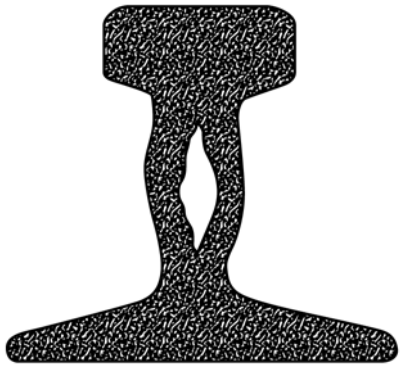

FIG. X2.17 Cross-sectional View of Piped Rail

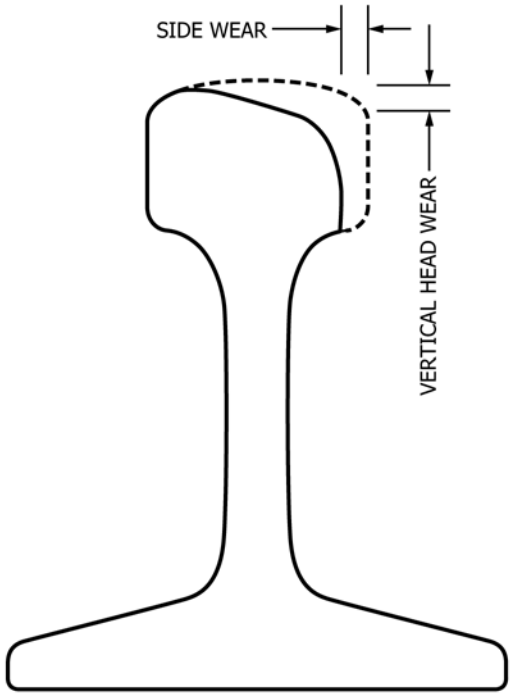

FIG. X2.18 General Appearance of Vertical Head and Side View

(1) Description—A sliver is the separation of a thin, tapered mass of metal from the surface of the head, web, or base of a rail. Slivers are not critical defects.

(2) Appearance in Track—Thin slivers on the surface of the rail head and parallel to the rail length similar to wood slivers (see Fig. X2.20).

X2.1.3.22 *Split Web:*

(1) Description—A progressive fracture through the web in a longitudinal or transverse direction, or both.

(2) Appearance in Track—Horizontal or vertical, or both, bleeding cracks in the web (see Fig. X2.21).

X2.1.3.23 *Surface Bent Rail:*

(1) Description—The permanent downward bending of the rail ends due to long-term passage of traffic over track with loose or poorly supported joints. Surface bent rail is not a critical defect and cannot be corrected without replacing the rail.

(2) Appearance in Track—A downward bending of the rail head near the rail ends giving the appearance of low joints. When track with surface bent rail is surfaced (raised and tamped), the rail ends soon return to a lower elevation. In the more serious cases the vertical curve in the rail head is still visible after surfacing.

X2.1.3.24 *Surface Damage:*

(1) Description—Any damage to the surfaces of the rail, both the running surface and the external surfaces, caused by deep engine burns (running surface) or by striking the rail. Surface damage is not normally a critical defect but may lead to detail fractures or engine burn fractures.

(2) Appearance in Track—Deep engine burns, dents, nicks, cuts, or other abnormalities on the surface of the rail.

X2.1.3.25 *Torch Rail Cut:*

(1) Description—Any rail that is cut or otherwise modified (including bolt holes) using an acetylene torch or other open flame.

(2) Appearance in Track—Irregular or rough rail ends or bolt holes, or both (see Fig. X2.22).

