



B BASIS OF DESIGN REPORT



D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL

February 24, 2015



Basis of Design

Technical Criteria for Concept & Preliminary Engineering

Final Report



U.S. Department of Transportation
Federal Railroad Administration

APPROVALS

This document was developed by the Virginia Department of Rail and Public Transportation (DRPT) with significant input and general concurrence from the following major stakeholders: Federal Railroad Administration (FRA); Virginia Department of Transportation (VDOT); CSX Transportation (CSXT); Amtrak; and the Virginia Railway Express (VRE). The basis of design (BOD) was developed using an iterative process with formal reviews and comments provided by the major stakeholders with responses by DRPT until general concurrence was achieved with FRA, VDOT, CSXT, Amtrak and VRE.

This basis of design shall be used by all members of the DRPT and its consultants and contractors for the development of an EIS and preliminary engineering for the Washington, D.C. to Richmond Southeast High Speed Rail project (DC2RVA). The purpose of the document is to provide a basis of design for the development of conceptual alternatives for evaluation in the EIS study and preliminary engineering for the preferred alternative only.

It is anticipated that the DC2RVA project will be constructed in the future in a series of incrementally phased design-bid-build or design-build packages. Final design and detailed engineering would be provided in the future prior to the construction of each package in accordance with the requirements of applicable design codes, laws, and major stakeholder requirements at the time the phased projects are implemented. Packages in the corridor may be constructed concurrently or in later years depending on funding availability.

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EXECUTIVE OVERVIEW

The basis of design presents the technical criteria to be followed for conceptual and preliminary engineering on the Washington, D.C. to Richmond Southeast High Speed Rail (DC2RVA) project. The basis of design has been developed in coordination with the major project stakeholders: the Federal Railroad Administration (FRA); Virginia Department of Rail and Public Transportation (DRPT); Virginia Department of Transportation (VDOT); CSX Transportation, Inc. (CSXT); Amtrak; and Virginia Railway Express (VRE).

This project contemplates a series of improvement projects that are required to deliver higher speed passenger rail service (up to 90 miles per hour) along the 123-mile corridor from Washington, D.C. to Richmond. The improvement projects to be evaluated include, but are not limited to, the following:

- Corridor-wide track and signal upgrades to achieve higher operating speeds, including curve realignments, high-speed interlockings, and grade crossing improvements.
- Corridor-wide station platform construction and improvements.
- Adding a fourth track from the Potomac River (RO) to Alexandria (AF), and Fredericksburg (FB) to Hamilton (HA).
- Adding a third track to multiple sections of track between Alexandria and Richmond.
- Track improvements between Greendale and Centralia.
- Richmond area station location(s) and related track and platform improvements for affected Amtrak and VRE stations.

The basic requirement for railroad geometric design shall be to provide safe, economical, and efficient rail passenger transportation on a freight rail corridor. The railroad geometric design must maintain CSXT freight operation neutrality while providing adequate factors of safety with respect to overall operation, maintenance, and rolling stock stability. Improvements should also have no adverse effect on Amtrak passenger operations and/or VRE commuter operations.

The primary purpose of this basis of design (BOD) is to establish the technical criteria to be used for infrastructure concept design and preliminary engineering in the project corridor. A separate document shall be developed by DRPT to establish the rolling stock criteria, service assumptions and projections, and operating criteria which shall be used to develop operating plans and simulation models. These operating plans and models will assist in determining the magnitude of infrastructure improvements required to support future operations.

The basis of design for rail components of the project emphasizes safety and follows accepted engineering practices used by CSXT, Amtrak, and VRE and as indicated in FRA track safety

standards and in the AREMA Manual for Railway Engineering. The basis of design for roadway components follows VDOT standards.

Key features of the basis of design include the following:

- Both new and existing mainline track will be designed for a maximum allowable speed of 90 mph where practicable.
- Mainline track centers shall be 15 feet between centerlines of all adjacent tracks.
- Both new and existing mainline tracks shall be designed for interoperability between all passenger and freight service.
- Passenger station improvements shall include low-level side or center island platforms serving all mainline tracks in accordance with FRA, Amtrak, and VRE standards.
- Utilization to the extent feasible and practicable of ongoing and previously completed studies, concept development, and rail improvement designs in the corridor.

The basis of design and key features discussed above are applicable only to areas where new construction or major remodeling might occur. Existing tracks where improvements are not required are exempt from the design criteria as well as the approvals and design variance process in Section 12. It is anticipated that portions of the existing track may need to be modified or upgraded for improved rail geometrics as well as to be included in modifications to the signal system.

1 PROJECT OVERVIEW

1.1 PROJECT DESCRIPTION

This project is funded through a cooperative agreement between the Virginia Department of Rail and Public Transportation (DRPT) and Federal Railroad Administration (FRA) for the completion of Tier II environmental review and preliminary engineering (PE) for the Washington, D.C. to Richmond Southeast High Speed Rail (SEHSR) Project that will result in the environmental review and approvals required to support the design-build or final design and construction of the Washington, D.C. to Richmond (DC2RVA) rail corridor in the future. This project contemplates a series of improvement projects from Arlington to Centralia that are required to deliver higher speed passenger rail service (up to 90 miles per hour) along the corridor. The improvement projects to be evaluated include, but are not limited to, the following:

- Corridor-wide track and signal upgrades to achieve higher operating speeds, including corridor curve realignments, high-speed interlockings, and grade crossing improvements.
- Corridor-wide station platform construction and improvements.
- Adding a fourth track, Potomac River (RO) to Alexandria (AF), and Fredericksburg (FB) to Hamilton (HA).
- Adding a third track to multiple sections of track between Alexandria and Richmond.
- Track improvements between Greendale and Centralia.
- Richmond area station location(s) and related track and platform improvements.

Additionally, the project includes PE and National Environmental Policy Act (NEPA) review for related capacity improvements on the CSXT Peninsula Subdivision in the Richmond area between AM Junction and Beulah to the east, and on the Buckingham Branch Railroad from AM Junction through Doswell to the north. The project also includes two localities where specific improvements have not been previously evaluated: Elmont to North Doswell (through Ashland), and Fredericksburg to Dahlgren (through Fredericksburg and across the Rappahannock River Bridge). These localities will be evaluated for station, track and safety improvements as well as the feasibility of a third mainline track, including greenfield alignments which may be considered, where feasible, at any location in the DC2RVA corridor.

The project will also conduct further analysis of the alignment of the route selected through the 2002 Tier I EIS and Record of Decision (ROD), including the Buckingham Branch Railroad and

the CSXT S-Line and A-Line routes from Greendale north of Richmond to Centralia south of Richmond.

It is anticipated that development of station alternatives, including a potential single consolidated station or a combination of an urban station and a north suburban station in the Richmond area will be determined as part of the EIS process prior to the preparation of the appropriate level engineering plans for Richmond area stations. In accordance with FRA's direction, the Project Team shall not advance detailed preliminary engineering (PE) for specific infrastructure or station improvements in the Richmond area (CP Greendale to CP Centralia) prior to determination of the preferred routing alternative through Richmond or the selection of the preferred station location(s) in the Richmond area. The Project Team may, however, advance conceptual preliminary engineering of infrastructure and station improvements in the Richmond area to support the analysis of the routing alternative and station location(s), as needed.

1.2 PROJECT LOCATION

The physical limits of the Project for environmental review and preliminary engineering extend approximately 123 miles from the CSX Transportation, Inc. Control Point RO (MP CFP-110) in Arlington, Virginia, south to (CSXT) A-Line/CSXT S-Line junction at milepost (MP) A-11 in Centralia, Virginia (Chesterfield County). At the northern terminus in Arlington, the project limits end at the Long Bridge over the Potomac River for infrastructure improvements in Virginia. The theoretical study area for the ridership and revenue and capacity modeling may extend beyond the physical study area, as required to appropriately capture the ridership market and represent the operating network, including Union Station in Washington, D.C., for the project corridor. The physical southern terminus in Centralia is the midpoint between downtown Richmond and downtown Petersburg. The physical project limits in Virginia are shown in Figure 1-1.

Additional segments of the physical project include the CSXT Peninsula Subdivision CA-Line from Beulah Road (MP CA-76.1) in Henrico County to AM Junction in the City of Richmond, and the Buckingham Branch Railroad from AM Junction to the RF&P Crossing (MP CA-111.8) in Doswell.

Proposed improvements are along CSXT-owned track, generally parallel to the I-95 corridor between northern Virginia and Richmond.

From north to south, the project travels through the following counties and cities:

- Arlington County
- City of Alexandria
- Fairfax County
- Prince William County
- Stafford County
- City of Fredericksburg
- Spotsylvania County
- Caroline County

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- Hanover County
- Henrico County
- City of Richmond
- Chesterfield County

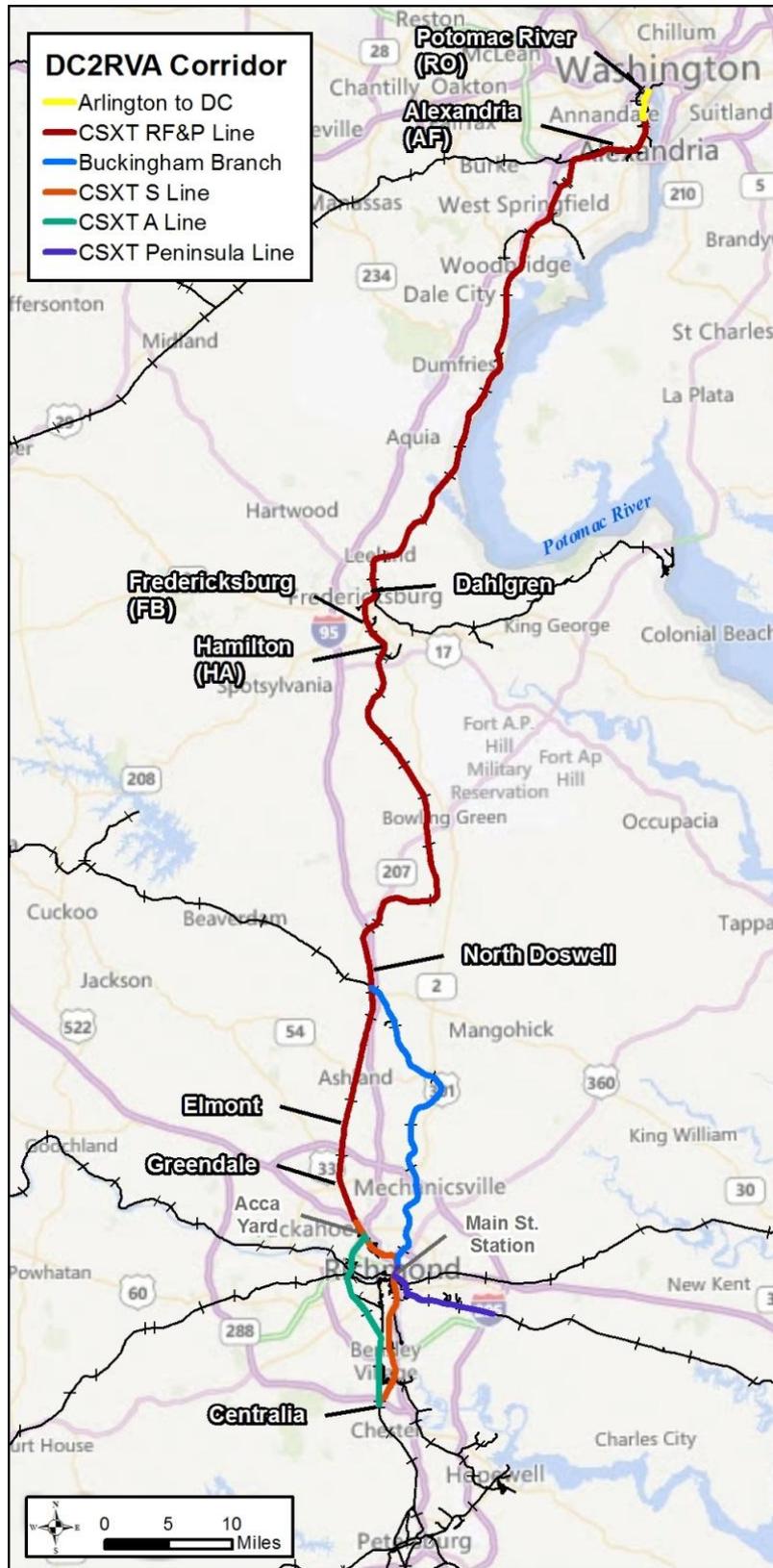


FIGURE 1-1: WASHINGTON, D.C. TO RICHMOND SOUTHEAST HIGH SPEED RAIL CORRIDOR

1.3 PROJECT APPROACH

This Basis of Design Report is a living document providing an introduction to the design standards to be used in the development of conceptual and preliminary engineering designs. Additional criteria, definitions and specifications shall be added to expand the function of this document for use in the development of final design and construction documents to be completed at a later time as part of a separate project or projects. Modifications to the basis of design require justification through the application of sound engineering judgment, practice and economics and application through the approval process described in Section 12.

The primary purpose of this basis of design (BOD) is to establish the technical criteria to be used for infrastructure concept design and preliminary engineering in the project corridor. A separate document shall be developed by DRPT to establish the rolling stock criteria, service assumptions and projections, and operating criteria which shall be used to develop operating plans and simulation models. These operating plans and models will assist in determining the magnitude of infrastructure improvements required to support future operations.

It is recognized that the rail corridor covers a large and diverse geographic area that includes dense urban land use, and that the 90 mph maximum allowable speed (MAS) for passenger trains for which the project will be designed may not be achievable everywhere in the corridor due to environmental, existing facilities, or operational constraints. The general project intent is to add a parallel track to the existing rail network and increase speeds to the extent practicable consistent with the corridor service objectives. Final infrastructure improvements will be determined using capacity modeling which may indicate additional tracks in limited locations with other infrastructure improvements while maintaining the existing number of tracks in other locations.

It is also recognized that a relatively significant number of environmental studies, concept studies and designs have previously been completed in the DC2RVA corridor. To the extent feasible and practicable, the Project Team will analyze alternatives and perform an environmental review of the alignments, prior to developing the proposed corridor design, with consideration of previous studies and designs to maximize the use of these work products.

Horizontal and vertical project control will be established in accordance with the Virginia State Plane Coordinate System (VSPCS). This project lies within both the North and South zones of the VSPCS. The vertical datum is NAD83. The project control network shall be developed to ensure that all data will be contiguous.

GIS data for conceptual design will be referenced to the VSPCS North Zone. GIS data collected in portions of the corridor that fall within the South Zone will be converted to North Zone coordinates.

The project “ground” coordinate system for preliminary engineering design will use multiple Low Distortion Coordinate Systems (LDCS) for the corridor. The term “low distortion” refers to both the horizontal distortion from presenting a curved surface on a plane and the vertical distortion caused by the projections being scaled to a regional height representative of the area being covered. LDCS was selected for the project over VSPCS Local Datum Plane Coordinates, which use combination factors to scale from plane to ground, because modern GIS and surveying software now enable the creation of low distortion map projections and coordinate systems that closely relate to measured distances on the ground. It is anticipated that two or three LDCS will cover the entire corridor with a maximum distortion of 1:50,000.

Mapping data will be collected using both LIDAR and high resolution aerial photography with a pixel resolution of 0.25/SF. Heavily vegetated areas and select edge conditions will be ground surveyed.

The disciplines whose basis of design is included in this report are as follows:

- Mainline track
- Passenger stations and layover related tracks
- Freight industry track connections
- Railroad bridges (structures) and major drainage crossings
- Retaining walls
- Utility relocation
- Roadway at-grade and grade separated crossings

1.4 PLANNING CONSIDERATIONS

Planning considerations are categorically defined as follows:

- Operations and service planning
- Community considerations
- Environmental considerations
- Standardization of equipment and materials

1.4.1 Operations and Service Planning

The objective of DC2RVA project is to provide sufficient additional railway capacity in the corridor for the expansion of passenger rail service while maintaining existing and future freight operation neutrality. Improvements should have no adverse effect on Amtrak passenger operations and/or VRE commuter operations. Passenger services shall be safe, reliable, cost-effective, environmentally friendly, and efficient within the corridor. Expansion of passenger service will be accomplished through one or more of the following objectives:

- Improved travel time
- Increase in maximum allowable passenger and freight operating speed
- Increase capacity and/or improve reliability
- Increase in frequency of service
- Increase in the number of rail cars (length of train/consist)
- Improvement to existing track geometry
- Improvement to crossing safety
- Safe and timely interchange of passengers and information among various local and regional modes of transportation
- Additional infrastructure to support improvements listed above

It is imperative that design staging for any project which intrudes on or has the potential to intrude on rail operations during construction be planned in such a way as to mitigate any impact on passenger or freight train operations. Further, the design review process shall clearly identify the required resources from the host railroad, CSXT and the railroads that operate over the corridor, considering the following:

- Track closure is not permitted during regular scheduled services. Track closure may be limited to the short off-peak service hours and on weekends and only when approved by CSXT, Amtrak, and/or VRE.
- Temporary track closures shall be scheduled and coordinated with CSXT, Amtrak, and VRE. Temporary track closures and the use of temporary tracks to maintain operations shall be considered on a case-by-case basis.
- Speed of temporary tracks shall be maintained per timetable speeds or as approved by CSXT, Amtrak, and/or VRE.

1.4.2 Community Considerations

To the extent possible, and whenever appropriate, community considerations shall be incorporated into the design. The design shall:

- Solicit and consider opinions and suggestions of the public, residential and business communities, pedestrians, bicyclists, and motorists as long as it is within the scope and budget of the project.
- Minimize impacts to adjacent properties.
- Consider historic preservation, visual intrusions, noise mitigation, and aesthetic improvements.
- Improve safety.

1.4.3 Environmental Considerations

The corridor passes through areas of cultural, historic, and environmentally sensitive areas that require analysis under the National Environmental Policy Act (NEPA). Potential impacts to these areas should be avoided to the extent possible. Unavoidable impacts should be minimized to the extent possible and the impact should be mitigated.

1.4.4 Standardization of Equipment and Materials

The design will include the use of standardized materials and equipment wherever possible. Standardization ensures ease of procurement and promotes effective inventory management; minimizes staff training; optimizes maintenance; and avoids long lead time for materials, equipment and components.

All equipment and track materials shall meet CSXT criteria for equipment and materials to be owned and maintained by CSXT, AREMA guidelines where applicable, and industry standards elsewhere, and shall be supplied by established manufacturers that have a well-documented history of furnishing quality products and materials to commuter, intercity passenger or freight railroads operating under conditions similar to those of the DC2RVA system. Selection of

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equipment and materials shall consider long term costs, ease of construction and maintenance, and readily available technical support.

2 RAILWAY

The basic requirement for railroad geometric design shall be to provide safe, economical and efficient rail passenger transportation on a freight rail corridor. The requirement must maintain freight operation neutrality while maintaining adequate factors of safety with respect to overall operation, maintenance, and rolling stock stability. Improvements should have no adverse effect on Amtrak passenger operations and/or VRE commuter operations.

The criteria presented herein relating to the design of operational components emphasizes safety and follows accepted engineering practices used by CSXT and as indicated in FRA track safety standards, in the AREMA Manual for Railway Engineering (MRE), by Amtrak, and by Virginia Railway Express (VRE).

2.1 SAFETY

All operations within the corridor of the host railroad must be reviewed and approved by the host railroad. The basis of design shall consider the safety of operations, the safety of the traveling public, and the safety of those who live in adjoining communities as the highest priority.

All designs shall be prepared with safety as the primary consideration.

Railroad safety promotion and regulation is governed by FRA's Office of Railroad Safety, which includes FRA Track Safety Standards - CFR Part 213.

The DC2RVA PE/NEPA project assumes that all freight and passenger trains will share all tracks at speeds up to 90 mph along all segments of the corridor. However, it is important to note that FRA regulations will require the preparation of a system safety plan, with partnership from the operating freight and passenger railroads, for the delivery of the expanded passenger and shared freight service prior to authorization to operate the new service at any speed.

2.2 DEFINITIONS

All definitions used in this document are in accordance with those used in AREMA Manual for Railway Engineering.

Key abbreviations used for terms for this project are identified in Table 2-1.

TABLE 2-1: KEY ABBREVIATIONS

| Abbreviation | Definition |
|---------------------|--|
| AAR | Association of American Railroads |
| AASHTO | American Association of State Highway Transportation Officials |
| Amtrak | National Railroad Passenger Corporation and Subsidiaries |
| AREMA | American Railway Engineering and Maintenance-of-Way Association |
| BOD | Basis of Design |
| CFS | Cubic Feet per Second |
| CSXT | CSX Transportation |
| DRPT | Virginia Department of Rail and Public Transportation |
| ES | Engineering Stationing |
| f/s | Feet per second |
| FRA | Federal Railroad Administration |
| HEC-RAS | Hydrologic Engineering Center – River Analysis System |
| HY-8 | Culvert Hydraulics Analysis Program |
| MAS | Maximum Allowable Speed |
| Mph | Miles per hour |
| MP | Mile Post |
| MRE | AREMA Manual for Railway Engineering |
| MT-1, MT-2, MT-3 | Main Track #1, #2 and #3 |
| MUTCD | Manual of Uniform Traffic Control Devices |
| ROW | Right-of-Way |
| SCC | Virginia State Corporation Commission, Division of Utility and Railroad Safety |
| VDOT | Virginia Department of Transportation |
| VRE | Virginia Railway Express |

2.3 DESIGN CODES, MANUALS, STANDARDS, SPECIFICATIONS, AND REGULATORY REQUIREMENTS

In general, the minimum design parameters that form the basis of design for a preliminary design effort primarily follow the engineering and operating standards of CSXT, followed by the recommendations contained in the AREMA Manual for Railway Engineering 2014 Edition and the specific requirements of this section. The railroad design shall meet all applicable parts of FRA safety requirements, federal laws, and the Commonwealth of Virginia general laws.

Unless specifically noted otherwise in these criteria, the latest edition of the code, regulation, standard and specification that is applicable at the time the design is initiated (2014) shall be used for conceptual and preliminary engineering. If a new edition or amendment to a code, regulation, or standard is issued before the final design is submitted to DRPT, the design shall conform to the new requirements to the extent approved or required by the agency enforcing the code, regulation, or standard changed.

The basis of design assembled in this document are based on industry standards, governmental regulations, AREMA recommended practices, and railroad standards. The following publications and documents were used as references:

- CSXT Engineering and Operating Standards (in effect as of November 1, 2014)
- CSXT Public Projects Information Manual (Rev. August 10, 2012)
- CSXT Design & Construction Standard Specifications - Pipeline Occupancies (Rev. February 24, 2010)
- CSXT Design & Construction Standard Specifications - Wirelines Occupancies (September 15, 2003)
- AREMA MRE 2014 Edition
- FRA Track and Rail and Infrastructure Integrity Compliance Manual (in effect as of November 1, 2014)
- FRA Station Area Planning for High-Speed and Intercity Passenger Rail Guidelines (June 2011)
- FRA Railroad Corridor Transportation Plans Guidelines (July 2005)
- Amtrak Station Program and Planning Guidelines (May 1, 2013)
- Amtrak Engineering Track Design Specification - Spec. No. 63 (Rev. August 1, 2013)
- VRE Station Design Guidelines (November 2002, as amended prior to November 1, 2014)
- Technical Bulletin T-13-01, Guidance Regarding the Application of Vehicle/Track Interaction Safety Standards; High-Speed and High Cant Deficiency Operations; Final Rule, Track Classes 1-5 (August 6, 2013)
- U.S. Code of Federal Regulations
- Strategic Rail Corridor Network (STRACNET) and Defense Connector Lines (December 1998) - <http://www.tea.army.mil/DODProg/RND/default.htm>

Absolute maximum/minimum values for any track design element shall comply with 49 CFR 213 for the applicable class of track unless specifically authorized by FRA waiver.

2.4 DESIGN LIFE

The design life for the new railroad related features and facilities are:

- Embankment: 50 years minimum
- Ballast and subballast: 10 years minimum

- Track structure (rail, ties, and fasteners): 35 years minimum
- Structures: 100 years minimum

Temporary facilities used to accommodate construction of permanent systems shall be designed for a period up to five years. Examples include shoofly (temporary tracks) and other temporary facilities during construction.

2.5 DESIGN LOADING

The design of track systems shall be based on a Cooper E-80 loading in accordance with AREMA MRE.

2.6 DESIGN SPEEDS

The design speed for main line track alignments shall be governed by the host railroad, CSXT, with a goal of FRA Class 5 track. Maximum allowable speeds shall be the CSXT maximum timetable speed for the corridor for freight trains, and 90 miles per hour for passenger trains. The CSXT governing freight speed is 60 miles per hour.

Higher speeds for passenger trains as discussed above may be achieved through one of the following procedures:

- Elimination of selected curves
- Optimization of horizontal curve (reduce the degree of curvature)
- Implementation of higher actual superelevation (E_a) in curved track with longer transition spirals
- Implementation of higher unbalance (E_u) acceptable for use with passenger trains on a freight track

Curves should be designed to the highest speeds possible for mixed traffic based on the design criteria, train performance models, and local conditions and should not be limited to the maximum allowable operating speeds.

Subject to the identification of physical and environmental constraints or infeasibility, a Limiting Allowable Speed (LAS) below 90 mph for passenger and below 60 mph for freight is anticipated at some locations along the corridor.

2.7 HORIZONTAL GEOMETRY

Curvature and superelevation of track alignment are related to design speed and to the acceleration and deceleration characteristics of the rail cars and locomotives. Where possible, track alignment shall be designed to maximize operating speed for mixed traffic. The design criteria for tangent, curve, design speed, superelevation, and spiral transition curve are shown in Table 2-2 and described in the following sections.

TABLE 2-2: LIMITING DESIGN ELEMENTS

| Design Elements | Major Limiting Factors |
|--|---|
| Minimum Tangent Length between Curves | <ul style="list-style-type: none"> - Passenger comfort - Vehicle truck/wheel forces |
| Horizontal Curves (Maximum Degree of Curve - Dc) | <ul style="list-style-type: none"> - Design speed - Trackwork maintenance - Vehicle truck/wheel forces |
| Compound and Reverse Curves | <ul style="list-style-type: none"> - Freight wheel/rail interface - Passenger comfort - Vehicle suspension travel - Trackwork maintenance |
| Length of Spiral Transition Curve | <ul style="list-style-type: none"> - Passenger comfort - Trackwork maintenance - Vehicle suspension travel |
| Superelevation | <ul style="list-style-type: none"> - Freight wheel/rail interface - Passenger comfort - Vehicle stability |
| Superelevation Runoff Rate | <ul style="list-style-type: none"> - Passenger comfort - Vehicle suspension travel |
| Special Trackwork | <ul style="list-style-type: none"> - Mixed traffic operations - Passenger comfort - Trackwork maintenance |
| Station Platforms | <ul style="list-style-type: none"> - Safety - Vehicle clearances - ADA platform gap requirements - SCC & CSXT clearances - Amtrak rolling stock configurations - VRE rolling stock configurations |
| Mixed Traffic (Freight Corridor with Passenger Shared use, including Commuter/HSR) | <ul style="list-style-type: none"> - Vehicle clearance - Trackwork maintenance - Compatibility of operations |

The parameters for the design of horizontal alignments are established in accordance with CSXT Standards and the recommendations of the AREMA MRE.

Horizontal alignments for mainline tracks shall be stationed along the centerlines of the existing CSXT alignment. Where physically possible, all main tracks and passing sidings shall be designed for maximum speeds of 90 mph for passenger operations and a maximum speed of 60 mph for freight operations.

Engineering stationing (ES) for mainline track shall follow as much as possible the existing system of ES as shown on the original CSXT Valuation Maps. The ES system increases from south to north and all the mileposts are tied into this system. ES equations shall be created at known points from bridges and/or other structures as required to maintain the historical ES system to the extent practical.

Existing and new sidings shall be assigned stations following the mainline stations and shall be coordinated with CSXT Valuation Maps. Industry turnouts shall be stationed separately.

2.7.1 Track Centers

Track centers (distance between the centerlines of two adjacent tracks) for mainline, lead tracks, tangent tracks and tracks parallel to mainline tracks shall be a minimum of 15 feet between an existing track and a proposed track or between two or more proposed tracks. Existing track centers will vary and shall not be a factor in determining track realignments for existing tracks. Track centers greater than 15 feet may be required as an avoidance alternative for existing or proposed infrastructure, i.e., bridge piers. Similarly, track centers less than 15 feet may be required to “squeeze” an additional track between existing infrastructure elements as an avoidance alternative, i.e., existing headwalls where pipe extensions are disallowed. In no case shall track centers be less than 13 feet. In all cases where track centers are less than 15 feet between a proposed track and any track, the minimum separation between tracks and the locations where the track centers return to 15 feet of separation shall be clearly indicated and stationed.

Platform widths and offsets will control the distances between tracks approaching the platform, at the platform, and departing from the platform. Where inter-track fence is proposed, track centers shall be in accordance with Amtrak Standard Track Plan AM 70050.

Refer to CSXT Standard Drawing 2603 for additional walkway widths at switch points.

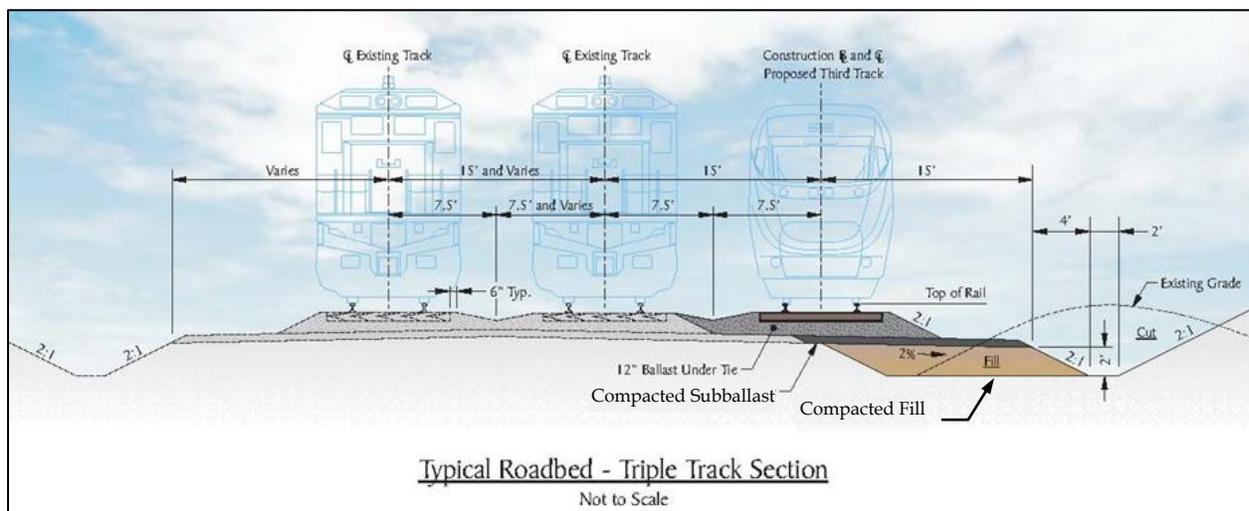


FIGURE 2-1: TYPICAL TRACK SECTION

Track centers for yard tracks shall be:

- Minimum acceptable distance: 14 feet
- Preferred minimum distance: 15 feet

Track centers for tracks parallel to ladder tracks shall be a minimum of 20 feet.

2.7.2 Tangent Alignment

The desired minimum tangent length (L) between mainline curves or spirals shall be determined by the following formula:

$$L = 3V$$

Where: L = minimum tangent length, feet

V = design speed through the curve, feet per second

The formula for tangent length ($L=3V$) for ride comfort is based on the rail car traveling at least two seconds on tangent track between two curves. The minimum tangent length for mainline tracks shall be established as per Table 2-3.

TABLE 2-3: MINIMUM TANGENT LENGTH – MAIN TRACK

| Tangent Location On Mainline Tracks | Minimum Tangent Length (feet) | |
|---|-------------------------------|------------------|
| | Preferred | Absolute Minimum |
| Between reverse curves | 3V | 200 |
| Between Point of Switches (PS) of turnouts (TO's) | 200 | 100 |
| Between PS and curve | 200 | 100 |
| Between PS and platform | 200 | 100 |
| Between PS and grade crossing | 200 | 100 |
| Between PS and bridge | 500 | 100 |
| Between PS and last long tie of T.O. | 200 | 100 |
| Between curve and platform | 100 | 80 |
| Between curve and grade crossing | 100 | 80 |

The minimum tangent length for yard and non-revenue tracks shall be established per Table 2-4. Where existing conditions or other design criteria constrain the ability to meet the absolute minimum lengths in Table 2-3 or 2-4, the maximum length attainable shall be indicated as a deviation from these standards subject to the approvals and design variances procedures in Section 12.

TABLE 2-4: MINIMUM TANGENT LENGTH – YARD AND NON-REVENUE TRACKS

| Tangent Location On Yard and Non-Revenue Tracks | Minimum Tangent Length (feet) | |
|---|-------------------------------|------------------|
| | Preferred | Absolute Minimum |
| Between reverse curves | 3V | 200 |
| Between Point of Switches (PS) of turnouts (TO's) | 200 | 50 |

2.7.3 Horizontal Curve Alignment

2.7.3.1 Superelevation

Superelevation is the height difference in inches between the high (outside) and low (inside) profile rail. Superelevation is used to counteract, or partially counteract the centrifugal force acting radially outward on a train when it is traveling along the curve. A state of equilibrium is reached when the centrifugal force acting on a train is equal to the counteracting force pulling on a train by gravity along the superelevated plane of the track.

Project methodology for calculating superelevation and speed shall be as follows:

- Using CSXT Plan 2511, find the degree of curvature and the MAS for freight trains for the curve
- The value in the corresponding row and column is the actual superelevation (E_a)
- Using the values from Table 2-5, establish the unbalanced superelevation (E_u) for each type of train in the corridor
- Add the E_a and E_u values from the previous steps to obtain the equilibrium superelevation (E_e)
- Using the E_e equation below, solve for maximum allowable posted timetable operating speed (V) to determine the MAS for the type of train

An example of this method for a 2 degree curve and freight MAS of 60 mph (CSXT may choose to restrict freight train operations to lower speeds) yields the following, shown in Table 2-5:

TABLE 2-5: EXAMPLE METHODOLOGY TO DETERMINE PASSENGER CURVE SPEED

| TYPE OF TRAIN | DEGREE OF CURVE (in decimal degrees) | ACTUAL SUPERELEVATION (in inches) | UNBALANCED SUPERELEVATION (in inches) | EQUILIBRIUM SUPERELEVATION (in inches) | MAXIMUM ALLOWABLE POSTED PASSENGER/COMMUTER TRAIN SPEED (in mph) |
|---------------|---|--------------------------------------|--|---|---|
| VRE | 2 | 3.5 | 3 | 6.5 | 68 |
| Amtrak | 2 | 3.5 | 4 | 7.5 | 73 |
| Higher Speed | 2 | 3.5 | 5 | 8.5 | 78 |

The benefits of superelevation are improved ride quality and reduced rail and equipment wear. FRA currently has established the maximum unbalanced superelevation as five inches with lean test results required by the FRA for unbalance greater than five inches, and the maximum actual superelevation as seven inches for track Classes 3 through 5. All curves with superelevation of five inches or more shall use the equations to determine the actual superelevation and shall require approval in accordance with Section 12.

Actual superelevation (E_a) shall be in accordance with CSXT Standard Plans 2510 and 2511 for freight rail service.

Unbalanced elevation (E_u) shall be limited in accordance with CSXT Standard Plans 2510 and 2511 for freight rail service. E_u for passenger rail service for the DC2RVA project shall be based on 4 inches of unbalance at 90 mph, while also showing the calculations for speeds at 3 inches and 5 inches in the track geometry table in the PE plans.

It is noted that DRPT and CSXT have ongoing discussions to potentially increase the unbalance to 5 inches or higher for VRE and Amtrak passenger services subject to lean test submittals and approvals by FRA. The potential future increase in unbalance would require negotiations with CSXT by DRPT to develop an operating agreement and would require approvals by FRA.

Equilibrium superelevation shall be determined by the following equation:

$$E_e = 0.0007 V^2 D_c$$

Where: E_e = equilibrium elevation, in inches.
 V = maximum allowable posted timetable operating speed through the curve, in mph
 D_c = degree of curvature, in degree

The total superelevation e is expressed as follows:

$$E_e = E_a + E_u$$

Where: E_a = actual superelevation in inches of elevation from the top of the low rail to the top of the high rail
 E_u = unbalanced superelevation (amount of superelevation not applied to the curve)

The actual superelevation shall be determined to the nearest $\frac{1}{4}$ inch by the formulae above. For any curve calculation on the main line which yields less than $\frac{1}{4}$ inch of the required superelevation, $\frac{1}{4}$ inch shall be specified.

Actual superelevation shall be based on the proposed MAS for freight trains. The passenger train speed shall be maximized based on the actual superelevation for freight trains and the application of higher unbalance to the passenger train.

The relationship between Velocity (V) and Unbalance (E_u) is expressed as follows:

$$V_{\max} = \sqrt{((E_a + E_u)/0.0007D_c)}$$

Where: V_{\max} = velocity of train (MAS in mph)
 E_a = actual superelevation (inches)
 E_u = unbalance (inches)
 D_c = degree of curvature (decimal degrees)

Slower speed tracks, such as yard and non-revenue tracks, and curves within special trackwork shall not be superelevated unless there are special circumstances requiring superelevation. Curves within station and grade crossings shall be avoided where possible. They may be superelevated only with approval in accordance with Section 12.

Where there are two or more superelevated tracks in a grade crossing, consideration shall be made to minimize the effect on the roadway surface. It may be feasible to change the profile of one (or two) of the tracks to better match the roadway profile to help minimize the sawtooth effect, or the same result may be achieved by lowering the actual superelevation.

Track was originally constructed in this corridor prior to the use of transition spirals for superelevation. Spiral curves and superelevation has been added over time which may or may not conform to these standards. Existing spiral curve and superelevation data will be reported and analyzed to determine if or where curve corrections or realignments are prudent and feasible.

2.7.3.2 Circular Curves

Circular curves shall be defined by the chord definition of curvature and specified by their degree of curvature. Lower degrees of curvature allow higher speeds. Higher degrees of curvature require lower speeds.

Horizontal curvature shall range from a minimum degree of curvature of 0 degrees to a maximum degree of curvature of 7 degrees 30 minutes. Existing curves above this maximum degree of curve for mainline tracks shall be realigned to reduce the degree of curvature. The minimum degree of curvature (maximum radius) that is feasible shall be used.

No turnouts shall be located within a horizontal curve.

Compound circular curves and circular curves joined by a transitional spiral shall be avoided to the extent practical. Existing curves of these types shall be replaced with a single circular curve and transitional spiral curves whenever practical.

2.7.3.3 Spiral Transition Curves

Spiral curves (transition or easement curves) are defined as transition curves with a constantly decreasing or increasing radius proportional between either a tangent and a circular curve (simple spiral) or between two curves with different radii (compound/intermediate spiral). More specifically, the spiral is a curve whose degree-of-curve increases incrementally with the distance along the curve from the point of spiral.

Spiral transition curves shall be used in mainline tracks to connect tangents to circular curves or to connect compound circular curves. The spiral to be used shall be the clothoid spiral. See Figure 2-2 for spiral and curve nomenclature.

Spirals are not required for curves less than 30 minutes with maximum allowable speed less than or equal to 20 MPH or on a curve that is part of a turnout. Adjustments of spurs or sidings to accommodate the third track.

Spiral curve length and superelevation rate of change or runoff are directly related to passenger comfort. While passenger comfort is a major consideration, the rate of change in superelevation in a spiral also affects the rail car bodies in term of twisting, racking or diagonal warp. According to AREMA, the superelevation differential between rail car truck centers should not exceed one inch. Therefore, based on an 85-foot long rail car with a truck center distance of 62 feet, the longitudinal slope of the outer (high) rail with respect to the inner (low) rail is limited to 1/744 or a rate of change of one inch per 62 feet in length in order to avoid wheel lift. The length of the spiral is based on passenger comfort and operational safety.

