



**North Carolina Railroad Company  
Engineering Department**

**Design and Construction Guidelines**

**January 2019**

**Version 2.0**

# **PREFACE**

**These Design and Construction Guidelines are provided as information only to assist planners and designers of new projects that may impact the North Carolina Railroad Company's corridor and infrastructure. There are additional considerations that impact potential projects, including both existing and planned uses of the corridor for railroad and other purposes. Sole use of these Design and Construction Guidelines does not guarantee that a project will be approved by NCRR.**

**Norfolk Southern Railway (NSR) has the responsibility for the operation and maintenance of the NCRR through existing agreements. These Design and Construction Guidelines do not in any way specify or govern the maintenance requirements and practices of NSR. All maintenance practices are at the sole discretion of NSR.**

**PRIOR TO THE START OF ANY PROJECT IMPACTING THE NCRR CORRIDOR, CONTACT THE VICE PRESIDENT – ENGINEERING AT THE NORTH CAROLINA RAILROAD COMPANY AT 919.954-7601. ALL PROJECTS MUST BE REVIEWED AND APPROVED BY NCRR AND, IF REQUIRED, THE OPERATING RAILROAD.**

# North Carolina Railroad Company Engineering Department Design and Construction Guidelines

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# North Carolina Railroad Company Engineering Department Design and Construction Guidelines

## 1.0 INTRODUCTION

### 1.1 General

The North Carolina Railroad Company (NCR) is a private corporation that owns and manages the 317-mile rail corridor stretching from Charlotte, Mecklenburg County to the State Port Terminal at Morehead City in Carteret County. The NCR corridor includes the Piedmont Main Line from Charlotte to Greensboro (93 miles), the H-Line from Greensboro to Goldsboro (130 miles) and the EC-Line from Goldsboro to Morehead City (94 miles).

Shares of the NCR stock are wholly owned by the State of North Carolina, its single shareholder. The NCR's **mission** is *"Putting the North Carolina Railroad to work for the good of the people of North Carolina"*. NCR's **vision** is *"To improve our state by: Expanding freight rail opportunities to grow business. Enabling rail to move people. Investing in North Carolina"*.

The NCR owns its railroad corridor between Charlotte and Morehead City, including the railroad infrastructure (tracks, bridges, culverts, etc.). The NCR has granted to Norfolk Southern Railway (NSR), under the terms set forth in a Trackage Rights Agreement, exclusive freight trackage rights over the lines and properties owned by NCR. NCR has also granted to NSR such operating rights as will permit operations of the National Railroad Passenger Corporation's ("Amtrak") intercity passenger trains over the lines of NCR. NSR fulfills freight common carrier duties of NCR on the NCR segments for which NSR holds the exclusive freight trackage rights.

The NCR has made improvements to, and continues to improve, its corridor to strengthen rail service and promote economic development. NCR funds projects from its capital resources and funds other projects in partnership with other parties such as NSR and the North Carolina Department of Transportation (NCDOT).

This NCR Engineering Department Design and Construction Guidelines (NCR Guidelines) provides guidance for the design and construction of new projects on the NCR corridor and is subject to change at the discretion of the NCR. All work on the NCR corridor is subject to further review and approval of the NCR.

NSR, through its Master Agreement with the NCR, has responsibility for the maintenance and operation of the NCR corridor. These NCR Guidelines are not intended to supersede the specifications, standards and/or requirements of NSR. All work on the NCR corridor is also subject to further review and approval by NSR unless otherwise notified by NCR. **These NCR Guidelines do not in any way**

specify or govern the maintenance requirements and practices of NSR. All maintenance practices are at the sole discretion of NSR.

*Before entering the NCRR corridor to perform inspection, design and/or construction related activities, all parties shall comply with NCRR's right of entry and insurance requirements.*

## 1.2 Abbreviations and Definitions

AASHTO – American Association of State Highway Transportation Officials  
Amtrak – National Railroad Passenger Corporation  
APTA – American Public Transit Association  
AREMA – American Railway Engineering and Maintenance of Way Association  
Company - North Carolina Railroad Company  
CP – Control point.  
FRA – Federal Railroad Administration  
MAS – Maximum Allowable Speed  
MP – Mile Post  
NCDOT – North Carolina Department of Transportation  
NCRR – North Carolina Railroad Company  
NS or NSR – Norfolk Southern Railway  
Railroad - Norfolk Southern Railway

## 1.3 Reference Documents and Standards

The NCRR will continue to comply with NSR and the American Railway Engineering and Maintenance of Way Association (AREMA) recommendations for track design and construction. Should these NCRR Guidelines conflict with any NSR specifications, standards or requirements and/or AREMA recommended practices, the most restrictive specification will be applied.