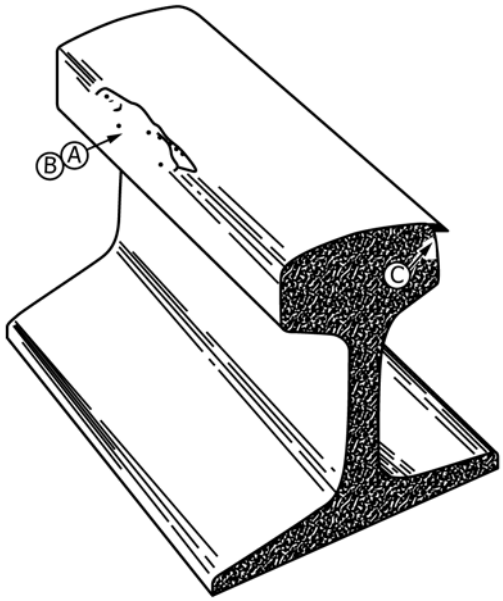

FIG. X2.19 General Appearance of Shelling

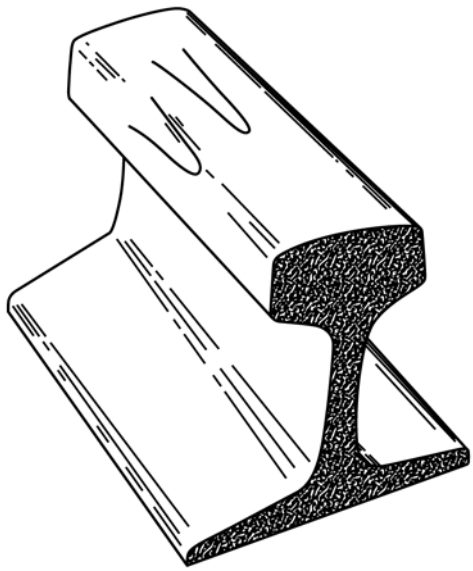

FIG. X2.20 General Appearance of Slivers

X2.1.3.26 *Transverse Defects* (compound fissure, transverse fissure, and detail fracture):

(1) Description—Any progressive fracture occurring in the rail head having a transverse separation, however slight. The exact type of transverse defect cannot be determined until after the rail is broken for examination.

(2) Appearance in Track—Not visible until the defect reaches an outer surface. A transverse defect may be recognized by one or more of the following characteristics:

(a) A hairline crack on the side of the head at right angles to the running surface, at the fillet under the head, and occasionally on the running surface.

(b) Bleeding at the crack.

(c) A hairline crack at the gauge corner of the rail head. On turned rail, this condition may occur at the field corner. Numerous small gauge cracks or head cracks are often present but should not cause suspicion unless a single crack extends much farther down the side or across the running surface, or both.

(d) A horizontal hairline crack in the side of the rail head turning upward or downward at one or both ends usually accompanied by bleeding. Under such conditions a flat spot will generally be present on the running surface.

(e) A hairline crack extending downward at right angles from a horizontal crack caused by sheeling of the upper gauge corner of the rail head (see Fig. X2.23).

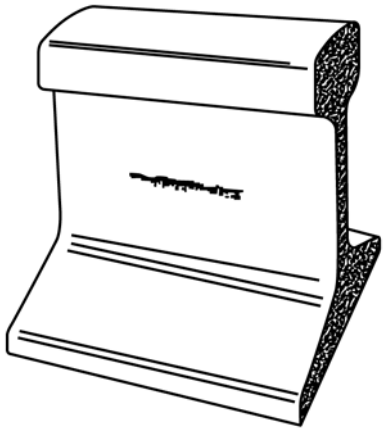

FIG. X2.21 General Appearance of Split Web

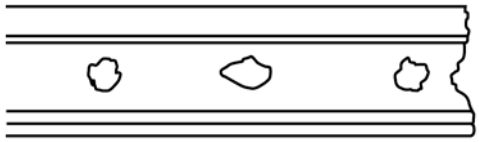

FIG. X2.22 General Appearance of Torch Cut Rail

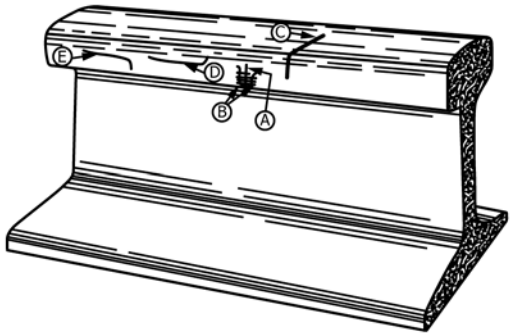

FIG. X2.23 General Appearance of Transverse Defects

X2.1.3.27 *Vertical Split Head:*

(1) Description—A progressive longitudinal fracture in the head of the rail perpendicular to the running surface.

(2) Appearance in Track—Can be recognized by one or more of the following:

(a) A dark streak on the running surface.

(b) Widening of the head for the length of the split. The cracked side of the head may show signs of sagging.

(c) Sagging of the head causing a rust streak to appear on the fillet under the head.

(d) A hairline crack near the middle of the rail head.

(e) In advanced stages, a bleeding crack is apparent on the rail surface and in the fillet under the head (see Fig. X2.24).

X2.2 Tie Condition Examples

X2.2.1 See Fig. X2.25.

X2.3 Vegetation Defect Codes

X2.3.1 The vegetation defect codes in Table X2.1 should be used to assist in describing problems when inspecting the railway track.