Based on AREMA Chapter 5, Section 3.1, the length of spiral for non-tilt trains shall be the longest distance as determined from the following three formulae:

1. $L_s = 1.63E_uV$; or $L_s = 1.22E_uV$ *
2. $L_s = 1.2E_aV$
3. $L_s = 62E_a$

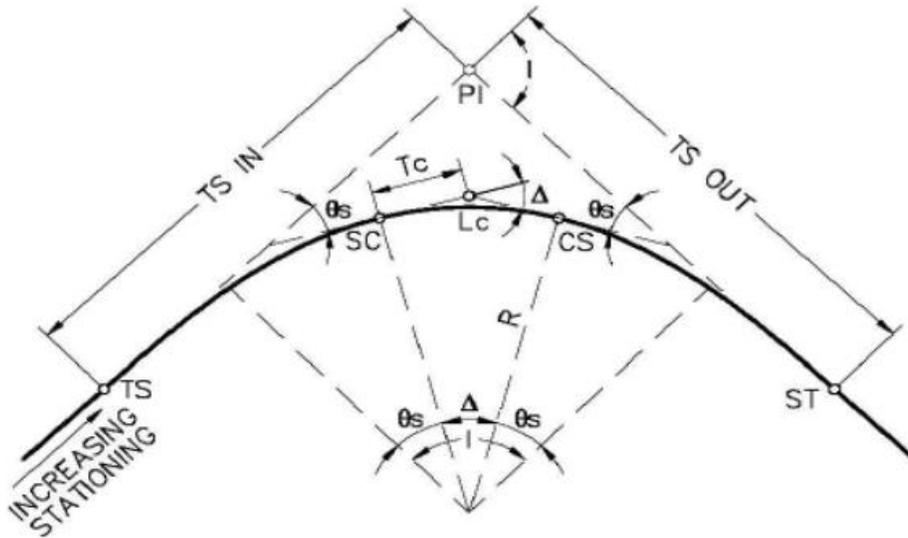
*Spiral length $L_s = 1.22E_uV$ requires approval in accordance with Section 12

Where: E_a = actual superelevation applied to the curve (in inches)
 E_u = unbalanced superelevation (amount of superelevation not applied to the curve)
 V = design speed (in mph)

In determining the spiral length for DC2RVA corridor curves, cost of construction and space constraints must also be considered because of the historic nature of the corridor, adjacent wetlands, and real estate costs in the corridor. Longer or extremely long spirals always provide a higher level of comfort, and ease on rolling stock, but they may be cost prohibitive to construct and maintain. As a result, the most economical approach using the above formulae is to determine the spiral length by balancing the actual and unbalanced superelevations based on the equilibrium superelevation.

When the two formulae are balanced (formulae 1 and 2 above), the spiral length determined should satisfy the design requirements for either unbalanced or actual superelevation.

After the actual and unbalanced superelevations are balanced, the spiral lengths will be established and the longest spiral will be used.



| | |
|------------|--|
| D_c | Degree of Curvature |
| I | Total Intersection Angle |
| θ_s | Spiral Angle = $(L_s D_c) / 200$ |
| Δ | Central Angle of Circular Curve = $I - 2 \theta_s$ |
| R | Radius of Circular Curve |
| T_c | Tangent Length of Circular Curve = $R \tan (\Delta / 2)$ |
| L_c | Length of Circular Curve = $(\Delta / 180) R$ |
| L_s | Length of Spiral |
| TS | Tangent to Spiral |
| SC | Spiral to Curve |
| CS | Curve to Spiral |
| ST | Spiral to Tangent |

FIGURE 2-2: CIRCULAR CURVE WITH SPIRAL TRANSITION

For active tilt passenger train operations, the length of spiral in feet shall be defined by the following formula, rounded to the nearest 10 feet, but not less than 100 feet:

$$L_s = 1.46Vt$$

Where V is the speed in mph, and t is the time required to tilt (in seconds)

Lengths of spiral transition curves shall be greater than the above absolute minimum length in accordance with the greatest length determined from the following:

- CSXT Standard Plan 2511 - Governing criteria
- VRE recommendations for passenger comfort - CSX may allow some longer spiral transition curve lengths on a case-by-case basis
- Amtrak recommendations for passenger comfort - CSX may allow some longer spiral transition curve lengths on a case-by-case basis

2.7.3.4 Concentric Circular Curves

Circular curves in parallel tracks shall vary the degree of curvature to be concentric and transitional spiral lengths to consistently maintain the track center spacing at both the approaching and departing tangent.

2.8 VERTICAL GEOMETRY

The profile grade shall represent the elevation of the top of the low rail. Vertical alignment shall represent the existing profile grade to the extent attainable.

In areas of curved alignment where profile is given for one track only, the gradients of the second track shall be adjusted uniformly to accommodate the differences in lengths throughout the curves. Turnouts and switches shall not be placed within a vertical curve.

Limiting design elements for vertical geometry are summarized in Table 2-6.

TABLE 2-6: LIMITING DESIGN ELEMENTS

| Design Elements | Major Limiting Factors |
|--|---|
| Vertical Tangent between Vertical Curves | <ul style="list-style-type: none"> - Passenger comfort - Turnout locations |
| Vertical Curve/Grade (Maximum Rate of Change) | <ul style="list-style-type: none"> - Passenger comfort - Vehicle suspension travel - Slack action and train handling - Horizontal and vertical tangents |

2.8.1 Grades

Compensated gradients as defined by AREMA will be used to designate grades.

The ruling mainline grade along the corridor is 1 percent based on freight train requirements for the mixed use freight/passenger rail operations between Washington, D.C. and Richmond. The preferred design gradient for long continuous grade shall match the existing grade. Maximum design gradient, with curve compensation at 0.04 percent per degree of curve if applicable, for grades up to 2 percent may be implemented for new construction projects with approval in accordance with Section 12.

At station platforms, a level gradient is preferred with a maximum grade of up to 0.5 percent is permitted. For yard tracks, where cars are stored, a level gradient is preferred, but a maximum non-rolling track gradient of 0.2 percent is permitted. For mainline track, the desired length of constant profile grade between vertical curves shall be determined by the following formula (but not less than 100 feet):

$$L = 3V$$

Where: L = minimum tangent length, feet
V = design speed in the area, mph

2.8.2 Vertical Curvature

All changes in grade shall be connected by a parabolic vertical curve as defined by AREMA MRE.

For main line tracks the minimum length of vertical curve shall be determined by the following formula:

$$L_{\min} = \frac{2.15V^2(G_2 - G_1)}{A}$$

Where: V = Speed of train in miles per hour
(G₂-G₁) = Absolute value of the algebraic difference in rates of grades (expressed as a decimal)
A = vertical acceleration in ft/sec/sec (ft/sec²)
L = length of vertical curve in feet (rounded up to the next 50 feet)

The recommended vertical accelerations (A) for passenger and freight trains for both sags and summits are as follows:

| <u>Train Type</u> | <u>Recommended Vertical Acceleration (ft/sec²)</u> |
|-------------------|---|
| Passenger Train | 0.60 (0.02g) |
| Freight Train | 0.10 |

The longer vertical curve based on the above recommended accelerations shall be used. Under no circumstances shall the length of vertical curve be less than 200 feet.

Station platform and special trackwork shall not be located inside vertical curves. End of platform and point of switch shall be located at least 100 feet from beginning and end points of a vertical curve.

Locating vertical curves on bridges or at-grade crossings should be avoided to the extent practical.

In summit areas, locations of all signals shall be checked for visibility.

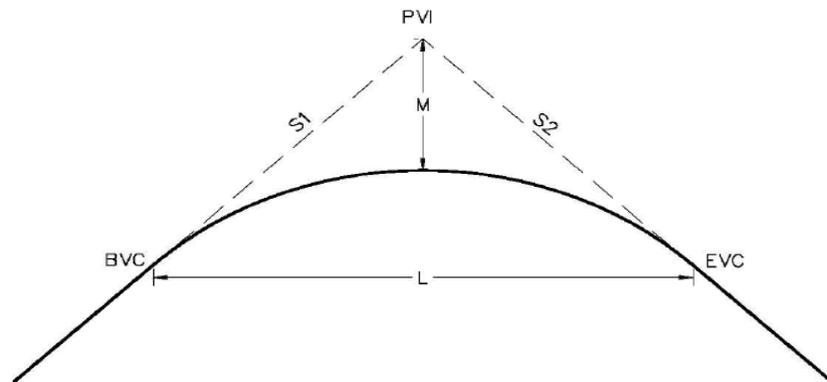
Complex profiles, such as those with more than three grade changes exceeding 1.0 percent each within a distance of 3,000 feet, may cause potential excessive dynamic forces and handling issues for long freight trains. In locations where complex profiles might occur the design shall be consistent with CSXT standard practices. See Figure 2-3 for vertical curve nomenclature.

When vertical curve is concave downward (summit):

$$M = \frac{[(EL @ PVI \times 2) - (EL @ BVC + EL @ PVI)]}{4}$$

When vertical curve is concave upward (sag):

$$M = \frac{[(EL @ BVC + EL @ EVC) - (EL @ PVI \times 2)]}{4}$$



| | |
|-----|---|
| BVC | Beginning of Vertical Curve |
| EVC | End of Vertical Curve |
| PVI | Point of Intersection for Vertical Curve |
| S1 | Slope of Entering Tangent in Percent |
| S2 | Slope of Departing Tangent in Percent |
| L | Length of Vertical Curve |
| M | Middle Ordinate and Correction of EL on Curve |
| EL | Elevation |

FIGURE 2-3: VERTICAL CURVE

2.9 CLEARANCES

The minimum railroad clearance standards described in CSXT Plans 2604 and 2605 (see Appendix A) shall be met or exceeded for all new construction or design and for all temporary construction or design. The clearances described in STRACNET shall also be met or exceeded for all new or temporary design.

All horizontal clearances shall be measured from center of track to the outermost obstruction.

All vertical clearances shall be measured from top of rail (T/R). At clearance locations where superelevation is present, vertical clearances shall be measured from the high rail.

In general, horizontal clearance from the centerline of the nearest track to any obstruction shall not be less than 9'-0" in tangent track. Additional distance shall be added to account for curvature in accordance with CSXT Clearance Diagrams for plate clearances. Whenever possible, clearances should be designed to be 10' or more depending on site conditions and type of obstruction. CSXT Plans 2604 and 2605 shall be used for clearances to platforms and canopies adjacent to mixed-use tracks. Amtrak Spec. No. 63 shall be used for clearances to platforms and canopies adjacent to tracks for passenger trains only.

In general vertical clearance from a horizontal plane at the top of the high rail to the nearest overhead obstruction shall be at least 24'-3" as defined by FRA in a letter dated January 25, 2012 to the Rail Division NCDOT for locations on the SEHSR corridor funded by FRA. The 24'-3" clearance for new structures is to accommodate potential future electrification of the corridor. Power lines shall be a minimum of 27'-0" above the plane of the top of rails and the distance shall be increased for higher voltages per NESC code.

Clearances to existing tracks may or may not meet these criteria and shall be reported as existing. Where prudent and feasible, proposed track designs shall endeavor to meet the criteria stated herein. Where imprudent and/or infeasible due to right-of-way, environmental, cost or other project constraints, design variances for new structures may be approved on a site specific basis in accordance with Section 12.

2.9.1 Bridges

CSXT has minimum requirements for outside parties constructing, rehabilitating, or replacing bridges over CSXT's railroad tracks (see Appendix A). These requirements are intended to provide safe and continuous passage of all train traffic during and after construction of bridges over its tracks. Part of these requirements is for the outside party to submit a detailed plan of the project as well as provide details of the construction methodology. The *CSXT Public Projects Information Manual* provides information on the CSXT requirements for overhead bridges.

Where the horizontal clearance from the centerline of the track to the face of a pier or abutment is greater than 25 feet, no crash wall will be required. Where this clearance is 25 feet or less, a crash wall shall be required in accordance with AREMA MRE Chapter 8, Part 2, Section 2.1.5 and with VDOT Volume V, Part 2, File No. 06.06 (see Appendix B).

Both CSXT and the agency or authority having jurisdiction for the structure shall approve the structure and clearances.

Structural inspections, bridge evaluations and load ratings are conducted regularly by CSXT, VDOT and other bridge owners in accordance with federal and state requirements. Concept

development and preliminary engineering for the DC2RVA study shall be based on a review of existing inspection reports to be provided by CSXT, VDOT, and other agencies as part of the project development process.

2.9.2 Station Platforms

All track clearances at passenger station platforms shall meet or exceed standards described in CSXT Plan 2611 (see Appendix A).

2.10 ROADBED SECTION

CSXT criterion shall apply to the Roadbed Section and shall be in accordance with CSXT Plan 2601 (see Appendix A). Additionally, the following criteria shall apply to the track's roadbed section.

2.10.1 Ballast Depth

For timber and/or concrete ties the ballast depth shall extend not less than 12 inches below bottom of tie for the full length of the tie and shoulders.

Ballast material shall be in accordance with CSXT material specifications.

Ballast material shall meet the requirements of CSXT in all track areas and shall be from a CSXT approved quarry.

2.10.2 Subballast Depth

Subballast depth shall be a minimum of 6 inches below ballast on mainline tracks and sidings, and a minimum of 4 inches below ballast in yards.

Subballast shall conform to AREMA Chapter 1 – Roadway and Ballast; Part 2- Ballast; Section 2.11 – Subballast specifications for site specific calculation of total/subballast thickness.

2.10.3 Shoulder Width

Ballast shoulder width shall be beyond the end of the tie in accordance with CSXT Plan 2602.

2.11 SPECIAL TRACKWORK

Special trackwork refers to trackwork units that are used for tracks to converge, diverge, or cross each other. Special trackwork includes turnouts, crossovers, gauntlets, and track crossings. All special trackwork design shall be based on CSXT Standard Drawings or approved vendor drawings and shall be manufactured from Head Hardened (HH) Rail.

2.11.1 Turnouts and Crossovers

Turnouts for trackwork shall comply with the standard plans of the CSXT and/or AREMA. All turnouts shall be sized either Nos. 10, 15, or 20 using CSXT standard plans in Appendix A. No other sizes shall be used unless approved by CSXT, Amtrak, and VRE. Secondary track shall utilize No. 10 or No.15 turnouts.

All new turnouts shall be constructed of new 136-RE CWR and concrete ties, unless turnouts are placed in timber tie track on existing mainlines or industrial sidings. All new crossovers shall be constructed of new 136-RE CWR and concrete ties. The design intent is to use concrete ties for new construction, unless there are specific areas where CSXT would require the use of timber ties due to potential existing track, operations or maintenance constraints. The potential locations of timber tie areas (if any) will be coordinated with CSXT during the concept development process.

Turnouts shall be continuously welded rail except at specific areas indicating a 36 inch whole joint bar bonded insulated which shall be a poly-insulated type.

Switch points, stock rails, closure rails, guard rails, and frog wing rails and all associated components shall be fabricated from new, high strength (head hardened) rail.

The following is a brief description of the various nomenclatures used to describe special trackwork:

- **Turnouts** are used for tracks to diverge or converge from one track to another track. Turnouts have different types and sizes (numbers). A turnout unit consists of a switch, a frog, and straight and curve stock rails, straight and curve closure rails, guard rails, plus a means to throw the switch and secure it.
- **Frog** is the portion of a turnout or track crossing where wheels cross from one track to another track. Typical types of frogs that will be used on the DC2RVA project are:
 - **Railbound Manganese (RBM)**, used on lower speed turnouts.
 - **Spring Frog (SRP)**, preferred where divergent moves are significantly lower in number than straight moves. Also provides improved ride comfort.
 - **Pseudo Tangential (TAN)**, may be used for higher speed turnouts.
- **Crossovers** are installed between two tracks for trains to move from one track to another adjacent track. A single crossover unit consists of two turnouts.
- **Universal crossover** unit consists of two continuous single crossovers installed in opposite directions.
- **Turnout size or number** is the number corresponding to the frog number of the turnout. The frog number is equal to the cotangent of the frog angle.

The following information is required for the design of turnouts:

- Turnout number
- Stationing at the point of switch (PS) of the turnout
- Stationing at the point of frog (PF) of the turnout
- Stationing at the point of intersection of turnout (PITO)

2.11.2 Speeds through Turnouts and Crossovers

Passenger train design speeds for turnouts and crossovers are governed by CSXT operating rules including CSXT signal aspects. Freight design speeds are for maximum of two inches of unbalanced superelevation. Refer to CSXT Common Standards for information on superelevation.

Based on AREMA criteria and CSXT MWI 601-01, the maximum authorized speeds (MAS) through turnouts and crossovers for passenger and freight trains are shown in Table 2-7.

TABLE 2-7: TURNOUT DIVERGING SPEEDS

| Turnout Data | Switch Length & Type | Passenger (mph) | Freight (mph) |
|--------------|----------------------|-----------------|---------------|
| #10 | 16'-6" Straight | 15 | 15 |
| #15 | 26'-0" Curved | 30 | 30 |
| #20 | 39'-0" Curved | 45 | 45 |

2.11.3 Standard Turnouts and Crossovers

Turnouts and crossovers shall be located to allow suitable placement of switch machines and/or switch stands to meet the requirements of CSXT Plan 2603, with consideration of the placement and visibility of control signals, and with easy access for operation and maintenance. Turnouts and crossovers shall be located on tangent tracks and shall meet the following requirements:

- 100 feet minimum from point of switch (PS) to horizontal or vertical curves
- Less than 100 feet from horizontal or vertical curves with approval in accordance with Section 12
- 100 feet minimum from PS to the edge of road crossings (including sidewalks)
- 50 feet minimum from PS to Insulated Joint
- 50 feet minimum from PS to opposing point of switch
- Crossovers shall be located in parallel tracks only
- Standard crossovers shall be on minimum of 15-foot track centers

2.11.4 Non-Standard Turnouts and Crossovers

Design of non-standard turnouts and crossovers, such as equilateral turnouts, shall require approval in accordance with Section 12 including:

- Crossovers in non-parallel tracks
- Crossovers with track center more than 25 feet
- Turnouts in curves
- Switches for gauntlet tracks or special trackwork near station platforms

2.11.5 Frogs

Frogs for turnouts used in high-speed diverging moves shall be designed in accordance with CSXT Maintenance of Way Regulations and Instructions Section 2400 Standard Frog Drawings.

2.11.6 Derails

Derails are mechanical and/or electrical safety devices intentionally used to derail or divert uncontrolled movement of train, rail vehicles, or on-track equipment away from adjacent or connecting tracks without fouling the tracks. See CSXT Plan 2216 for layout and details and CSXT MWI 602-01 for the policy governing the installation and maintenance of derails. The design of split-point derails and electric locks on all non-interlocked or non-signalized tracks connecting to the mainline for FRA-funded passenger projects shall also comply with the requirements and policies of the FRA Office of Railroad Policy and Development.

The designer shall closely coordinate with the signal designer for design and layout requirements. Derails shall be installed on the downgrade end of yard and secondary track that is normally used for storage of unattended vehicles, if this track is directly connected to the main track, and if its prevailing grade is descending toward the main track. With approval in accordance with Section 12, derails may be used at other track locations where cars are moved or locomotives are stored to prevent or minimize injury to passengers and personnel, and/or damage to equipment.

Derails shall be located so that they derail equipment in a direction away from the main track. Derails shall be located beyond the clearance points of converging tracks. Double point split switch derails are installed at locations as required by CSXT including locations where operating locomotives are stored and where cars are moved or switched by non-railroad personnel.

Derails are connected to the signal system to indicate when they are lined for train movement.

Detailed design of derails and electric locks will be prepared by CSXT as part of the signals and communication design. The preliminary plans prepared by the DC2RVA Project Team will include a note or symbol at each non-signalized turnout intersecting the mainline on the plans identifying the placement of the devices.

2.11.7 Industry Access

Turnouts to maintain connections to industrial sidings and leads shall be designed using the CSXT Standard Specifications for the Design and Construction of Private Sidetracks as issued June 1, 2007.

2.12 TRACK GAUGE

The standard track gauge shall be 4 feet 8½ inches. Track gauge shall be measured between the gauge sides of the heads of rails at a distance of 5/8 inch below the top of rails.

Gauges for special trackwork shall be as recommended in the AREMA portfolio of trackwork plans except as modified to reflect the physical and operational characteristics of the system as approved by CSXT.

2.13 RAIL

The standard rail section shall be new 136 RE Continuous Welded Rail (CWR), meeting AREMA material requirements on mainline tracks as modified and approved by CSXT. Premium new 136 RE CWR shall be required in curves with a degree of curve greater than 4°

00' 00". Premium rail is defined in CSXT MWI 505-01 as having a minimum 352 BHN and an average 363 BHN Head Hardened or Fully Heat Treated specification.

2.14 RAIL ANCHORING

In conventional ballasted track construction, where timber ties, tie plates and track spikes are used, rail anchors shall be applied. Details shall be in accordance with CSXT MWI 703-06.

2.15 TIE PLATES

Tie plates for timber ties with track spikes or resilient fasteners (as designated by CSXT) shall be a dimension as designated in CSXT Plan 2516. In the case of resilient fasteners, it must be of a type approved for use with resilient fasteners by the resilient fastener manufacturer.

2.16 TIES

2.16.1 Concrete Ties

Where specified by CSXT, track construction shall utilize concrete ties for regular track and for turnouts. All construction of new mainline track and new crossovers shall use concrete ties. The following criteria shall apply for concrete ties:

- Concrete ties shall be spaced at 20 inches, center to center.
- Concrete ties shall be of the type as specified by CSXT and shall conform to the CSXT material specifications.

2.16.2 Timber Ties

Where specified by CSXT, track construction shall utilize timber ties for regular track and turnouts. The following criteria shall apply for timber ties:

| | |
|---------|----------|
| Length: | 8.5 feet |
| Height: | 7 inches |
| Width: | 9 inches |

Timber ties shall be in accordance with CSXT MWI 401-02.

Timber tie spacing shall be a maximum of 20 inches and a minimum of 18 inches, center to center.

2.17 SIGNALS AND COMMUNICATIONS

DRPT will contract directly with CSXT and its exclusive signal and communication (S&C) systems designer to develop all conceptual and preliminary S&C designs, including associated cost estimates and schedules. This separate contract will run concurrently and share a similar timeline with the DC2RVA consultant team contract and work efforts. The consultant team will

RAILWAY

incorporate the S&C design information into the DC2RVA project as appropriate and will coordinate directly with CSXT, the CSXT S&C representative, and DRPT throughout the study.

A separate document for the design standards for concept and preliminary design of the S&C shall be submitted to DRPT by CSXT for subsequent review and approval by the FRA prior to design of the systems. FRA shall also approve the signal system route, aspect charts, and signal design speeds.

3 HIGHWAY

Roadway design shall be provided in accordance with VDOT standards, including the *2007 Road and Bridge Specifications*, *2008 Road and Bridge Standards*, *2009 MUTCD*, *2011 Virginia Supplement to the MUTCD*, *2011 Virginia Work Area Protection Manual*, and the *2011 AASHTO Policy on Geometric Design of Highways and Streets* (commonly referred to as the AASHTO “Green Book”).

3.1 DEFINITIONS

All definitions used in this Roadway Design Criteria document are in accordance with those used in AASHTO and VDOT references.

3.2 SAFETY

The design should always attempt to provide for the highest degree of safety and best level of service that is economically feasible. The “minimum” roadway design criteria shown in the tables should only be used when overriding economic or environmental considerations so dictate.

All operations which cross through, over or under a rail corridor must be reviewed and approved by the host railroad. The elements of design must be cognizant of items that impact safety of rail operations, safety for the traveling public, and the safety of those who live in adjoining communities.

3.3 CRITERIA

3.3.1 Roadway Standards

For the design of roadway elements for the project, the designers shall utilize the AASHTO *Policy on Geometric Design of Highways and Streets, 6th Edition, 2011*, commonly referred to as the “Green Book, as long as there are no local standards which exceed the “Green Book” standards. If county or city standards are more stringent, then those design criteria shall be incorporated into the design.

The *Virginia DOT Road Design Manual*, available at the following location: <http://virginiadot.org/business/locdes/rdmanual-index.asp> shall be utilized in conjunction with the “Green Book.” “Appendix A -Section A-1-Geometric Design Standards” of the *Virginia DOT Road Design Manual* has specific details and requirements for the design elements to be utilized for the various classifications of facilities to be encountered along the length of the project.

The geometric design standards established in AASHTO for various elements of the roadway design and indicated in the text and tables within the “Green Book” and the noted appendix provide the minimum geometric standards.

3.3.2 Resurfacing, Restoration & Rehabilitation

Guidelines for resurfacing, restoration, and rehabilitation (RRR) projects located in Appendix A, Section A-4 of the *Virginia DOT Road Design Manual* are not applicable for this project.

3.3.3 Quality Control

Application of the criteria provided in the geometric design standard tables should be reviewed to determine the design’s impact on the roadway system and sound engineering judgment utilized in the selection of design elements. The design shall consider economic, environmental and social factors involved in the design.

3.3.4 Design Content

Designs and plans shall be completed to the preliminary stage in accordance with the Quality Control Checklist for Roadway Design – Form LD-436. At minimum, the checklist items and those noted below will be included on the drawings:

- Street Improvement Plans (layouts illustrating curb lines, median layout, limits of pavement work, proposed locations for joining existing improvements, street widths, and centerline profile)
- Typical Sections (typical sections only)
- Pavement Alternatives (Coordinated with VDOT)
- Traffic signing, lighting and striping
- Horizontal alignments
- Vertical profiles
- Major cross-drainage structures
- Major retaining walls
- Right-of-way
- Access management
- Utility conflicts/relocations

Cross-sections shall be provided at 100 feet for stations and at critical locations if necessary.

3.3.5 Alternative Designs

Avoidance alternatives shall be developed to minimize overall project impacts along the corridor.

For segments of the design which have multiple alternatives, the design team shall coordinate with the owner to develop a comparison matrix and weighting system to be utilized in

quantifying right-of-way (ROW) impacts/relocations, earthwork, environmental impacts, and structures (bridges and major drainage).

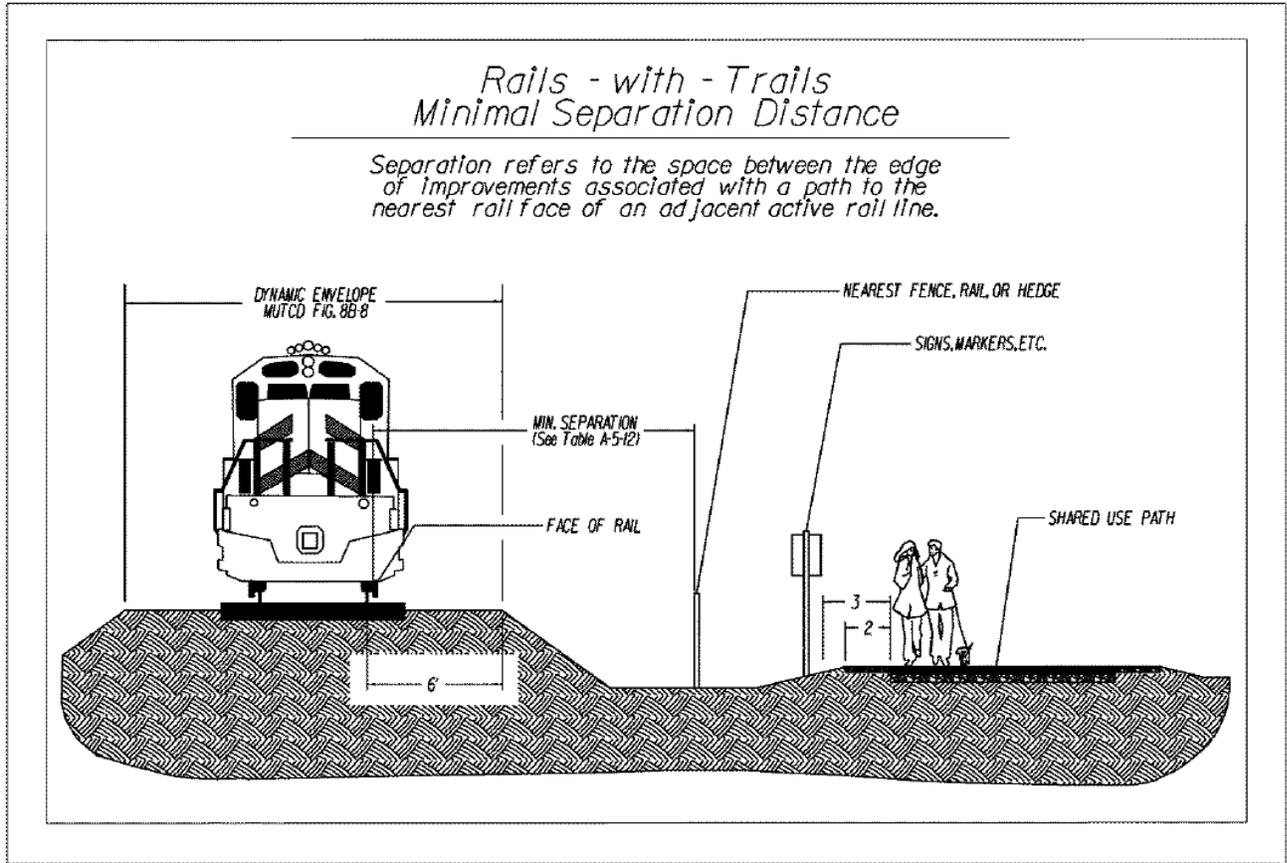
Due to the nature of the comparison items, the weighting will likely vary along segments of the multiple alternatives – i.e., a section through historic Richmond would have a different ROW weighting than one through farmland. The limits of the weighting and the values for the segments shall be clearly marked and be logical in their context so that the rankings generated are valid.

3.3.6 Pedestrians/Bike Paths/Trails

Public or private parallel at-grade paths/trails are not permitted on active CSXT right-of-way in accordance with CSXT Public Project Information dated August 10, 2012. Bicycle/pedestrian paths/trails crossing the corridor shall be grade-separated. At-grade roadway crossings with sidewalks that serve as bicycle/pedestrian paths/trails shall be evaluated for potential grade separations on a case-by-case basis.

The geometric design standards established in the *Virginia Department of Transportation Road Design Manual* and the *AASHTO Guide for the Development of Bicycle Facilities 4th Edition (2012)* will determine the minimum standards to be utilized in the development of these items. If county or city standards are more stringent, then those design criteria shall be incorporated into the design.

For trails parallel to the rail corridor, the designs shall provide for the safest facility possible. Figures 3-1 and 3-2 dictate the minimum offsets allowed for the incorporation of these elements into the final design. These figures were taken from Appendix A of the Road Design Manual and the designer shall utilize the most up to date version acceptable to CSXT (the host railroad). Physical barriers referenced in Figure 3-2 include fences, walls, solid barriers, or any other type of barriers restricting public access to active rail lines. All physical barriers shall be located outside of CSXT right-of-way unless specifically approved otherwise by CSXT on a case-by-case basis.



Source: Adapted from the [VTrans Pedestrian and Bicycle Facility Planning and Design Manual](#)

FIGURE 3-1: RAILS-WITH-TRAILS MINIMAL SEPARATION DISTANCE

| Recommended Separation between Active Rail Lines and Paths (RWT) | | |
|---|---|--|
| Type of Rail Operation | Setting Characteristic | Recommended Minimum Separation |
| High Volume/High Speed | | |
| 11 trains or more per day Max speed over 45 mph | Typical Conditions | 25 feet with fence |
| | | 15 feet with a solid barrier |
| | Constrained Areas (cut/fill, bridges, etc.) | 15 feet with fence or other physical barrier |
| | Vertical Separation of at least 10 feet | 20 feet |
| Medium Volume/Medium Speed | | |
| Fewer than 11 trains per day Max speed 45 mph | Typical Conditions | 25 feet |
| | | 15 feet with physical barrier |
| | Constrained Areas | 11 feet with physical barrier |
| | High Trespassing Areas | 11 feet with physical barrier |
| Low Volume/Low Speed | | |
| Fewer than 11 trains per day Max speed 45 mph | Typical Conditions | 25 feet desired |
| | | 11 feet minimum |
| | Constrained Areas | 11 feet with physical barrier |

Adapted from FHWA Rails with trails Lessons Learned
 Source: *VT Trans Pedestrian and Bicycle Facility Planning and Design Manual*

FIGURE 3-2: RECOMMENDED SEPARATION BETWEEN ACTIVE RAIL LINES AND PATHS

4

DRAINAGE, HYDROLOGY, AND HYDRAULICS

Hydrologic and hydraulic analysis of floodways shall be performed using computer modeling software in accordance with the requirements of FEMA. Designs impacting FEMA or Locality-Mapped streams shall be in accordance with 44 CFR 60.3(c)(10), unless state or local jurisdictions have a more stringent floodplain management criteria. In addition, impacts to streams that are not mapped by FEMA or the locality shall be limited to a 1.0 foot increase in the 100-year flood elevation, unless a potentially insurable structure is impacted. Then, no increase shall be allowed.

Drainage structures that are larger than 6 feet by 6 feet box culverts or 6 feet diameter pipe culverts are considered major drainage structures and will be analyzed and sized during the preliminary engineering plan development. Drainage structures that are smaller than 6 feet by 6 feet box culverts or 6 feet diameter pipe culverts are considered minor structures and shall be shown as pipe and culvert extensions on the preliminary engineering plans.

To the extent applicable, drainage, hydrology and hydraulic design for railroad features of the DC2RVA project shall conform to the land disturbance and discharge requirements for “linear projects” as defined in the Virginia Code and as administered by the Virginia Department of Environmental Quality (DEQ). The project development shall conform to the specific requirements for railroad projects (Virginia Code 62.1-44.15:31) in which the host railroad (CSXT) annually submits a set of standards and specifications for DEQ approval that describes how land disturbing activities are conducted, including regulations governing Virginia Stormwater Management Program (VSMP) Permit for Discharges of Stormwater from Construction Activities and the Erosion and Sediment Control Law and associated regulations. Railroad features for the DC2RVA project will be developed in accordance with the CSXT standards and specifications as approved by DEQ effective December 2014.

It is noted that the Class I railroads are regulated by the Surface Transportation Board (STB), not by local or state governments, and that the federal preemption provisions contained in 49 USC 10501(b) shields railroad operations and facilities from the application of most state and local laws. Preemptive rights, however, do not exempt railroads from certain federal environmental statutes. Rail projects that utilize federal funds must be in compliance with appropriate National Environmental Policy Act (NEPA) requirements as administered by FRA, FHWA, or FTA for commuter projects.

Drainage, hydrology and hydraulic design for railroad ditches shall be designed in accordance with CSXT standards and specifications and/or AREMA MRE. Dimensions of railroad ditches will vary based on local conditions and may differ from the typical dimensions shown in Figure 2-1. CSXT Design & Construction Standard Specifications - Pipeline Occupancies and CSXT Standard Specifications for the Design and Construction of Private Sidetracks provide requirements for design and construction of drainage facilities in CSXT right-of-way. Culverts

under railroad embankments shall be adequately sized to carry the drainage without ponding water against the roadbed based on the 100-year storm event.

Drainage, hydrology, and hydraulic design for roadways shall conform to the requirements of the *2002 VDOT Drainage Manual* with revisions effective July 2014. Requirements for major drainage structures or bridged waterways shall be identified. Drainage facilities that may impact the required right-of-way shall be identified.

Drainage, hydrology, and hydraulic design for the preliminary engineering phase of the DC2RVA project shall be developed to a level sufficient to evaluate the impacts of potential stormwater management requirements, assess potential space requirements (ROW), and provide their associated costs in the project cost estimate. Detailed final design and permitting would be performed in the future for each project segment prior to construction.

5

BRIDGES AND STRUCTURES

Structure requirements for overhead bridges, grade separations, under-grades (bridges), major drainage, and waterway crossings shall be consistent with current CSXT Criteria for Overhead Bridges, CSXT Criteria for Ballast Deck Railroad Bridges, and AREMA criteria. As a minimum, under-grades (bridges) shall be designed to provide two feet of freeboard for the 50-year storm event and to remain below the bottom of the ballast during the 100-year storm event.

Overhead bridges for roadways and paths/trails will be developed in accordance with VDOT's *2008 Road and Bridge Standards* and requirements of the *AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012* (with 2013 Interim Specifications and VDOT Modifications).

Where the horizontal clearance from the centerline of the track to the face of a pier or abutment is greater than 25 feet, no crash wall will be required. Where this clearance is 25 feet or less, a crash wall shall be required in accordance with AREMA MRE Chapter 8, Part 2, Section 2.1.5 and with VDOT Volume V, Part 2, File No. 06.06 (see Appendix B).

Structural Inspections, bridge evaluations and load ratings are conducted regularly by CSXT, VDOT, and other bridge owners in accordance with federal and state requirements. Concept development and preliminary engineering for the DC2RVA study shall be based on a review of existing inspection reports to be provided by CSXT, VDOT, and other agencies as part of the project development process.

6 AT-GRADE CROSSINGS

All at-grade crossings shall be evaluated using the Risk Model from the FRA. A highway-rail engineering analysis shall be performed to assess the applicability of existing at-grade crossing protection for higher train speeds and increased train traffic.

Public at-grade crossings shall be consolidated to the maximum extent possible and may include grade separations where feasible to eliminate at-grade crossings. Crossings shall be evaluated to determine if an individual crossing may be closed to roadway traffic in conjunction with improvements to alternate adjacent crossings. Improvements may include roadway infrastructure, traffic signals, grade separations and crossing safety improvements and as a minimum shall be designed based on CSXT and VDOT at-grade crossing standards. At-grade roadway crossings with sidewalks shall be evaluated for grade separations on a case-by-case basis.

Crossing recommendations, public or private, will be determined on site-specific conditions. All publically accessible at-grade crossings, public or private, shall have train activated warning systems. Constant warning time AFO circuits are preferred. All crossing recommendations will require approval from CSXT, FRA, DRPT, and VDOT (and/or the local authority having jurisdiction for the road).

7 **RIGHT-OF-WAY**

Existing right-of-way shall be established using CSXT Val Maps and readily available assessor maps or tax maps.

Right-of-way impacts shall be identified using the proposed grading footprints of the railroad and roadways. Permanent and temporary easements shall be estimated using drainage and structure concept footprints. Temporary easements required for construction and/or maintenance access shall be indicated as well.

Sections along the corridor shall be classified as rural, suburban or urban based on the density and type of development. Impacted properties shall be identified as business, residential, commercial or industrial based on the types of structures and occupancy with the total area of the property, the impacted area of the property, and the residual area of the property tabulated.

Proposed right-of-way, including the use of off-corridor right-of-way where feasible, shall be considered on a case-by-case basis where needed for:

- Additional tracks
- Bridges
- Culverts
- Permanent slopes
- Relocated highways
- Private property access due to grade separations, crossing closures, or other access impacts
- Corridor access

8 STATIONS

The stations design criteria in this section provides a discussion of improved guidelines, practices, procedures, and policies that reflect current regulations, proven and accepted technological developments, and best available rail industry design practices. These station design criteria provide the minimum requirements for the design and planning of new or rehabilitated stations.

DRPT intends to apply the recommended station design criteria when new stations or major improvements are proposed. Station designs shall provide a safe and enjoyable transit experience that promotes ridership growth, integrates with other travel modes and public transportation systems for the convenience of the passengers, and encourages economic development opportunities in adjacent areas.

The design of a train station is typically site specific and reflects the surrounding community. However, the functionality of stations must be practical and consistent in order to effectively serve a range of potential users as well as safely address corridor and operational considerations.