In addition to the requirements of these NCRR Guidelines, the design criteria, requirements and recommendations used for the design of new projects on the NCRR will include, but not be limited to, current versions the following:

### Norfolk Southern Railway

- Public Projects Manual
- Guidelines for Design of Highway Separation Structures Over Railroad
- Guidelines for Design of Highway Separation Structures Under Railroad
- Guidelines for Design of Structures Under Railroad
- Standard Plans
- Standard Specifications for Materials and Construction
- Design Criteria & Guidelines for Main Tracks and Detours
- State Laws for Crossing Clearances

- MW&S Standard Procedure Number 040 – Clearances; Vertical and Horizontal
- MW&S Standard Procedure Number 090 – Curves: Design, Construction, Maintenance and Construction
- Clearances for Tracks Located on Industry Property
- Underpass Grade Separation Design Criteria
- Passenger Station Requirements

#### Federal Railroad Administration

- FRA Standard Rules, Regulations and Specifications
- Code of Federal Regulations, Title 49

#### American Railway Engineering and Maintenance of Way Association (AREMA)

- AREMA Manual of Recommended Practices for Railway Engineering
- AREMA Portfolio of Track Work Plans

#### Amtrak

- Station Program and Planning Guidelines

#### CSX

- Public Project Information for Construction and Improvement Projects That May Involve the Railroad (Only for projects located between Cary (Fetner, MP H-73) and Raleigh (Boylan, MP H-80.8) that impact the CSX owned track.

#### NCDOT

- Roadway standard drawing and standard specifications and provisions (for projects involving roadway work).

### **1.4 Operations**

Local and through freight railroad operations on the NCRR are conducted by Norfolk Southern.

Intercity passenger railroad operations on the NCRR are operated by Amtrak. Intercity passenger services operate between Charlotte and Greensboro on the Piedmont Main Line and between Greensboro and Selma on the H-Line.

Norfolk Southern dispatches trains and controls operations on the North Carolina Railroad with the exception of the portion of the H-Line between Cary (CP Fetner, MP H-73) and Raleigh (CP Boylan, MP H-80.8) which is dispatched and controlled by CSX.

CSX operates on portions of the NCRR corridor primarily between Cary (Fetner) and Raleigh (Boylan) and also in East Durham.

## **1.5 Safety**

All NSR safety requirements shall be complied with at all times. Any designer, contractor, or agency shall obtain right of entry permission from NCRR and NSR before entering the railroad corridor and should comply with the FRA Roadway Worker Safety Requirements and the Norfolk Southern's Safety Guidelines for Personnel Working on Company Corridor as appropriate.

## **2.0 GENERAL DESIGN GUIDELINES**

The following general guidelines shall govern the development of the designs of projects on, or impacting, the NCRR corridor. However, these are guidelines only and the detailed scope of any individual project needs to be developed with and confirmed by both NCRR and NSR.

The NCRR Piedmont Main Line between Greensboro and Charlotte is designated by NSR Strategic Planning as a Core Rail Line while the NCRR H-Line between Raleigh and Greensboro is designated as a Tactical Rail Line. These designations guide some of the requirements herein.

### **2.1 Designing for Future Capacity**

The design and construction of bridges, retaining walls and other features on the NCRR right of way shall take into consideration the potential for construction of additional tracks and other railroad facilities to accommodate future capacity to support potential freight and passenger rail services. The designer shall verify any additional site specific considerations with the NCRR Vice President – Engineering. These considerations include, but are not limited to, the following.

### **2.2 Future Track Requirements**

The construction of additional tracks on the NCRR corridor to support both potential freight and passenger rail operations is anticipated. In general, projects shall be designed to accommodate the following:

- On the NCRR Piedmont Main Line provide for four main tracks (two additional main tracks in addition to the two existing main tracks). Additional sidings and other auxiliary tracks may also be required at site specific locations.
- On the NCRR H-Line between Greensboro (Milepost H-0) and Selma (Milepost H-109.3) provide for four main tracks (three additional main tracks in addition to the one existing main track). An exception is that projects designed for the portion of the corridor between Cary (Fetner) and Raleigh (Boylan) shall accommodate a total of four tracks (two additional tracks in addition to the two existing tracks). Additional sidings and other auxiliary tracks may also be required at site specific locations.
- On the NCRR H-Line between Selma (Milepost H-109.3) and Goldsboro (Milepost H-130) provide for three main tracks (two additional main tracks in addition to the one existing main track). Additional sidings and other auxiliary tracks may also be required at site specific locations.



- On the NCRR EC-Line provide for three main tracks (two additional main tracks in addition to the one existing main track). Additional sidings and other auxiliary tracks may also be required at site specific locations.

In January 2017, NCRR completed the NCRR Future Track Infrastructure Planning Study that shows the potential location of future additional main tracks on the NCRR corridor. The purpose of the study is to provide guidance to agencies, designers and planners for the evaluation and design of projects impacting the NCRR corridor. Plans and electronic files are available from NCRR upon request.

### 2.3 Undergrade Railroad Bridges

In general, undergrade bridge projects shall be designed to accommodate the following:

- On the NCRR Piedmont Main Line (a designated NSR Core Rail Line) the construction of new undergrade railroad bridges over roadways shall provide for a minimum of one additional main track regardless of the number of existing main tracks. However, provisions shall be made for no less than a minimum of three (3) main line tracks plus any additional tracks due to local needs. Undergrade railroad bridges over roadways on the Piedmont Main Line shall be designed for the future expansion of the bridge to accommodate not less than four main tracks
- On the NCRR H-Line and EC-Line, new undergrade railroad bridges over roadways shall be constructed to provide for a minimum of two (2) main tracks unless otherwise directed by NCRR. Undergrade railroad bridges over roadways on the H-Line and EC-Line shall be designed for the future expansion of the bridge to accommodate not less than four main tracks between Greensboro and Selma and three main tracks between Selma and Morehead City.
- Where existing bridges are being rehabilitated and the existing substructure is to remain, the rehabilitated superstructure shall provide for the existing tracks.
- Undergrade railroad bridges over physical features other than roadways (waterways, etc.) shall be designed and constructed to provide for the existing tracks. The preliminary bridge layout plans, however, shall be prepared for the existing tracks plus additional tracks as required by NCRR. The purpose of the preliminary design is to locate piers and abutments such that the bridge is expandable in the future to accommodate the additional tracks.
- Where new tracks are being placed on existing undergrade railroad bridges and there is sufficient bridge width to accommodate an additional track, no additional bridge width for future tracks is required.