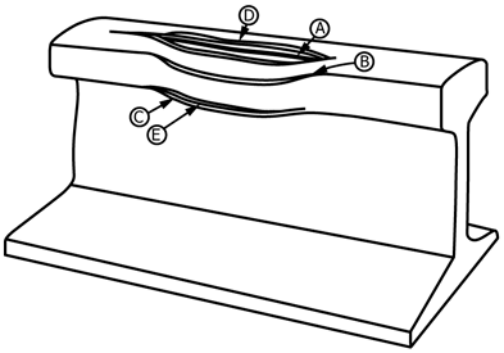

FIG. X2.24 General Appearance of Vertical Split Head

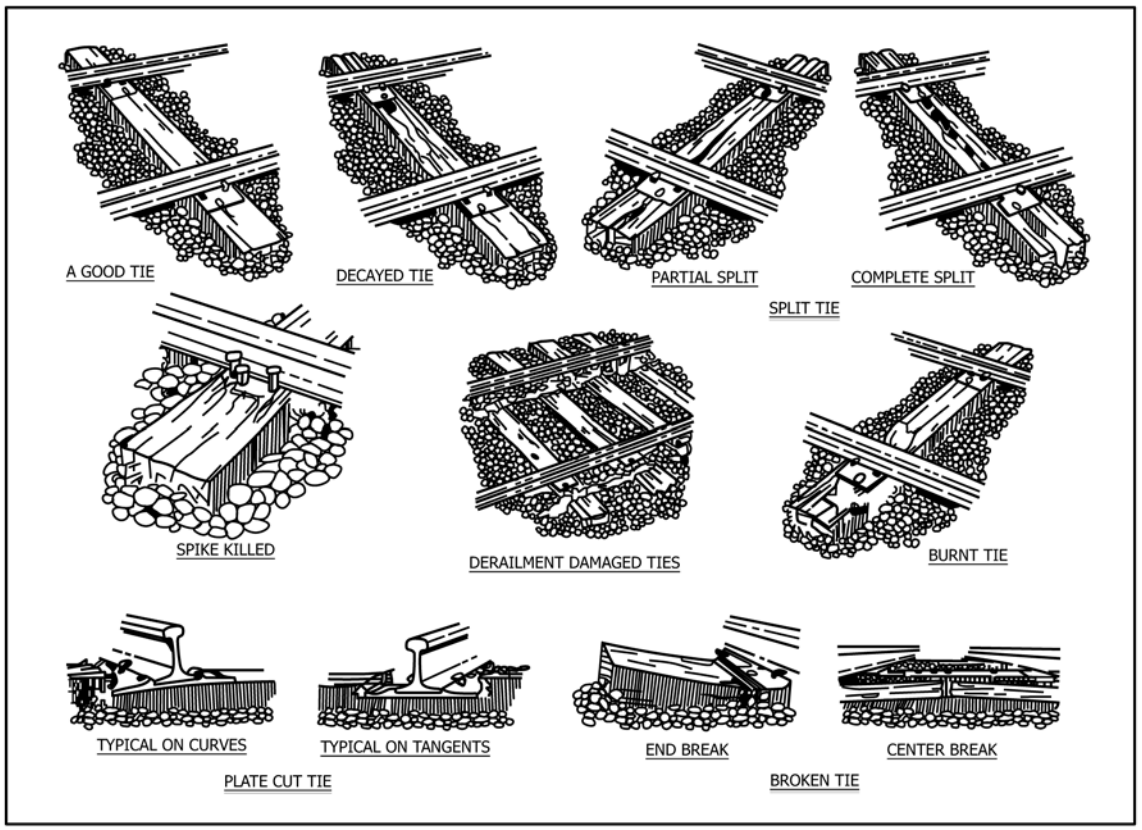

FIG. X2.25 Tie Condition Examples

TABLE X2.1 Vegetation Defect Codes

	Defect Codes
37.01	Combustible vegetation around track-carrying structures.
37.02	Vegetation obstructs visibility of railroad signs and fixed signals.
37.03	Vegetation obstructs passing of day and night signals by railroad employees.
37.04	Vegetation interferes with railroad employees performing normal trackside duties.
37.05	Vegetation prevents proper functioning of signal or communication lines, or both.
37.06	Excessive vegetation at train order office, depot, interlocking plant, a carman's building, etc., prevents employees on duty from visually inspecting moving equipment when their duties so require.
37.07	Excessive vegetation at train meeting points prevents proper inspection of moving equipment by railroad employees.
37.08	Excessive vegetation in toepaths and around switches where employees are performing normal trackside duties.
37.09	Vegetation brushing sides of rolling stock.
37.10	Vegetation obstructs visibility of grade crossing warning signs and signals by the traveling public.