Existing passenger stations within the Washington, D.C. to Richmond Southeast High Speed Rail (DC2RVA) corridor are served by Amtrak and/or VRE as shown below:

- Union Station, Washington, D.C. - Amtrak/VRE (for ridership/revenue only)
- L'Enfant Station - VRE (north of project area limits)Crystal City Station - VRE
- Alexandria Station - Amtrak/VRE
- Franconia/Springfield Station - VRE
- Lorton Auto Train Station - Amtrak
- Lorton Station - VRE
- Woodbridge Station - Amtrak/VRE
- Rippon Station - VRE
- Potomac Shores Station - VRE (scheduled to open in 2017)
- Quantico Station - Amtrak/VRE
- Brooke Station - VRE
- Leeland Road Station - VRE
- Fredericksburg Station - Amtrak/VRE
- Spotsylvania Station - VRE (scheduled to open in 2015)

STATIONS

- Ashland Station – Amtrak
- Staples Mill Road Station, Richmond – Amtrak
- Main Street Station, Richmond – Amtrak

Key design considerations and criteria are summarized in the following subsections.

8.1 STANDARDS, CODES AND GUIDELINES

Stations and station infrastructure shall be programmed using FRA Station Area Planning for High-Speed and Intercity Passenger Rail Guidelines (June 2011), FRA Railroad Corridor Transportation Plans Guidelines (July 2005), Amtrak Station Program and Planning Guidelines (May 2013), and VRE Station Design Guidelines (November 2002, as amended prior to November 1, 2014).

All components of the station shall conform to the requirements of the Americans with Disabilities Act (ADA).

Passenger platform clearances shall conform to the applicable requirements of CSXT Plans 2604 and 2611.

Station design shall comply with:

- National Fire and Life Safety Code
- Virginia Fire and Life Safety Code
- Virginia Building Code

Station architecture, layout, parking, landscaping, and streetscape shall be designed to meet applicable county, city, district, or neighborhood guidelines and requirements.

For shared Amtrak/VRE passenger station situations the design intent is to meet the applicable criteria of both Amtrak and VRE, but in the event of potential conflicts between the criteria, the federal Amtrak criteria will control unless an alternate criteria has been established and approved by the affected project stakeholders.

Intermodal connections at stations served by WMATA, PRTC, and NVTC shall be designed in accordance with the transit agency's guidelines. Where those guidelines conflict with Amtrak and or VRE criteria, Amtrak criteria will control followed by VRE criteria.

8.2 PASSENGER CAR TYPES

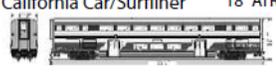
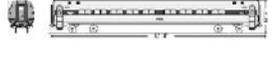
The DC2RVA corridor currently operates with equipment types that are a result of the mixed operations that are shared with VRE and Amtrak operating on CSXT freight railroad property and infrastructure. Typical passenger cars consist of either a bi-level design, with a low-level entry floor height, or a single-level design, with a high-level entry floor height. Both single level and bi-level equipment are currently used within the corridor and will continue to be used into the future.

Important characteristics include:

- VRE bi-level equipment works well on shared passenger/freight routes where freight trains have clearance requirements limiting platform heights to 8 inches above top of rail (ATR).
- Bi-level equipment has approximately 50 percent more capacity for the same train length than high floor equipment, but may present ADA access challenges due to the equipment having three internal steps. This equipment will accommodate ADA level-boarding requirements using on-board mechanical lifts in each doorway.
- Bi-level equipment has one set of doors in the center of each side on the lower level of each car.
- Single level high floor equipment has a nominal floor height of 48 inches ATR and is primarily used on the east coast where tunnels limit vehicle heights.
- Single level equipment has two sets of doors per side located at the ends of the car with steps at each exit door that may be used to serve low level platforms. However, this equipment may present ADA access challenges due to the need for platform-based portable lifts.

Figure 8-1 shows examples of typical Amtrak passenger cars that operate at various locations in the U.S. rail system, including some passenger car types that do not operate within the DC2RVA corridor.

Passenger Cars

| Name | Deck Height | Dimensions | Occupancy Per Car | Location Used | Other |
|---|-------------|---------------------|----------------------|--|--|
| Bi-Level Passenger Cars | | | | | |
|  <p>Superliner</p> | 18" ATR | 85' L, 16' H, 10' W | 74 coach/ 40 sleeper | Long Distance Routes not out of New York or Boston | Variations include sleeper, diner, lounge, baggage, coach, arcade |
|  <p>California Car/Surfliner</p> | 18" ATR | 85' L, 16' H, 10' W | 70 – 90 | California | Provides extendable wheelchair lift. Two sets of automatic doors speed passenger boarding. Owned by the state of California. |
| Single-Level Passenger Cars | | | | | |
|  <p>Amfleet</p> | 51" ATR | 85' L, 13' H, 10' W | 60–70 | East Coast | Traps in vestibule enables car to serve low level platforms |
|  <p>Horizon</p> | 51" ATR | 85' L, 13' H, 10' W | 60–70 | Michigan, Missouri Wisconsin, Illinois | Traps in vestibule enables car to serve low level platforms |
|  <p>North Carolina Coach</p> | 51" ATR | 85' L, 13' H, 10' W | 55–65 | North Carolina | Traps in vestibule enables car to serve low level platforms, owned by NCDOT Rail Division |
|  <p>Viewliner Sleeper</p> | 51" ATR | 85' L, 14' H, 10' W | 30 | East Coast | Traps in vestibule enables car to serve low level platforms, extra windows for person in top bunk |
|  <p>Acela</p> | 51" ATR | 85' L, 14' H, 10' W | 299 (Per Trainset) | Northeast Corridor | Only service with first class seating Tilts to go around curves faster |
|  <p>Talgo</p> | 24" ATR | 43' L, 11' H, 10' W | 269 (Per Trainset) | Pacific Northwest | Tilts to go around curves faster. Provides extendable wheelchair lift and extendable step. Owned by the State of Washington. |

Source: Amtrak Station Program and Planning Guidelines

FIGURE 8-1: TYPICAL AMTRAK PASSENGER CARS

8.3 LOCOMOTIVE TYPES

Locomotive types provide important considerations in the design of platforms in that the overall platform length must consider access to the locomotive cab from the platform where crew changes are scheduled to take place. Typical locomotives currently operating in the DC2RVA corridor include P-42 diesel-electric locomotives operated by Amtrak and MP36-3C diesel electric locomotives operated by VRE. Figure 8-2 shows some typical Amtrak locomotives, including some locomotive types that do not operate within the DC2RVA corridor.

STATIONS

Locomotives

| Name | Type | Dimensions | Top Speed | Location Used | Other |
|--|----------|---------------------|-----------|--|---|
|  Acela Power Car | Electric | 69' L, 14' H, 10' W | 150 mph | Northeast Corridor | Fastest locomotives in the country |
|  AEM 7 | Electric | 51' L, 14' H, 10' W | 125mph | Northeast Corridor, Keystone Corridor | |
|  HHP 8 | Electric | 65' L, 14' H, 10' W | 125 mph | Northeast Corridor | |
|  P-42 | Diesel | 69' L, 14' H, 10' W | 110 mph | Nationwide | Variation used in New York utilizes electric 3rd rail |
|  F59 | Diesel | 58' L, 15' H, 10' W | 110 mph | California, Oregon, Washington, North Carolina, California | Owned by California, Washington, and North Carolina, which use specific paint schemes |

Source: Amtrak Station Program and Planning Guidelines

FIGURE 8-2: TYPICAL AMTRAK LOCOMOTIVES

Tables 8-1 and 8-2 show Amtrak and VRE consist and equipment data.

TABLE 8-1: AMTRAK AND VRE TRAIN DATA

| Train | Cars | Locomotives | Length (w/o locomotive) | Length (w/ locomotive) |
|---|------|-------------|-----------------------------------|-----------------------------------|
| Amtrak Standard Northeast Regional | 8 | 1 | 682 ft., 8 in. | 751 ft., 8 in. |
| Amtrak Shortened Northeast Regional (1 RVR set) | 7 | 1 | 597 ft., 4 in. | 666 ft., 3 in. |
| Amtrak Weekend Northeast Regional (Lynchburg) | 9 | 1 | 768 ft. 0 in. | 837 ft., 0 in. |
| Amtrak Holiday Northeast Regional | 9/10 | 1/1 | 768 ft., 0 in./ 853 ft., 4 in. | 837 ft., 0 in./ 922 ft., 4 in. |
| Amtrak Overnight BOS-NPN Regional (Nos. 66/67) | 6 | 1 | 511 ft., 8 in. | 580 ft. 8 in. |
| Amtrak Standard Carolinian | 7 | 1 | 597 ft., 0 in. | 666 ft., 0 in. |
| Amtrak Standard Palmetto | 7 | 1 | 597 ft., 0 in. | 666 ft., 0 in. |
| Amtrak Holiday Palmetto | 8 | 1 | 682 ft., 4 in. | 751 ft., 4 in. |

TABLE 8-1: AMTRAK AND VRE TRAIN DATA

| Train | Cars | Locomotives | Length (w/o locomotive) | Length (w/ locomotive) |
|--------------------------------------|-------------|--------------------|------------------------------------|-----------------------------------|
| Amtrak Standard Silver Meteor | 10 | 2 | 852 ft., 8 in. | 990 ft., 8 in. |
| Amtrak Holiday Silver Meteor | 11 | 2 | 938 ft., 0 in. | 1,076 ft., 0 in. |
| Amtrak Standard Silver Star | 9 | 2 | 767 ft., 4 in. | 905 ft., 4 in. |
| Amtrak Holiday Silver Star | 11 | 2 | 938 ft., 0 in. | 1,076 ft., 0 in. |
| Amtrak Standard Crescent | 9 | 2 | 767 ft., 4 in. | 905 ft., 4 in. |
| Amtrak Holiday Crescent | 10 | 2 | 852 ft., 8 in. | 990 ft., 8 in. |
| Amtrak Cardinal | 6 | 1 | 511 ft., 8 in. | 580 ft., 8 in. |
| Amtrak Standard Auto Train (avg.) | 40 | 2 | 3,520 ft., 0 in. | 3,658 ft., 0 in. |
| Amtrak Peak/Holiday Auto Train | 50 | 2 | 4,420 ft., 0 in. | 4,558 ft., 0 in. |
| Current minimum VRE consist | 4 | 1 | 340 ft., 0 in. | 410 ft., 0 in. |
| Current maximum VRE consist | 8 | 1 | 680 ft., 0 in. | 750 ft., 0 in. |
| Proposed maximum VRE consist | 10 | 1 | 850 ft., 0 in. | 920 ft., 0 in. |

TABLE 8-2: AMTRAK AND VRE EQUIPMENT DATA

| Equipment Type | Builder | Date | Length over coupler |
|--|----------------|-------------|----------------------------|
| Amtrak P42 diesel locomotive (4,250 hp/110 mph) | GE | 1996 - 2001 | 69 feet, 0 inches |
| Amtrak P40 diesel locomotive (4,000 hp/100 mph) | GE | 1993 | 69 feet, 0 inches |
| Amtrak Heritage baggage car | Varies | 1950 - 1961 | 85 feet, 0 inches |
| Amtrak Heritage dining car | Varies | 1950 - 1961 | 85 feet, 0 inches |
| Amtrak Amfleet I Capstone coach | Budd | 1975 - 1977 | 85 feet, 4 inches |
| Amtrak Amfleet I Capstone Business class | Budd | 1979 - 1977 | 85 feet, 4 inches |
| Amtrak Amfleet I all-table dinette | Budd | 1975 - 1977 | 85 feet, 4 inches |
| Amtrak Amfleet I club-dinette | Budd | 1975 - 1977 | 85 feet, 4 inches |
| Amtrak Amfleet II coach | Budd | 1981 - 1983 | 85 feet, 4 inches |
| Amtrak Amfleet II diner-lounge | Budd | 1981 - 1983 | 85 feet, 4 inches |

TABLE 8-2: AMTRAK AND VRE EQUIPMENT DATA

| Equipment Type | Builder | Date | Length over coupler |
|--|--------------------|-------------------------------|----------------------------|
| Amtrak Viewliner sleeping car | MK/Amerail | 1995 - 1996 | 85 feet, 4 inches |
| Amtrak Viewliner dining car | MK/Amerail | 1996 | |
| Amtrak Viewliner II car (baggage, sleeper, diner) | CAF | 2014 - 2015 | 85 feet, 4 inches |
| Amtrak Superliner I Sightseer lounge car | Pullman-Standard | 1979 - 1981 | 85 feet, 0 inches |
| Amtrak Superliner II coach | Bombardier | 1993 - 1996 | 85 feet, 0 inches |
| Amtrak Superliner II sleeping car | Bombardier | 1993 - 1996 | 85 feet, 0 inches |
| Amtrak Superliner II deluxe sleeping car | Bombardier | 1993 - 1996 | 85 feet, 0 inches |
| Amtrak Superliner II transition dorm | Bombardier | 1993 - 1996 | 85 feet, 0 inches |
| Amtrak Superliner II diner | Bombardier | 1993 - 1996 | 85 feet, 0 inches |
| Amtrak Aluminum Vehicle Carrier | FreightCar America | 2005 | 90 feet, 0 inches |
| VRE MP36PH-3C diesel locomotive (3,600 hp) | MotivePower | 2010 - 2012 | 70 feet, 0 inches |
| VRE Gallery IV bilevel car | Nippon Sharyo | 2006 - 2009 2014 - present | 85 feet, 0 inches |

At present, all train service, both passenger and freight in the Washington to Richmond corridor, is powered by diesel locomotives. Amtrak passenger service is electrified north of Washington to New York City and beyond to Boston. Amtrak Northeast Corridor (NEC) passenger trains now originating in Newport News, Norfolk, and Richmond must change engines in Washington, a time consuming process, in order to proceed northward on the corridor since diesel service is not permissible into and through New York City. This is due to the long tunnels and confined underground station spaces in New York that cannot accommodate diesel powered engines and the exhaust they produce. FRA has affirmed that the Southeast High Speed Rail Corridor (SEHSR) development will include provisions as to not preclude the possibility of future electrification in a letter to the North Carolina Department of Transportation dated January 25, 2012.

Previously completed studies in the DC2RVA mixed freight/passenger corridor have documented serious operational, liability, and maintenance concerns by CSXT for potential electrification. The railroad would probably never utilize the electrical power for their freight trains, but they would be required to make substantial changes to the way they operate and maintain the rail line. The supports for the overhead power lines would impact the right-of-way and clearances for maintenance. The vertical clearance of almost all highway grade separation bridges in the corridor would need to be raised significantly to meet electrification requirements. There would also be a new safety risk associated with the electrical power system with personnel entering the right-of-way.

The Southeast High Speed Rail Corridor between Washington, D.C. and Charlotte, NC, which includes the Washington to Richmond Corridor, does not propose electrification. The Alternatives Analysis and Tier I Environmental Impact Statement that have been completed for SEHSR recommend the use of modern diesel locomotives which are capable of operating at speeds well in excess of the maximum allowable speed of 90 mph proposed in this study. Further, the level of service provided and the number of passengers served in this corridor did not justify the huge expense of installing an overhead catenary electric power system.

For the DC2RVA project, the concept and preliminary engineering will be based on the use of diesel powered locomotives. The proposed design would not prevent the potential future electrification of the corridor.

8.4 PLATFORMS

8.4.1 Platform Configuration

Stations shall be designed in accordance with Section 8.1 with side platforms located opposite one another on the outside of the tracks or with center island platforms based on site-specific conditions and operational considerations. All stations shall be accessible. However, flag stops (if any exist in the corridor) are exempt (to be defined by Amtrak).

In designing the station platforms, consideration shall be given to future track additions; future platform extensions for longer train consists; future designs for lighting, security, PID's, signage, utilities, and amenities; and, future level-boarding requirements. In multi-track territory, all tracks shall have direct access to a platform. Future designs items required for the function and operation of the platform shall be included in the preliminary engineering opinions of probable construction costs, where possible.

Minimum platform widths using Amtrak Station Program and Planning Guidelines are as follows:

| | |
|--------------------------|---|
| Side Platforms: | Preferred = 15 feet; Absolute = 12 feet |
| Center Island Platforms: | Preferred = 24 feet; Absolute = 20 feet |

Site-specific constraints may require a reduction below these minimum platform widths in accordance with Section 12 on a case-by-case basis.

For side platform configurations, the minimum allowable track centers are 18 feet to allow for inter-track fence between the tracks to prevent pedestrians from crossing between platforms at grade. For center island platforms fencing should be considered in areas where pedestrians may cross the tracks to access the platform. Fence design shall adhere to CSXT clearance requirements from CSXT Plan 2611 and Amtrak Standard Track Plan AM 70050.

Platform widths should consider space required for canopies, baggage handling/carts, and overhead crossing or under-grade structures. The center platform width allows the minimum required width for an overhead crossing tower with its stairs and elevator. To the extent practical platforms should be clear of any obstructions and provide for access by baggage and service vehicles.

STATIONS

All side platforms should slope away from the track a minimum of 1 percent and no more than 2 percent in accordance with ADA Standards Chapter 4, Section 403, Article 403.3. At center island platforms, the slope shall be to the centerline of the platform with area drains for discharge to the municipal storm drain system. The entire station site and contiguous railroad right-of-way shall be properly drained.

Low level side or center island platforms shall be at an elevation 8 inches above the top of the adjacent rail. The platform edge shall be 5 feet 1 inch from the centerline of track. Platforms shall have a solid surface on a firm foundation.

Preferred minimum platform lengths are:

| | |
|---------------------------------|------------|
| Amtrak Regional and VRE Trains: | 850 feet |
| Amtrak Long Distance Trains: | 1,200 feet |

Preliminary engineering plans shall indicate typical full length passenger train at the platform, platform gap at each boarding location, taper of platform approaching a curve, and the maximum lateral deflection of a typical passenger railcar at the midpoint and both ends of a railcar in a curve.

8.4.2 Stairs/Ramps/Walkways

When grade separated access is provided to the platforms, the placement of stairs, ramps, or elevators should be carefully planned to be convenient for passengers and clear of freight railroad operations. Stairways should be a minimum of 48 inches wide using a maximum tread riser of 7 inches. Ramps with slopes of 5 percent or greater must have handrails per ADA Chapter 5, Section 505, Article 505.1. Walkways to and from platforms should be a minimum of 10 feet wide. There should be no walls, columns, stairwells, escalator faces, and other similar obstructions within 14 feet of the centerline of the nearest track to allow for passenger circulations and sight distances.

8.4.3 Handicap Access

Federal regulations (49 CFR Parts 37 and 38) require level boarding wherever it would not be prevented by freight train clearance requirements. This requirement applies to new platform construction and reconstruction of existing platforms.

The U.S. Department of Transportation "Level Boarding Final Rule," issued on September 9, 2011, requires passenger railroads to ensure, at new and altered station platforms, that passengers with disabilities can board and alight any passenger rail car of the train. Where level-entry boarding cannot be provided due to freight-clearance requirements or mixed equipment, the passenger railroad operator must submit to the FRA or FTA a narrative that shows how they intend to meet the performance standard.

Level boarding for the mobility-impaired transit users shall be provided by one or more of the following methods:

- **High level platforms.** High level platforms provide level boarding where they would not conflict with freight train clearances.

- **Railcar-equipped wheelchair lifts.** Railcars equipped with mechanical lifts provide handicap access to all railcars.
- **Wheelchair Lifts.** At low-level platforms without level boarding, portable wheelchair lifts can be utilized to provide ADA access. The wheelchair lift should be kept on or very near the platform, where it can be retrieved by the conductor and taken to the rail car. The lift is manually operated and does not require any batteries or power. It should be kept in an enclosed protective shed, which is accessible to the train crew when needed. Wheelchair lifts are not recommended for stations with annual total ridership greater than 7,500 “ons and offs” in accordance with Amtrak policy adopted in May 2012. Stations that exceed this threshold will be evaluated on a case-by-case basis.

8.5 PEDESTRIAN CROSSINGS

The preferred design is to have completely grade-separated pedestrian access to separate platforms, with an inter-track fence between the tracks to prevent persons from crossing between platforms at grade. All new pedestrian crossings must be approved by CSXT, Amtrak, VRE, and DRPT through a formal application process.

Where the track is at or below natural grade, then an overhead crossing may be used. Where the track is at-grade or elevated on an embankment, the use of an underpass becomes the preferable alternative to an overpass.

8.5.1 Overhead Crossings

The overhead crossing shall be a minimum of 24 feet 3 inches clear above top of rail and shall be a minimum of 10 feet wide. The overhead crossing can be served by stairs and either an elevator or a ramp system complying with ADA requirements. Ramps are preferred due to the reliability and maintenance cost issues of elevators, but shall be protected from the weather. If elevators are used, an alternate access should be designed for use in the event of elevator failure. The overhead crossing tower structure shall not be closer than a minimum of 16 feet from the centerline of track with a preferred clearance of 18 feet where practical in accordance with Amtrak’s Standard Track Plan for Minimum Roadway Clearances, with the exception of a center island platform. Fencing or enclosure of overhead crossings is required to prevent the dropping of objects on passing trains.

8.5.2 Under-Grade Crossings

If under-grade bridges or crossings are used, the minimum inside clear dimensions of a pedestrian under-grade structure shall not be less than 9 feet wide by 9 feet high. The maximum inside clear dimensions of the pedestrian under-grade structure shall not be more than 16 feet wide by 10.5 feet high. The under-grade structure should have as open an aspect as possible at each end and should include provisions for waterproofing, drainage and pumping (if required).

ADA-compliant access can be provided through the use of elevators or ramps. Ramps are preferred due to the reliability and maintenance cost issues of elevators, but shall be protected from the weather. If elevators are used, an alternate access should be designed for use in the event of elevator failure.

Provisions for closed circuit television (CCTV), lighting, and security should be included in a pedestrian under-grade structure. Also, a barrier system, such as gates or vertical rolling door, may be included at each end of the pedestrian under-grade structure to secure the structure when not in use. Provision should be made for an emergency lighting system in the event of a power outage. Future design items required for the function and operation of the under-grade crossings shall be included in the preliminary engineering opinions of probable construction costs, where possible.

8.5.3 At-Grade Crossings

If the only practical design is to have an at-grade pedestrian crossing at a station, then the crossing(s) shall be constructed at the end(s) of the platform. This prevents the blockage of the crossing(s) by a standing train. The pedestrian crossing shall include active warning devices (flashing lights and gates) and emergency exit gates. At-grade pedestrian crossings shall include channelization requiring the pedestrians to look in both directions along the track prior to crossing the track.

8.6 STATION PARKING

The parking area should be configured to separate bus movements from passenger vehicle circulation, and provide efficient flow for vehicles entering, exiting, and circulating the station. It is recommended that the number of entrances and exits to a station be minimized while still remaining compliant with local traffic requirements. The reduced number of entrances/exits allows for better security monitoring and control of the parking area. The parking area layout should be designed to reduce conflicts between vehicles traveling up and down lanes and vehicles backing out. Exit lanes are recommended to provide for controlled exiting and to minimize the back-up of vehicles into the parking stall lanes.

An area should be designated for short-term parking for pick-up and drop-off. The area must be compliant with ADA accessibility guidelines and should be located to prevent conflicts with buses or vehicles traveling down parking stall lanes.

The station layout will include provisions to allow maintenance-of-way and signal and communications trucks to access the right-of-way on both sides of the station. If this access is to be provided from the public parking or driveway areas, a locked gate will be used to keep unauthorized vehicles from entering the right-of-way.

Park-and-ride lots shall comply with the *VDOT Statewide Park & Ride Program Policy and Procedures Manual* and the *VDOT Statewide Park & Ride Program Best Practices Guide*, both dated February 2013.

9 **YARD AND SHOP FACILITIES**

Potential sites for layover, maintenance and shop facilities shall be identified along the preferred corridor. Existing CSXT, Amtrak, and VRE yards and adjacent properties shall be evaluated for additional storage and service capacity.

10 UTILITIES

Utility design shall adhere to the standards and specifications of the utility owner.

Utility line crossings beneath railroad tracks shall be designed in accordance with *CSXT Public Projects Manual* and Chapter 1, Part 5 of AREMA MRE.

All utility line crossings beneath main line tracks shall be installed using a protective casing pipe. The casing pipe may be omitted for non-pressure sewer or storm drain lines located in branch or industrial line tracks.

The casing pipe and joints shall be leak proof and capable of withstanding a minimum railway load of Cooper E-80. The steel casing shall have minimum yield strength of 35,000 PSI and have a protective coating.

Clearances over rails shall adhere to CSXT Design & Construction Standard Specifications for Wireline Occupancies issued September 15, 2003.

11

HIGHWAY TRAFFIC ENGINEERING

Traffic analysis will be performed in order to quantify the alternatives' impacts on the adjacent roadway network.

From the traffic projections the traffic analysis will be performed using the applicable methodologies and regulations provided in the Virginia Department of Transportation (VDOT) Traffic Analysis Regulations (24VAC30-155, January 1, 2012). This analysis will include four sections:

- 1) Existing Conditions
- 2) Future Conditions without Railway and Related Improvements
- 3) Future Conditions with Railway and Related Improvements
- 4) Future Conditions with Railway, Related Improvements, and Mitigation Measures

Specifically, "Railway and Related Improvements" describe the infrastructure changes relating to the railway that impact highway traffic. That is, grade crossing closures, grade separations, and other roadway modifications. Mitigation measures describe the highway infrastructure improvements to mitigate the impacts attributed to the Railway and Related Improvements.

The analysis will result in calculating the level of service (LOS) of the necessary roadway intersections per scope and VDOT requirements. LOS calculations will be performed using the techniques described in the *Highway Capacity Manual* (TRB, 2010). Software used to perform these calculations will be selected and used according to the *VDOT Traffic Operational Analysis Tool Guidebook* (version 1.1, August, 2013).

12

APPROVALS AND DESIGN VARIANCES

Where required by the basis of design, submittals and requests for approval shall be developed by the design team and submitted to the affected stakeholder(s) by DRPT as appropriate to the technical issue involved. The intent of the approval process is that the major stakeholders would be responsible for any approvals required for their respective legal areas of responsibility (CSXT for approving CSXT submittals and modifications, Amtrak and VRE for approving station and platforms, FRA and DRPT for regulatory approvals, etc.).

All proposed designs for construction on CSXT property shall be reviewed and approved by CSXT.

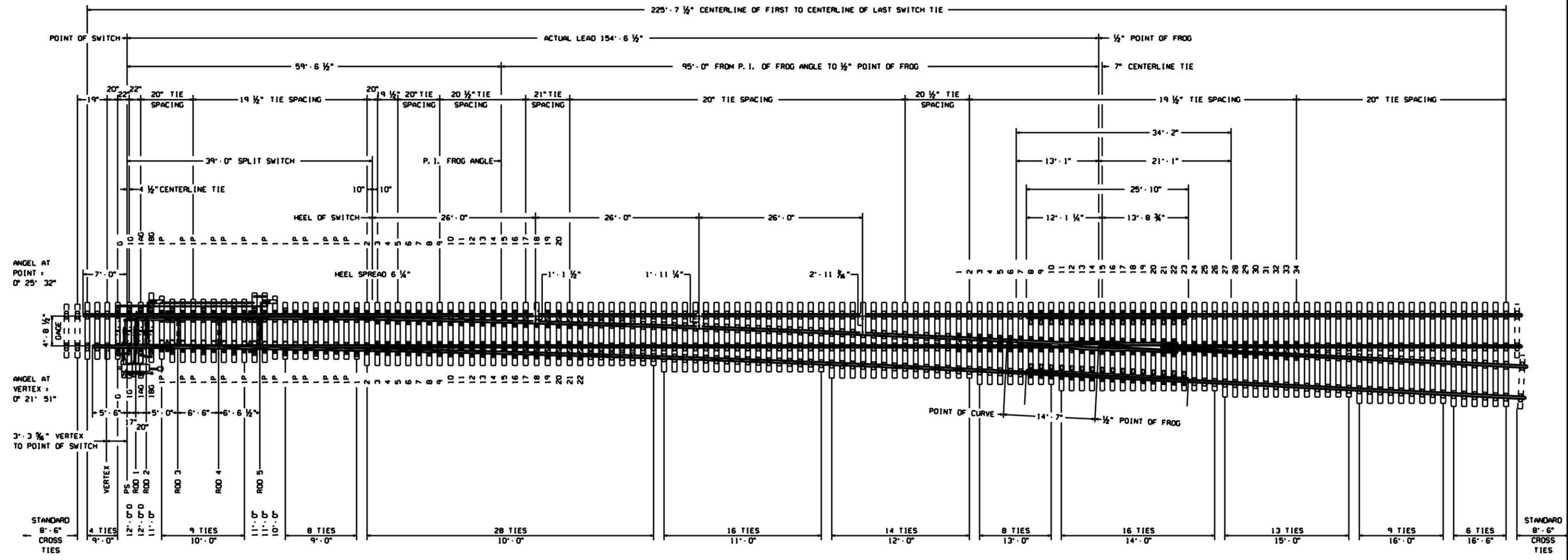
Designers shall in all instances adhere to these criteria in the design of the Washington, D.C. to Richmond High Speed Rail project infrastructure. In cases where these criteria cannot be met, or where a variance from the criteria would improve the performance or cost-effectiveness of project infrastructure, the designer shall submit in writing the details of the purpose and need for a variance from the design criteria. Variances from the criteria must be approved on a case-by-case basis for a specific location in advance of their incorporation into the design of the project by all affected major project stakeholders. Designers shall request all variances to the criteria in writing. All design variance requests shall be tracked on a design variance log until resolved.

The basis of design is applicable to areas where new construction or major remodeling might occur. Existing areas that remain unchanged are exempt from the design criteria as well as the approvals and design variance process.

APPENDIX A: STANDARD CSXT PLANS

DISTANCE FROM POINT OF SWITCH TO CENTER LINE OF SWITCH TIE

- 6'-3 1/2"
- 4'-8 1/2"
- 3'-1 1/2"
- 1'-5 1/2"
- 0'-4 1/2"
- 2'-2 1/2"
- 3'-10 1/2"
- 5'-6 1/2"
- 7'-2 1/2"
- 8'-10 1/2"
- 10'-6 1/2"
- 12'-2"
- 13'-9 1/2"
- 15'-5"
- 17'-0 1/2"
- 18'-8"
- 20'-3 1/2"
- 21'-11"
- 23'-6 1/2"
- 25'-2"
- 26'-9 1/2"
- 28'-5"
- 30'-0 1/2"
- 31'-8 1/2"
- 33'-3 1/2"
- 35'-11"
- 36'-6 1/2"
- 38'-2"
- 39'-10"
- 41'-5 1/2"
- 43'-1"
- 44'-9"
- 46'-5"
- 48'-1"
- 49'-9"
- 51'-5 1/2"
- 53'-2"
- 54'-10 1/2"
- 56'-7"
- 58'-3 1/2"
- 60'-0"
- 61'-8 1/2"
- 63'-5"
- 65'-2"
- 66'-11"
- 68'-8"
- 70'-5"
- 72'-1"
- 73'-9"
- 75'-5"
- 77'-1"
- 78'-9"
- 80'-5"
- 82'-1"
- 83'-9"
- 85'-5"
- 87'-1"
- 88'-9"
- 90'-5"
- 92'-1"
- 93'-9"
- 95'-5"
- 97'-1"
- 98'-9"
- 100'-5"
- 102'-1"
- 103'-9"
- 105'-5"
- 107'-1"
- 108'-9"
- 110'-5"
- 112'-1"
- 113'-9"
- 115'-5"
- 117'-1"
- 118'-9"
- 120'-5"
- 122'-1"
- 123'-9"
- 125'-5 1/2"
- 127'-2"
- 128'-10 1/2"
- 130'-7"
- 132'-3 1/2"
- 134'-0"
- 135'-7 1/2"
- 137'-3"
- 138'-10 1/2"
- 140'-6"
- 142'-1 1/2"
- 143'-9"
- 145'-4 1/2"
- 147'-0"
- 148'-7 1/2"
- 150'-3"
- 151'-10 1/2"
- 153'-6"
- 155'-1 1/2"
- 156'-9"
- 158'-4 1/2"
- 160'-0"
- 161'-7 1/2"
- 163'-3"
- 164'-10 1/2"
- 166'-6"
- 168'-1 1/2"
- 169'-9"
- 171'-4 1/2"
- 173'-0"
- 174'-7 1/2"
- 176'-3"
- 177'-10 1/2"
- 179'-6"
- 181'-1 1/2"
- 182'-9"
- 184'-4 1/2"
- 186'-0"
- 187'-8"
- 189'-4"
- 191'-0"
- 192'-8"
- 194'-4"
- 196'-0"
- 197'-8"
- 199'-4"
- 201'-0"
- 202'-8"
- 204'-4"
- 206'-0"
- 207'-8"
- 209'-4"
- 211'-0"
- 212'-8"
- 214'-4"
- 216'-0"
- 217'-8"
- 219'-4"



PLAN OF RIGHT HAND TURNOUT

WORKMANSHIP AND MATERIALS SHALL BE PER CURRENT AREA SPECIFICATIONS UNLESS OTHERWISE SPECIFIED.

SINCE THE ALLOWABLE VARIATION IN STANDARD LENGTHS OF RAILS, FROGS AND SWITCH POINTS IS GREATER THAN THE NORMAL EXPANSION GAPS AT RAIL JOINTS AND THICKNESS OF INSULATING END POST IN INSULATED JOINTS, NO ALLOWANCE HAS BEEN MADE FOR EXPANSION GAPS AND INSULATING END POSTS IN COMPUTING LENGTHS OF RAIL SHOWN.

USE 39'-0" CURVED SPLIT SWITCH WITH UNIFORM RISERS PER DRAWINGS 2305, 2312, AND 2313.

SEE DRAWING 2309 FOR STRAIGHT AND CURVED CLOSURE RAILS, AND STRAIGHT AND CURVED LEAD RAILS.

SWITCH HAS ADJUSTABLE PANDROL BRACES PER DRAWING 2317.

FROG USES MILLED SEAT AND FLAT PLATES WITH WELDED PANDROL SHOULDER PER DRAWING 2407.

ALL TIES TO WHICH AN ANCHOR CAN BE APPLIED WILL BE BOX ANCHORED ON BOTH THE THROUGH TRACK AND DIVERGING TRACK, AND FOR A DISTANCE OF 234 FEET IN EACH DIRECTION. DO NOT PLACE ANCHORS WHERE THEY MAY INTERFERE WITH MOVING PARTS. EXCEPTION: RAIL ANCHORS ARE NOT USED IF PANDROL TIE PLATES ARE INSTALLED.

THE FOUR SWITCH POINT ROLLERS ARE TO BE FURNISHED BY TRAIN CONTROL.

THE NUMBER OF INSULATED JOINTS REQUIRED DEPENDS ON TURNOUT LOCATION.

LEAD RAIL WILL NOT BE FURNISHED FOR TURNOUTS TO BE INSTALLED BY PROGRAM RAIL GANGS LAYING NEW RAIL.

SWITCH PLATE AND TIE LAYOUT ARRANGED FOR POWER THROW MECHANISM PER TRAIN CONTROL STANDARDS.

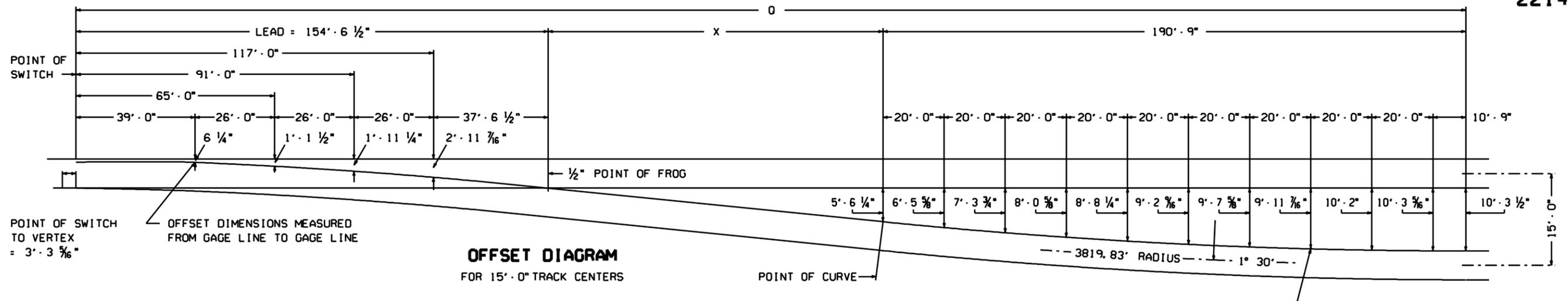
| TURNOUT DATA | |
|-----------------------------|-------------|
| NUMBER | 20 |
| ANGLE | 2° 51' 51" |
| TOTAL LENGTH | 34'-2" |
| TOE LENGTH | 13'-1" |
| HEEL LENGTH | 21'-1" |
| TOE SPREAD | 7 1/2" |
| HEEL SPREAD | 13 1/2" |
| LENGTH OF SWITCH POINT | 39'-0" |
| HEEL SPREAD | 6 1/4" |
| HEEL ANGLE | 1° 06' 17" |
| THICKNESS OF POINT | 0" |
| ANGLE AT POINT | 0° 25' 32" |
| RADIUS | 3291.6863' |
| VERTEX DISTANCE | 0" |
| THICKNESS OF POINT | 1/4" |
| ANGLE AT POINT | 0° 21' 51" |
| RADIUS (OF STOCK RAIL) | 3015.1060' |
| VERTEX DISTANCE | 3'-3 3/8" |
| ACTUAL LEAD | 154'-6 1/2" |
| RADIUS OF CENTERLINE | 3289.332' |
| DEGREE OF CURVE | 1° 44' 31" |
| STRAIGHT CLOSURE LENGTH | 102'-5 1/2" |
| CURVED CLOSURE LENGTH | 102'-6 1/2" |
| P. C. TO 1/2" POINT OF FROG | 14'-7" |

| BILL OF SWITCH TIES | | | | |
|-----------------------------|---------|-----------|----------|----------|
| LENGTH | TURNOUT | CROSSOVER | | QUANTITY |
| | | 14'-0" | 15'-0" | |
| 9'-0" | 12 | 24 | 24 | 1 |
| 10'-0" | 38 | 76 | 76 | 1 |
| 11'-0" | 19 | 38 | 38 | 1 |
| 12'-0" | 14 | 28 | 28 | 1 |
| 12'-0" (Dapped) | 2 | 4 | 4 | 1 |
| 13'-0" | 8 | 16 | 16 | 1 |
| 14'-0" | 16 | 38 | 32 | 400 |
| 15'-0" | 13 | 0 | 26 | 16 |
| 16'-6" | 9 | 0 | 0 | 2 OR 4 |
| 16'-6" | 6 | 0 | 0 | 300 |
| 23'-0" | 0 | 24 | 16 | 12 |
| TOTAL NUMBER | 137 | 248 | 260 | 850 |
| BOARD MEASURE | 8,682.0 | 16,102.5 | 16,743.0 | 472 |
| ALL SWITCH TIES ARE 7" X 9" | | | | 228 |

| BILL OF TRACK MATERIAL | |
|------------------------|---|
| QUANTITY | DESCRIPTION |
| 1 | NO. 20 RAILBOUND MANGANESE STEEL FROG, COMPLETE, PER DRAWING 2407. |
| 2 | GUARD RAILS, ADJUSTABLE, 25'-10", COMPLETE, PER DRAWING 2412. |
| 1 | 59'-6" STRAIGHT STOCK RAIL PER DRAWING 2309. |
| 1 | 51'-0" BENT & CURVED STOCK RAIL PER DRAWING 2309. |
| 1 | 39'-0" CURVED SPLIT SWITCH, COMPLETE, WITH UNIFORM RISERS, PER DRAWINGS 2305, 2309, 2312, 2313, 2314, 2316, & 2317. |
| 1 | 39'-0" RAIL W/INSULATED JT. 24'-0" 15'-0" LEGS |
| 1 | 39'-0" RAIL W/INSULATED JT. 29'-0" 10'-0" LEGS |
| 400 | FEET OF WELDED RAIL |
| 16 | JOINTS, COMPLETE |
| 12 | INSULATED JOINTS AT SWITCH POINT OR CLEARANCE. |
| 850 | TIE PLATES - MINIMUM |
| 472 | KEGS, TRACK SPIKES, 100 POUND KEGS. |
| | RAIL ANCHORS |
| | SCREW SPIKES. |
| | PANDROL CLIPS, REGULAR. |

CSX TRANSPORTATION
NUMBER 20 TURNOUT AND CROSSOVER
RAILBOUND MANGANESE FROG
FOR 122CB, 132RE, AND 136RE RAIL

SIGNED _____ SIGNED _____
 REVIEWED DIRECTOR, STANDARDS AND TESTING APPROVED ASSISTANT VICE PRESIDENT, EQUIPMENT AND TRACK SYSTEMS ENGINEERING
 ISSUED, AUGUST 29, 1997 REVISED, MAY 29, 1998

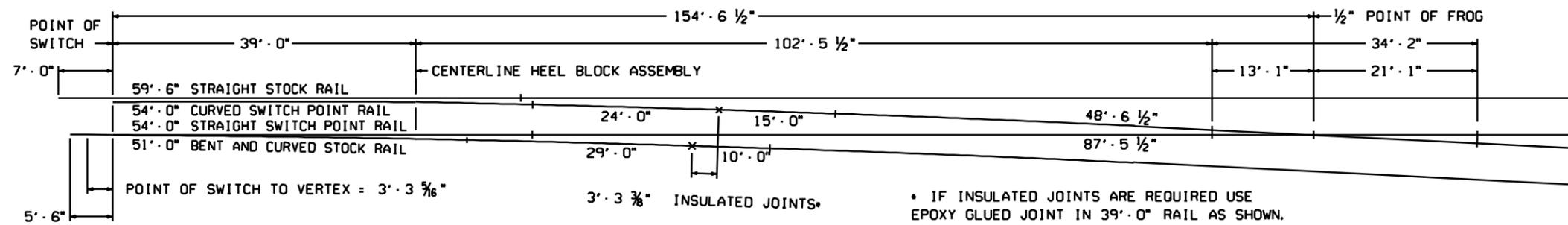


OFFSET DIAGRAM
FOR 15' 0" TRACK CENTERS

OFFSET DIMENSIONS MEASURED FROM GAGE LINE TO GAGE LINE. FOR TRACK CENTERS OTHER THAN 15' 0", INCREASE OR DECREASE OFFSET DIMENSIONS BY SAME AMOUNT THAT TRACK CENTERS ARE INCREASED OR DECREASED FROM 15' 0", AND ADJUST "X" DISTANCE.