### 2.4 Overhead Bridges

In general, overhead bridge projects shall be designed to accommodate the following:

- On the NCRR Piedmont Main Line and on the H-Line between Greensboro and Selma, new overhead bridges carrying roadways over the railroad shall be designed as a minimum to span four mainline tracks at 15' track centers plus a minimum of 25' from the centerline of the nearest existing or future track to any

bridge piers and /or abutments. The bridges may also need to be designed to span additional tracks, including freight, inter-city passenger, and commuter rail and transit tracks, as directed by NCRR. Minimum clear span between bridge piers and/or abutments shall be 100' (perpendicular to track centerlines).

- On the NCRR H-Line between Selma and Goldsboro and the EC-Line, new overhead bridges carrying roadways over the railroad shall be designed to span three mainline tracks at 15' track centers plus a minimum of 25' from the centerline of the nearest track to any bridge piers and /or abutments. The bridges may need to be designed to span additional tracks, including freight, passenger, commuter rail and transit tracks, as directed by NCDOT and the Railroads. Minimum clear span between bridge piers and/or abutments shall be 80' (perpendicular to track centerlines).

If the distance from the centerline of a track (existing and/or future) to bridge piers and/or abutments is less than 25 feet, crash walls will be required to be constructed by the bridge project.

## 2.5 Vertical Clearances

The desired minimum vertical clearance for new bridges and structures over all main tracks, measured at a distance of 5'-6" from centerline of track shall be 24'-3" at the following locations (designated route for the Southeast High Speed Rail Corridor) in order to provide for the potential of future electrification by means of an overhead catenary system.

- NCRR H-Line, Greensboro to Raleigh (MP H 0.0 to MP H 80.7)
- NCRR Piedmont Main Line, Charlotte to Greensboro (MP 284.0 to MP 378.3)

The absolute minimum vertical clearance at these locations shall be 23'-0".

The absolute minimum vertical clearance for new bridges and structures over all main tracks, measured at a distance of 5'-6" from centerline of track shall be 23'-0" at the following locations:

- NCRR H-Line, Raleigh to Goldsboro (MP H-80.7 to MP H-130).
- NCRR EC-Line, Goldsboro to near Kinston (MP EC-0.0 to MP EC-22.3).

The absolute minimum vertical clearance for new bridges and structures over all main tracks, measured at a distance of 5'-6" from centerline of track, at the following locations shall be 24'-11":

- NCRR EC-Line, near Kinston to Morehead City (MP EC-22.3 to MP EC-94.2).

The absolute minimum clearance over all tracks other than main tracks shall be 23'-0".

Minimum clearances as described above shall be provided over potential future tracks with the assumption that the vertical profile of the potential future tracks matches that of the adjacent tracks.

## 2.6 Culverts

Stone box culverts and other drainage structures that cannot be extended to accommodate additional tracks shall be replaced by new 36” minimum diameter smooth steel culvert pipes which shall be installed by the bore and jack method unless otherwise approved by NCR and NSR. The length of the new culvert pipes shall be of sufficient length to accommodate three main tracks on the Piedmont Main Line and two main tracks on the H-Line and EC-Line. Culvert pipes may be required to have additional length to accommodate siding, yard and other tracks.

Extensions to concrete box culverts and smooth steel pipes shall be of sufficient length to accommodate three main tracks on the Piedmont Main Line and two main tracks on the H-Line and EC-Line. Culverts may be required to have additional length to accommodate siding, yard and other tracks.

All culvert pipes shall have headwalls on both the inlet and outlet ends.

## 2.7 Retaining Walls and Other Hard Features

On the Piedmont Main Line and the H-Line between Greensboro and Selma, the design of retaining walls and other hard features should accommodate up to a total of four tracks (existing plus proposed plus future tracks). Where feasible, the designs of retaining walls and other “hard” elements of construction shall be such that minimum reconstruction of these elements would be required for the future construction of up to four tracks.

On the H-Line between Selma and Goldsboro and the EC-Line, the designs should accommodate up to a total of three tracks (existing plus proposed future tracks). Where feasible, the designs of retaining walls and other “hard” elements of construction shall be such that minimum reconstruction of these elements would be required for the future construction of up to three tracks.

## 3.0 NCR CORRIDOR

NCR owns, with few exceptions, a 200’ wide corridor between Charlotte and the North Carolina State Port at Morehead City. Train operations require varying widths that extend a distance of approximately 25’ both sides from the centerline of tracks. ***Any uses that propose to encroach into or otherwise occupy any portion of the NCR corridor requires the approval of the NCR Real Estate Department and/or NCR Engineering Department.***

Usage by utilities or local governments for wires or pipelines requires application to the NCR Engineering Department. Compliance with NCR’s engineering requirements is necessary. Applicable fees will be charged. See Section 4.0 for further details regarding utility occupancy of the NCR corridor.