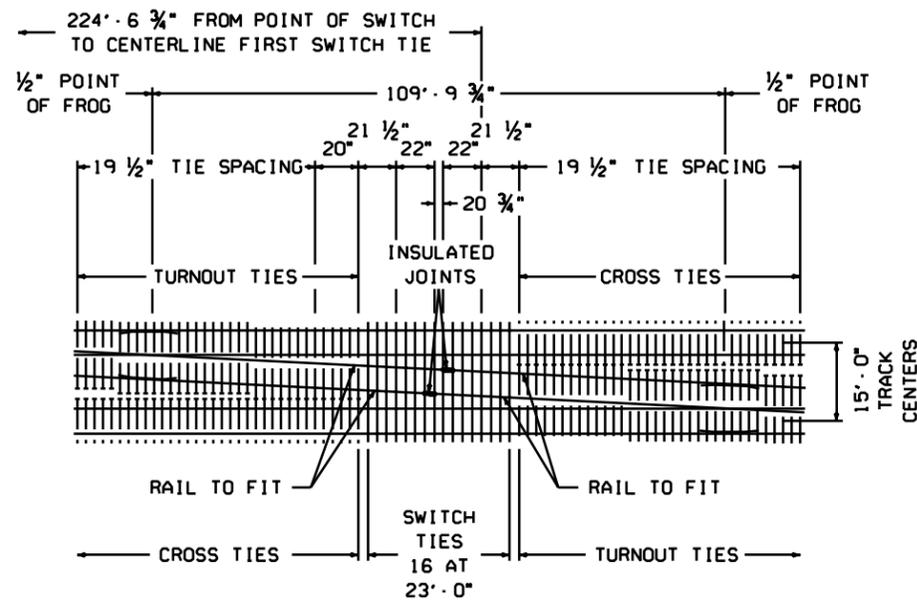
| CROSSOVER DATA | | |
|----------------|---------------------------------------|-------------|
| TRACK CENTERS | DISTANCE BETWEEN 1/2" POINTS OF FROGS | |
| | MAIN TRACK | CROSSOVER |
| 15' 0" | 109' 9 3/4" | 110' 2 1/4" |
| 14' 0" | 89' 9 7/8" | 90' 2 1/8" |
| 1.0" CHANGE | 19' 11 7/8" | 20' 0 1/8" |
| 1' 0" CHANGE | 19.988" | 20.013" |

| TRACK CENTERS | CURVE DATA | |
|---------------|--------------|-------------|
| | 0 | X |
| 13' 0" | 414' 10 1/2" | 69' 6 3/2" |
| 14' 0" | 434' 10 1/2" | 89' 6 7/2" |
| 15' 0" | 454' 10 7/2" | 109' 6 7/2" |
| 16' 0" | 474' 10 1/2" | 129' 6 7/2" |
| 1.0" CHANGE | 19.988" | 19.988" |

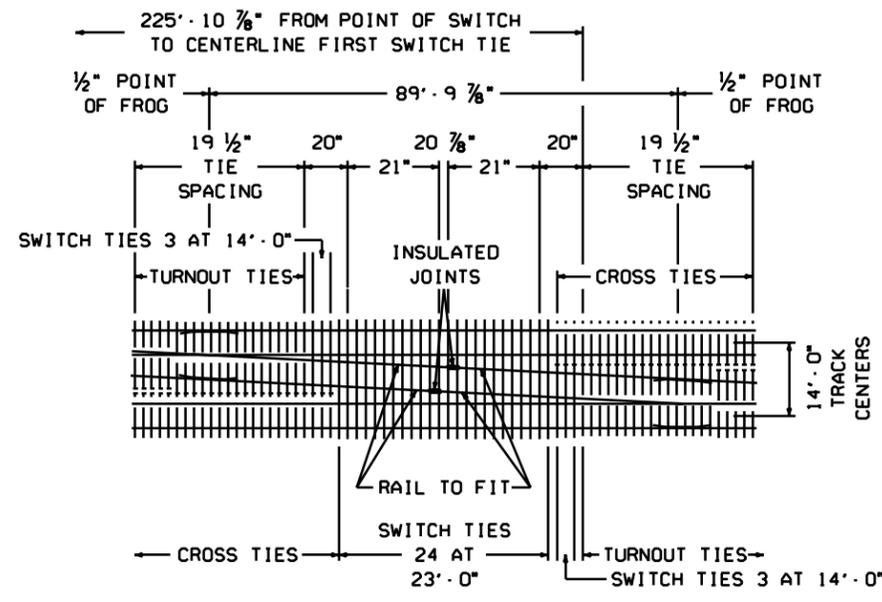


RAIL LAYOUT DIAGRAM

* IF INSULATED JOINTS ARE REQUIRED USE EPOXY GLUED JOINT IN 39' 0" RAIL AS SHOWN. MAXIMUM STAGGER ANY PAIR OF INSULATED JOINTS IS 4' 6".



CROSSOVER - 15' 0" TRACK CENTERS



CROSSOVER - 14' 0" TRACK CENTERS



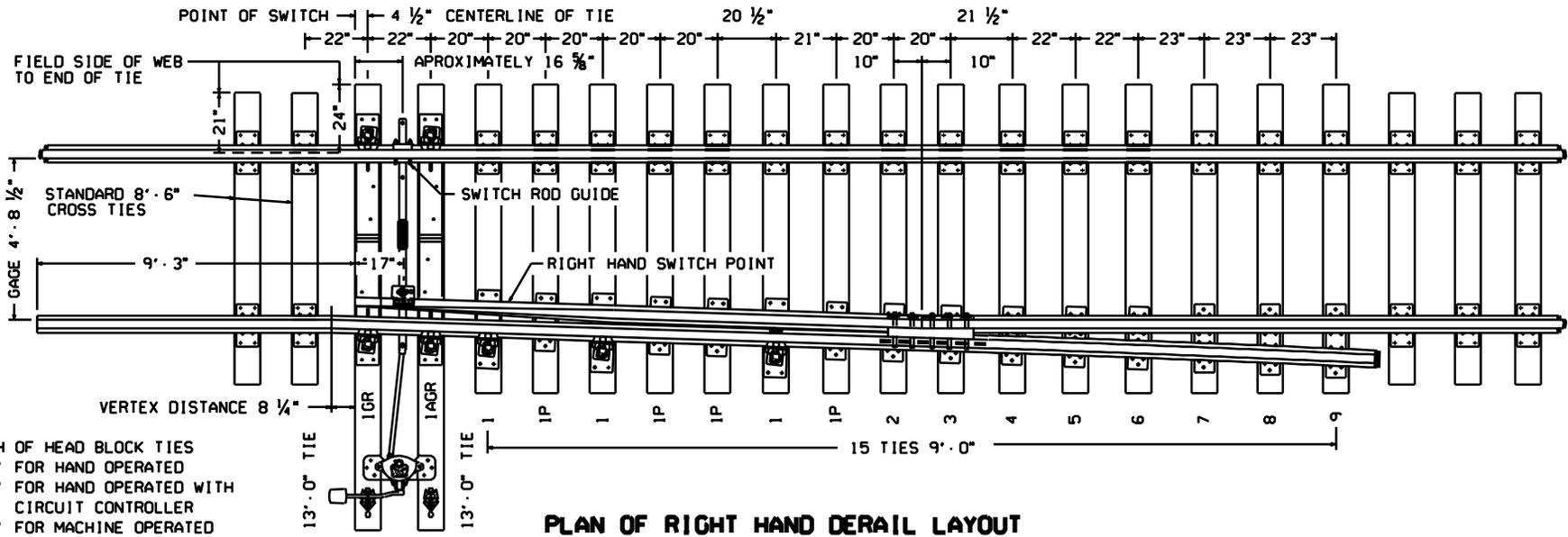
NUMBER 20 OFFSET AND LAYOUT DIAGRAMS FOR 122CB, 132RE, AND 136RE RAIL

SIGNED
REVIEWED -
DIRECTOR,
STANDARDS AND TESTING

ISSUED, AUGUST 29, 1997

SIGNED
APPROVED -
ASSISTANT VICE PRESIDENT,
EQUIPMENT AND TRACK
SYSTEMS ENGINEERING

REVISED, MAY 29, 1998



PLAN OF RIGHT HAND DERAIL LAYOUT

SWITCH POINT PER STANDARD PLAN 2301.

STOCK RAIL PER STANDARD PLAN 2306.

SWITCH PLATES PER STANDARD PLANS 2310 AND 2311. NOT ALL PLATES ARE USED WITH DERAIL.

MAIN TRACK TIES MAY BE USED IN PLACE OF SWITCH TIES WHEN THE DERAIL IS INSTALLED IN OTHER THAN A MAIN TRACK.

FOR MACHINE OPERATED DERAIL, USE A 9' - 0" SWITCH TIE AHEAD OF SWITCH POINT AND DAPPED HEAD BLOCK TIES PER SIGNAL STANDARDS.

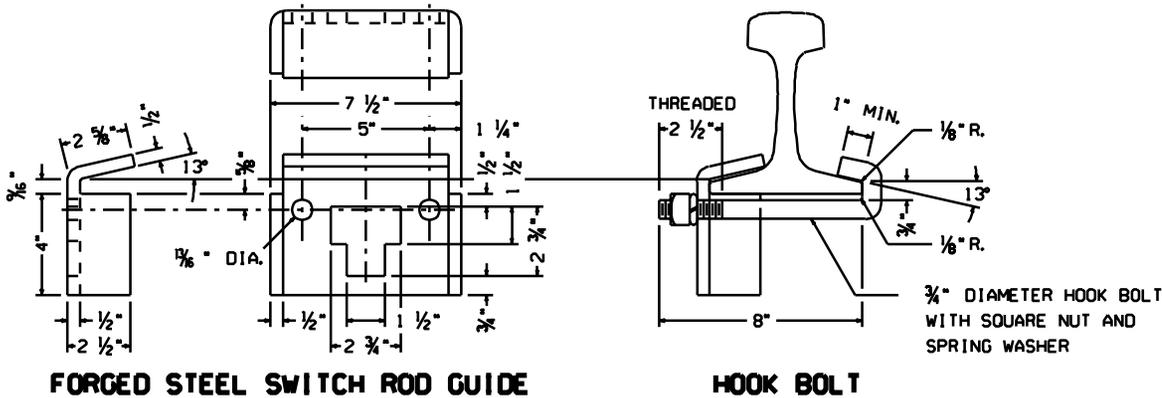
ROD GUIDE TO BE POSITIONED ON RAIL SO THAT SWITCH ROD IS PARALLEL TO SWITCH TIES.

FOR MACHINE OPERATED DERAIL, USE OG, 1GRE (OR 1GLE), AND 1AGRE (OR 1AGLE) GAGE PLATES INSTEAD OF TIE PLATES AND GAGE PLATES 1GR AND 1AGR.

USE TWO VERTICAL SWITCH RODS FOR MAIN TRACK DERAILS AND A SINGLE SWITCH ROD FOR OTHER THAN MAIN TRACK DERAILS.

WHEN TWO SWITCH RODS ARE REQUIRED, USE TWO, NUMBER 1 RODS. THE STANDARD 5' - 8" LONG NUMBER 2 ROD WILL NOT EXTEND THROUGH THE SWITCH ROD GUIDE WHEN THE SWITCH POINT IS IN THE THE NON-DERAILING POSITION.

THE SWITCH ROD GUIDE SHOWN IS MADE FROM A SINGLE PLATE BENT TO SHAPE. A SWITCH ROD GUIDE MADE FROM FLAT PLATES WELDED TOGETHER IS AN APPROVED ALTERNATE.



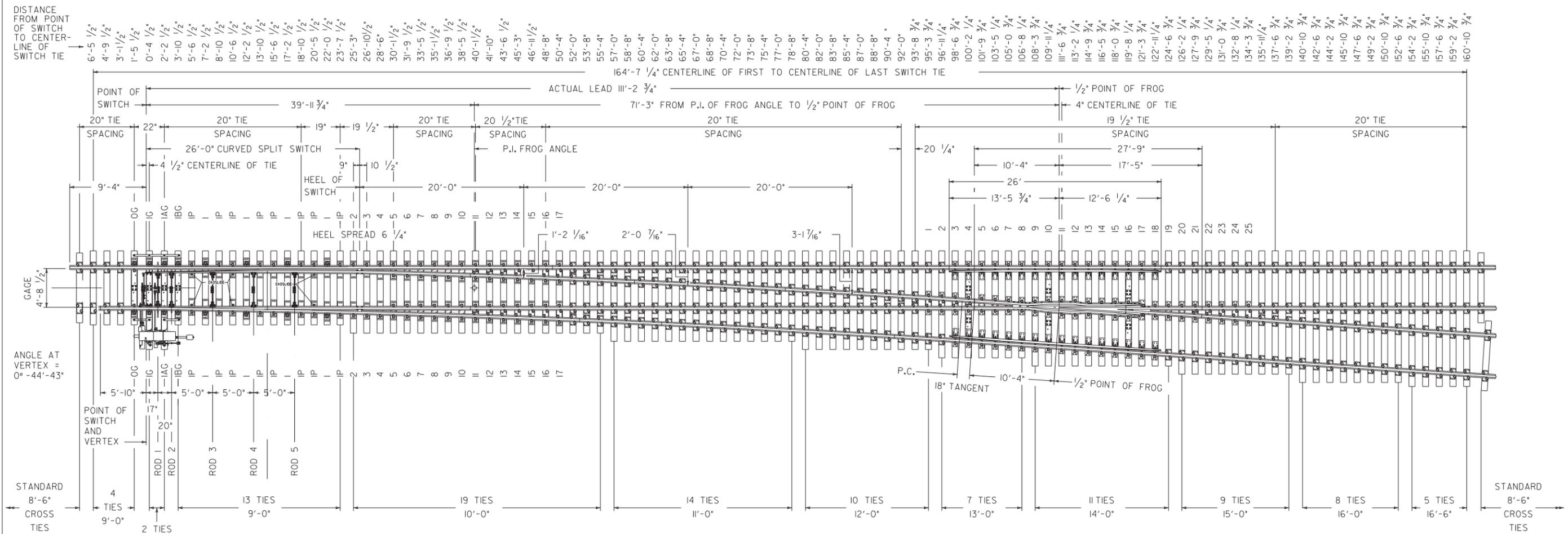
16' - 6" SWITCH POINT DERAIL

SIGNED _____
 REVIEWED -
 DIRECTOR,
 STANDARDS AND TESTING

SIGNED _____
 APPROVED -
 ASSISTANT VICE PRESIDENT,
 EQUIPMENT AND TRACK
 SYSTEMS ENGINEERING
 REVISED, INITIAL ISSUE

ISSUED, JULY 19, 1996

11/5/12 - ADDED FRONT ROD ASSEMBLY



PLAN OF RIGHT HAND TURNOUT

WORKMANSHIP AND MATERIALS SHALL BE PER CURRENT AREMA SPECIFICATIONS UNLESS OTHERWISE SPECIFIED. SINCE THE ALLOWABLE VARIATION IN STANDARD LENGTHS OF RAILS, FROGS AND SWITCH POINTS IS GREATER THAN THE NORMAL EXPANSION GAPS AT RAIL JOINTS AND THICKNESS OF INSULATING END POST IN INSULATED JOINTS, NO ALLOWANCE HAS BEEN MADE FOR EXPANSION GAPS AND INSULATION END POSTS IN COMPUTING LENGTHS OF RAIL SHOWN.

USE 26'-0" CURVED SPLIT SWITCH WITH UNIFORM RISERS PER DRAWING 2321.

SEE DRAWING 2218 FOR STRAIGHT AND CURVED CLOSURE RAILS, AND STRAIGHT AND CURVED LEAD RAILS.

MANUFACTURER SHALL VERIFY ALL DIMENSIONS BEFORE FABRICATION.

SWITCH HAS ADJUSTABLE BOLTLESS BRACES. PREFERRED SWITCH BRACE IS PRS CLAMPTITE. ALTERNATE IS BETHLEHEM BOLTLESS.

FROG USES MILLED SEAT AND FLAT PLATES WITH WELDED PANDROL SHOULDERS PER DRAWING 2415.

EVERY TIE WILL BE BOX ANCHORED FOR A DISTANCE OF 234 FEET AHEAD OF THE SWITCH POINT, AND EVERY TIE ON BOTH TRACKS WILL BE BOX ANCHORED FOR A DISTANCE OF 234 FEET BEYOND THE JOINT OR WELD AT THE HEEL OF FROG.

THE NUMBER OF INSULATED JOINTS REQUIRED DEPENDS ON TURNOUT LOCATION.

USE 6-1/2" COMMON STANDARD SCREWS ON ALL PLATES 3/4" THICK OR MORE. OTHERWISE USE 6" SCREW SPIKES.

SWITCH PLATE AND TIE LAYOUT ARRANGED FOR POWER THROW MECHANISM PER TRAIN CONTROL STANDARDS.

ALL FROG PLATES TO BE MILLED SEAT 3/4" UNDER RAIL BASE

ORDERING INFORMATION

| CLASS | ITEM | DESCRIPTION |
|-------|---------|--|
| 10 | 6650300 | TURNOUT PANELED RH 136RE ON WOOD TIES NO 15 W/RBM FROG PER CSX DWG 2217 & 2218 |
| 10 | 6650310 | TURNOUT PANELED LH 136RE ON WOOD TIES NO 15 W/RBM FROG PER CSX DWG 2217 & 2218 |

BILL OF TRACK MATERIAL

| QUANTITY | DESCRIPTION |
|----------|---|
| 1 | NO.15 RAILBOUND MANGANESE STEEL FROG, COMPLETE, PER DWG. 2415 BONDED FOR SIGNALS |
| 2 | GUARD RAILS, COMPLETE, (26' ADJUSTABLE) |
| 1 | 58'-10" STRAIGHT STOCK RAIL PER DRAWING 2322 |
| 1 | 58'-8" BENT STOCK RAIL PER DRAWING 2322 |
| 1 | 38'-5" RAIL W/PREMIUM INSULATED JT.10'-0"-28'-5" LEGS |
| 1 | 38'-5" RAIL W/PREMIUM INSULATED JT.20'-0"-18'-5" LEGS |
| 1 | STRAIGHT CLOSURE RAIL: 61'-4 3/4" |
| 1 | CURVED CLOSURE RAIL: 23'-1" |
| 260 | FEET OF PREMIUM WELDED RAIL |
| 1 | 26'-0" CURVED SPLIT SWITCH, COMPLETE, WITH UNIFORM RISERS, PER DWGS. 2321, 2322, 2323, 2324, 2325, AND 2326 |
| 1 | FRONT ROD ASSEMBLY PER SS001 AND SS044 |
| 12 | JOINTS, COMPLETE INCL. J CLIPS AND BOLTS |
| 6 | INSULATED JOINTS, COMPLETE INC. E2063B CLIPS |
| 1300 | SCREW SPIKES 6 1/2" LONG OR 7 1/2" LONG EVERGRIP SPIKES |
| 3 | KEG TRACK SPIKES |
| 196 | PANDROL TIE PLATES |
| 659 | PANDROL CLIPS, REGULAR |
| 1 | PANDROL CLIP, LEFT HAND |

TURNOUT DATA

| | |
|------------------------------|-------------|
| NUMBER | 15 |
| ANGLE | 3°-49'-06" |
| TOTAL LENGTH | 27'-9" |
| TOE LENGTH | 10'-4" |
| HEEL LENGTH | 17'-5" |
| TOE SPREAD | 7 3/4" |
| HEEL SPREAD | 14 3/16" |
| LENGTH OF SWITCH POINT | 26'-0" |
| HEEL SPREAD | 6 1/4" |
| HEEL ANGLE | 1°-32'-57" |
| THICKNESS OF POINT | 0" |
| ANGLE AT POINT | 0°-44'-47" |
| RADIUS | 1,855.769' |
| VERTEX DISTANCE | 0' |
| THICKNESS OF POINT | 0" |
| ANGLE AT POINT | 0°-44'-43" |
| RADIUS | 1,851.061' |
| VERTEX DISTANCE | 0' |
| ACTUAL LEAD | 11'-2 3/4" |
| RADIUS OF CENTERLINE | 1,853.415' |
| DEGREE OF CURVE | 3°-03'-30" |
| CENTRAL ANGLE - SWITCH | 0°-48'-10" |
| CENTRAL ANGLE - CLOSURE | 2°-16'-09" |
| CENTRAL ANGLE - TOTAL | 3°-04'-19" |
| STRAIGHT CLOSURE LENGTH | 74'-10 3/4" |
| CURVED CLOSURE LENGTH | 75'-0" |
| TANGENT ADJACENT TOE OF FROG | 18" |

| LENGTH | TURNOUT ONLY | CROSSOVER | |
|-----------------------------|--------------|-----------|----------|
| | | 14'-0" | 15'-0" |
| 9'-0" | 17 | 34 | 34 |
| 10'-0" | 19 | 38 | 38 |
| 11'-0" | 14 | 28 | 28 |
| 12'-0" | 10 | 20 | 20 |
| 12'-0" (Dapped) | 2 | 4 | 4 |
| 13'-0" | 7 | 14 | 14 |
| 14'-0" | 11 | 26 | 22 |
| 15'-0" | 9 | 0 | 18 |
| 16'-0" | 8 | 0 | 0 |
| 16'-6" | 5 | 0 | 0 |
| 23'-0" | 0 | 20 | 15 |
| TOTAL NO. | 102 | 184 | 193 |
| BOARD MEAS. | 6,458.1 | 11,997.5 | 12,517.3 |
| ALL SWITCH TIES ARE 7" x 9" | | | |



NO. 15 TURNOUT AND CROSSOVER WITH 26'-0" CURVED SWITCH POINTS FOR 136RE RAIL

Legend Okul

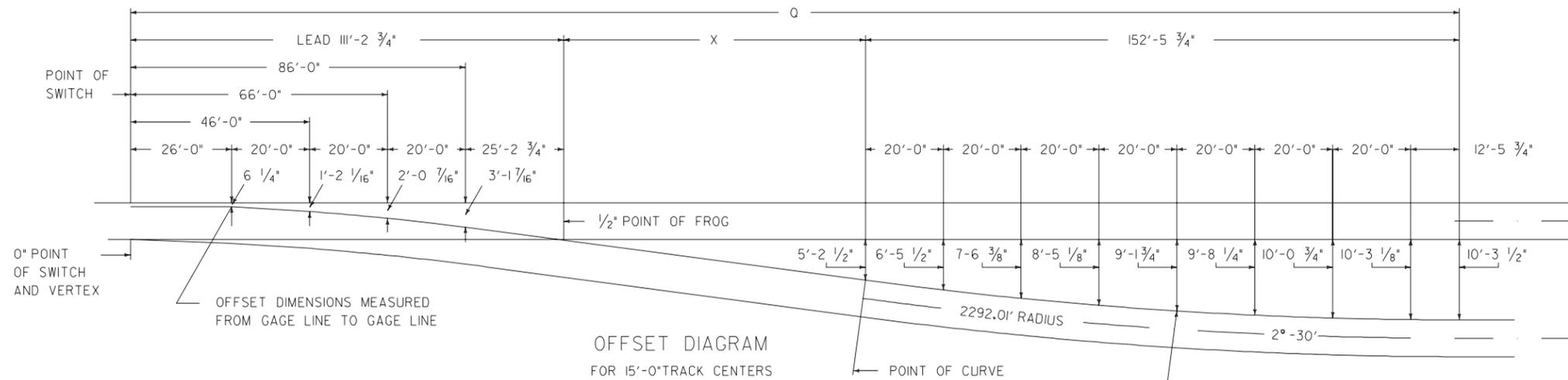
APPROVED - DIRECTOR ENGINEERING STANDARDS

M.E. Austin

APPROVED - ASSISTANT VICE PRESIDENT ENGINEERING

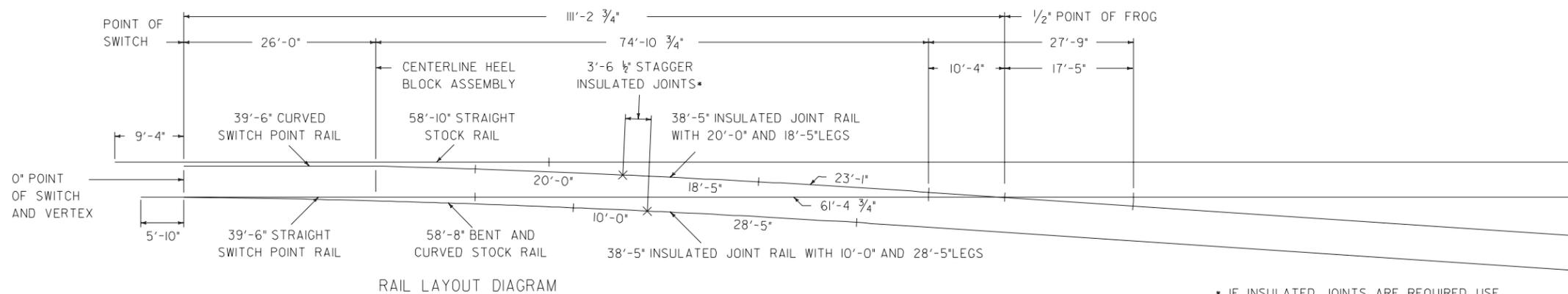
PREPARED BY, M.E. AUSTIN

ISSUED: MARCH 01, 2000
REVISED: DECEMBER 23, 2011

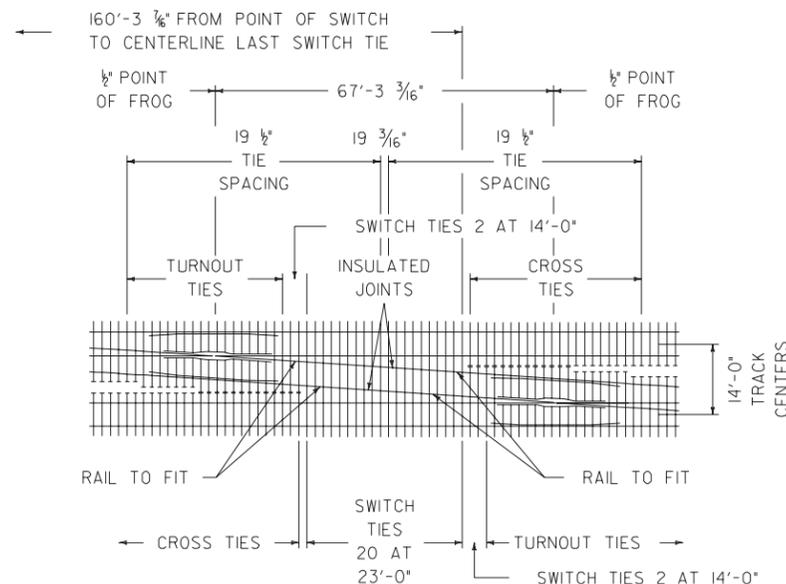
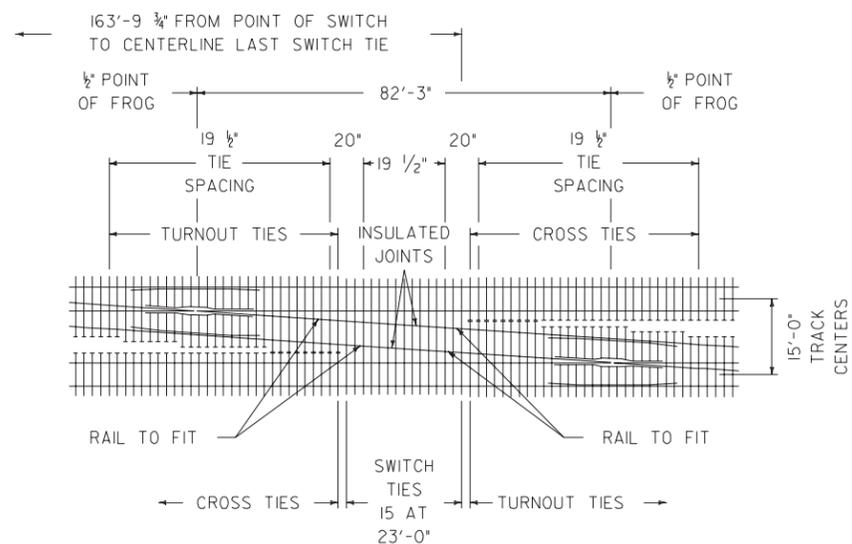


| CROSSOVER DATA | | |
|----------------|--------------------------------------|--------------|
| TRACK CENTERS | DISTANCE BETWEEN 1/2 POINTS OF FROGS | |
| | MAIN TRACK | CROSSOVER |
| 15'-0" | 82'-8 3/32" | 82'-8 3/32" |
| 14'-0" | 67'-3 3/16" | 67'-8 29/32" |
| 1'-0" CHANGE | 14'-11 13/16" | 15'-0 3/16" |
| 1" CHANGE | 14.9844" | 15.0156" |

| TRACK CENTERS | CURVE DATA | |
|---------------|-------------|------------|
| | DIMENSION | |
| | Q | X |
| 13'-0" | 311'-2" | 47'-5 1/2" |
| 14'-0" | 326'-1 3/4" | 62'-5 1/4" |
| 15'-0" | 341'-1 5/8" | 77'-5 1/8" |
| 16'-0" | 356'-1 3/8" | 92'-4 7/8" |
| 1.0" CHANGE | 14.9844" | 14.9844" |



• IF INSULATED JOINTS ARE REQUIRED, USE PREMIUM INSULATED JOINT IN 38'-5" RAIL WITH LEGS AS SHOWN. MAXIMUM STAGGER ANY PAIR OF INSULATED JOINTS IS 4'-6".



NUMBER 15 OFFSET AND LAYOUT DIAGRAMS FOR I36RE RAIL

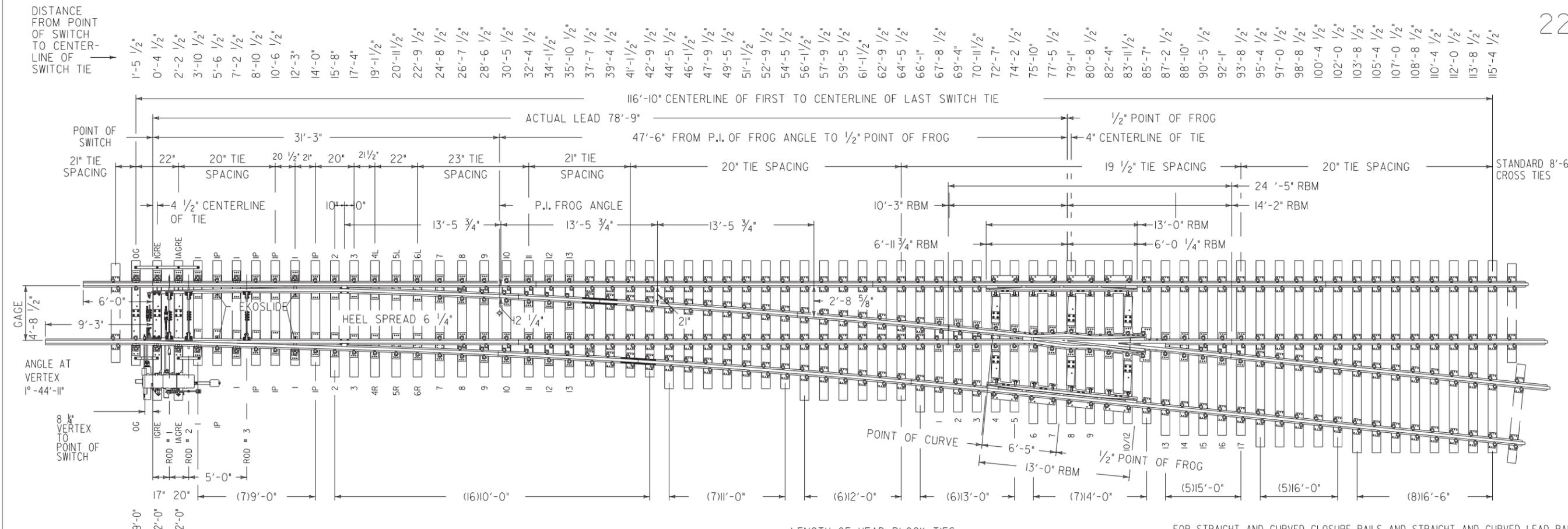
APPROVED - DIRECTOR ENGINEERING STANDARDS

APPROVED - ASSISTANT VICE PRESIDENT ENGINEERING

PREPARED BY: M.E. AUSTIN

ISSUED: MARCH 01, 2000
REVISED: DECEMBER 23, 2011

11/6/12 ADDED FRONT ROD ASSEMBLY



PLAN OF RIGHT HAND TURNOUT

SWITCH PLATE AND TIE LAYOUT ARRANGED FOR POWER THROW MECHANISM PER SIGNAL SECTION DRAWING NO. S5001

LENGTH OF HEAD BLOCK TIES
 13'-0" FOR HAND OPERATED
 14'-0" FOR HAND OPERATED WITH CIRCUIT CONTROLLER
 12'-0" FOR MACHINE OPERATED
 16'-0" FOR SPRING SWITCH
 VERTICAL SWITCH RODS SHOWN

FOR STRAIGHT AND CURVED CLOSURE RAILS, AND STRAIGHT AND CURVED LEAD RAILS, SEE DRAWING 2225.
 SWITCH HAS ADJUSTABLE BOLTLESS BRACES, PREFERRED SWITCH BRACE IS PRS CLAMPTITE, ALTERNATE IS BETHLEHEM BOLTLESS.
 RBM FROG USES MILLED SEAT PLATES WITH WELDED PANDROL SHOULDERS PER DRAWING 2431.
 ON PLATES WHERE THERE ARE 3 ADJACENT ROUND HOLES, THE CENTER HOLE IS RESERVED FOR FUTURE MAINTENANCE.
 RAIL ANCHORS ARE NOT TO BE USED IF PANDROL TIE PLATES ARE INSTALLED.

IF PANDROL PLATES ARE NOT USED, ALL TIES IN THE TURNOUT TO WHICH AN ANCHOR CAN BE APPLIED WILL BE BOX ANCHORED ON BOTH THE THROUGH TRACK AND DIVERGING TRACK. EVERY TIE WILL BE BOXED ANCHORED FOR A DISTANCE OF 130 TIES AHEAD OF THE SWITCH POINT. EVERY TIE ON BOTH TRACKS WILL BE BOX ANCHORED FOR A DISTANCE OF 130 TIES BEYOND THE END OF SWITCH TIES ON THE FROG END OF TURNOUT. DO NOT PLACE ANCHORS WHERE THEY MAY INTERFERE WITH MOVING PARTS.

ALL FROG PLATES TO BE MILLED SEAT 1" THICK 1/4" MILLED

WORKMANSHIP AND MATERIALS SHALL BE PER CURRENT AREMA SPECIFICATIONS UNLESS OTHERWISE SPECIFIED.

SINCE THE ALLOWABLE VARIATION IN STANDARD LENGTHS OF RAILS, FROGS AND SWITCH POINTS IS GREATER THAN THE NORMAL EXPANSION GAPS AT RAIL JOINTS AND THICKNESS OF FIBRE END POST IN INSULATED JOINTS, NO ALLOWANCE HAS BEEN MADE FOR EXPANSION GAPS AND FIBRE END POSTS IN COMPUTING LENGTHS OF RAIL SHOWN.

| BILL OF SWITCH TIES | | | |
|---------------------|--------------|-----------|--------|
| LENGTH | TURNOUT ONLY | CROSSOVER | |
| | | 14'-0" | 15'-0" |
| 9'-0" | 8 | 16 | 16 |
| 10'-0" | 16 | 32 | 32 |
| 11'-0" | 7 | 14 | 14 |
| 12'-0" | 6 | 12 | 12 |
| 12'-0" (Dapped)* | 2 | 4 | 4 |
| 13'-0" * | 6 | 12 | 12 |
| 14'-0" | 7 | 22 | 14 |
| 15'-0" | 5 | 0 | 16 |
| 16'-0" * | 5 | 0 | 0 |
| 16'-6" | 8 | 0 | 0 |
| 23'-0" | 0 | 10 | 8 |
| TOTAL NO. | 70 | 122 | 128 |
| BOARD MEAS. | 4549.8 | 7881.5 | 8312.0 |

ALL SWITCH TIES ARE 7"x 9"
 * ADJUST THE NUMBER OF 12'-0" DAPPED TIES IF LAYOUT REQUIRES THE USE OF 13'-0", 14'-0", OR 16'-0" HEAD BLOCK TIES.

| TURNOUT DATA | | BILL OF TRACK MATERIAL | | ORDERING INFORMATION | |
|--------------|--------------------------|------------------------|---|----------------------|---------|
| | RBM | QUANTITY | DESCRIPTION | CLASS | ITEM |
| FROG | NUMBER | 10 | NO. 10 RAILBOUND MANGANESE STEEL FROG, COMPLETE, PER DRAWING 2422 ROUNDED FOR SIGNALS. | O10 | 6650171 |
| FROG | TOTAL LENGTH | 24'-5" | | O10 | 6650170 |
| FROG | TOE LENGTH | 10'-3" | GUARD RAILS A-8 "E, WITH A 7'-0" MINIMUM STRAIGHT GUARDING FACE. | O10 | 6650250 |
| FROG | HEEL LENGTH | 14'-2" | | O10 | 6650180 |
| FROG | TOE SPREAD | 11 13/16" | 39'-0" STRAIGHT STOCK RAIL PER DRAWING 2307. | O10 | 6650181 |
| FROG | HEEL SPREAD | 17 1/2" | 39'-0" BENT STOCK RAIL PER DRAWING 2307. | O10 | 6650255 |
| FROG | ANGLE | 5°-43'-29" | 16'-6" LONG RAIL STRAIGHT SPLIT SWITCH, COMPLETE, WITH UNIFORM RISERS, PER DRAWINGS 2307, 2317, 2325, 2326, 2335, 2336, & 2337. | O10 | 6650255 |
| SWITCH | LENGTH OF SWITCH POINT | 16'-6" | FRONT ROD ASSEMBLY PER S5001 AND S5044 | | |
| SWITCH | HEEL SPREAD | 6 1/4" | | | |
| SWITCH | SWITCH ANGLE | 1°-44'-11" | | | |
| SWITCH | THICKNESS OF POINT | 1/4" | 35'-8" RAIL WITH INSULATED JT. 12'-1" x 23'-7" LEGS | | |
| SWITCH | VERTEX DISTANCE | 8 1/4" | 37'-2" RAIL WITH INSULATED JT. 7'-0" x 30'-2" LEGS | | |
| | ACTUAL LEAD | 78'-9" | JOINTS, COMPLETE INCL. J CLIPS AND BOLTS | | |
| | RADIUS OF CENTERLINE | 779.39 | 200 lbs TRACK SPIKES | | |
| | DEGREE OF CURVE | 7°-21'-24" | 144 PANDROL TIE PLATES | | |
| | 1/2" PT. TO PT. OF CURVE | 6'-5" | 434 PANDROL CLIPS | | |
| | STRAIGHT CLOSURE LENGTH | 52'-0" | 884 6 1/2" SCREW SPIKES OR 7 1/2" EVERGRIP SCREWS | | |
| | CURVED CLOSURE LENGTH | 52'-2" | 223 FEET OF PREMIUM RAIL | | |



NUMBER 10 TURNOUT AND CROSSOVER
 RAILBOUND MANGANESE FROG FOR 136RE RAIL

Legend O'Neil

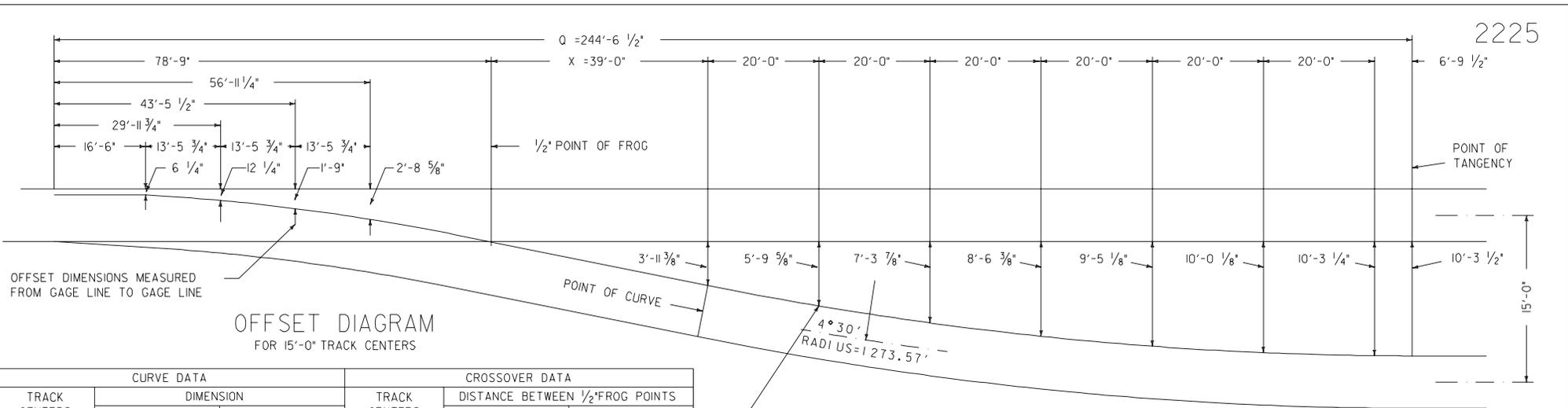
M.E. McMaster

APPROVED - DIRECTOR
 ENGINEERING STANDARDS

APPROVED - ASSISTANT VICE
 PRESIDENT ENGINEERING

PREPARED BY,
 M.E. AUSTIN

ISSUED: APRIL 17, 2001
 REVISED: DECEMBER 23, 2011

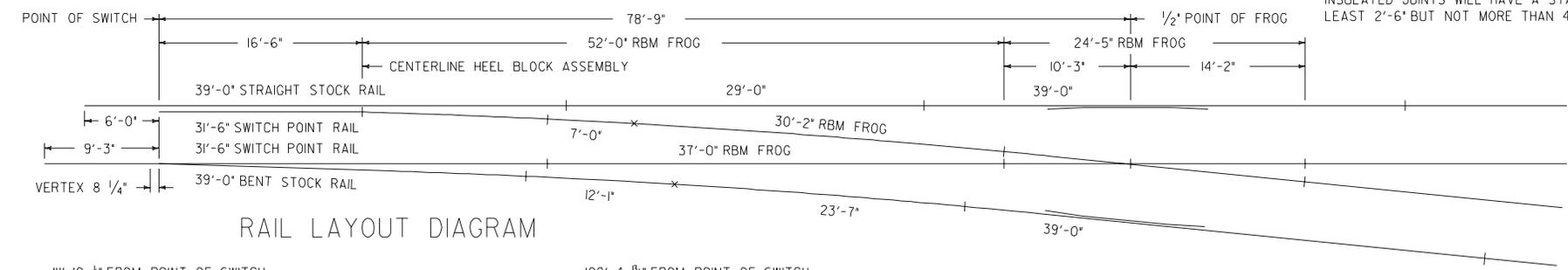


OFFSET DIAGRAM
FOR 15'-0" TRACK CENTERS

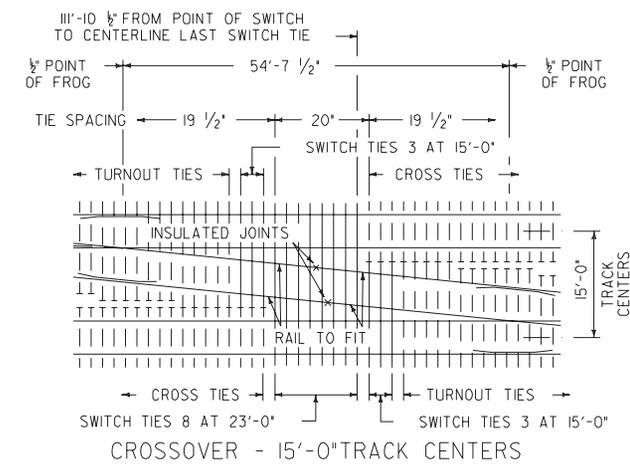
| TRACK CENTERS | CURVE DATA | | TRACK CENTERS | CROSSOVER DATA | |
|---------------|-------------|-------------|---------------|-----------------------------------|-------------|
| | 0 | X | | DISTANCE BETWEEN 1/2" FROG POINTS | |
| 13'-0" | 224'-7 1/8" | 19'-0 5/8" | 15'-0" | 54'-7 1/2" | 55'-4 1/2" |
| 14'-0" | 234'-6 3/8" | 29'-0 3/8" | 14'-0" | 44'-7 13/16" | 45'-4 3/16" |
| 15'-0" | 244'-6 1/2" | 39'-0" | 1'-0" CHANGE | 9'-11 1/16" | 10'-0 5/16" |
| 16'-0" | 254'-6 1/4" | 48'-11 3/4" | 1'-0" CHANGE | 9.974" | 10.026" |
| 1'-0" CHANGE | 9.974" | 9.974" | | | |

OFFSET DIMENSIONS MEASURED FROM GAGE LINE TO GAGE LINE. FOR TRACK CENTERS OTHER THAN 15'-0" REDUCE OR INCREASE OFFSET DIMENSIONS BY SAME AMOUNT THAT TRACK CENTERS ARE INCREASED OR DECREASED FROM 15'-0", AND ADJUST 'X' DISTANCE.

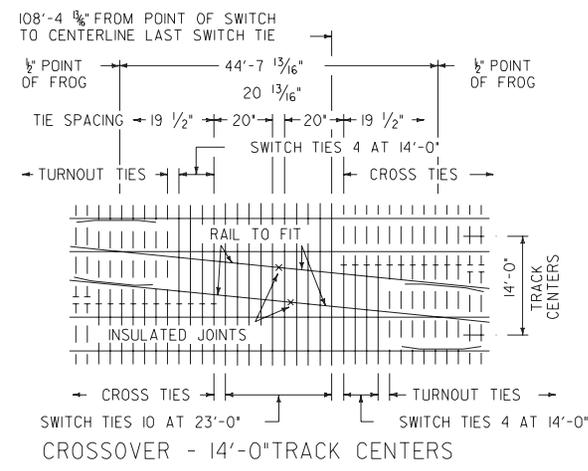
IF INSULATED JOINTS ARE REQUIRED WITH 31'-6" LONG SWITCH POINT RAILS, USE PREMIUM INSULATED JOINTS IN THE FOLLOWING LENGTH RAILS. FOR RAILBOUND MANGANESE FROGS (DWG 2422). 37'-2" LONG WITH 7'-0" AND 30'-2" LEGS 35'-8" LONG WITH 12'-1" AND 23'-7" LEGS INSULATED JOINTS WILL HAVE A STAGGER OF AT LEAST 2'-6" BUT NOT MORE THAN 4'-6".



RAIL LAYOUT DIAGRAM



CROSSOVER - 15'-0" TRACK CENTERS



CROSSOVER - 14'-0" TRACK CENTERS



NUMBER 10 OFFSET AND LAYOUT DIAGRAMS WITH RAILBOUND MANGANESE FROG FOR 136RE RAIL

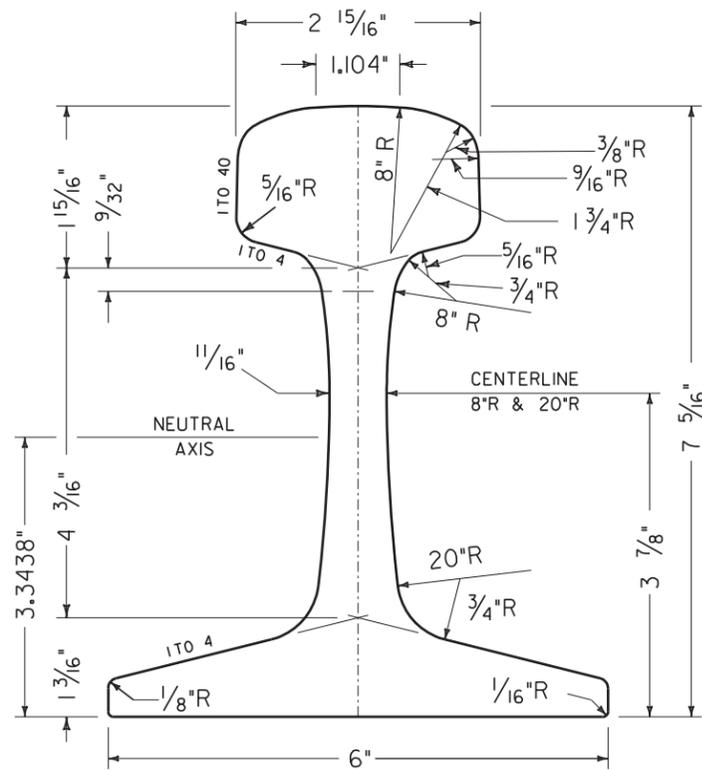
Herold O'Neil *M.E. McWaters*

APPROVED - DIRECTOR
ENGINEERING STANDARDS

APPROVED - ASSISTANT VICE
PRESIDENT ENGINEERING

PREPARED BY:
M.E. AUSTIN

ISSUED: APRIL 17, 2001
REVISED: FEBRUARY 07, 2012



136 RE

AREA :
 HEAD - 4.82 IN.² = 36.3 %
 WEB - 3.64 IN.² = 27.1 %
 BASE - 4.87 IN.² = 36.6 %

RAIL WEIGHT :
 135.9 LBS./YD.

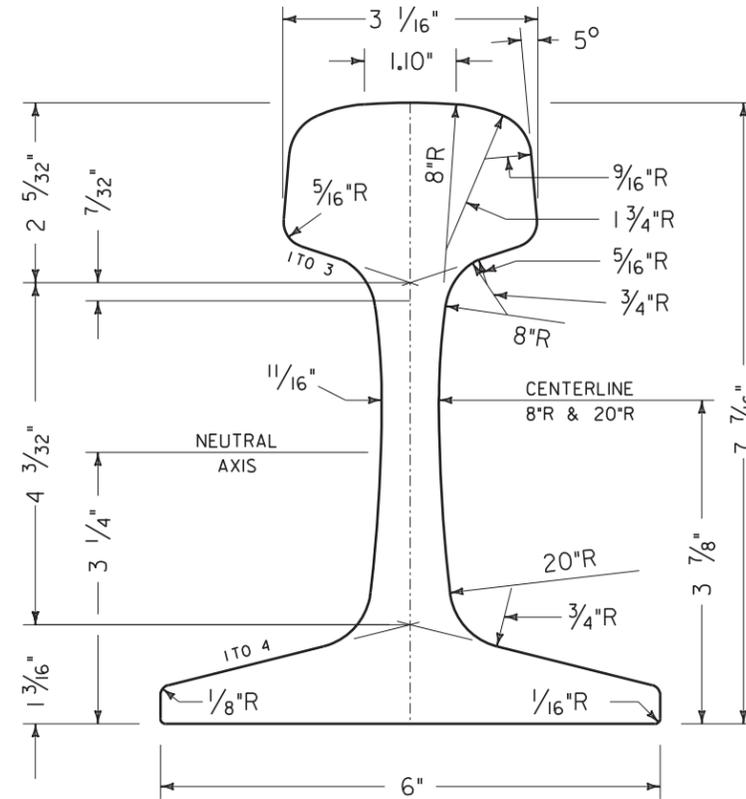
MOMENT OF INERTIA :
 94.2 IN.⁴

SECTION MODULUS :
 HEAD = 23.7 IN.³
 BASE = 28.2 IN.³

NET TONS PER TRACK MILE :
 239.36 TONS

RAIL DRILLING :
 3 3/32 IN. ABOVE BASE

HEAD WIDTH :
 MAXIMUM = 2.9375 IN.
 AT GAGE PT. = 2.8903 IN.



141 RE

AREA :
 HEAD - 5.38 IN.² = 38.9 %
 WEB - 3.56 IN.² = 25.8 %
 BASE - 4.87 IN.² = 35.3 %

RAIL WEIGHT :
 140.91 LBS./YD.

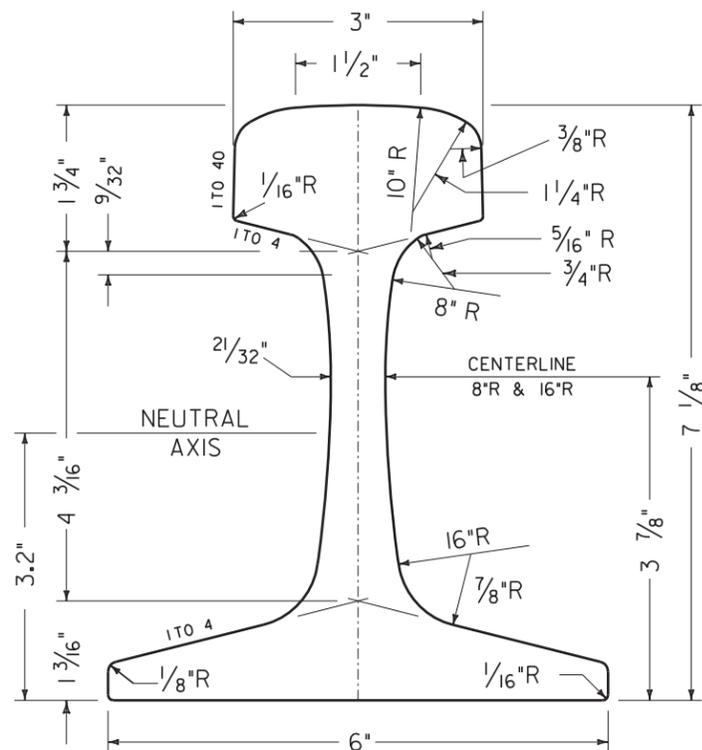
MOMENT OF INERTIA :
 100.44 IN.⁴

SECTION MODULUS :
 HEAD = 25.3 IN.³
 BASE = 29.0 IN.³

NET TONS PER TRACK MILE :
 248.00 TONS

RAIL DRILLING :
 3 3/32 IN. ABOVE BASE

HEAD WIDTH :
 MAXIMUM = 3.0625 IN.
 AT GAGE PT. = 2.9063 IN.



132 RE

AREA :
 HEAD - 4.42 IN.² = 34.1 %
 WEB - 3.66 IN.² = 28.3 %
 BASE - 4.87 IN.² = 36.6 %

RAIL WEIGHT :
 132.1 LBS./YD.

MOMENT OF INERTIA :
 87.9 IN.⁴

SECTION MODULUS :
 HEAD = 22.4 IN.³
 BASE = 27.4 IN.³

NET TONS PER TRACK MILE :
 232.32 TONS

RAIL DRILLING :
 3 3/32 IN. ABOVE BASE

HEAD WIDTH :
 MAXIMUM = 3.0000 IN.
 AT GAGE PT. = 2.9650 IN.

CSX TRANSPORTATION

132 RE, 136 RE, AND 141 RE
 RAIL SECTIONS

K.A. Deenard
 APPROVED - CHIEF ENGINEER
 MAINTENANCE OF WAY

James D. Bayley
 APPROVED - VICE PRESIDENT
 ENGINEERING

PREPARED BY:
 D.C. CLARK

ISSUED: DECEMBER 7, 2000
 REVISED: JUNE 22, 2007

FRA MAXIMUM ALLOWABLE OPERATING SPEEDS FOR CURVED TRACK · 4" UNBALANCE

2510

| DEGREE OF CURVE | ELEVATION IN INCHES | | | | | | | | | | | | | | | | | | | | | | | | SHEET 1 OF 2 | | | |
|-----------------|--|-----|-----|-----|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|--------------|-----|--|--|
| | 0 | 1/4 | 1/2 | 3/4 | 1 | 1-1/4 | 1-1/2 | 1-3/4 | 2 | 2-1/4 | 2-1/2 | 2-3/4 | 3 | 3-1/4 | 3-1/2 | 3-3/4 | 4 | 4-1/4 | 4-1/2 | 4-3/4 | 5 | 5-1/4 | 5-1/2 | 5-3/4 | 6 | | | |
| | MAXIMUM ALLOWABLE OPERATING SPEEDS IN MILES PER HOUR | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0° 10' | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 0° 20' | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 0° 30' | 106 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 0° 40' | 92 | 95 | 98 | 100 | 103 | 106 | 108 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 0° 50' | 82 | 85 | 87 | 90 | 92 | 94 | 97 | 99 | 101 | 103 | 105 | 107 | 109 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 1° 00' | 75 | 77 | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 94 | 96 | 98 | 100 | 101 | 103 | 105 | 106 | 108 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | | |
| 1° 15' | 67 | 69 | 71 | 73 | 75 | 77 | 79 | 81 | 82 | 84 | 86 | 87 | 89 | 91 | 92 | 94 | 95 | 97 | 98 | 100 | 101 | 102 | 104 | 105 | 106 | 106 | | |
| 1° 30' | 61 | 63 | 65 | 67 | 69 | 70 | 72 | 74 | 75 | 77 | 78 | 80 | 81 | 83 | 84 | 85 | 87 | 88 | 90 | 91 | 92 | 93 | 95 | 96 | 97 | 97 | | |
| 1° 45' | 57 | 58 | 60 | 62 | 63 | 65 | 67 | 68 | 70 | 71 | 72 | 74 | 75 | 76 | 78 | 79 | 80 | 82 | 83 | 84 | 85 | 86 | 88 | 89 | 90 | 90 | | |
| 2° 00' | 53 | 55 | 56 | 58 | 59 | 61 | 62 | 64 | 65 | 66 | 68 | 69 | 70 | 72 | 73 | 74 | 75 | 76 | 77 | 79 | 80 | 81 | 82 | 83 | 84 | 84 | | |
| 2° 15' | 50 | 51 | 53 | 54 | 56 | 57 | 59 | 60 | 61 | 63 | 64 | 65 | 66 | 67 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 79 | | |
| 2° 30' | 47 | 49 | 50 | 52 | 53 | 54 | 56 | 57 | 58 | 59 | 60 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 75 | | |
| 2° 45' | 45 | 47 | 48 | 49 | 51 | 52 | 53 | 54 | 55 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 72 | | |
| 3° 00' | 43 | 45 | 46 | 47 | 48 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 69 | | |
| 3° 15' | 41 | 43 | 44 | 45 | 46 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 67 | | |
| 3° 30' | 40 | 41 | 42 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 58 | 59 | 60 | 61 | 62 | 63 | 63 | 63 | | |
| 3° 45' | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 | 58 | 59 | 60 | 60 | 61 | 61 | | |
| 4° 00' | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 50 | 51 | 52 | 53 | 54 | 55 | 55 | 56 | 57 | 58 | 59 | 59 | 59 | | |
| 4° 30' | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 51 | 52 | 53 | 54 | 54 | 55 | 56 | 56 | | |
| 5° 00' | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 50 | 51 | 52 | 52 | 53 | 53 | | |
| 5° 30' | 32 | 33 | 34 | 35 | 36 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 51 | | |
| 6° 00' | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 40 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 46 | 47 | 48 | 48 | 48 | | |
| 6° 30' | 29 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 46 | 46 | | |
| 7° 00' | 28 | 29 | 30 | 31 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 42 | 43 | 44 | 44 | 45 | 45 | | |
| 8° 00' | 26 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | | |
| 9° 00' | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 38 | 38 | 39 | 39 | 39 | | |
| 10° 00' | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 37 | | |
| 11° 00' | 22 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | | |
| 12° 00' | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 34 | | |
| 13° 00' | 21 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 31 | 32 | 32 | 33 | 33 | | |
| 14° 00' | 20 | 20 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | 31 | 31 | 31 | 31 | | |
| 15° 00' | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 30 | 30 | 30 | 30 | | |
| 16° 00' | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | | |
| 17° 00' | 18 | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | 29 | 29 | | |
| 18° 00' | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | | |
| 19° 00' | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | | |
| 20° 00' | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | | |

AFTER DETERMINING THE SUPERELEVATION REQUIRED BASED ON FREIGHT TRAIN SPEED CURRENT EXISTING INSTRUCTIONS, THIS TABLE IS TO BE USED TO DETERMINE THE ALLOWABLE OPERATING SPEED FOR PASSENGER TRAINS BASED ON THE DEGREE OF CURVE AND THE NEW SUPERELEVATION.

THE MAXIMUM ALLOWABLE OPERATING SPEED FOR EACH CURVE IS DETERMINED BY THE FOLLOWING FORMULA:

$$V_{MAX} = \sqrt{\frac{E_A \cdot 4}{0.0007D}}$$

V_{MAX} = MAXIMUM ALLOWABLE OPERATING SPEED (MILES PER HOUR).

E_A = ACTUAL ELEVATION OF THE OUTSIDE RAIL (INCHES).

D = DEGREE OF CURVATURE (DEGREES).

110+ INDICATES CALCULATED SPEED IS GREATER THAN, BUT LIMITED TO 110 MPH.



FRA MAXIMUM AUTHORIZED SPEEDS FOR CURVED TRACK 4" UNBALANCE

SIGNED

REVIEWED · DIRECTOR, ENGINEERING STANDARDS

PREPARED BY, D. N. WITT

SIGNED

APPROVED · CHIEF ENGINEER MAINTENANCE OF WAY

ISSUED JUNE 14, 1999 REVISED, INITIAL ISSUE

FRA MAXIMUM ALLOWABLE PASSENGER TRAIN OPERATING SPEEDS FOR CURVED TRACK · 3" UNBALANCE

2510

| DEGREE OF CURVE | ELEVATION IN INCHES | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------|--|-----|-----|-----|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|-----|-------|-------|-------|-----|-----|
| | 0 | 1/4 | 1/2 | 3/4 | 1 | 1-1/4 | 1-1/2 | 1-3/4 | 2 | 2-1/4 | 2-1/2 | 2-3/4 | 3 | 3-1/4 | 3-1/2 | 3-3/4 | 4 | 4-1/4 | 4-1/2 | 4-3/4 | 5 | 5-1/4 | 5-1/2 | 5-3/4 | 6 | |
| | MAXIMUM ALLOWABLE OPERATING SPEEDS IN MILES PER HOUR | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0° 10' | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 0° 20' | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 0° 30' | 92 | 96 | 100 | 103 | 106 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 0° 40' | 80 | 83 | 86 | 89 | 92 | 95 | 98 | 100 | 103 | 106 | 108 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 0° 50' | 71 | 74 | 77 | 80 | 82 | 85 | 87 | 90 | 92 | 94 | 97 | 99 | 101 | 103 | 105 | 107 | 109 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| 1° 00' | 65 | 68 | 70 | 73 | 75 | 77 | 80 | 82 | 84 | 86 | 88 | 90 | 92 | 94 | 96 | 98 | 100 | 101 | 103 | 105 | 106 | 108 | 110 | 110 | 110 | 110 |
| 1° 15' | 58 | 60 | 63 | 65 | 67 | 69 | 71 | 73 | 75 | 77 | 79 | 81 | 82 | 84 | 86 | 87 | 89 | 91 | 92 | 94 | 95 | 97 | 98 | 100 | 101 | 101 |
| 1° 30' | 53 | 55 | 57 | 59 | 61 | 63 | 65 | 67 | 69 | 70 | 72 | 74 | 75 | 77 | 78 | 80 | 81 | 83 | 84 | 85 | 87 | 88 | 90 | 91 | 92 | 92 |
| 1° 45' | 49 | 51 | 53 | 55 | 57 | 58 | 60 | 62 | 63 | 65 | 67 | 68 | 70 | 71 | 72 | 74 | 75 | 76 | 78 | 79 | 80 | 82 | 83 | 84 | 85 | 85 |
| 2° 00' | 46 | 48 | 50 | 51 | 53 | 55 | 56 | 58 | 59 | 61 | 62 | 64 | 65 | 66 | 68 | 69 | 70 | 72 | 73 | 74 | 75 | 76 | 77 | 79 | 80 | 80 |
| 2° 15' | 43 | 45 | 47 | 48 | 50 | 51 | 53 | 54 | 56 | 57 | 59 | 60 | 61 | 63 | 64 | 65 | 66 | 67 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 75 |
| 2° 30' | 41 | 43 | 44 | 46 | 47 | 49 | 50 | 52 | 53 | 54 | 56 | 57 | 58 | 59 | 60 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 71 |
| 2° 45' | 39 | 41 | 42 | 44 | 45 | 47 | 48 | 49 | 51 | 52 | 53 | 54 | 55 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 68 |
| 3° 00' | 37 | 39 | 40 | 42 | 43 | 45 | 46 | 47 | 48 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 65 |
| 3° 15' | 36 | 37 | 39 | 40 | 41 | 43 | 44 | 45 | 46 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 62 | 62 |
| 3° 30' | 35 | 36 | 37 | 39 | 40 | 41 | 42 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 58 | 59 | 60 | 60 |
| 3° 45' | 33 | 35 | 36 | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 56 | 57 | 58 | 58 |
| 4° 00' | 32 | 34 | 35 | 36 | 37 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 50 | 51 | 52 | 53 | 54 | 55 | 55 | 56 | 56 |
| 4° 30' | 30 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 50 | 51 | 51 | 52 | 53 | 53 |
| 5° 00' | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 46 | 47 | 47 | 48 | 49 | 50 | 50 | 50 |
| 5° 30' | 27 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 36 | 37 | 38 | 39 | 40 | 41 | 41 | 42 | 43 | 44 | 44 | 45 | 46 | 47 | 47 | 48 | 48 |
| 6° 00' | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 40 | 40 | 41 | 42 | 43 | 43 | 44 | 45 | 45 | 46 | 46 |
| 6° 30' | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 43 | 43 | 44 | 44 |
| 7° 00' | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | 41 | 42 | 42 | 42 |
| 8° 00' | 23 | 24 | 25 | 25 | 26 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 34 | 35 | 36 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 40 |
| 9° 00' | 21 | 22 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | 32 | 32 | 33 | 33 | 34 | 35 | 35 | 36 | 36 | 37 | 37 | 37 |
| 10° 00' | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 26 | 26 | 27 | 28 | 28 | 29 | 29 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 35 |
| 11° 00' | 19 | 20 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 26 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 |
| 12° 00' | 18 | 19 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 32 | 32 | 32 |
| 13° 00' | 18 | 18 | 19 | 20 | 21 | 21 | 22 | 22 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 30 | 30 | 31 | 31 | 31 |
| 14° 00' | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | 29 | 30 | 30 |
| 15° 00' | 16 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 |
| 16° 00' | 16 | 17 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 28 |
| 17° 00' | 15 | 16 | 17 | 17 | 18 | 18 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 27 | 27 | 27 |
| 18° 00' | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 26 | 26 | 26 | 26 |
| 19° 00' | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 24 | 24 | 24 | 24 | 25 | 25 | 26 | 26 |
| 20° 00' | 14 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 25 | 25 | 25 |

AFTER DETERMINING THE SUPERELEVATION REQUIRED BASED ON FREIGHT TRAIN SPEED CURRENT EXISTING INSTRUCTIONS, THIS TABLE IS TO BE USED TO DETERMINE THE ALLOWABLE OPERATING SPEED FOR PASSENGER TRAINS BASED ON THE DEGREE OF CURVE AND THE NEW SUPERELEVATION.

THE MAXIMUM ALLOWABLE OPERATING SPEED FOR EACH CURVE IS DETERMINED BY THE FOLLOWING FORMULA:

$$V_{MAX} = \sqrt{\frac{E_A \cdot 3}{0.0007D}}$$

V_{MAX} = MAXIMUM ALLOWABLE OPERATING SPEED (MILES PER HOUR).

E_A = ACTUAL ELEVATION OF THE OUTSIDE RAIL (INCHES).

D = DEGREE OF CURVATURE (DEGREES).

110+ INDICATES CALCULATED SPEED IS GREATER THAN, BUT LIMITED TO 110 MPH.



FRA MAXIMUM AUTHORIZED SPEEDS FOR CURVED TRACK 3" UNBALANCE

SIGNED

REVIEWED · DIRECTOR, ENGINEERING STANDARDS

SIGNED

APPROVED · CHIEF ENGINEER MAINTENANCE OF WAY

PREPARED BY, D. N. WITT

ISSUED, MARCH 24, 1997
REVISED, JUNE 14, 1999

| INCHES SUBTRACTED | SPEED IN MILES PER HOUR | DEGREE OF CURVE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|-------------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---|--|
| | | 0° - 10' | 0° - 20' | 0° - 30' | 0° - 40' | 0° - 50' | 1° - 00' | 1° - 15' | 1° - 30' | 1° - 45' | 2° - 00' | 2° - 15' | 2° - 30' | 2° - 45' | 3° - 00' | 3° - 15' | 3° - 30' | 3° - 45' | 4° - 00' | 4° - 30' | 5° - 00' | 5° - 30' | 6° - 00' | 6° - 30' | 7° - 00' | 8° - 00' | 9° - 00' | 10° - 00' | 11° - 00' | 12° - 00' | 14° - 00' | 16° - 00' | 18° - 00' | 20° - 00' | | |
| EQUILIBRIUM ELEVATION MINUS 1 1/2" OR 2 1/2" BASED ON SPEED | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1/2" | 10 | | | | | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | | |
| | 20 | | | | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 1 3/4 | 2 1/2 | 3 | 3 1/2 | 4 | |
| | 25 | | | | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 1 | 1 | 1 1/4 | 1 1/2 | 2 | 2 1/2 | 2 3/4 | 3 1/4 | 3 3/4 | 4 1/2 | | | | | |
| | 30 | | | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 3/4 | 1 | 1 1/4 | 1 3/4 | 2 | 2 1/4 | 2 1/2 | 3 | 3 1/2 | 4 1/4 | | | | | | | | | |
| | 35 | | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 3/4 | 1 | 1 1/4 | 1 1/2 | 1 3/4 | 2 | 2 1/2 | 2 3/4 | 3 1/4 | 3 1/2 | 4 | 4 1/2 | | | | | | | | | | | |
| | 40 | | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 1 | 1 1/4 | 1 1/2 | 1 3/4 | 2 1/4 | 2 1/2 | 2 3/4 | 3 | 3 1/2 | 4 | 4 1/2 | | | | | | | | | | | | | | |
| | 45 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 1 | 1 1/4 | 1 3/4 | 2 | 2 1/2 | 2 3/4 | 3 | 3 1/2 | 3 3/4 | 4 1/4 | | | | | | | | | | | | | | | | | |
| | 50 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 3/4 | 1 1/4 | 1 1/2 | 2 | 2 1/2 | 3 | 3 1/4 | 3 3/4 | 4 1/4 | | | | | | | | | | | | | | | | | | | | |
| | 55 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 1/4 | 1 3/4 | 2 1/4 | 2 3/4 | 3 1/4 | 3 3/4 | 4 1/4 | 4 3/4 | | | | | | | | | | | | | | | | | | | | | |
| 60 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 | 1 3/4 | 2 1/4 | 3 | 3 1/2 | 4 1/4 | 4 3/4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 1/2" | 65 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 1/4 | 2 | 2 3/4 | 3 1/2 | 4 1/4 | 5 | | | | | | | | | | | | | | | | | | | | | | | | |
| | 70 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 | 1 3/4 | 2 3/4 | 3 1/2 | 4 1/4 | | | | | | | | | | | | | | | | | | | | | | | | | |

THE REGIONAL ENGINEER TRACK WILL USE THIS TABLE TO DETERMINE SUPERELEVATION AND ENTER INTO SCREEN OECV.

FIELD PERSONNEL ARE TO USE SCREEN OECV TO FIND THE SUPERELEVATION REQUIRED FOR A SPECIFIC CURVE.

LIMITS ON SUPERELEVATION FOUND ON THIS PAGE MUST BE OBSERVED.

TABLE BASED ON EQUILIBRIUM ELEVATION MINUS AN UNBALANCE BASED ON SPEED AS FOLLOWS AND ADJUSTED TO NEAREST 1/4".
 1 1/2" UNBALANCED FOR SPEEDS UP TO AND INCLUDING 60 MPH
 2 1/2" UNBALANCED FOR SPEEDS OF 65 AND 70 MPH

NOTE - E = 0.0007V²D
 WHERE E = EQUILIBRIUM ELEVATION IN INCHES

LIMITS ON SUPERELEVATION

- 5" MAXIMUM SUPERELEVATION ON ANY CURVE.
- 4 1/2" SUPERELEVATION ON CURVES GREATER THAN 3 - 00' WHEN REQUIRED TO MAINTAIN MAXIMUM AUTHORIZED SPEED.
- 4" SUPERELEVATION ON NON-SIGNALLED BRANCH LINES HAVING A MAXIMUM AUTHORIZED SPEED OF 30 MPH OR LESS.
- 4" SUPERELEVATION ON GRADES WHERE FREIGHT TRAINS REGULARLY OPERATE BELOW 25 MPH.
- CURVES SHALL BE REGULARLY EXAMINED FOR PREMATURE OR ACCELERATED WEAR ON THE HIGH OR LOW RAIL. A REQUEST FOR A DEVIATION FROM THE STANDARD SUPERELEVATION MUST BE SUBMITTED ON FORM "ELEVATION CHANGE REQUEST" TO CHIEF ENGINEER, MAINTENANCE OF WAY FOR CONCURRENCE.

MINIMUM LENGTH OF SPIRAL

| MAXIMUM AUTHORIZED SPEED IN MPH | MINIMUM SPIRAL LENGTH PER 1/2 INCH OF SUPERELEVATION |
|---|--|
| NEW CONSTRUCTION AND EXISTING TRACKS WHERE PRACTICAL. | |
| UP TO 50 | 31 FEET |
| 55 TO 60 | 39 FEET |
| 70 TO 80 | 50 FEET |
| 85 AND 90 | 55 FEET |
| EXISTING TRACKS | |
| UP TO 50 | 31 FEET |
| 55 TO 80 | 39 FEET |
| 85 AND UP | 50 FEET |



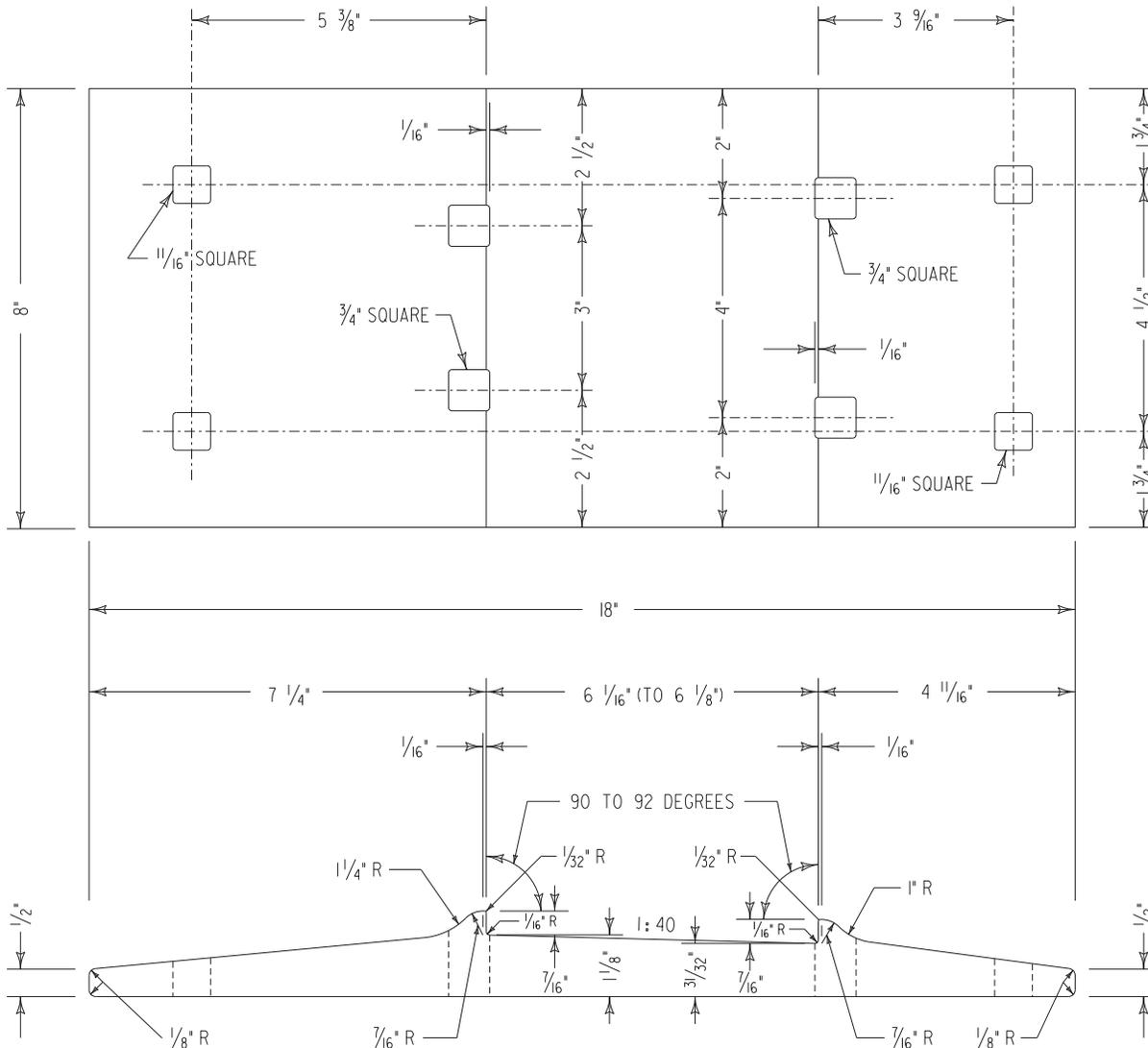
SUPERELEVATION OF CURVES

REVIEWED - GENERAL MANAGER
 ENGINEERING STANDARDS &
 INDUSTRIAL ENGINEERING

APPROVED - CHIEF ENGINEER
 MAINTENANCE OF WAY

PREPARED BY,
 D. N. WITT

ISSUED, MARCH 24, 1997
 REVISED, NOVEMBER 25, 2002



NOTES

1. PLATES ARE TO BE FURNISHED WITHOUT RIBS.
2. RAIL SEAT IS TO BE FLAT, WITHOUT CAMBER.
3. ALL SPIKE HOLES USE 1/16" FILLETS IN THE CORNERS.
4. PLATES TO BE BRANDED IN ACCORDANCE WITH SECTION 5 OF THE AREMA MANUAL.
5. MATERIAL AND PROCESS ARE TO CONFORM TO AREMA STANDARDS.
 CARBON - 0.40 % MIN.
 COPPER - 0.20 % MIN.
6. ESTIMATED WEIGHT - 36.52 LBS.