All work on the NCR corridor shall be in accordance with the current edition of the NCR/NSR Special Provisions for Protection of Railway Interest.

### **3.1 Right of Entry**

*Prior to the entry onto the NCRR's right of way by any agency, consultant contractor, or any other party; such party must execute and deliver to NCRR and NSR a standard construction right-of-entry agreement in a form approved by NCRR and NSR, together with any certificates of insurance required therein. Application is made on NCRR Right of Entry Form (see ncr.com).*

Furthermore, any crossing of railroad tracks will be addressed by a standard temporary crossing agreement in a form approved by NCRR and NSR.

### **3.2 Right of Entry Agreements**

Right of entry agreements are required for right of entry onto the NCRR corridor and are processed through the NCRR Engineering Department. Typical agreements include, but are not limited to, the following:

- NCRR/NS Indemnification Agreement (Principal) and Right of Entry
- NCRR/NS Indemnification Agreement (Individual) and Right of Entry
- NCRR/NS Indemnification Agreement (Principal) and Right of Entry for Construction

These right of entry agreements may be modified as needed to meet the specific requirements of individual projects and/or applicants.

Environmental right of entry agreements are processed through the NCRR Real Estate Department.

### **3.3 Occupancy Agreements (Non-utilities)**

Occupancy agreements are required for occupancy or use of the NCRR corridor. NCRR and NSR cooperate on the preparation and execution of occupancy agreements.

The NCRR Engineering Department has responsibility for the preparation of, or coordinating with others for the preparation of, 1) public and private roadway crossings either at-grade or grade separated agreements; and 2) lead track, industrial track and siding agreements. License and environmental agreements are the responsibility of the NCRR Real Estate Department.

Typical siding agreements include:

- Siding agreement for construction and operation of siding
- Siding agreement for operation of siding track only

See Section 4 for details regarding utility occupancy agreements.

### **3.4 Removal of Industry Turnouts**

Industry turnouts shall not be removed from main tracks without the prior approval of the NCRR's Economic Development and Engineering Departments and the NSR Industrial Development Department. The Request to Remove Industry Turnout Form shall be completed prior to approval of any requests to remove industry turnouts.

## 4.0 UTILITY OCCUPANCY

Usage by utilities or local governments for wires or pipelines requires application through the NCRR Occupancy Agreement Process.

All utility occupancies shall comply with the applicable engineering requirements and shall be approved by the Vice President – Engineering, or designee. Applicable fees will be charged.

Utilities shall be designed and installed in accordance with the requirements of the North Carolina Railroad Company. Application for utility occupancy shall be made to NCRR, or to NCRR’s designee, through the process described in the Pipeline and Underground/Aerial Wireline Occupancy Application Instructions.

For additional information please refer to the NCRR website ([www.ncrr.com](http://www.ncrr.com)).

## 5.0 DESIGN AND CONSTRUCTION GUIDELINES

### 5.1 Clearances

#### 5.1.1 General

Overhead and horizontal clearances for existing tracks shall be in accordance with Norfolk Southern MW&S Standard Procedure 040 – Clearances: Horizontal and Vertical.

Overhead and horizontal clearances for new tracks shall be in accordance with Norfolk Southern MW&S Standard Procedure 040 – Clearances: Horizontal and Vertical, except as noted herein.

Also see Section 2.5 Vertical Clearances for additional information.

#### 5.1.2 Vertical

Vertical clearance is measured from the top of rail to the lowest point above the track. The absolute minimum vertical clearance for new bridges and structures over all main and siding tracks shall be 23’-0” above top of rail as measured at a distance of 5’-6” from centerline of track, except as noted below.

The desired minimum vertical clearance for new bridges and structures over all main tracks, measured at a distance of 5’-6” from centerline of track shall be 24’-3” at the following locations (designated route for the Southeast high Speed Rail Corridor) in order to provide for the potential for future electrification by means of an overhead catenary system.

- H-Line, Greensboro to Raleigh (MP H 0.0 to MP H 80.7)
- Piedmont Main Line, Charlotte to Greensboro (MP 284.0 to MP 378.3)

The absolute minimum vertical clearance for new bridges and structures over all main tracks, measured at a distance of 5’-6” from centerline of track, at the following locations shall be 24’-11”:

- EC-Line, near Kinston to Morehead City (MP EC-22.3 to MP EC-94.2).

The absolute minimum clearance over all tracks other than main tracks shall be 23'-0".

Minimum clearances as described above shall be provided over potential future tracks with the assumption that the vertical profile of the potential future tracks matches that of the adjacent tracks.

### 5.1.3 Horizontal

Horizontal clearances shall be in accordance with NS MW&S Standard Procedure 040. Minimum side clearance to obstructions for new construction shall be 13 feet from the centerline of track.

To accommodate the possibility of future tracks the minimum horizontal clearance between back walls, columns, and piers must be a minimum of 80' for bridges being constructed between Selma and Morehead City. For bridges being constructed between Selma and Charlotte the horizontal clearance should be a minimum of 100'. The horizontal clearance may vary due to site specific conditions and designers should contact the NCRP before beginning design. An example would be a bridge over several yard tracks that may require additional clearance or at locations where an access roadway is required.

Track center spacing shall be as described in Section 5.3 herein.

## 5.2 Speeds

Main tracks shall generally be designed for the following maximum allowable speeds (MAS) in accordance with NSR standards. MAS at specific locations may be restricted due to geometric or other constraints. Design speeds will be as determined by the operating railroad.

### Piedmont Main Line: Greensboro to Charlotte

- Passenger trains – 79 miles per hour (mph)
- Rail-highway trains – 60 mph
- Freight trains – 50 mph

### H-Line: Greensboro to Raleigh

- Passenger trains – 79 mph
- Rail-highway trains – 60 mph
- Freight trains – 50 mph

### H-Line: Raleigh to South Selma

- Passenger trains – 79 mph
- Rail-highway trains – 50 mph
- Freight trains – 50 mph

### H-Line: South Selma to Goldsboro

- Passenger trains – 40 mph;
- Rail-highway trains – 40 mph;
- Freight trains – 40 mph

### EC-Line: Goldsboro to Morehead City

- Passenger trains – 40 mph
- Rail-highway trains – 40 mph
- Freight trains – 40 mph

Design speeds for specific projects may be modified due to infrastructure or operational constraints. All deviations from the design speeds noted above shall be approved by NCRR and NSR.

Design speeds for yard and storage tracks shall be a minimum of 10 mph.

Design speeds for other than main tracks shall be as determined by NSR.

### **5.3 Gauge**

Standard gauge shall be 4' 8½".

### **5.4 Track Center Spacing**

New track construction should preferably provide for 15' track centers, but no less than 14' compensated for curvature or differences in super-elevation.

Minimum track center distances for existing tracks shall be as specified in NS MW&S Standard Procedure 040, Clearances: Vertical and Horizontal. The minimum spacing of tangent main tracks for new track construction shall be 14'-0". Other required minimum track center requirements include:

- Between any main track and sidings: 14'-0".
- Between any main track and industry tracks: 15'-0".
- Between siding and industry tracks: 15'-0".

Track center spacing may be increased as directed by NCRR and/or NSR to meet specific project requirements such as interfacing with adjacent track work; inter-track fences at passenger stations or specific siding uses such as maintenance of way sidings.

Track centers for the above shall be increased 1" per degree of curvature on curved tracks. In multiple curved track territory, when the track on the inside of the curve has less super elevation than the track on the outside of the curve, track centers must be increased 4½" for each inch difference in super elevation between the involved tracks.

Curved main tracks shall have track center spacing increased to account for curvature and possible differences in elevation on adjacent tracks. Track centers shall be increased on curved main tracks in accordance with NS Plan 7-2C, Track Centers for Curved Tracks, Table 3 – Desirable Track Centers for Curved Track in Feet and Inches.

### **5.5 Horizontal Geometry**

The horizontal alignment of mainline tracks consists of tangents joined to circular curves usually by transition spirals. The calculations for horizontal geometry shall be as specified in the AREMA Manual for Railway Engineering, Chapter 5. Horizontal geometry shall be based upon the chord definition which defines the degree of curve as the central angle subtended by a 100' chord.

Track alignments shall employ the minimum degree of curve (i.e., maximum radius) practicable. The maximum curvature for spur tracks is 12 degrees and for lead tracks it is 10 degrees. The desirable maximum curvature for main tracks is 1 degree 30 minutes.

The degree of curve is denoted by  $D_c$ , where

$$\sin (\frac{1}{2} D_c) = 50 / r$$

where “r” is the radius of the curve.

The minimum length of circular curve ( $L_c$ ) shall be three times the ultimate design speed for the curve, (i.e. 240’ for a passenger train MAS of 80 mph).

Broken back curves should be avoided.

#### 5.5.1 Reverse Curves

Tangent segments of track shall be provided between the spirals of reverse curves.

The minimum length of tangent track between reverse curves for main tracks shall be 220’. The desirable length of the tangent segment shall be three (3) times the future passenger train design speed (240’ for an MAS of 80 mph).

Tangent distance between reverse curves on other than main line tracks should be at least 100’ but not less than 70’.

Distance between facing point switches leading from opposite sides of a through track (creating a reverse curve effect) should be at least 100’, but not less than 70’.

#### 5.5.2 Cant Deficiency

Cant deficiency, or unbalance super elevation ( $E_u$ ), is defined as the difference between the equilibrium super elevation ( $E$ ) and the actual super elevation in the track ( $E_a$ ). Curves shall be designed with a desirable cant deficiency of 1½” or 2” for freight trains and 3” for passenger trains (for a passenger train MAS up to 80 mph).

Spiral lengths on main tracks located between Charlotte and Raleigh may be designed to accommodate a future 90 mph MAS for passenger trains with a desirable maximum cant deficiency of 4” and an absolute maximum cant deficiency of 5” with the approval of NCRR and NSR. (Note: These cant deficiencies are not currently approved for use by NCRR or NSR.)

#### 5.5.3 Super Elevation

All curves shall be super elevated in accordance with NS Standard Plan 7-2. The actual super elevation for any curve shall not exceed 4” on tracks carrying only freight trains and 5” on tracks with passenger train operations. Where both freight and passenger trains operate on the same track, the higher super elevation is to be used.



Super elevation shall be completely transitioned (runoff) linearly within the length of the spiral. The super elevation transition (runoff) may not occur in tangent track.