RELAY PLATE LIMITS

1. SHOULDER HEIGHT - 1/32" MINIMUM
2. RAIL SEAT WIDTH - 6-1/4" MAXIMUM
3. SPIKE HOLE SIZE - 27/32" MAXIMUM
4. PLATE THICKNESS AT EDGE - 15/32" MINIMUM
5. RAIL SEAT FLATNESS - 1/16" MAXIMUM
6. PLATE BOTTOM FLATNESS - 1/8" MAXIMUM



8" X 18" TIE PLATE
FOR 6" BASE RAIL SECTIONS

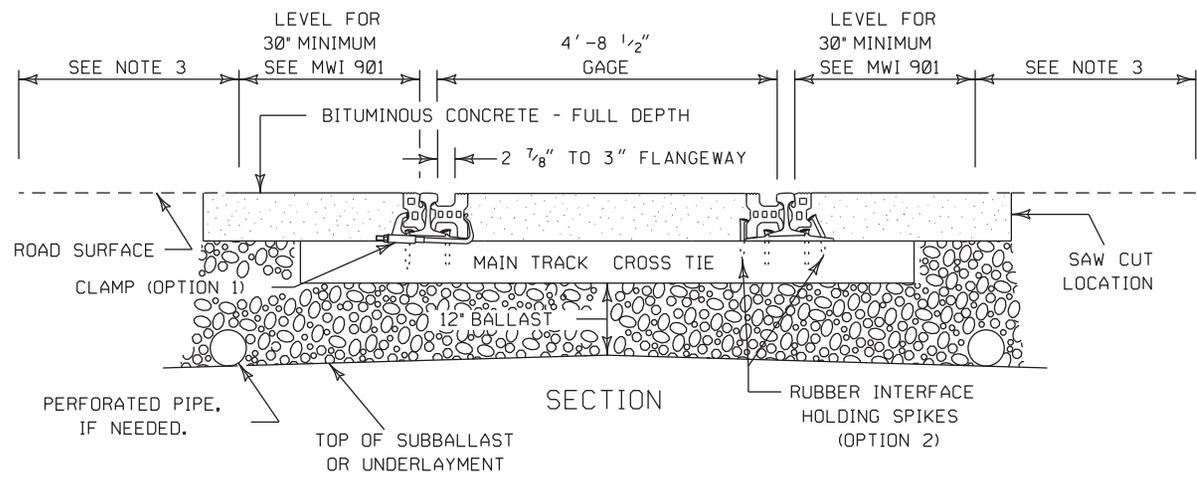
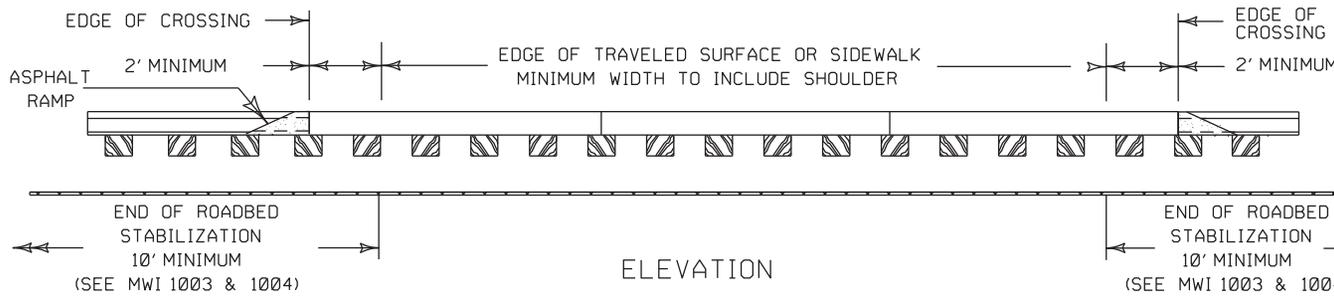
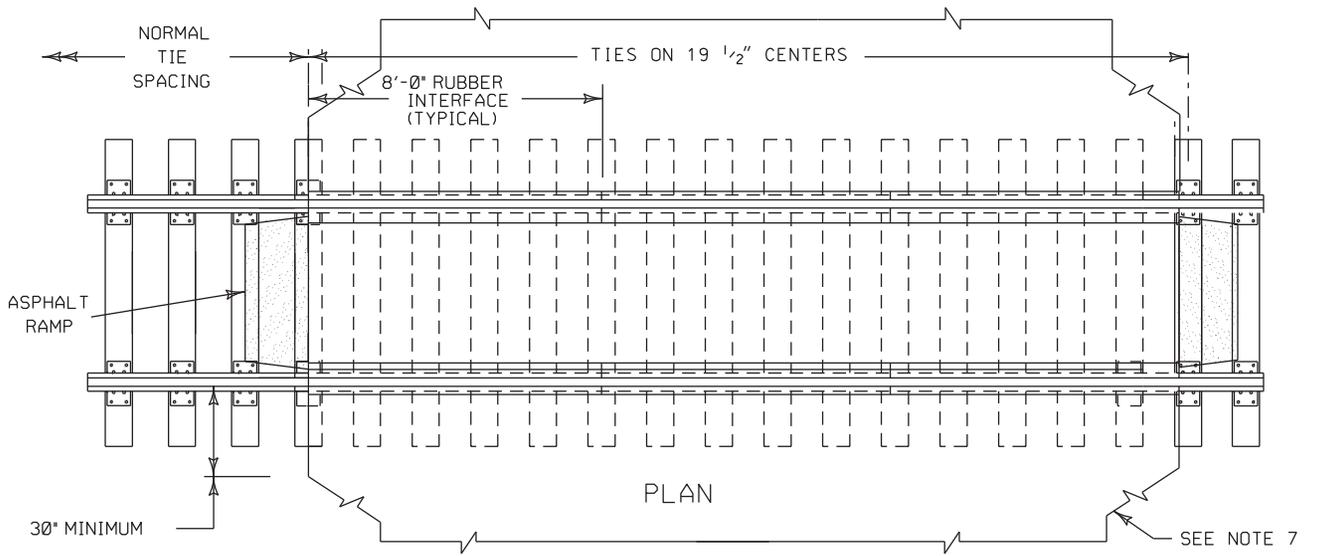
| ORDERING INFORMATION | | | |
|--|-------|-------|---------|
| DESCRIPTION | UNITS | CLASS | ITEM |
| PLATE, TIE, 8" X 18" FOR 6" BASE RAILS | EACH | 013 | 6150675 |

APPROVED - DIRECTOR
ENGINEERING STANDARDS

APPROVED - CHIEF ENGINEER
ENGINEERING SERVICES

PREPARED BY:
M. E. AUSTIN

ISSUED: JANUARY 11, 2005
REVISED: OCTOBER 28, 2014



- NOTES
1. MWI 901 (LATEST REVISION) IS TO BE USED IN CONJUNCTION WITH THIS DRAWING.
 2. FOR NEW CONSTRUCTION, HIGHWAY SHOULD INTERSECT RAILROAD AT OR NEARLY RIGHT ANGLES.
 3. FOR NEW CONSTRUCTION, HIGHWAY SURFACE SHOULD NOT BE MORE THAN 3" HIGHER OR LOWER THAN TOP OF THE NEAR RAIL 30' FROM THE RAIL ALONG THE ROAD CENTERLINE, UNLESS TRACK SUPERELEVATION DICTATES OTHERWISE.
 4. USE STATE D.O.T. SPECIFICATIONS FOR BITUMINOUS CONCRETE AND ASPHALT SPRAY TACK COAT FOR THE STATE IN WHICH THE CROSSING IS LOCATED.
 5. CROSSINGS SHOULD BE CONTINUOUS BETWEEN ROADWAY OR SIDEWALK EDGES. IF NOT PRACTICABLE, ADEQUATE DRAINAGE MUST BE PROVIDED BETWEEN CROSSING AREAS TO ELIMINATE WATER POCKETS.
 6. USE TWO CLAMPS PER CRIB OR FOUR (4) RUBBER INTERFACE HOLDING SPIKES PER TIE.
 7. SLOPE PAVING TO RETURN TO ORIGINAL PAVEMENT SURFACE. LENGTH OF TRANSITION WILL DEPEND ON LOCAL CONDITIONS. USE A RUNOFF OF 1 IN. PER 10 FT. WHERE PRACTICABLE.
 8. IF ROADBED STABILIZATION IS REQUIRED, EXTEND IT 10 FT. BEYOND EDGE OF CROSSING UNDER TRACK.
 9. PERFORATED PIPE TO BE SIZED AND LOCATED FOR SITE CONDITIONS. USE MIN. 6" DIA. PIPE AND LOCATE AT LEAST 12' BEYOND THE END OF TIE.

| ORDERING INFORMATION | | |
|----------------------|-----------|---|
| ITEM NO. | RAIL WGT. | DESCRIPTION |
| Ø14 5250135 | 90-100 | CROSSING RUBBER INTERFACE, LIGHT DUTY. ORDER BY "TRACK FEET" IN 8 FT. INCREMENTS. EACH TRACK FOOT INCLUDES 2 GAGE SIDE AND 2 FIELD SIDE SECTIONS. |
| Ø14 5250140 | 115 | |
| Ø14 5250142 | 122 | |
| Ø14 5250145 | 132 | |
| Ø14 5250147 | 136 | |
| Ø14 5250160 | 140 | |
| Ø14 5250170 | 141 | |
| Ø14 5250260 | 90-141 | CLAMP, RUBBER INTERFACE USE 2 PER CRIB. |



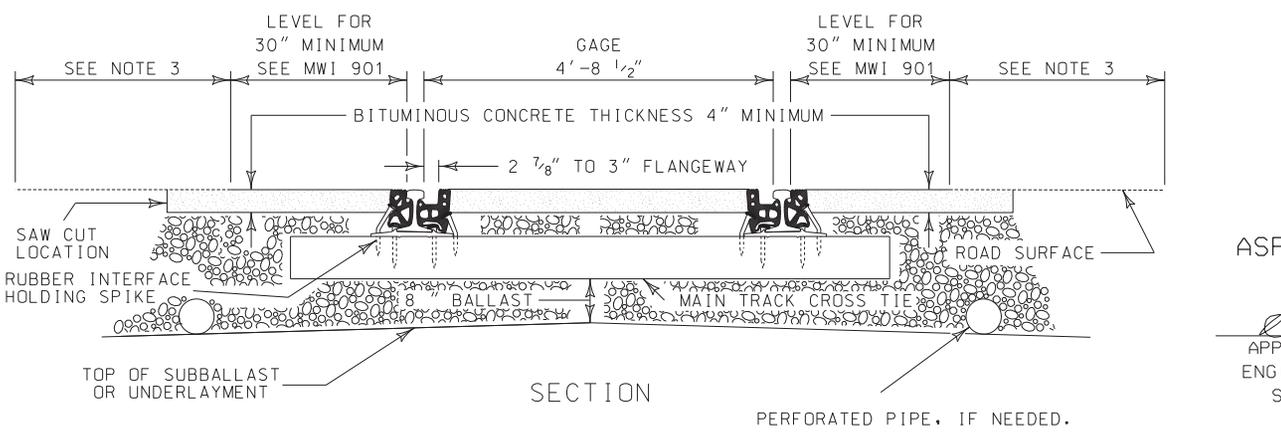
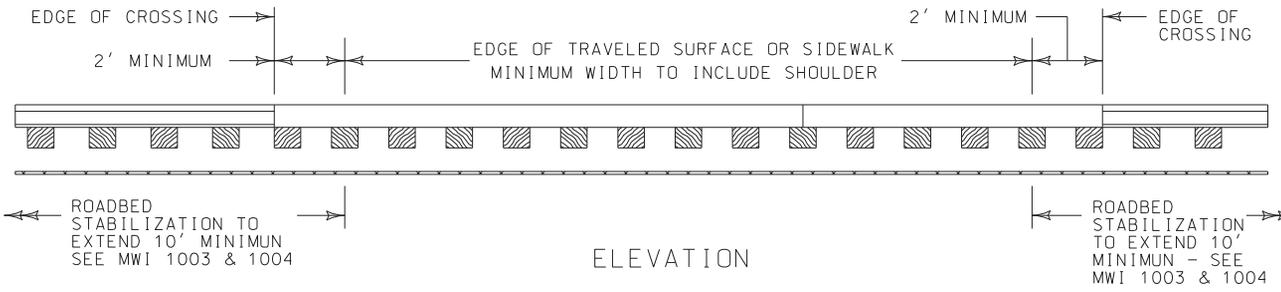
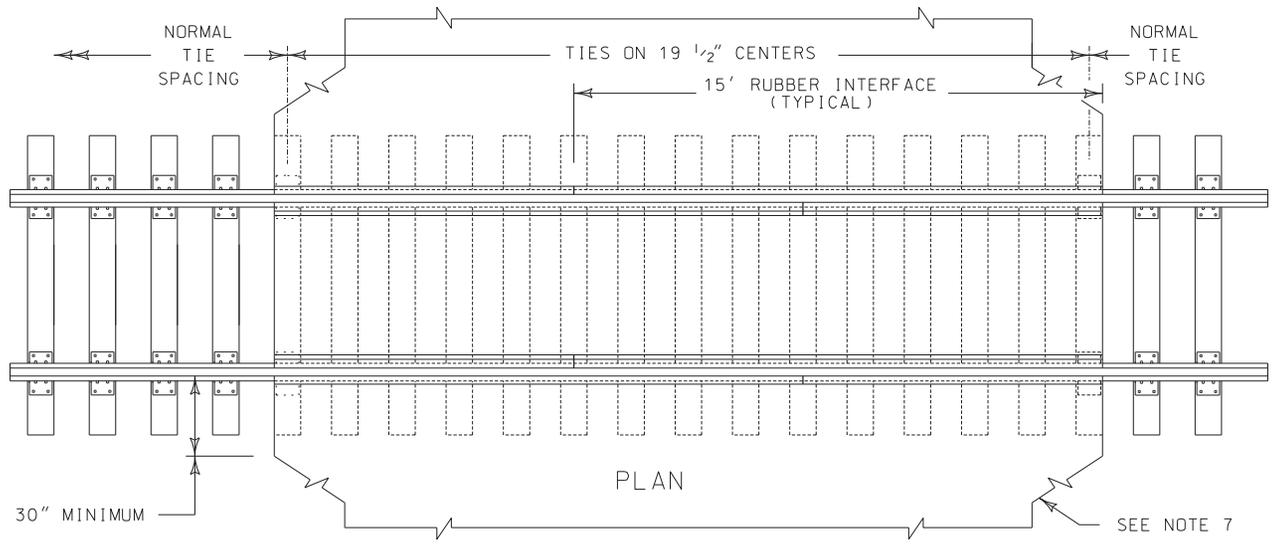
NORMAL AND LIGHT DUTY ROAD CROSSING ASPHALT AND RUBBER INTERFACE ON WOOD TIES

[Signature]
 APPROVED DIRECTOR
 ENGINEERING STANDARDS

[Signature]
 APPROVED - CHIEF ENGINEER
 ENGINEERING SERVICES

PREPARED BY:
 M. E. AUSTIN

ISSUED: MAY 27, 1997
 REVISED: SEPTEMBER 18, 2014



NOTES

1. MWI 901 (LASTEST REVISION) IS TO BE USED IN CONJUNCTION WITH THIS DRAWING.
2. FOR NEW CONSTRUCTION, HIGHWAY SHOULD INTERSECT RAILROAD AT OR NEARLY RIGHT ANGLES.
3. FOR NEW CONSTRUCTION, HIGHWAY SURFACE SHOULD NOT BE MORE THAN 3" HIGHER OR LOWER THAN TOP OF NEAR RAIL 30' FROM RAIL ALONG THE ROAD CENTERLINE, UNLESS TRACK SUPERELEVATION DICTATES OTHERWISE.
4. USE STATE D.O.T. SPECIFICATIONS FOR BITUMINOUS CONCRETE AND ASPHALT TACK COAT FOR THE STATE IN WHICH THE CROSSING IS LOCATED.
5. CROSSINGS SHOULD BE CONTINUOUS BETWEEN ROADWAY OR SIDEWALK EDGES. IF NOT PRACTICABLE, ADEQUATE DRAINAGE MUST BE PROVIDED BETWEEN CROSSING AREAS TO ELIMINATE WATER POCKETS.
6. USE FOUR (4) PANEL HOLDING SPIKES PER TIE, OR TWO (2) CLAMPS IN ALTERNATE CRIBS.
7. SLOPE PAVING TO RETURN TO ORIGINAL PAVEMENT SURFACE. LENGTH OF TRANSITION WILL DEPEND ON LOCAL CONDITIONS. USE A RUNOFF OF 1 IN. PER 10 FT. WHERE PRACTICABLE.
8. IF ROADBED STABILIZATION IS REQUIRED, EXTEND IT 10 FT. BEYOND EDGE OF CROSSING UNDER TRACK.
9. PERFORATED PIPE TO BE SIZED AND LOCATED FOR SITE CONDITIONS. USE MIN. 6" DIA. PIPE AND LOCATE AT LEAST 12" BEYOND END OF TIE.

| ORDERING INFORMATION | | |
|----------------------|-----------|---|
| ITEM NO. | RAIL WGT. | DESCRIPTION |
| 014 5250135 | 90-100 | CROSSING RUBBER INTERFACE, LIGHT DUTY. ORDER BY "TRACK FEET" IN 5 FT. INCREMENTS. EACH TRACK FOOT INCLUDES 2 GAGE SIDE AND 2 FIELD SIDE SECTIONS. INTERFACE DELIVERED IN 5', 10' OR 15' SECTIONS. |
| 014 5250140 | 115 | |
| 014 5250142 | 122 | |
| 014 5250145 | 132 | |
| 014 5250147 | 136 | |
| 014 5250160 | 140 | |
| 014 5250170 | 141 | |
| 014 5250260 | 90-141 | CLAMP, RUBBER INTERFACE USE 2 PER CRIB. |



FARM / RESIDENTIAL ROAD CROSSING
ASPHALT AND RUBBER INTERFACE ON WOOD TIES

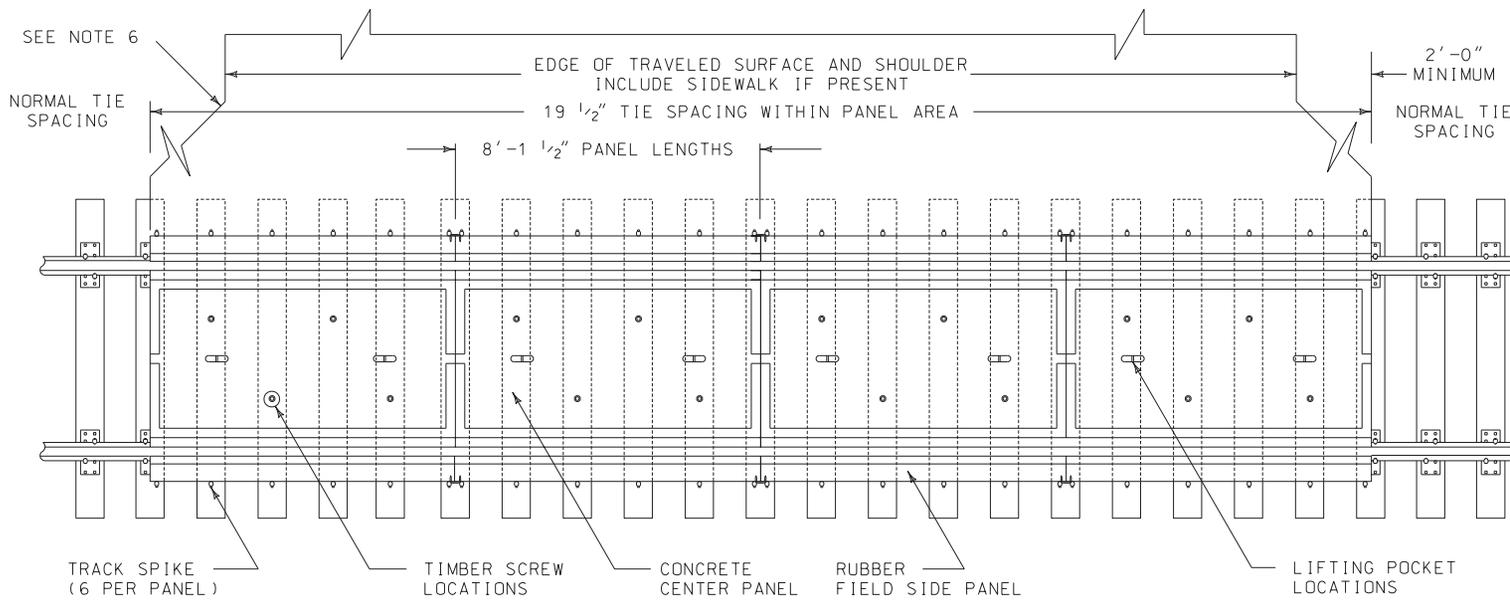
[Signature]
APPROVED - VICE PRESIDENT
ENGINEERING AND MECHANICAL
STANDARDS AND QUALITY

[Signature]
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY:
J. E. BEYERL

ISSUED, MAY 29, 1998
REVISED, MARCH 22, 2005

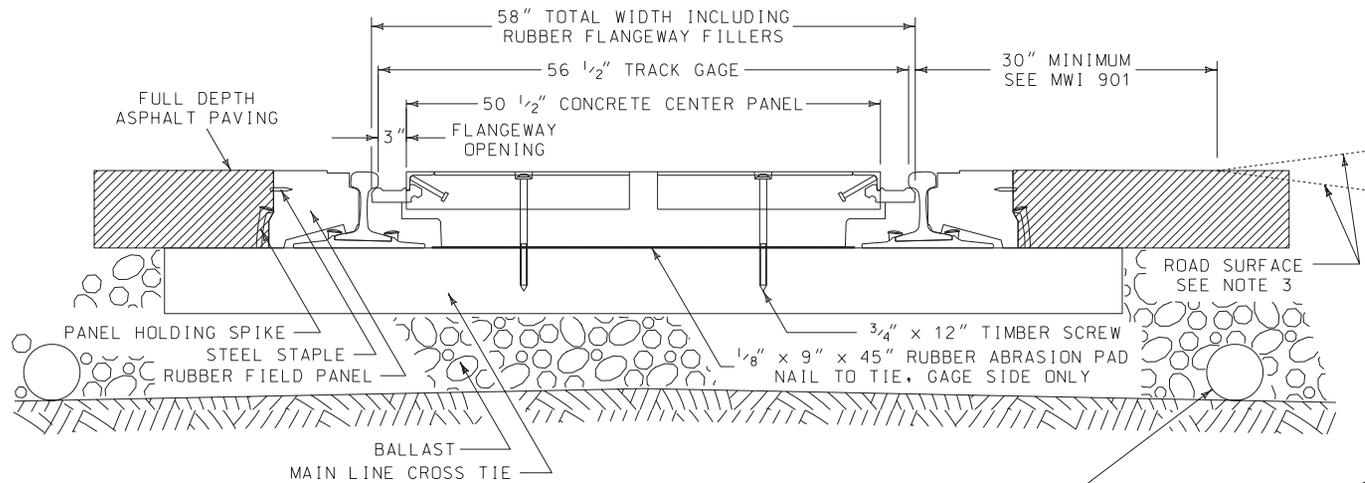
2524



CROSSING PLAN VIEW

NOTES

1. MWI 901 (LATEST REVISION) IS TO BE USED IN CONJUNCTION WITH THIS DRAWING.
2. FOR NEW CONSTRUCTION, HIGHWAY SHOULD INTERSECT RAILROAD AT OR NEARLY RIGHT ANGLES.
3. FOR NEW CONSTRUCTION, HIGHWAY SURFACE SHOULD NOT BE MORE THAN 3 IN. HIGHER OR LOWER THAN TOP OF NEAR RAIL 30 FT. FROM THE RAIL ALONG THE ROAD CENTERLINE, UNLESS TRACK SUPERELEVATION DICTATES OTHERWISE.
4. USE STATE DOT SPECIFICATIONS FOR BITUMINOUS CONCRETE AND ASPHALT SPRAY TACK COAT FOR THE STATE IN WHICH THE CROSSING IS LOCATED.
5. CROSSING SHOULD BE CONTINUOUS BETWEEN ROADWAY OR SIDEWALK EDGES. IF NOT PRACTICABLE, DRAINAGE MUST BE PROVIDED BETWEEN PAVED AREAS TO ELIMINATE WATER POCKETS.
6. SLOPE PAVING TO RETURN TO PAVEMENT SURFACE. LENGTH OF TRANSITION WILL DEPEND ON LOCAL CONDITIONS. USE A RUNOFF OF 1 IN. PER 10 FT. WHERE PRACTICABLE.
7. IF ROADBED STABILIZATION IS REQUIRED, EXTEND IT 10 FT BEYOND EDGE OF CROSSING UNDER TRACK.
8. APPROXIMATE WEIGHT FOR 136# MATERIALS:
3,200 LBS. - CONCRETE CENTER PANEL
275 LBS. - RUBBER FIELD SIDE PANEL



SECTION

PERFORATED PIPE, IF NEEDED, TO BE SIZED AND LOCATED FOR SITE CONDITIONS, USING 6" MIN. DIA PIPE AND PLACED AT LEAST 12" BEYOND TIE.

| ORDERING INFORMATION | | |
|----------------------|-----------|---|
| ITEM NO. | RAIL WGT. | DESCRIPTION |
| 014 5250270 | 115 - 122 | CROSSING, CONCRETE PANEL, LIGHT DUTY WITH RUBBER INTERFACE FOR WOOD TIES. ORDER BY TRACK FEET IN APPROX. 8 FT. INCREMENTS. |
| 014 5250275 | 132 - 136 | EACH 8'-1 1/2" SECTION INCLUDES 1 CONCRETE CENTER PANEL WITH RUBBER FLANGWAY FILLER AND 2 FIELD SIDE RUBBER INTERFACE SECTIONS. |
| 014 5250285 | 141 | |



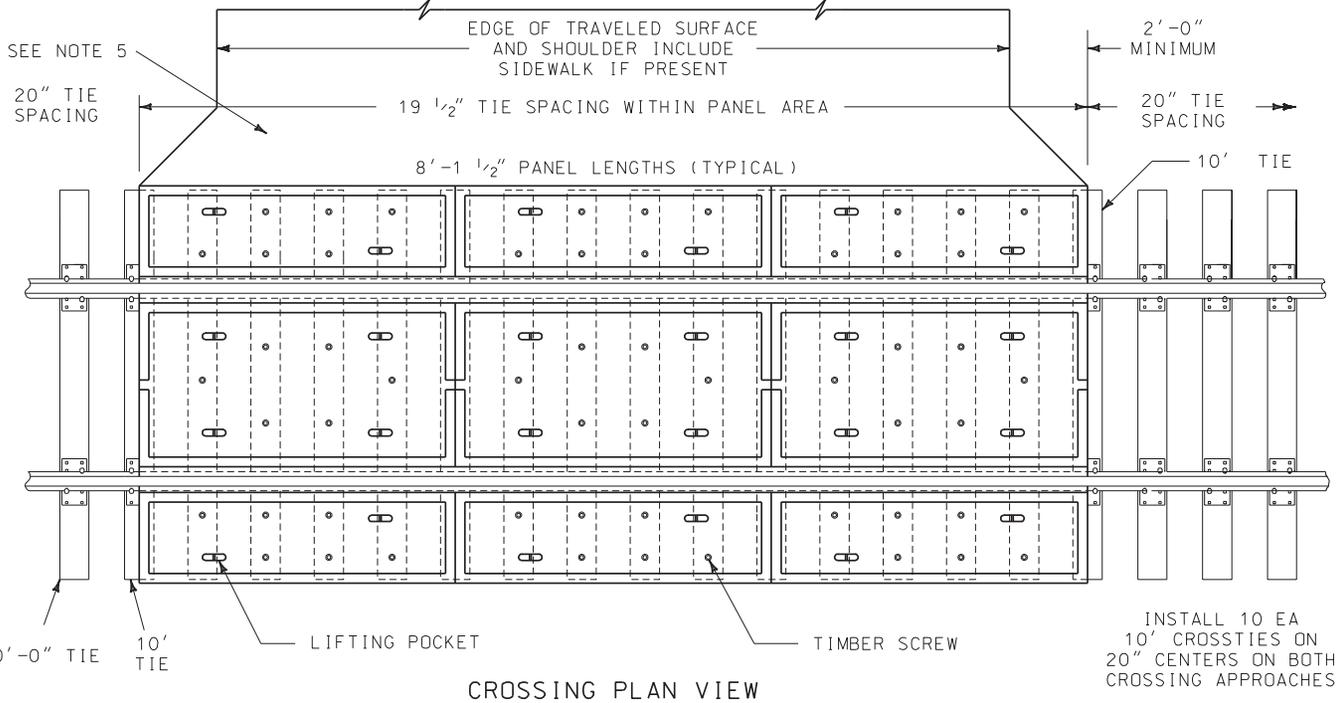
LIGHT DUTY ROAD CROSSING
CONCRETE AND RUBBER ON WOOD TIES

Ch. Kadlik
APPROVED - VICE PRESIDENT
ENGINEERING AND MECHANICAL
STANDARDS AND QUALITY

James D. Bagley
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY:
J. E. BEYERL

ISSUED, MAY 22, 1999
REVISED, MARCH 22, 2005



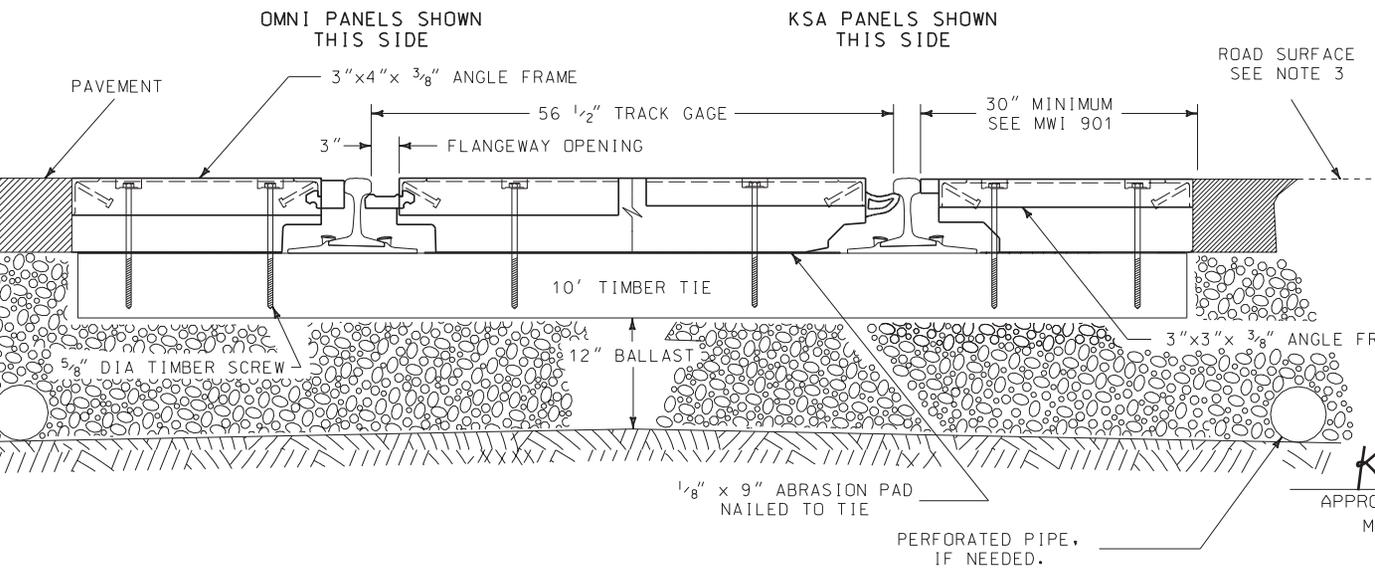
CROSSING PLAN VIEW

NOTES

1. MWI 901 (LASTEST REVISION) IS TO BE USED IN CONJUNCTION WITH THIS DRAWING.
2. FOR NEW CONSTRUCTION, HIGHWAY SHOULD INTERSECT RAILROAD AT OR NEARLY RIGHT ANGLES.
3. FOR NEW CONSTRUCTION, HIGHWAY SURFACE SHOULD NO BE MORE THAN 3 IN. HIGHER OR LOWER THAN TOP OF NEAR RAIL 30 FT. FROM THE RAIL ALONG THE ROAD CENTERLINE, UNLESS TRACK SUPERELEVATION DICTATES OTHERWISE.
4. USE STATE DOT SPECIFICATIONS FOR BITUMINOUS CONCRETE AND SPRAY TACK COAT FOR THE STATE IN WHICH THE CROSSING IS LOCATED.
5. CROSSING SHOULD BE CONTINUOUS BETWEEN ROADWAY OR SIDEWALK EDGES. IF NOT PRACTICABLE, DRAINAGE MUST BE PROVIDED BETWEEN PAVED AREAS TO ELIMINATE WATER POCKETS.
6. SLOPE PAVING TO RETURN TO ORIGINAL PAVEMENT SURFACE. LENGTH OF TRANSITION WILL DEPEND ON LOCAL CONDITIONS. USE A RUNOFF OF 1 IN. PER 10 FT. WHERE PRACTICABLE.
7. IF ROADBED STABILIZATION IS REQUIRED, EXTEND IT 10 FT. BEYOND EDGE OF CROSSING UNDER TRACK.
8. APPROXIMATE WEIGHT FOR 136RE MATERIALS:
3,200 LBS. - CONCRETE CENTER PANEL
1,700 LBS. - CONCRETE FIELD PANEL
9. PERFORATED PIPE TO BE SIZED AND LOCATED FOR SITE CONDITIONS. USE 6" MIN. DIA. PIPE AND LOCATE AT LEAST 12" BEYOND END OF TIE.
10. INSTALL 10 EA 10 FT. CROSSTIES EITHER SIDE OF CROSSING. INSTALL 10 FT. CROSSTIES 20" CENTER-TO-CENTER.

INSTALL 10 EA 10' CROSSTIES ON 20" CENTERS ON BOTH CROSSING APPROACHES

| ORDERING INFORMATION | | |
|----------------------|-----------|---|
| ITEM NO. | RAIL WGT. | DESCRIPTION |
| 014-5250300 | 115 - 122 | CROSSING, CONCRETE PANELS, HEAVY DUTY, FOR 10 FT. WOOD TIES. ORDER BY "TRACK FEET" IN APPROX. 8 FT. INCREMENTS. |
| 014-5250305 | 132 - 136 | |
| 014-5250310 | 141 | EACH 8'-1 1/2" SECTION INCLUDES 1 CONCRETE CENTER AND 2 CONCRETE FIELD PANELS WITH RUBBER FILLERS. |



CROSS SECTION



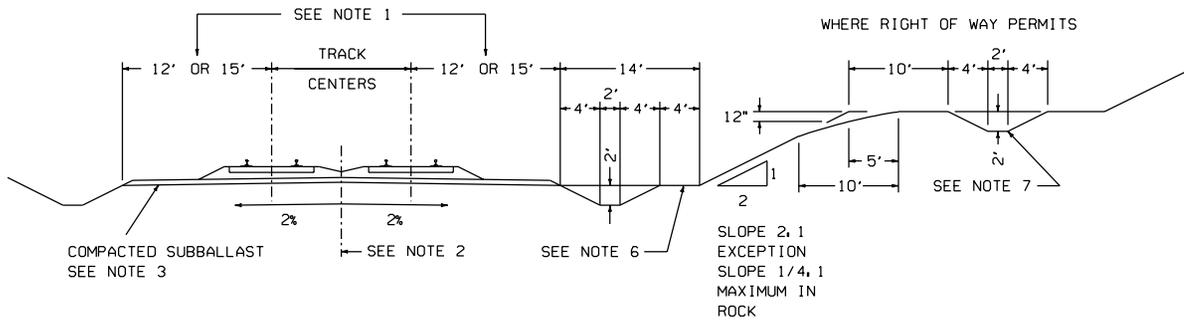
HEAVY DUTY ROAD CROSSING
FULL WIDTH CONCRETE ON WOOD TIES

K.A. Dawson
APPROVED - CHIEF ENGINEER
MAINTENANCE OF WAY

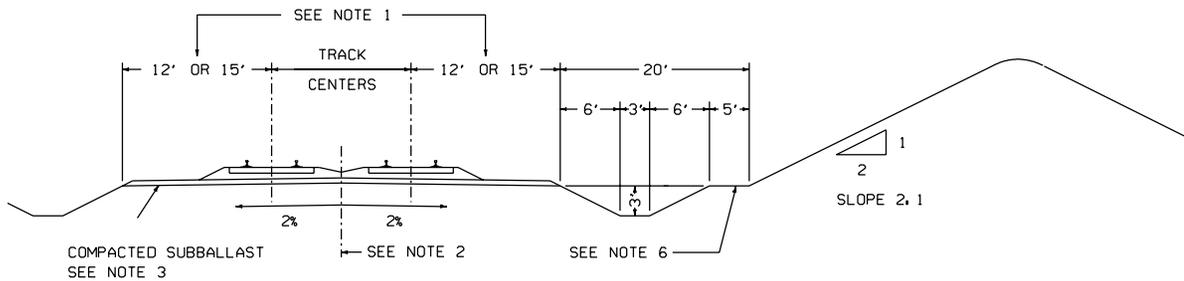
James D. Bagley
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY:
J. E. BEYERL

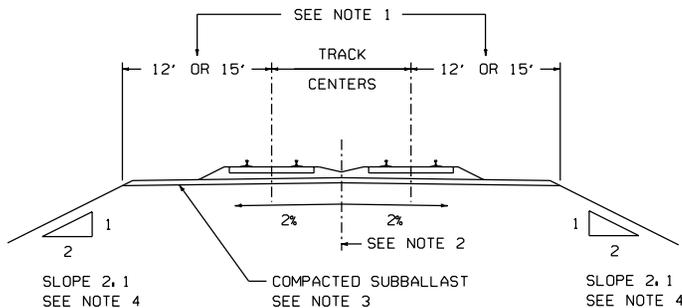
ISSUED: DECEMBER 12, 2002
REVISED: DECEMBER 11, 2006



TYPICAL CUT SECTION



TYPICAL WET CUT SECTION



TYPICAL FILL SECTION

NOTES:

1. ROADBED WIDTHS AT TOP OF SUBGRADE.
 - A. SINGLE MAIN TRACKS, SIDINGS, AND HEAVY TONNAGE TRACKS. 15'-0" FROM CENTERLINE OF TRACK, 30'-0" TOTAL
 - B. SINGLE YARD, INDUSTRY, AND OTHER TRACK, 12'-0" FROM CENTERLINE OF TRACK, 24'-0" TOTAL
 - C. MULTIPLE PARALLEL TRACKS. 12'-0" OR 15'-0" FROM CENTERLINE OF TRACK DEPENDING ON THE TYPE OF TRACKS PLUS DISTANCE BETWEEN TRACK CENTERLINES.
2. LOCATION OF GRADE POINT.
 - A. SINGLE MAIN OR OTHER TRACK IS THE CENTERLINE OF TRACK.
 - B. DOUBLE MAIN TRACKS IS THE CENTERLINE BETWEEN TRACKS.
 - C. GRADE POINT FOR MAIN TRACK AND SIDING IS CENTERLINE OF MAIN TRACK.
3. DEPTH OF SUBBALLAST.
 - A. SUBBALLAST ON MAIN TRACKS, SIDINGS AND HEAVY TONNAGE TRACKS IS 6" OVER THE 30' ROADBED WIDTH.
 - B. SUBBALLAST ON YARD, INDUSTRIAL AND OTHER TRACKS IS 4" OVER THE 24' ROADBED WIDTH.
4. THE STANDARD SLOPE ON FILL SECTIONS MAY BE INCREASED TO A MAXIMUM OF 1 1/2 TO 1 AT LOCATIONS WHERE THE BEARING CAPACITY OF THE NATURAL BED HAS BEEN VERIFIED BY FIELD TESTS AND THE STABILITY OF THE FILL MATERIAL VERIFIED BY LABORATORY TESTS.
5. INSTRUCTIONS FOR THE USE AND INSTALLATION OF GEOTEXTILES AND GEOGRIDS ARE INCLUDED IN MWI-1003.
6. OMIT BENCH WHERE EXCAVATION IS 5 FEET OR LESS.
7. OMIT BERM DITCH WHEN NATURAL GROUND SLOPES AWAY FROM THE EXCAVATION.