Super elevation is determined by the formula:

$$E_a = .0007 V^2 D - E_u,$$

Where

$E_a$  = actual super elevation (inches)

$V$  = design speed (miles per hour)

$D$  = degree of curvature (chord definition)

$E_u$  = unbalanced elevation (inches)

The elevations indicated on NS Plan 7-2 are calculated on the basis of 1½” or 2” unbalanced elevation for freight trains and 3” unbalanced elevation for passenger trains.

Yard and storage tracks shall not be super elevated.

#### 5.5.4 Spirals

A spiral shall be used for all curves between tangent and circular curve or between the different degrees of curvature of a compound curve in accordance with AREMA Chapter 5, Section 3.1 and NS Plan 7-2, Super elevation of Curves for Maximum Speeds. The desirable length of a spiral curve shall be the greater of the lengths determined from the following formulae:

$$(1) L_s = 1.63 E_u V \text{ or } L_s = 62 E_a,$$

Where:

$L_s$  = spiral length (feet)

$E_a$  = actual super elevation (inches)

$E_u$  = unbalanced elevation (inches)

$V$  = design speed (miles per hour)

The length of spiral generated through the use of formula (1) above may result in unreasonably long spirals, in which case the spiral lengths may be calculated with the use of formula (2) below with the approval of NCR and NSR.

The absolute minimum length of a spiral curve shall be:

$$(2) L_s = 1.22E_uV.$$

At locations where passenger trains operate, spiral lengths shall be calculated based upon a design speed of 80 MPH, or the maximum speed achievable at up to 5” cant deficiency. Spiral lengths may be based upon a design speed of 90 MPH to facilitate increasing the passenger train speed in the future with the approval of NCR and NSR.

It is desirable for spiral lengths to be in increments of 31’.

## 5.6 Vertical Geometry

Track grades should be kept to a minimum. The desirable maximum grade for main tracks shall be 1.0% (compensated). Where an additional main track is being designed adjacent to an existing main track, the design profile shall follow, but not exceed, that of the existing track.

The maximum grade is 2.0% (compensated) on lead tracks and 3.0% (compensated) on individual spur tracks.

Yard and storage tracks shall have a desired maximum grade of 0.0% and an absolute maximum grade of 0.25%.

The low rail (inside rail) on curves shall be maintained as the profile grade. At highway and private road crossings the top of rail gradient shall be constant for all tracks where practicable.

All changes in gradients shall be made using vertical curves and shall be in accordance with AREMA Chapter 5, Section 3.6. The minimum length of vertical curve shall be determined by using the following AREMA formula:

$$L = D \times V^2 \times K / A$$

Where:

L = Minimum length of vertical curve (feet)

A = Vertical acceleration in ft/sec<sup>2</sup>

= 0.10 ft/sec<sup>2</sup> (freight train)

= 0.60 ft/sec<sup>2</sup> (passenger train)

D = Absolute value of the difference in rates of grades expressed as a decimal

K = 2.15 (Conversion factor to give L in feet)

V = Speed of the train (miles per hour)

The absolute minimum length of vertical curve shall be:

- Main tracks: 200'
- Lead tracks: 100 times the algebraic difference of grades in percent for summits and sags.
- Spur tracks up to 1500' in length: 33.3 times the algebraic difference of grades in percent for summits and 40 times the algebraic difference for sags.
- Spur tracks over 1500' in length: 40 times the algebraic difference of grades in percent for summits and 50 times the algebraic difference for sags.

Vertical curves shall be separated by a vertical tangent segment of track with a minimum length of 100'.

Permanent adjacent main tracks shall not be constructed with more than 6" difference in elevation in tangent track.

### 5.6.1 Compensated Grades

Grades shall be compensated due to horizontal curvature at the rate of 0.04 percent per degree of curvature.

## 5.7 Turnouts and Special Trackwork

### 5.7.1 General

Turnouts shall not be located on either horizontal or vertical curves unless approved by NCRR and NSR.

No. 8 through No. 20 turnout geometry shall be in accordance with NS Plan 2-17: Data on Turnouts and Crossovers, Return Curves and Ladders.

No. 24 turnouts shall be in accordance with this Design and Construction Policy Manual.

### 5.7.2 No. 8 Turnouts

No. 8 turnouts are generally used on industrial and yard tracks. No. 8 turnouts shall not be used in main tracks unless approved by NCRR and NS.

No. 8 turnouts shall be in accordance with NS Plans as follows:

- Plan No. 2-3: No.8 132/136 Turnout with 16' 6" Switch, S.M.S.G.
- Plan No. 2-3: No.8 132/136 Turnout with 16' 6" Switch, S.M.S.G. and Switch Point Guard

### 5.7.3 No. 10 turnouts

No. 10 turnouts are generally used to connect main tracks to sidings and industrial tracks and to connect siding and industrial tracks. No. 10 turnouts in main tracks shall be designed for use with spring frogs.

No. 10 turnouts shall be designed in accordance with NS Plans as follows:

- Plan 2-6: No. 10 132/136RE Turnout with 16' 6" Switch and Solid Manganese Self Guarded Frog for Yards.
- Plan 2-7: No. 10 132/136RE Turnout with 16' 6" Switch and Rail Bound Manganese Frog.
- Plan 2-8: No. 10 13 /136RE Turnout with 16' 6" Switch and Spring Frog.

### 5.7.4 No. 15 Turnouts

No. 15 turnouts are generally used to connect main tracks.

No. 15 turnouts shall be designed in accordance with NS Plans as follows:

- Plan No. 2-11: No. 15 132/136RE Turnout with 30'-0" Switch
- Plan No. 2-12: No. 15 132/136RE Turnout with 30'-0" Switch.

### 5.7.5 No. 20 turnouts

No. 20 turnouts are used to connect main tracks.

No. 20 turnouts shall be designed in accordance with NS Plan No. 2-15: No. 20 132/136RE Turnout with 39'-0" Switch.

#### 5.7.6 No. 24 Turnouts

No. 24 turnouts may be used to connect main tracks on lines with passenger rail operations. The design of the turnout shall permit a diverging speed of 60 mph for passenger trains with 3" unbalance super elevation. No. 24 turnouts shall only be used with the approval of NCRR and NS.

### 5.8 Derails

Derails will be installed on sidings, industry tracks and storage tracks that have a descending gradient toward the main track and other tracks which require this protection. Derails may be sliding derails or split switch derails depending upon the gradient.

A double switch point derail will be installed at the 15' clear point of a track which has a descending grade toward the main track. The entire double switch point derail shall be installed on tangent track.

A double switch point derail shall be installed on any track that handles hazardous materials.

Derails should be installed with a minimum 15' track centers where conditions permit. On sections of the railroad where tracks exist with closer clearances, derails are installed at the normal clearance point (location where the adjacent track becomes parallel) but in no event less than on 12' track centers.

### 5.9 Bumping Posts

Industrial and side tracks with bumping posts or earth mounds located at the end of track should be lined away from the main track for the last 100' to prevent a derailed car from fouling the main.

### 5.10 Typical Sections

The typical roadbed section shall be in accordance with NSR Standard Plans as follows:

- Plan 1-19: Roadbed Section, Double Main Tracks
- Plan 1-20: Roadbed Section, Single Main Track
- Plan 1-21: Roadbed Section, Heavy Tonnage Tracks Other Than Main Tracks
- Plan 1-22: Roadbed Section, Industrial Tracks
- Plan 1-23: Roadbed Section, New Siding Parallel to Existing Single Main Line

### 5.11 Track and Roadbed - Materials and Construction

The furnishing of materials to be incorporated into the track structure and the construction of railroad roadbed and trackwork shall be in accordance with the requirements of NCRR and NSR.

The materials and construction referenced herein are in accordance with Norfolk Southern's Standard Specifications for Materials and Construction, dated November 2017 or current version.

All materials for the construction of mainline and siding tracks shall be new. Good relay materials may be permitted for the construction of industrial tracks only.

#### 5.11.1 Subgrade

Subgrade shall be constructed to the elevations indicated on the typical roadbed sections and the specific project cross sections. Subgrade shall be graded and compacted to the requirements of Specification Section GR – Grading.

#### 5.11.2 Sub-ballast

Dense graded aggregate in accordance with the requirements of NS Standard Specification Section GA – Graded Aggregate shall be furnished for sub-ballast material.

The gradation shall meet the requirements of Appendix A, Table 2 of NS Standard Specification Section GA. The gradation may be modified at the discretion of the NCRR or NS to accommodate locally produced dense graded aggregate that complies with North Carolina Department of Transportation specifications.

#### 5.11.3 Stone Ballast

Stone ballast shall be in accordance with the requirements of NS Standard Specification Section BA – Ballast.

Mainline ballast shall comply with the NS modified AREMA gradation No. 3 as shown in Appendix A, Table 1 of NS standard Specification Section BA.

Yard ballast shall comply with AREMA gradation No. 5 as shown in Appendix A, Table 1 of NS Standard Specification Section BA.

#### 5.11.4 Cross Ties

Ties in main tracks and controlled sidings shall be treated hardwood. Concrete ties may be used only with the approval of NCRR and NS.

Ties in yard tracks and non-sigaled sidings may be treated hardwood, concrete, or steel.

##### 5.11.4.1 Wood Ties

Wood ties shall be 7" high x 9" wide x 8' 6" long. Normal tie spacing is 20" center to center.

Wood ties shall be in accordance with Norfolk Southern Specification NS RT003 – Wooden Crossties.

#### 5.11.4.2 Wood Switch Ties

Wood switch ties shall be in accordance with Norfolk Southern Specification NS RT005 – Wooden Switch Ties.

#### 5.11.4.3 Concrete Ties

(To be developed)

#### 5.11.4.4 Steel Ties

(To be developed)

### 5.11.5 Fasteners and Other Track Material

Fasteners (cut spikes, screw spikes, bolts, nuts and washers) and other track material (joint bars, rail anchors, and tie plates) shall be new and shall be compatible with the rail section.

- Spiking details shall be in accordance with Norfolk Southern Plan No. 7-03: Track Spiking Pattern.
- Rail anchoring shall be in accordance with Norfolk Southern Plan No. 7-04: Rail Anchoring Pattern.
- Joint bars for 132/136RE rail shall be in accordance with Norfolk Southern Plan No. 1-15.
- Bolts, nuts and washers shall be in accordance with Norfolk Southern plan Nos. 1-04 through 1-04g.
- Rail anchors shall be in accordance with Norfolk Southern Specification NS RT001 – Rail Anchors.
- Track spikes shall be in accordance with Norfolk Southern Specification NS RT002 – Soft Steel Track Spikes and NS Plan No. 1-03.
- Screw spikes shall be in accordance with Norfolk Southern NS Plan No. 1-03.
- Tie plates shall be in accordance with Norfolk Southern Specification NS RT010 – Tie Plates.