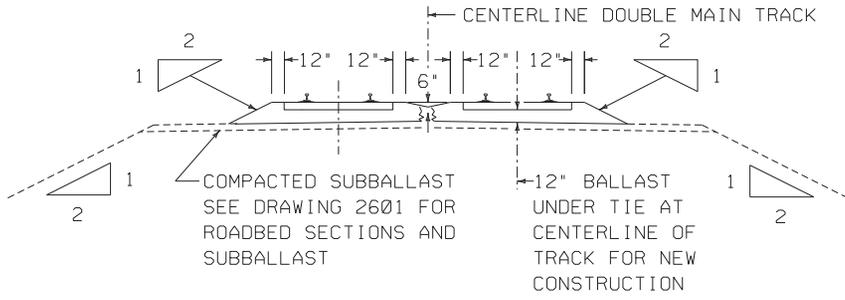
ROADBED SECTIONS

Signed _____
 REVIEWED -
 DIRECTOR,
 STANDARDS AND TESTING

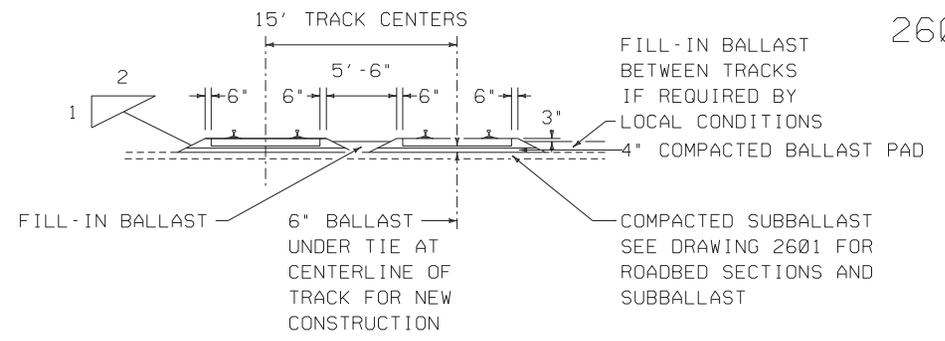
Signed _____
 APPROVED -
 ASSISTANT VICE PRESIDENT,
 EQUIPMENT AND TRACK
 SYSTEMS ENGINEERING

ISSUED, JANUARY 27, 1997

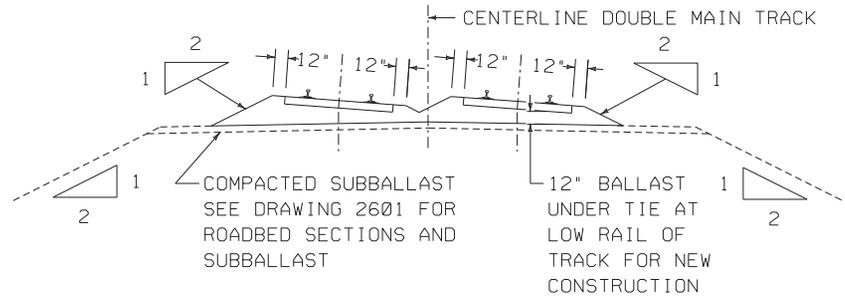
REVISED, INITIAL ISSUE



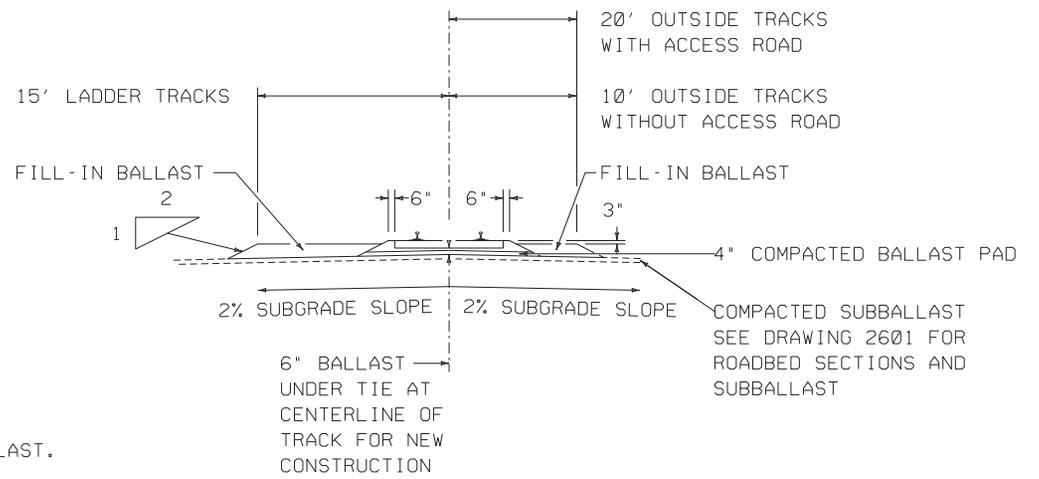
MAIN TRACK, SIDINGS AND HEAVY TONNAGE TRACKS
TANGENT TRACKS



INTERIOR YARD TRACKS



MAIN TRACK, SIDINGS AND HEAVY TONNAGE TRACKS
SUPERELEVATED TRACKS



LADDER AND OUTSIDE TRACKS

NOTES.

1. BALLAST TO CONFORM TO THE CURRENT CSXT SPECIFICATION FOR BALLAST.
2. AREMA GRADATION 4A BALLAST IS TO BE USED ON ALL TRACK EXCEPT YARD TRACKS WHERE AREMA GRADATION 5 IS TO BE USED.
3. BALLAST PAD 4" THICK OF AREMA GRADATION 4A WILL BE USED UNDER TRACK FOR NEW CONSTRUCTION OF YARD TRACKS.
4. FILL-IN BALLAST WILL BE AREMA GRADATION 5.
5. BALLAST TO BE EVEN WITH TOP OF TIE.
6. BALLAST SHOULDER WILL EXTEND 12" FROM END OF TIE TO EDGE OF SLOPE ON ALL MAIN TRACKS, SIDING, AND HEAVY TONNAGE TRACKS.
7. BALLAST SHOULDER WILL EXTEND 6" FROM END OF TIE TO EDGE OF SLOPE ON ALL YARD TRACKS AND INDUSTRIAL SIDING TRACKS.



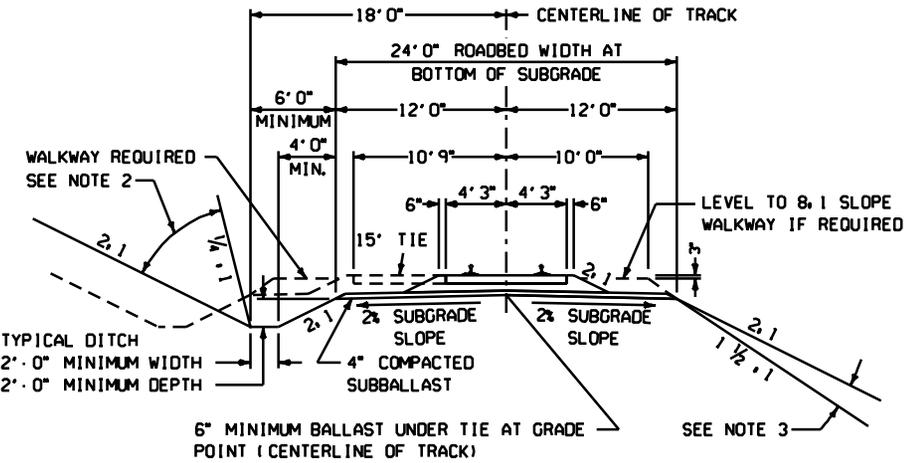
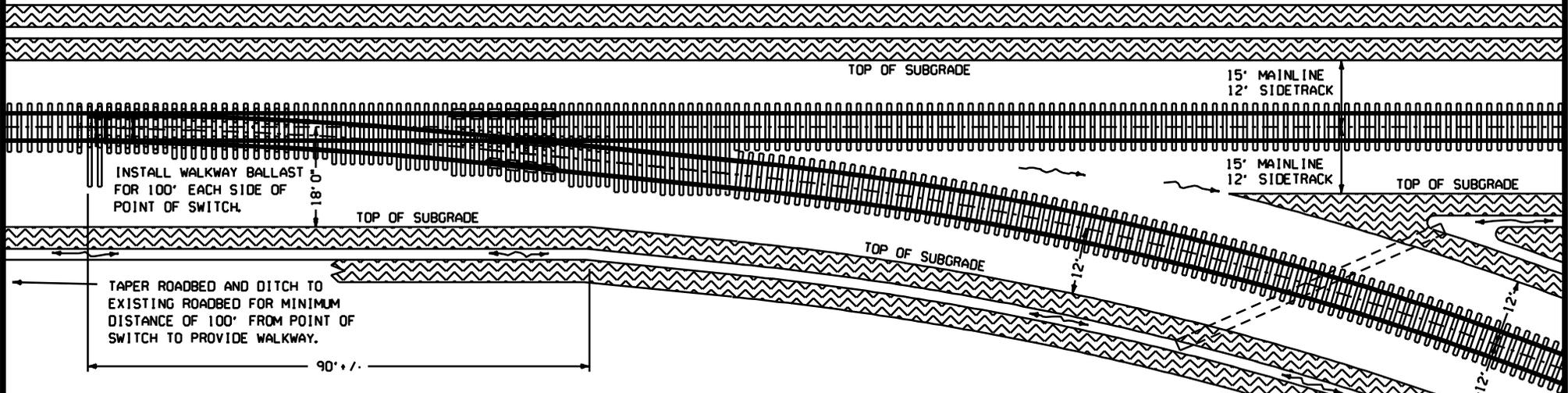
BALLAST SECTIONS

[Signature]
APPROVED - DIRECTOR
ENGINEERING STANDARDS

[Signature]
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY,
D.C. CLARK

ISSUED: JANUARY 27, 1997
REVISED: AUGUST 3, 2010



NOTES, CONTINUED

5. MINIMUM PIPE DIAMETER IS 24".
6. LENGTH OF PIPE UNDER SIDE TRACK IS DEPENDANT ON DEPTH BELOW BOTTOM OF TIE (2' MINIMUM).
7. LOCATION, ANGLE TO TRACK, AND GRADE OF PIPE DEPENDANT ON DRAINAGE CONDITIONS AT SITE. PIPE TO BE LOCATED AND INSTALLED TO MAINTAIN EXISTING DRAINAGE OR TO DIVERT RUNOFF TO ANOTHER FACILITY THAT WILL ACCEPT IT.



ROADBED SECTIONS AND GRADING FOR INDUSTRIAL TRACK TURNOUTS

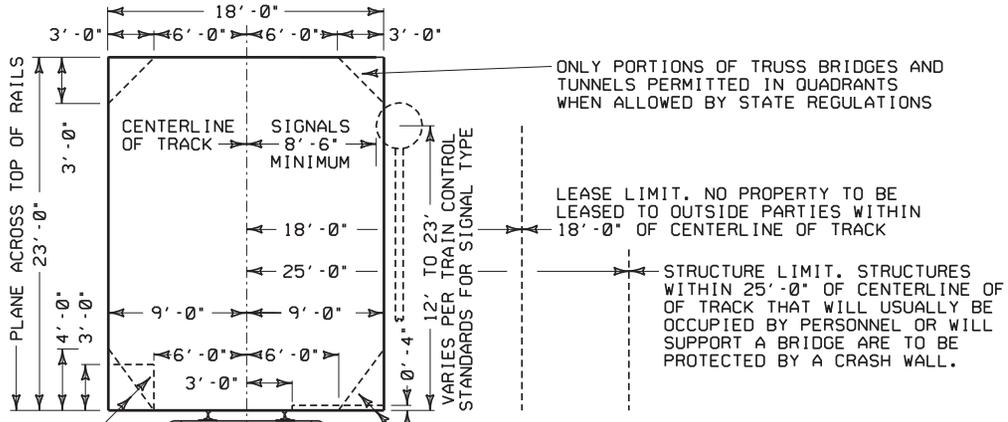
TYPICAL SECTIONS

CUT SECTION **INDUSTRIAL TRACKS** **FILL SECTION**

NOTES:

1. MINIMUM WIDTH OF CUT SECTION AND DITCH WIDTH SHOWN. TRACK AND DITCH GRADIENTS MAY INCREASE DITCH SIZE AND ITS DISTANCE FROM CENTERLINE OF TRACK.
2. SLOPE CAN VARY AS NEEDED FOR STABILITY FROM 2:1 IN SAND TO 1/4 : 1 IN SOLID ROCK
3. SLOPE AS REQUIRED BY FILL MATERIAL. 1 1/2 : 1 MAXIMUM.
4. GEOTEXTILES, IF USED, SHALL BE PLACED BETWEEN THE TOP OF THE SUBGRADE AND THE BOTTOM OF THE SUBBALLAST

| | |
|--|---|
| SIGNED | SIGNED |
| REVIEWED - DIRECTOR, STANDARDS AND TESTING | APPROVED - ASSISTANT VICE PRESIDENT, EQUIPMENT AND TRACK SYSTEMS ENGINEERING |
| ISSUED, JANUARY 27, 1997 | REVISED, INITIAL ISSUE |



1. STANDARD CLEARANCES ARE TO BE USED FOR ALL NEW CONSTRUCTION WHERE THERE ARE NO LEGAL REQUIREMENTS THAT DICTATE GREATER CLEARANCES.
2. CLEARANCES FOR RECONSTRUCTION, REHABILITATION AND ALTERATION WORK ARE DEPENDENT ON EXISTING PHYSICAL CONDITIONS. WHERE POSSIBLE, THEY WILL BE IMPROVED TO COMPLY WITH THE STANDARD CLEARANCES.
3. STATE OR CANADIAN CLEARANCE LAWS MUST NOT BE VIOLATED. LEGAL REQUIREMENTS MAY BE MODIFIED ONLY BY THE GOVERNMENTAL BODY THAT ISSUED THEM.
4. STANDARD CLEARANCE MAY BE MODIFIED ONLY IF APPROVED BY THE CHIEF ENGINEER DESIGN, CONSTRUCTION, AND CAPACITY.
5. STANDARD CLEARANCE DIAGRAMS SHOWN ARE FOR TANGENT TRACK AND INCREASES MUST BE PROVIDED FOR THE EFFECTS OF CURVATURE AND SUPERELEVATION.

A. ADDITIONAL CLEARANCE DUE TO CURVATURE:

WHEN A FIXED OBSTRUCTION IS LOCATED ADJACENT TO A CURVED TRACK, THE HORIZONTAL CLEARANCE WILL BE INCREASED 1 1/2 INCHES PER DEGREE OF CURVATURE ON BOTH SIDES OF THE TRACK CENTERLINE PER TABLE 1. EXCEPTION: FLORIDA REQUIRES 2 INCHES PER DEGREE.

B. ADDITIONAL CLEARANCE DUE TO SUPERELEVATION:

WHEN A FIXED OBSTRUCTION IS LOCATED ADJACENT TO A SUPERELEVATED TRACK, THE HORIZONTAL CLEARANCE ON THE LOW RAIL SIDE OF THE TRACK WILL BE INCREASED TO ALLOW FOR TILT. THE MINIMUM INCREASE IS SHOWN ON GRAPH NO. 1.

C. ADDITIONAL CLEARANCE DUE TO CURVATURE AND SUPERELEVATION:

WHEN A FIXED OBSTRUCTION IS LOCATED ADJACENT TO A CURVED AND SUPERELEVATED TRACK, THE HORIZONTAL CLEARANCE INCREASE WILL BE THE SUM OF THE INCREASES OBTAINED USING 5.A AND 5.B ABOVE. EXCEPTION: CANADA REQUIRES A MINIMUM OF 2 INCHES PER DEGREE.

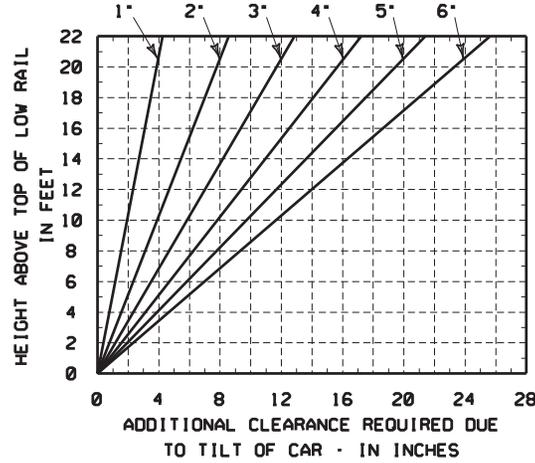
D. ADDITIONAL CLEARANCE ON TANGENT TRACKS:

WHEN A FIXED OBSTRUCTION IS ADJACENT TO TANGENT TRACK BUT THE TRACK IS CURVED WITHIN 80 FEET OF THE OBSTRUCTION, THE HORIZONTAL CLEARANCE WILL BE INCREASED AS FOLLOWS:

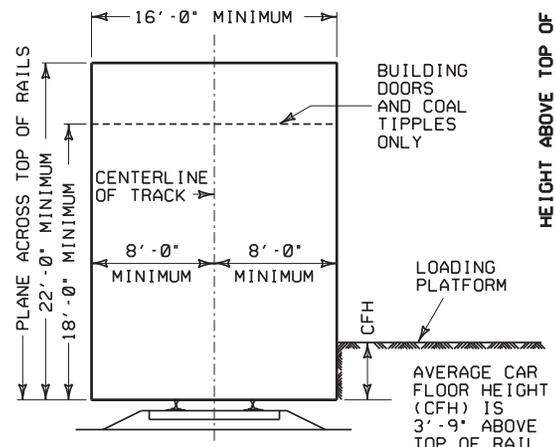
| DISTANCE FROM OBSTRUCTION TO CURVED TRACK - FEET | INCREASED HORIZONTAL CLEARANCE |
|--|--------------------------------|
| 0 TO 20 | 100% OF PARAGRAPH 5.C |
| 21 TO 40 | 75% OF PARAGRAPH 5.C |
| 41 TO 60 | 50% OF PARAGRAPH 5.C |
| 61 TO 80 | 25% OF PARAGRAPH 5.C |

6. VERTICAL CLEARANCE ON SUPERELEVATED TRACK IS MEASURED FROM THE TOP OF THE HIGH RAIL.

GRAPH NUMBER 1
DIAGONAL LINES INDICATE SUPERELEVATION



GENERAL
MAIN TRACKS, YARD TRACKS AND SIDINGS



INDUSTRIAL SIDE TRACKS

TABLE NUMBER 1

| ADDITIONAL CLEARANCE REQUIRED DUE TO CURVATURE - IN INCHES | | | | | | | | | | | | |
|--|-------|---|-------|---|-------|----|--------|----|--------|----|--------|----|
| DEGREE OF CURVE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| ALL LOCATIONS EXCEPT FLORIDA | 1 1/2 | 3 | 4 1/2 | 6 | 7 1/2 | 9 | 10 1/2 | 12 | 13 1/2 | 15 | 16 1/2 | 18 |
| IN THE STATE OF FLORIDA | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |



CLEARANCE DIAGRAMS

Wab W. Ophardt
APPROVED - CHIEF ENGINEER
DESIGN, CONSTRUCTION, & CAPACITY

James D. Bagley
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY:
D.C. CLARK

ISSUED: JULY 19, 1996
REVISED: SEPTEMBER 5, 2006

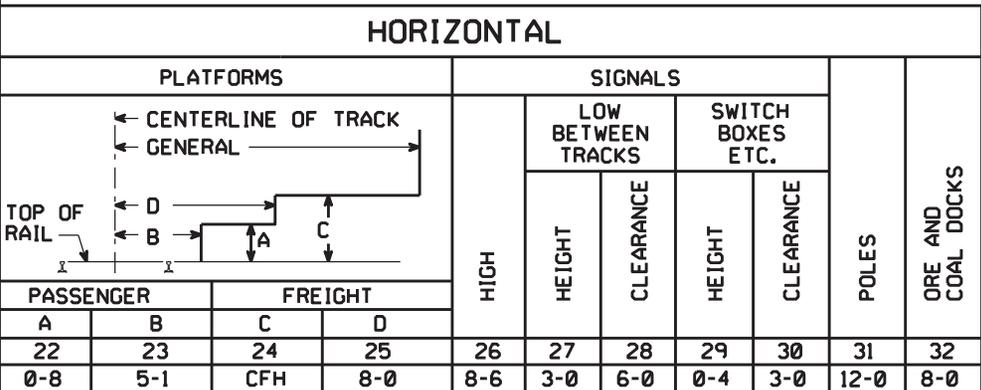
DIMENSIONS - NOTES:

ARE SHOWN IN FEET AND INCHES (FT-IN).
 ARE FOR TANGENT TRACK. SEE CSX 2604 FOR INCREASE DUE TO CURVATURE.
 VERTICAL CLEARANCE IS MEASURED FROM TOP OF HIGH RAIL FOR THE ENTIRE FULL HORIZONTAL WIDTH DESCRIBED BELOW.
 HORIZONTAL CLEARANCE IS MEASURED FROM CENTERLINE OF NEAREST TRACK.
 APPLY TO ALL NEW CONSTRUCTION, RECONSTRUCTION AND ALTERATIONS
 ALL COLUMNS ARE MINIMUM EXCEPT COLUMNS 22, 24, 27, AND 29 WHICH ARE MAXIMUM
 CFH = CAR FLOOR HEIGHT.
 REFERENCE CHAPTER 28 OF AREMA MANUAL FOR RAILWAY ENGINEERING FOR ENTIRE DETAILS OF STATE LEGAL CLEARANCES

| TRACK CENTERS | | | | | | | | |
|---------------|-------------------------|---|---|-------------------------------------|----------------------------------|----------------------|-------------------------------|--|
| MAIN TRACKS | ANY TWO NON-MAIN TRACKS | ADJACENT NON-MAIN TRACK TO ANY MAIN TRACK | LADDER TRACK ADJACENT TO ANY PARALLEL TRACK | TWO ADJACENT PARALLEL LADDER TRACKS | LADDER TRACKS AND CABOOSE TRACKS | TEAM TRACKS IN PAIRS | UNLOADING TRACKS AT PLATFORMS | MAIN TRACK AND BULK LOADING OR UNLOADING TRACK |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 15-0 | 14-0 | 20-0 | 20-0 | 19-0 | 14-0 | 13-6 | 13-6 | 20-0 |

| VERTICAL | | | | | | HORIZONTAL | | | | | |
|-------------------------------|--------------|----------------------------------|---------|----------------|--------------|-------------------------------|--------------|----------------------------------|---------|----------------|--------------|
| GENERAL (UNLESS PROVIDED FOR) | THRU BRIDGES | HIGHWAY BRIDGE (SPANNING TRACKS) | TUNNELS | BUILDING DOORS | IN BUILDINGS | GENERAL (UNLESS PROVIDED FOR) | THRU BRIDGES | HIGHWAY BRIDGE (SPANNING TRACKS) | TUNNELS | BUILDING DOORS | IN BUILDINGS |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 23-0 | 23-0 | 23-0 | 23-0 | 18-0 | 22-0 | 9-0 | 9-0 | 25-0 | 9-0 | 8-0 | 8-0 |

EXCEPTIONS:
 COLUMN 6 SHALL BE 17-0 IN MASSACHUSETTS
 COLUMN 7 AND 8 SHALL BE 14-0 IN MICHIGAN
 COLUMN 14 SHALL BE 21-0 IN OHIO; 22-0 IN INDIANA, WEST VIRGINIA, & CANADA; 22-6 IN CONNECTICUT, MASSACHUSETTS, & MICHIGAN
 COLUMN 15 SHALL BE 22-6 IN CONNECTICUT, MASSACHUSETTS, & MICHIGAN; 23-0 IN DELAWARE
 COLUMN 16 SHALL BE 12-0 IN PENNSYLVANIA
 COLUMN 20 SHALL BE 8-6 IN MASSACHUSETTS AND MICHIGAN
 COLUMN 21 SHALL BE 8-6 IN MICHIGAN



EXCEPTIONS:
 COLUMN 22 SHALL BE 0-4 IN ILLINOIS
 COLUMN 23 SHALL BE 5-2 IN CONNECTICUT
 COLUMN 25 SHALL BE 8-6 IN CONNECTICUT, MARYLAND, MICHIGAN, NEW YORK, & PENNSYLVANIA
 COLUMN 26 SHALL BE 9-0 IN DELAWARE; 12-0 IN PENNSYLVANIA
 COLUMN 27 SHALL BE 4-0 IN CANADA
 COLUMN 29 SHALL BE 0-5 IN CANADA
 COLUMN 30 SHALL BE 3-10 IN CANADA
 COLUMN 32 SHALL BE 8-4 1/4 IN CANADA; 8-6 IN DC, & MARYLAND



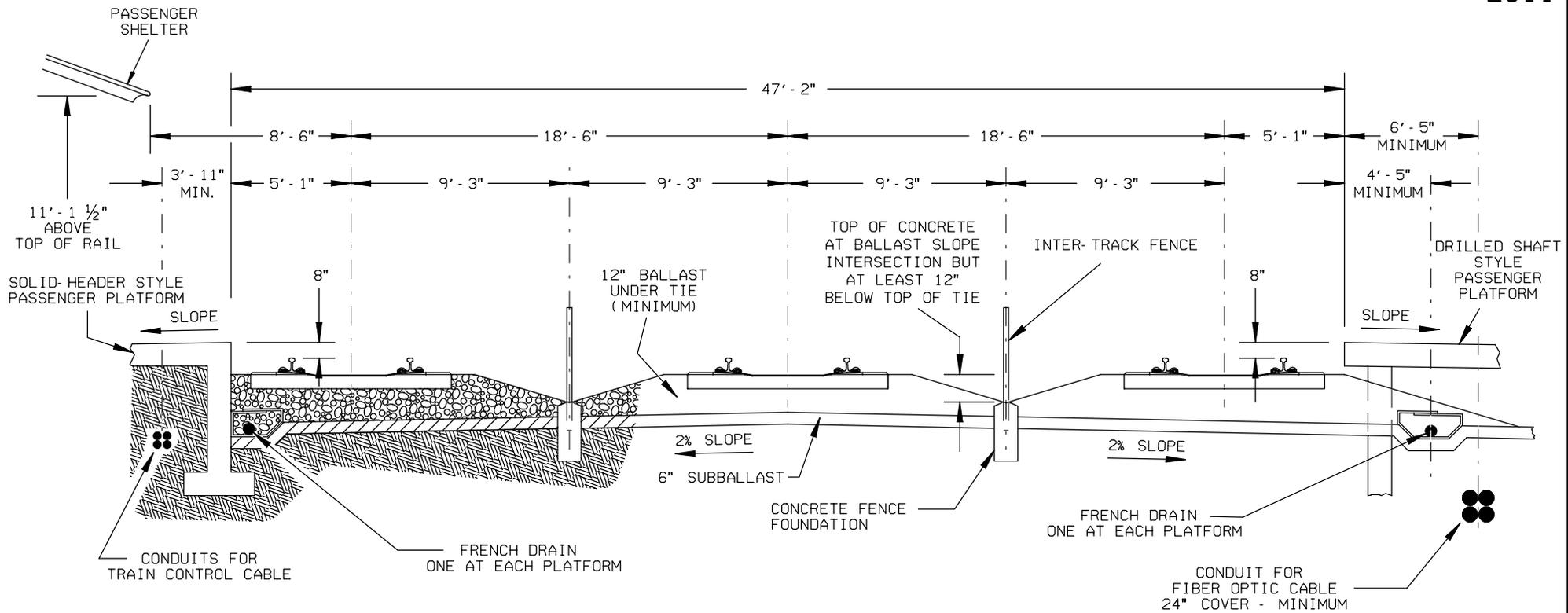
STANDARD CLEARANCE MATRIX

[Signature]
 APPROVED - DIRECTOR
 ENGINEERING STANDARDS

[Signature]
 APPROVED CHIEF ENGINEER -
 ENGINEERING SERVICES

PREPARED BY:
 C.S. MOALE

ISSUED: JULY 19, 1996
 REVISED: NOVEMBER 12, 2014



STATION LIGHTING SHALL BE DESIGNED IN A MANNER TO ENSURE THAT IT DOES NOT INTERFERE WITH TRAIN CONTROL SIGNALS.

TRAIN CONTROL CONDUITS - USE 4 EACH 4" SCHEDULE 40 PIPES WITH PULL WIRES. EXTEND 36" BEYOND PLATFORM AND CAP.

FRENCH DRAINS - USE 6" PERFORATED DRAINAGE PIPE, EITHER POLYETHYLENE OR CORRUGATED METAL. WRAP BALLAST AND PIPE WITH 6 OZ NONWOVEN GEOTEXTILE.

FIBER OPTIC CABLE CONDUIT - USE 4 EACH 8" HDPE - HDR11 OR STEEL CONDUIT WITH MINIMUM 0.388" WALL THICKNESS. EXTEND 36" BEYOND PLATFORM AND CAP.

INTER-TRACK FENCE - 4'-0" TALL, 6" WIDE MAX. REMOVABLE, FENCE PANELS SHALL EXTEND A MINIMUM OF 100' BEYOND ENDS OF LONGEST PLATFORM OR TO A POINT WHERE OTHER ELEMENTS RESTRICT PEDESTRIAN MOVEMENT ACROSS TRACKS.

CONCRETE TIES WITH ELASTIC FASTENERS SHALL EXTEND A MINIMUM OF 150' BEYOND THE PLATFORMS. IN WOOD TIE TERRITORY, THE TRANSITION ZONE SHALL NOT BE IN A CURVE. WOOD TIES WITH APPROPRIATE FASTENERS MAY BE USED IF THE TRACK CENTERS ARE INCREASED TO 20 FEET OR GREATER.

CLEARANCES SHOWN ARE BASED ON STRAIGHT AND LEVEL TRACK. IF ACTUAL CONDITIONS DIFFER, CLEARANCES MUST BE REVIEWED. STATE OR CANADIAN CLEARANCE LAWS MUST NOT BE VIOLATED. SEE CSXT DRAWING 2605.

PEDESTRIAN CROSSINGS ARE TO BE GRADE SEPARATED.



GENERAL ARRANGEMENT AT PASSENGER PLATFORMS

SIGNED

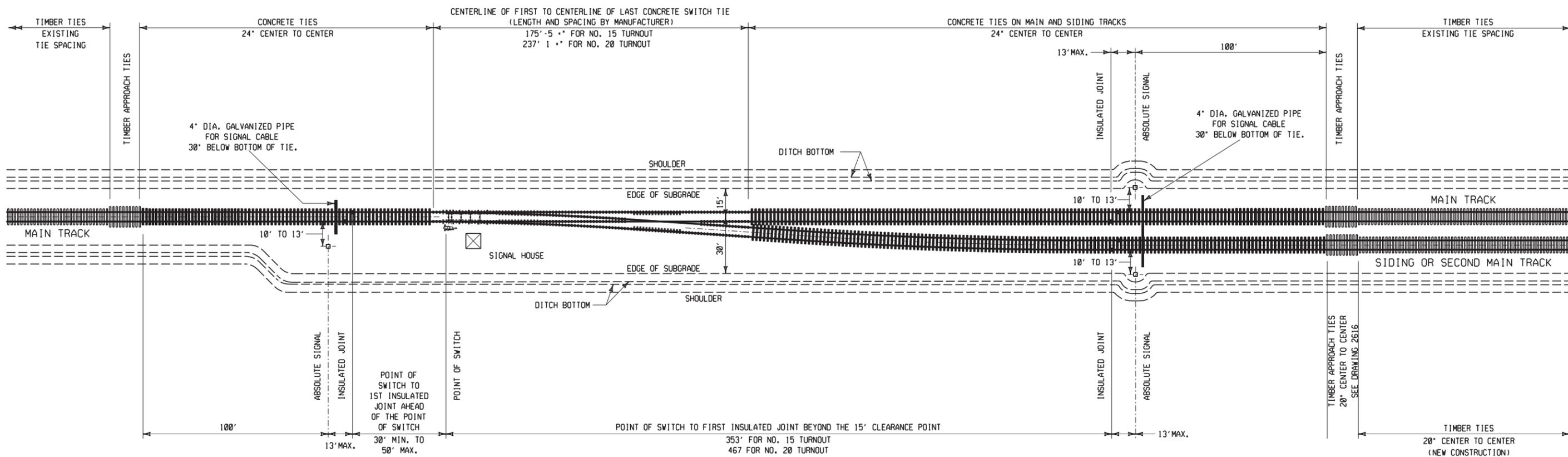
REVIEWED - DIRECTOR
ENGINEERING STANDARDS

PREPARED BY:
D. N. WITT

SIGNED

APPROVED - CHIEF ENGINEER
MAINTENANCE OF WAY

ISSUED, FEBRUARY 28, 2002
REVISED, INITIAL ISSUE



NOTES:

- TIMBER TRANSITION TIES WITH PANDROL TIE PLATES AND FASTNERS AT 20' TIMBER TIE SPACING 10 EACH 10'-0" TIES. SEE STANDARD DRAWING 2616.
- TIMBER TO CONCRETE TIE TRANSITIONS SHOULD BE AVOIDED IN CURVES.
- UNDERLAYMENT (WHERE REQUIRED) -
USE 6" HOT MIX ASPHALT UNDERLAYMENT.
COLD MIX MAY BE SUBSTITUTED, IF HOT MIX IS NOT AVAILABLE.
- WINTER SWITCH PROTECTION -
SEE MWI 608 FOR APPROPRIATE USAGE.
ELECTRIC RESISTANCE SWITCH HEATERS ARE SHOWN ON STANDARD DRAWINGS 2330 AND 2331.
HOT AIR BLOWER SWITCH HEATERS ARE SHOWN ON STABDARD DRAWING 2332.
- SEE DRAWING SS515 AND SS516 FOR EXACT PLACEMENT OF SIGNAL EQUIPMENT.
- TRACK BALLAST -
USE 12" OF MAIN LINE BALLAST THROUGHOUT.

CSX TRANSPORTATION

GENERAL ARRANGEMENT
AT END OF SIDINGS AND DOUBLE TRACK

K.A. Donald
APPROVED - CHIEF ENGINEER
MAINTENANCE OF WAY

James D. Bagley
APPROVED - VICE PRESIDENT
ENGINEERING

PREPARED BY:
D.C. CLARK

ISSUED: APRIL 30, 2003
REVISED: APRIL 11, 2007



PURPOSE: To provide uniform instructions for anchoring the track structure.

SAFETY: Observe all applicable Safety, and Operating Rules and Regulations; and Safe Job Procedures

LOCATION: All CSXT tracks.

ENVIRONMENTAL: Observe all applicable Federal, State and Local environmental rules and regulations.

I. DISCUSSION

- A. Rail anchors are essential in achieving a stable track structure. They are designed to prevent longitudinal movement of the rail and work together with the other components of the track structure to prevent buckling.
- B. Rail anchors are required on both jointed and continuously welded rail tracks. They will be applied before the track is returned to service.
- C. All tracks, which are not in compliance with this rail anchoring policy, will be brought up to standard during the next System Team Rail Laying, Curve Patch, or Bridge Timbering operation. During System Timbering operations, missing anchors will be replaced to match the pattern currently in track. Tracks, that have a history of buckling or excessive rail movement, will be reviewed by the Division Engineer on a case-by-case basis to establish a date for compliance. If the next System Team cycle is too far away, a schedule for compliance will be prepared by the Division Engineer and approved by the Chief Engineer - Maintenance of Way.
- D. New rail anchors will be manufactured from mill certified steel.
- E. Relay rail anchors will not be used on main tracks or passing sidings when laying new rail by system rail teams. Rail anchors removed to perform other maintenance activities may be reinstalled if effective.

II. PROCEDURE

A. All Track

1. To avoid tie skewing, anchors should be applied against the same tie on opposite rails. (Opposite rails should be anchored the same)
2. Definition: Box Anchor – Anchors applied against both sides of the tie on opposite rails to restrain longitudinal rail movement in both directions. [Four (4) rail anchors per tie.]

B. Jointed Rail Territory

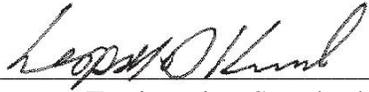
The track will have 16 rail anchors per 39 ft. rail. Box anchor 8 ties per rail length spaced in accordance with Rail Anchor Pattern Sketch shown on page 5, where practical.

C. Continuous Welded Rail Territory

1. Definition: Continuous Welded Rail (CWR) – A number of rails welded together into lengths exceeding 400 feet.
2. When laying continuous welded rail (CWR), it will be box anchored on every other tie throughout the entire section of CWR. Additional rail anchors are required at the following locations:
 - a. Joints installed in CWR will be box anchored on every tie for 130 consecutive ties in each direction within 60 days except ties supporting rail joints.
 - b. Curves 3 degrees and greater on main track and sidings – CWR being installed will be anchored on every tie. (Anchors applied against both sides of each tie.)
 - c. Turnouts - CWR will be box anchored on every tie for 130 consecutive ties in each direction from the long ties of the turnout.
 - d. Railroad Crossings - CWR will be box anchored on every tie for 130 consecutive ties in each direction from the railroad crossing.
 - e. Road Crossings - CWR will not be anchored within the road crossing unless required by the design of the road crossing surface material. If the road crossing is 50 ft. wide or greater, CWR will be box anchored on every tie for 130 consecutive ties in each direction from the road crossing.
 - f. All Open Deck Bridge Approaches - CWR will be box anchored on every tie for 130 consecutive ties in each direction from the backwall of the bridge.
 - g. Epoxy Bonded Insulated Joints - Structurally sound epoxy bonded insulated joints do not require additional anchors.
3. CWR laid across bridges will be anchored as follows:
 - a. Ballast Deck Bridges - CWR will use the standard anchor pattern as described in paragraph II.C.2.