### 5.11.6 Running Rail

NCRR tracks including main tracks, sidings, and yard tracks will be constructed with continuous welded rail and strings shall be joined by field welding. Running rail for new track construction shall be 136 pounds per yard RE section continuously welded rail (CWR).

Good relay rail may be used for siding and yard tracks with the approval of NCRR and NSR.

Running rail shall be in accordance with Norfolk Southern Specification NS RT002 – Steel Rails.

#### 5.11.7 Special Trackwork

Special trackwork materials shall be new.

#### 5.11.8 Track Construction

Track construction shall be in accordance with the Project Specifications and Norfolk Southern's Standard Specifications for Materials and Construction.

Underground and overhead signal wires and cables shall be protected in place except with the approval of the Railroad's signals and communication designers.

#### 5.11.9 Connections to Industrial Tracks

Connections to industrial tracks shall be designed and constructed in accordance with the requirements of NCRR and NSR.

### 5.12 Civil Site Construction

#### 5.12.1 Gates

Right of Way gates shall be furnished and installed in accordance with Norfolk Southern Plan No. 7-11. Location of gates shall be as determined by NCRR and NSR.

#### 5.12.2 Signs

No trespassing signs shall be furnished and installed as directed by NSR and NCRR. Signs shall be similar to NS Plan No. 6-21 or as may be otherwise approved by NCRR. Sign post and attachment details shall be in accordance with NS Plan No. 6-20.

### 5.13 Drainage

One of the most important elements of the track structure is drainage. Therefore, new and replaced culverts shall be designed with the completion of a hydraulic survey and consultation with NS as the freight operator and NCRR. The culverts shall be designed and constructed to accept a 100 year storm.

All culverts must have head walls. Open cutting under the track will only be permitted if railroad traffic can be detoured or discontinued. Jacking or boring shall be under the direction of a qualified engineer. During such operations care must be taken to prevent settlement or degradation of the track structures.

Culverts should be placed so there is a minimum of 12" between top of culvert and bottom of the tie. This may require use of box culverts, elliptical culverts or more than one pipe.

#### 5.13.1 Ditches

Ditches shall be constructed as shown on the roadbed sections and in accordance with Norfolk Southern standard Specifications for Material and Construction Section DR - Drainage.

### 5.13.2 Culvert Pipes

Culvert pipes shall be constructed as shown on the roadbed sections and in accordance with Norfolk Southern Standard Specifications for Material and Construction Section DR – Drainage and the following:

- Norfolk Southern Guidelines for Under Track Culverts
- Norfolk Southern Corrugated Metal Culvert Gage selection and Installation
- Norfolk Southern Installation Instructions, Corrugated Metal Pipe Culverts.

Concrete pipes are not permitted beneath tracks.

Minimum size of culvert pipe under main tracks shall be 36". All culvert pipes shall have headwalls on both the inlet and outlet ends.

Bore and jack method of construction should be considered for installation of culvert pipes under main tracks for continuous maintenance of rail traffic. Heavy gauge steel casing pipe should be used for culverts installed by bore and jack method.

## 5.14 Structures

New or rebuilt undergrade bridges must have walkways and hand rails. The transition from bridge walkways to railroad roadbed shall provide a secure path for walking.

Undergrade bridges must be designed and constructed with ballasted decks. No open deck bridges are permitted without the approval of NCR and NS.

Retaining walls shall be designed and built to Norfolk Southern specifications. They shall be located to the greatest extent possible such that the construction of future additional tracks will require minimal modification of the retaining walls.

## 5.15 Passenger Facilities

The planning, design and construction of passenger station facilities, including inter-city rail, high speed rail, and commuter rail, shall be in compliance with the requirements of the passenger system operator and the following:

- Americans with Disabilities Act requirements
- Norfolk Southern
  - Passenger Station Requirements
  - Public Projects Manual
  - Standard Plans and Specifications
- Amtrak
  - Station Program and Planning Guide
  - Graphic Signage and Standards Manual
- North Carolina Railroad Company
  - NCR/NSR – Special Provisions for Protection of Railway Interests
  - Specifications for Wire, Cable and Conduit Occupations of NCR Property
  - Specifications for Pipeline Occupancy of NCR Property



- Specific requirements of NCRR for Work On Its Right of Way
- NCRR Engineering Guidelines
- American Railway Engineering and Maintenance of Way Association (AREMA)
  - Manual for Railway Engineering

High level platforms shall not be placed adjacent to main tracks utilized by freight traffic.

In locations where low level platforms are placed on the outside of two main tracks an inter-track fence is to be installed. This fence should be removable to facilitate track work and tie renewal.

### **5.16 Signal and Communication**

Signal and communication systems design criteria are not specified herein but are as required by the operating railroad. Track design shall be coordinated with the railroad signal requirements.

Insulated joints are considered to be part of track systems.

Switch machines and operating rods to the point of connection to the basket are considered to be part of signal systems.

Track and civil designs shall incorporate features to support the installation of signal equipment and bungalows, including but not limited to, graded pads and walkways.