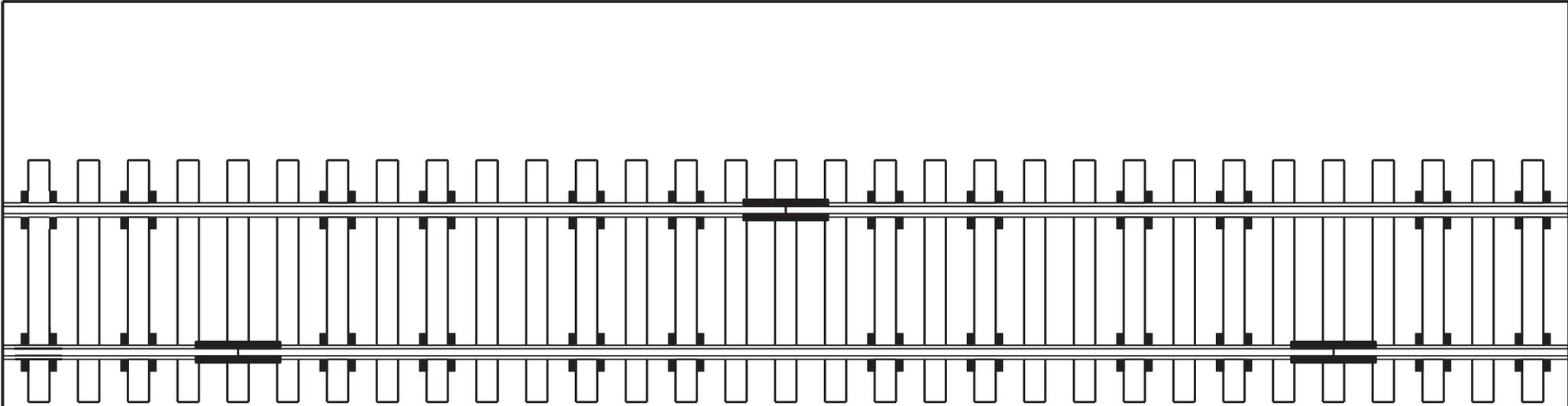
- b. Open Deck Bridges with total length 100 ft or less - CWR will be box anchored on every tie that is fastened to the bridge span.
 - c. Open Deck Bridges with total length between 100 ft. and 500 ft. with an alignment of 2 degrees or less:
 - 1) CWR will be box anchored on every tie that is fastened to the bridge span, throughout all spans less than 100 ft.
 - 2) CWR will be box anchored on every tie that is fastened to the bridge span, for the first 100 ft. from the fixed end of individual spans with length greater than 100 ft.
 - d. Rail anchor pattern will be specified by the Asst. Chief Engineer – Structures when any of the following conditions exist:
 - 1) Open Deck Bridges with a total length greater than 500 feet
 - 2) Alignment is greater than 2 degrees
 - 3) Bridges with existing rail expansion joints
 - 4) Other special situations
4. Turnouts within CWR territory will have every tie box anchored, where anchors can be applied, on both the straight side and diverging side of the turnout. Care must be taken to ensure that anchors do not interfere with the movable portion of the switch. Ensure that the requirements in paragraph II.C.2.d. are met. Ties with positive restraint rail fasteners are considered to be anchored.
5. Ties that have a positive restraint fastener on one end only should be box anchored on the other end. MWI 701, *Use of Premium Rail Fasteners in CWR*, details the use of these fasteners.
6. At some locations, there may be two or more of the above situations present. In that case the requirements will be additive.
- For example: A turnout located 100 ft. from an open deck bridge (75 ft. long). In this example, the CWR will be box anchored on every tie between the backwall at the end of the bridge and the turnout. The turnout will be box anchored on every tie, where anchors can be applied, on both the straight side and diverging side of the turnout. The CWR will be box anchored on every tie for 130 ties beyond long ties of the turnout.
7. Rail Anchor Patterns are illustrated on attached plans.

Prepared by: Mark E. Austin
Engineer Standards II

Reviewed: 
Director – Engineering Standards

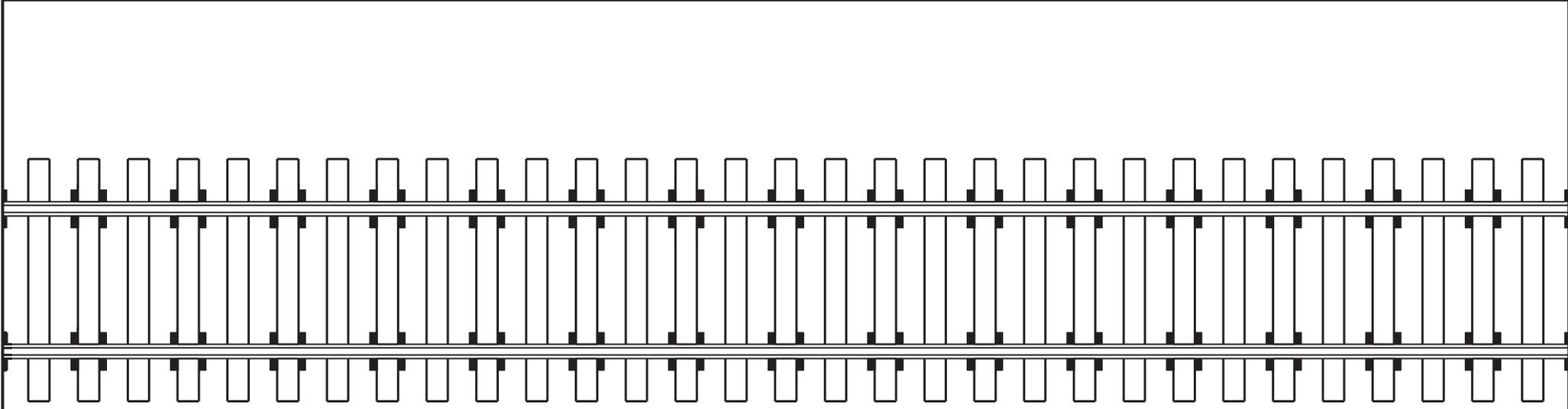
Approved: 
Assistant Vice President – Engineering

Office of the Vice President, Engineering
Jacksonville, Florida



JOINTED RAIL - 16 ANCHORS PER 39 FOOT RAIL, BOX ANCHOR 8 TIES.

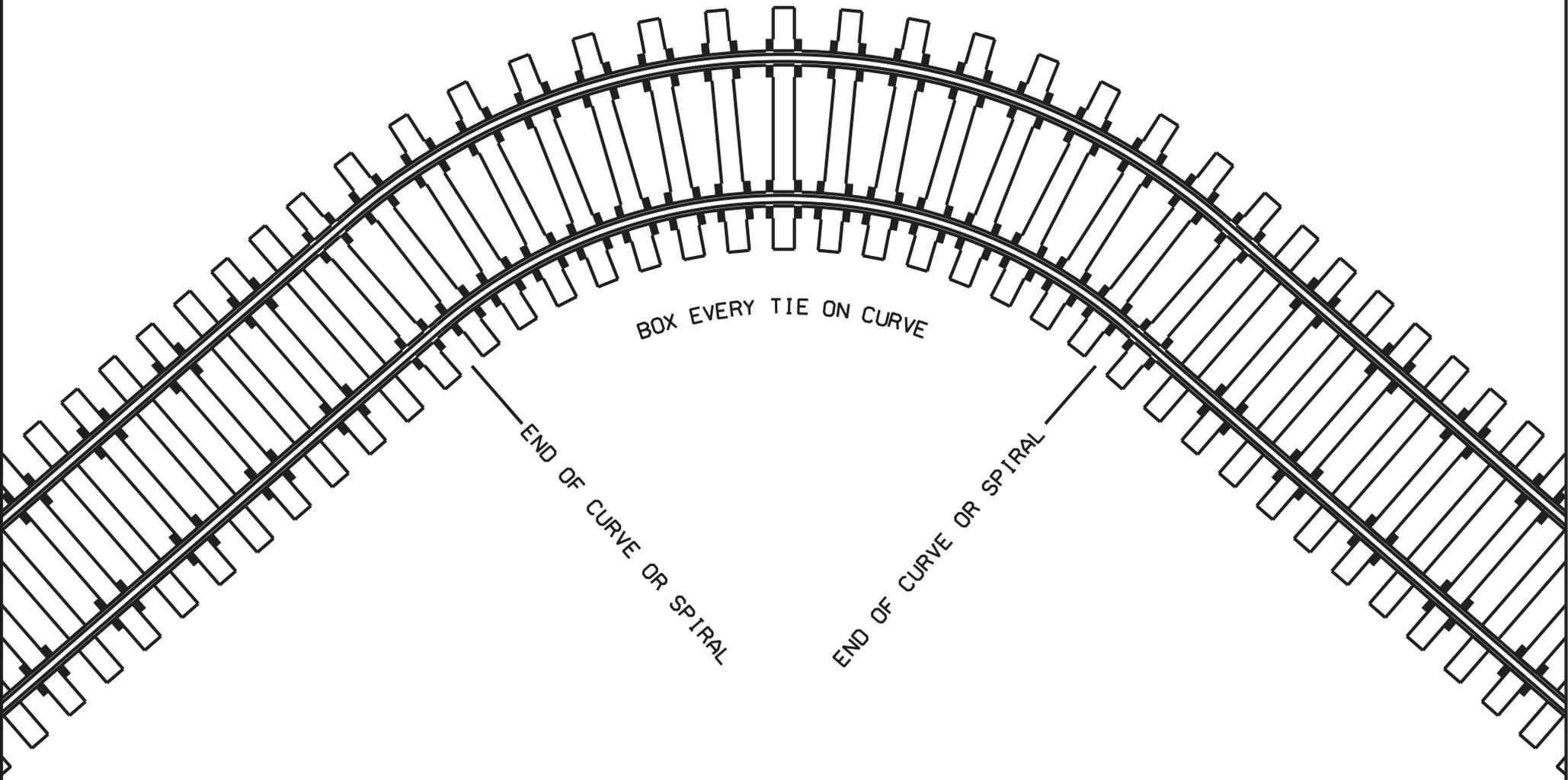
RAIL ANCHOR PATTERNS



WELDED RAIL - TANGENTS AND CURVES LESS THAN 3 DEGREES - BOX ANCHOR EVERY OTHER TIE.
 SAME PATTERN FOR BALLAST DECK BRIDGES.

RAIL ANCHOR PATTERNS

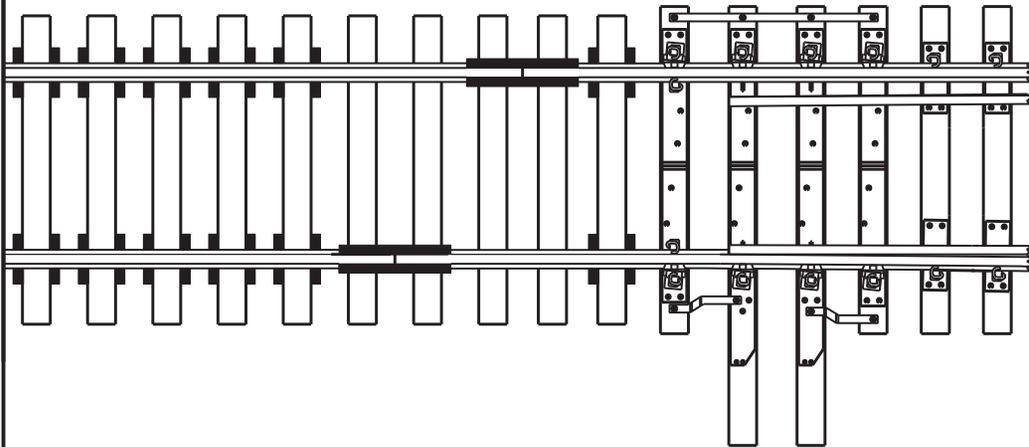
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WELDED RAIL - CURVES, 3 DEGREES AND GREATER
BOX ANCHOR EVERY TIE ON CURVE AND SPIRALS
RAIL ANCHOR PATTERNS

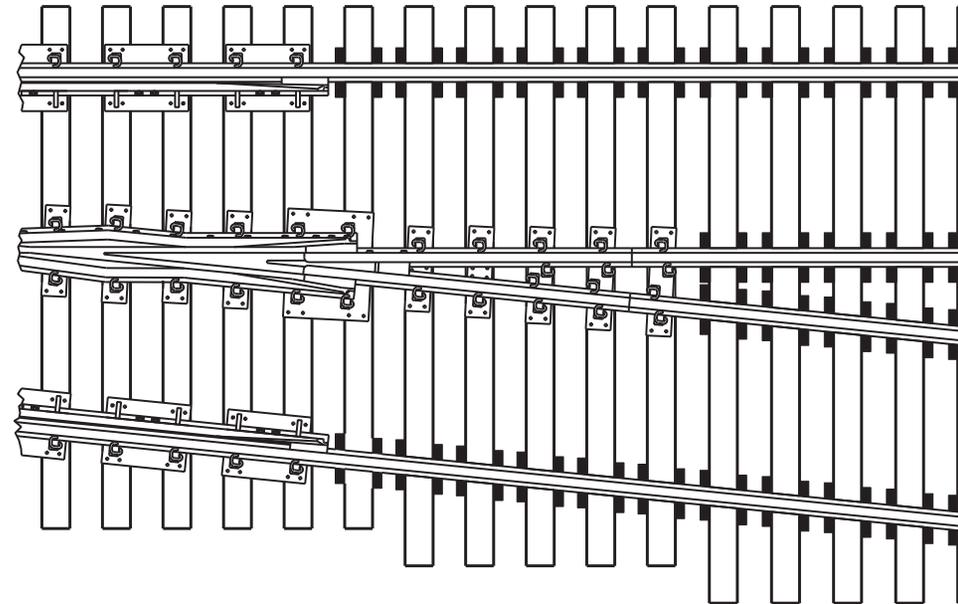
AHEAD OF SWITCH POINT :

- BOX ANCHOR EVERY TIE FOR 130 TIES. COUNT FROM FURTHEST JOINT FROM SWITCH POINT OR FROM TIE AHEAD OF BRACE PLATES IF STOCK RAILS ARE WELDED INTO TRACK.
- IF JOINT BARS ARE PERMANENT, DO NOT APPLY ANCHORS OPPOSITE BARS



BEHIND HEEL OF FROG :

- BOX ANCHOR EVERY TIE FOR 130 TIES ON BOTH THE THROUGH TRACK AND TURNOUT TRACK. COUNT FROM THE LAST LONG TIE.
- BOX ANCHOR EVERY TIE TO END OF GUARD RAIL.

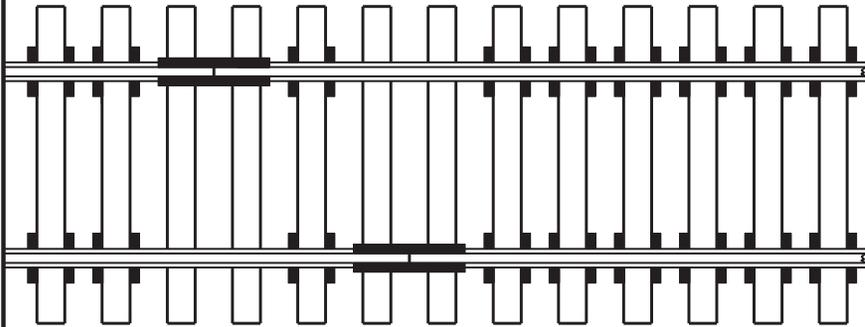


- BETWEEN SWITCH HEEL AND TOE OF FROG, BOX ANCHOR EVERY TIE THAT CAN BE ANCHORED ON AS MANY RAILS AS POSSIBLE. (REFER TO APPLICABLE STANDARD DRAWINGS)

WELDED RAIL ANCHOR PATTERN ADDITIONS

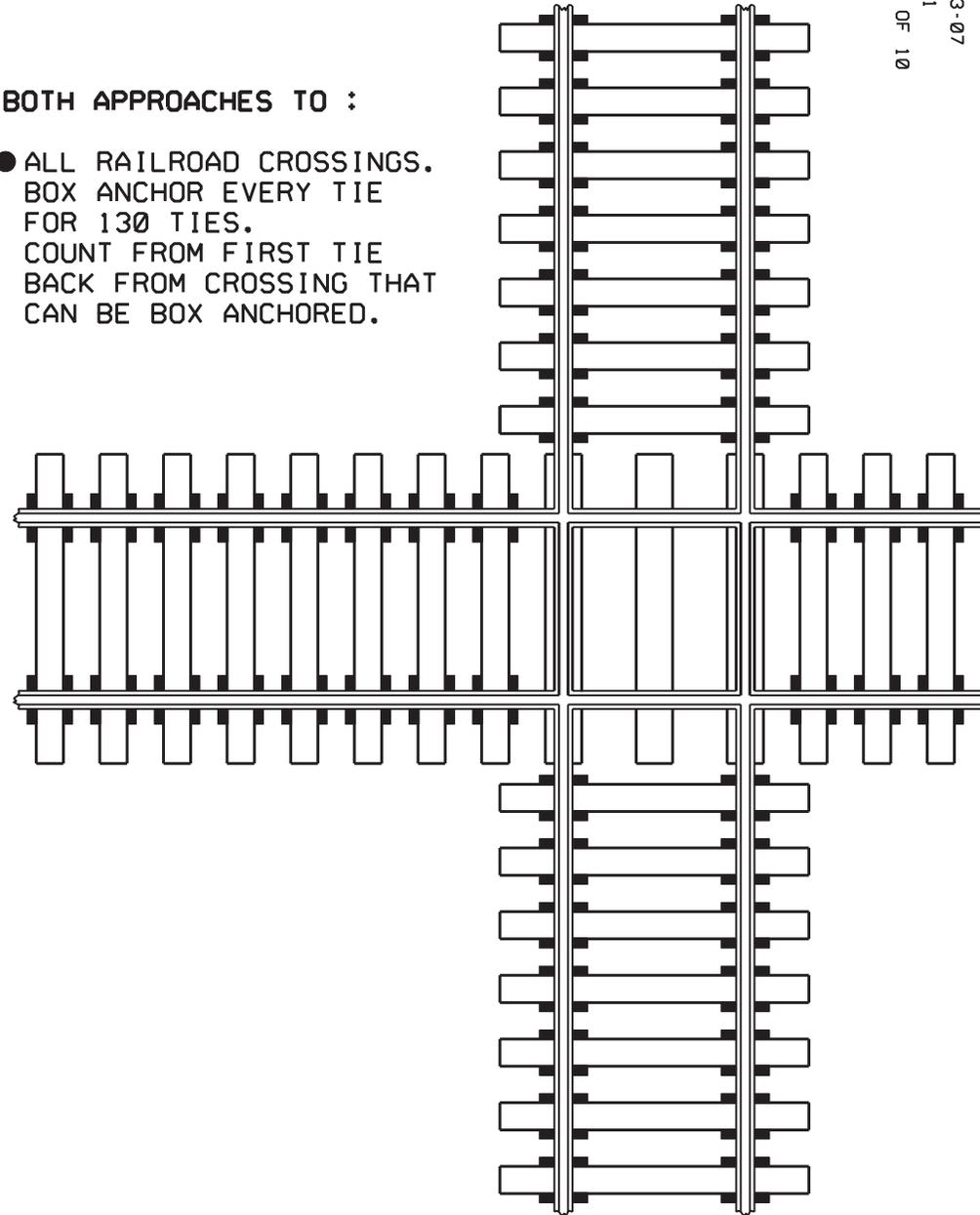
BOTH SIDES OF RAIL JOINTS :

- BOX ANCHOR EVERY TIE FOR 130 TIES.
- USE NORMAL ANCHOR PATTERN FOR :
 - EPOXY GLUED INSULATED JOINTS.
 - JOINTS WHICH ARE TO BE WELDED AS THE RAIL IS BEING LAID OR IMMEDIATELY AFTER IT IS LAID.



BOTH APPROACHES TO :

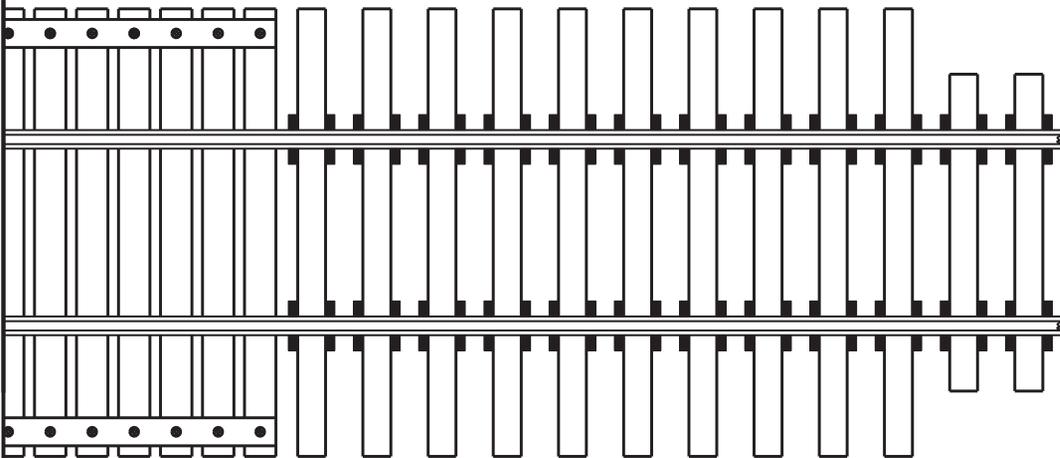
- ALL RAILROAD CROSSINGS.
BOX ANCHOR EVERY TIE FOR 130 TIES.
COUNT FROM FIRST TIE BACK FROM CROSSING THAT CAN BE BOX ANCHORED.



WELDED RAIL ANCHOR PATTERN ADDITIONS

BOTH APPROACHES TO :

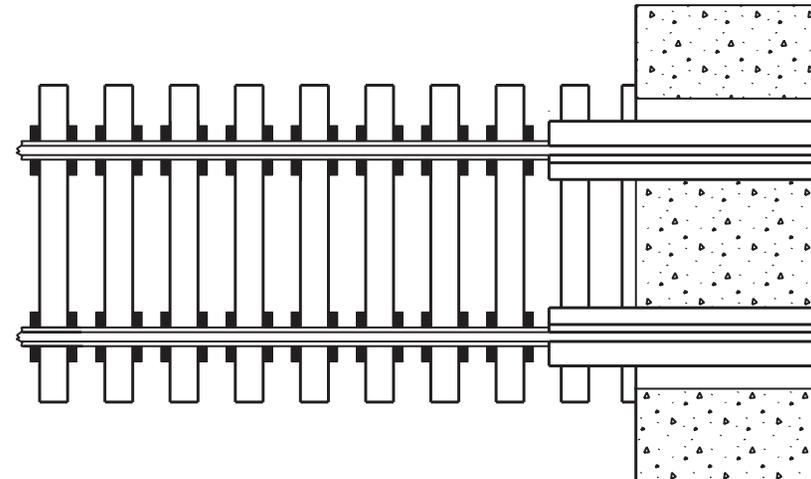
- ALL OPEN DECK BRIDGES.
BOX ANCHOR EVERY TIE FOR 130 TIES.



COUNT FROM BACKWALL OF BRIDGE.

BOTH APPROACHES TO :

- ROAD CROSSINGS 50 FOOT OR GREATER.
BOX ANCHOR EVERY TIE FOR 130 TIES.
- ROAD CROSSINGS UNDER 50 FOOT.
USE NORMAL ANCHOR PATTERN.

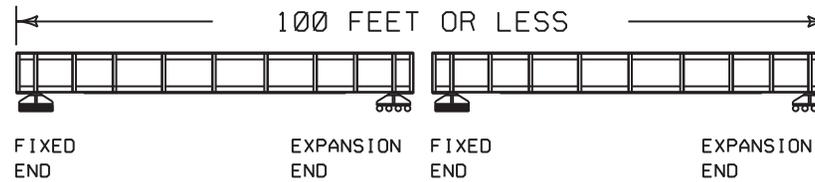


COUNT FROM FIRST TIE BACK
FROM END OF CROSSING OR FROM
JOINTS FOR CROSSING WARNING
IF NOT EPOXY GLUED JOINTS.

WELDED RAIL ANCHOR PATTERN ADDITIONS

OPEN DECK BRIDGES WITH A TOTAL LENGTH OF 100 FEET OR LESS :

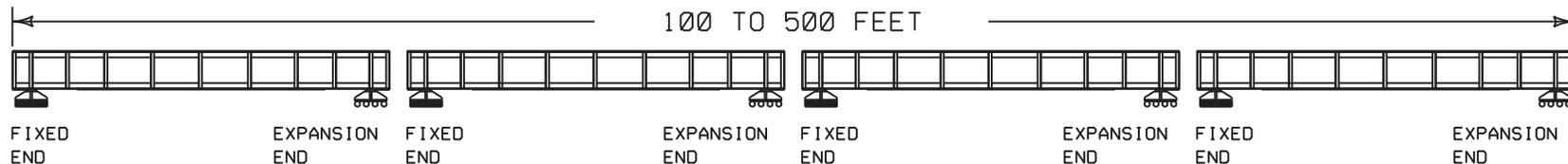
- RAIL ANCHORS WILL BE APPLIED ON ALL TIES FASTENED TO THE BRIDGE SPAN.



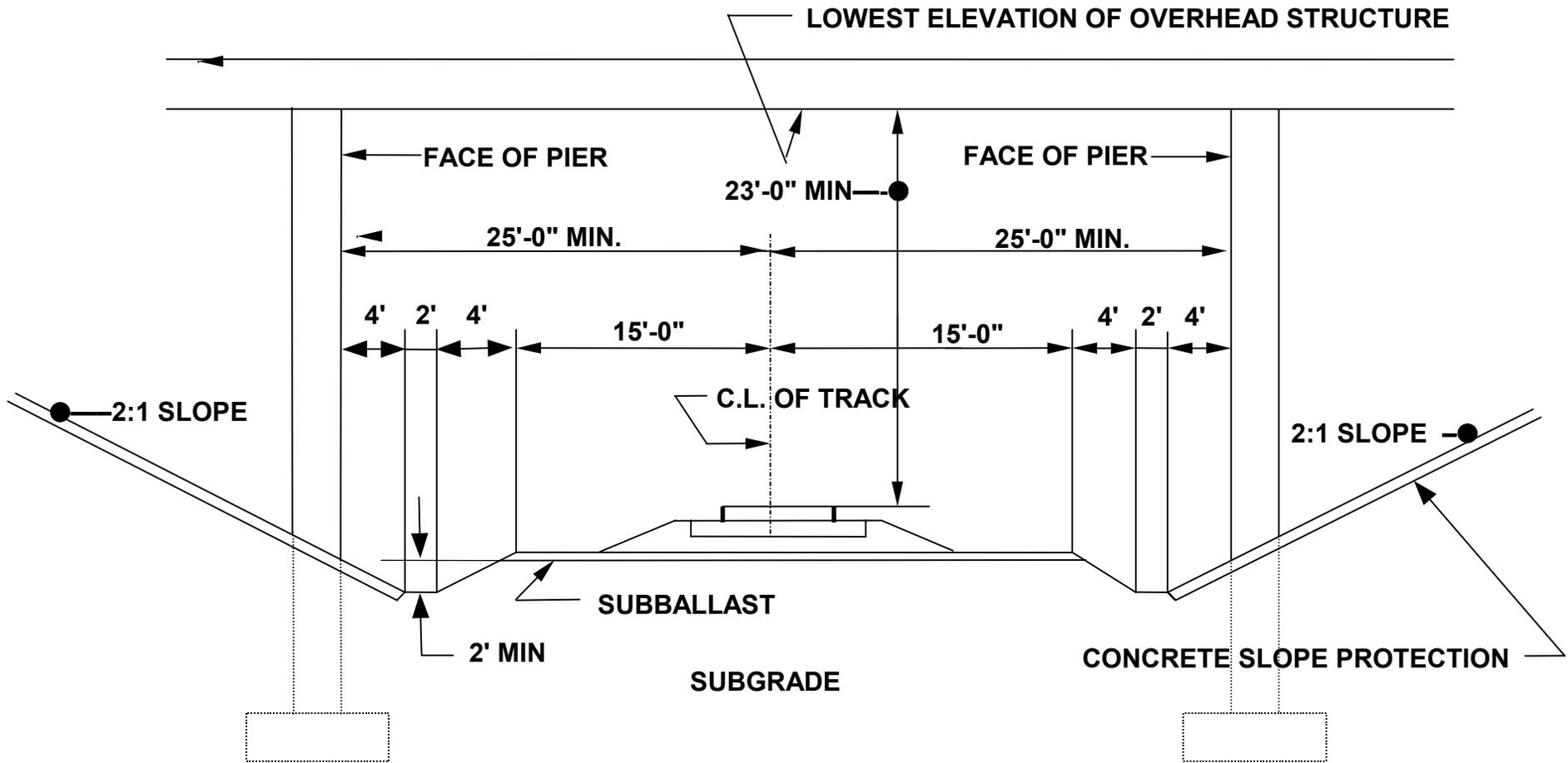
OPEN DECK BRIDGES WITH TOTAL LENGTH BETWEEN 100 FEET AND 500 FEET :

RAIL ANCHORS WILL BE APPLIED WITHIN THE LENGTH DESIGNATED ON ALL TIES FASTENED TO THE BRIDGE SPAN.

- RAIL ANCHORS WILL BE APPLIED THROUGHOUT ALL SPANS LESS THAN 100 FEET.
- RAIL ANCHORS WILL BE APPLIED FOR THE FIRST 100 FEET MEASURED FROM THE FIXED END FOR INDIVIDUAL SPANS WITH LENGTH GREATER THAN 100 FEET.



WELDED RAIL ANCHORING ON OPEN DECK BRIDGES

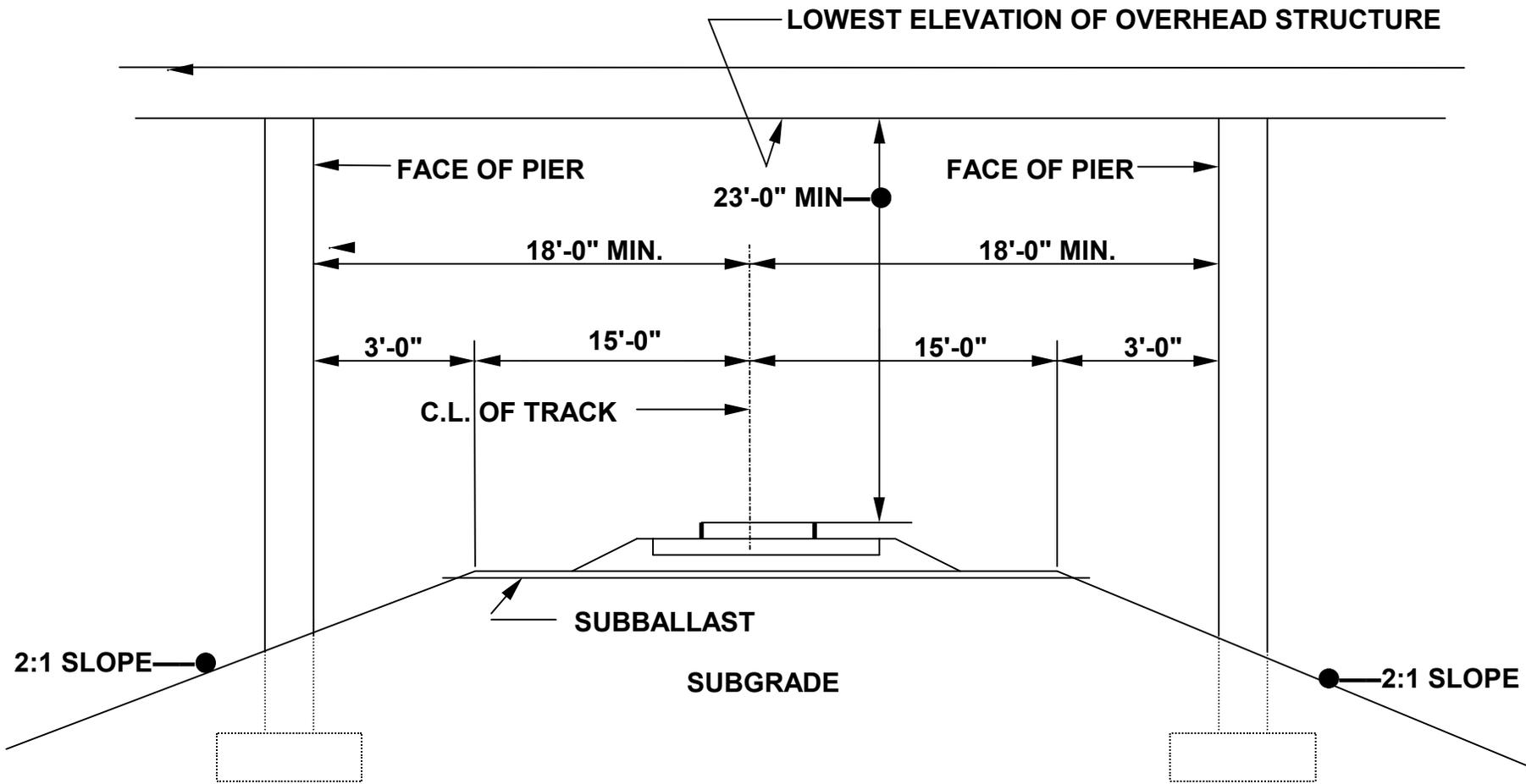


CLEARANCES REQUIRED FOR OVERHEAD STRUCTURES
TYPICAL ROADBED SECTION WITH STANDARD DITCHES

NOTE: FOR MULTIPLE TRACKS, STANDARD TRACK CENTERS IS 15'-0"

CSX TRANSPORTATION
 ENGINEERING DEPARTMENT

STANDARD CLEARANCES FOR OVERHEAD STRUCTURES



CLEARANCES REQUIRED FOR OVERHEAD STRUCTURES
TYPICAL SECTION FOR ROADBED IN FILL
 (WHERE NO DEFINED DITCHES ARE NEEDED)

NOTE: FOR MULTIPLE TRACKS, STANDARD TRACK CENTERS IS 15'-0"

CSX TRANSPORTATION
ENGINEERING DEPARTMENT

STANDARD CLEARANCES FOR OVERHEAD STRUCTURES

APPENDIX B: VDOT GEOMETRICS FOR BRIDGES OVER RAILROADS

Notes:

T/R – Denotes top of rail or top of high rail.

All geometrics shown herein are for CSX Transportation and Norfolk Southern Railway. Values shown are those which would normally be acceptable to the railroad. Other railroad companies are required to submit a formal request for clearances to the office of VDOT Structure and Bridge Division for review, consideration and approval.

Horizontal clearances may be increased, as requested by the railroad company and with concurrence of the Department, to accommodate future tracks, access roads, and other railroad facilities.

A statement for additional space for off-track equipment (8 feet maximum) shall be required. For two or more tracks, if the railroad company requests clearances for off-track equipment on both sides, detailed specifics are required.

Edges of footing shall not be closer than 11'-0" (13'-0" for Norfolk Southern Railway) from centerline of the track to provide adequate room for sheeting.

Values may be increased depending on track template and span arrangement, e.g., to make all spans equal, continuous layouts, etc.

Vertical clearance on superelevated track is measured from the top of high rail to the lowest point of the structure in the horizontal clearance area. Vertical clearance shown is the maximum a railroad may request without justification.

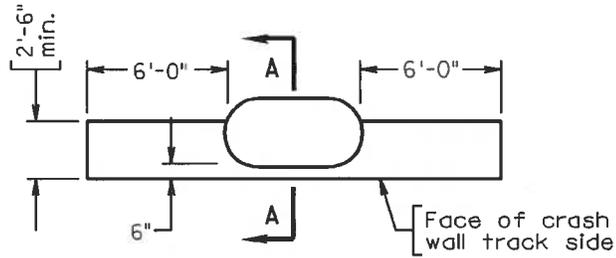
When sheeting for excavation is used, face of sheeting shall be at a distance not less than 10 feet from C track. The sheeting shall be designed and the details shall be included in the plans. Design calculations and three sets of detailed drawings (four for Norfolk Southern Railway) shall be submitted to the railroad for review and approval. See VDOT L&D *Road Design Manual*, pages 2E - 25 thru - 27.

Drainage from bridge deck drains must be conveyed through pipes and drained away from railroad property.

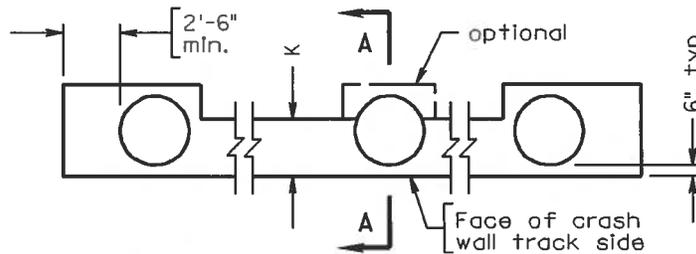
For sections and dimension table, see previous sheet.

**GEOMETRICS
BRIDGES OVER RAILROADS
CLEARANCES**

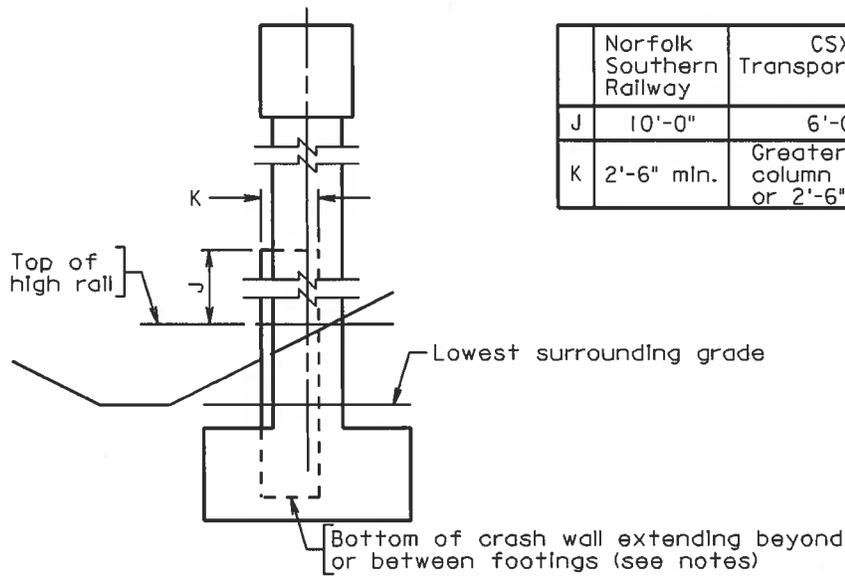
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SINGLE COLUMN



MULTI COLUMN



SECTION A-A

CRASH WALL DETAILS

For notes, see next sheet.

**GEOMETRICS
BRIDGES OVER RAILROADS
CRASH WALL REQUIREMENTS**

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Notes:

The dimensions and details provided in this section are the minimum requirements from the AREMA and railroad publications. For suggested detailing of piers adjacent to railways adhering to these minimums and suggested design for collision force, see Chapter 15, Pier Details.

Piers having less than 25 feet horizontal clearance from the centerline of a main or passing railroad track shall be of heavy construction or shall be protected by a reinforced concrete crash wall. Columns shall be considered of heavy construction if they have a cross-sectional area equal to or greater than 30 sf (50 sf for CSX Transportation) and the larger of its dimensions is parallel to the track. Use of and orientation of columns for straddle piers requires VDOT approval during the preliminary design phase. When economically feasible, piers should be located at a distance from centerline of the track so that neither the crash wall nor the sheeting for excavation near the tracks will be needed.

The crash wall shall extend to not less than 6 feet (10 feet for Norfolk Southern Railway) above top of rail for piers 12 to 25 feet from the centerline and 12 feet above top of rail for piers less than 12 feet from the centerline. The face of a crash wall shall extend a distance of at least 6" beyond the face of the column(s) on the side adjacent to the track.

When two or more light columns compose a pier, a wall at least 2'-6" thick for Norfolk Southern Railway or the greater of column width or 2'-6" for CSX Transportation shall connect the columns and extend at least 2'-6" beyond the outermost columns.

When a pier consists of a single column with a stem less than 3 feet in width and 12 feet in length, it shall be protected by a crash wall parallel to the track. The wall shall be at least 2'-6" thick and shall extend for a distance of at least 6 feet from both sides of the column.

Reinforcement for the crash wall shall be anchored to the column(s) and footing(s) with adequate reinforcement.

Bottom of crash wall shall extend a minimum of 4 feet below the lowest surrounding grade. When rock is encountered and this is not practical, the wall may be socketed a minimum of 12" into competent rock provided that the rock is not fractured.

When mechanically stabilized earth, MSE, walls are used in front of the abutments, the minimum horizontal clearance shall be 25 feet. Abutments with spread footings shall not be used behind the MSE wall. Abutment piles shall not be within 6 feet of the wall face unless approved by the Geotechnical Section of the S&B Division.

For maintenance and repair projects, these guidelines will be evaluated on a case by case basis.

See AASHTO *LRFD Bridge Design Specifications*, Article 11.7.2.2, AREMA *Manual for Railway Engineering*, Vol. 2, pg. 8-2-6, Article 2.1.5, Norfolk Southern *Overhead Grade Separation Design Criteria* and CSX Transportation *Criteria for Overhead Bridges*.

For details and dimension table, see previous sheet.

**GEOMETRICS
BRIDGES OVER RAILROADS
CRASH WALL REQUIREMENTS**

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