TRACK DESIGN SPECIFICATION

Scope: This specification is for use by non-Amtrak professional engineers designing railroad rights of way and track alignments. Although many of the requirements are common to most railroads, some are more closely allied with the needs associated with passenger service.

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1. Definitions and Abbreviations

1.1. The following abbreviations are used throughout this document:

A	vertical acceleration
AREMA	American Railway Engineering and Maintenance of Way Association
CAD	computer aided design
CMPF	curved, movable point frog
CONC	concrete ties
CR	crotched
C.S.	curve to spiral
CSI	Construction Standards Institute
C.T.	curve to tangent
D_c	degree of curve
E_a	actual superelevation
E_e	balanced superelevation
EQ	equilateral turnout
E_u	underbalance
(F)	freight
H	horizontal
L	length of vertical curve
L_c	length of horizontal curve
L_s	length of spiral
LH	left-hand
LLT	last long tie in a turnout
MPF	movable point frog
mph	miles per hour
(P)	passenger
P.C.	Point of curve
P.C.C.	point of compound curve
P.F.	½” point of frog
P.I.T.O.	turnout point of intersection
P.S.	point of switch
PSI	pounds per square inch
P.T.	point of tangent
P.V.C.	point of vertical curve
P.V.I.	point of vertical intersection
P.V.T.	point of vertical tangent
‘r‘	rate of change of grade in a vertical curve
R	radius
RBM	rail-bound manganese
RH	right-hand
S.C.	spiral to curve
SF	spring frog
SG	self-guarded
SMPF	straight, movable point frog
S.T.	spiral to tangent
T	tangential geometry
T.C.	tangent to curve
T.O.P.I.	turnout point of intersection
TPF	theoretical point of frog
T.S.	tangent to spiral
V	vertical or velocity
V_{max}	maximum velocity

1.2. Distances shall be shown in inches, feet or miles, as appropriate.
Velocity shall be miles per hour (mph).
Angles and degrees of curve shall be shown as Degrees, Minutes, and Seconds. Minutes and Seconds shall be shown with two digits each, with the first digit a zero for numbers less than 10.
Grades shall be shown in percent as determined by dividing the number of units of rise per 100 units of run.
Slopes shall be shown as units of run per unit of rise so that a 2:1 slope would have two feet of run for every foot of rise.

1.3. The English system of measurement was used for creating Amtrak’s standards. When a dimension is converted from one system to another, the converted dimension must not jeopardize safe and reliable construction and operation. As an example, if the original minimum dimension of something is 10 feet, the conversion to metric of 3 meters would be 1.9

inches less than the specified minimum of 10 feet; “3 meters” would not necessarily be a satisfactory conversion.

2. Roadbed

2.1. Cross Section

2.1.1. Roadbeds, embankments and excavations should be constructed in accordance with Amtrak Standard Plan AM 70003.

2.1.2. The minimum width at the top of the subgrade based on 14 foot track centers is:

Number of tracks	1	2	3	4
Required width (feet)	40	54	68	82
NOTE: The dimensions noted above must be increased where track centers more than 14 feet are used. (See Section 4.11.)				

2.1.3. On curves, the widths must be increased as prescribed on Amtrak Standard Plan AM 70003.

2.1.4. The required width at the top of the subgrade for the addition of a track adjacent to an existing track, measured from the centerline of the existing track, is the distance between the centerlines of the existing and the new track (14 feet minimum track centers) plus 19.75 feet to the top of the slope of the adjacent ditch in cut sections or the top of the slope in embankment sections.

2.2. Subgrade

2.2.1. Generally, the subgrade must meet the local state’s DOT highway specifications for suitability of materials, compaction, and stability. In addition to the state DOT’s requirements, the following will also be required for new construction.

2.2.2. In areas where there has been a history of stability problems on adjacent tracks, subsurface investigations and / or ground-penetrating radar (GPR) added by William Pagano on 6-1-13 should be used to determine the cause of the instability and take corrective action to prevent the same occurrence in the proposed track.

2.2.3. If the subgrade contains unsuitable material, it should be removed and replaced with an approved backfill material. The use of a geo-synthetic or other geotechnical measures may be considered as an option if the depth of removal of unsuitable material is determined to be economically unfeasible or could cause service disruptions to the adjacent track or damage to an existing structure.

2.2.4. Usually, if the subgrade is soft, the soil is high in organics, clay or silt material and water. The ability of the soil to support the repeated movement of construction equipment is usually determined by the amount of moisture present and if the soil is moisture sensitive. If the area of the proposed track construction is in a cut section, placement of perforated drainpipes (either longitudinal and / or perpendicular) should be considered for use in addition to the adjacent ditches before the placement of the subballast.

2.2.5. The top of the subgrade must be graded so that there is a slope of 2% towards the adjacent ditch or embankment slope. In single or multiple new track construction, the subgrade must be crowned in the center of the embankment in tangent construction. On curved track, the subgrade construction must reflect the direction and amount of super-elevation of the proposed track but in no case be less than a 2% slope. Where a track is to be added to an existing track bed, the subgrade must be graded on a 2% slope to the adjacent ditch in cut sections or to the top of the adjacent subgrade slope in embankment sections.

2.2.6. A flat-bottomed drainage ditch must be provided adjacent to the outside track in cut sections. The slopes down to the flat-bottomed ditch are to be configured on a 2H:1V grade. The ditch is to be sized to handle the designed storm flows specified in Section 2.5. The depth of the bottom of the ditch to the top of the subgrade below the subballast, or ballast if no subballast is specified, must be at least 12 inches.

2.2.7. In sinkhole prone areas, the ditches must be lined with an impermeable material.

2.2.8. All soil, subballast, and ballast slopes are to be designed no steeper than 2H:1V and constructed along a uniform slope. All rock cut slopes must have a pre-split face, a catchment ditch at the base of the slope designed to prevent rock falls from bouncing or rolling onto the tracks, and offset as far as practical from the proposed tracks.

2.2.9. A diversion ditch is to be provided on the top of all slopes that are up-gradient of tracks to prevent storm water from washing over the slopes

2.3. Subballast

2.3.1. Standard Amtrak Subballast (Amtrak's Specification 57 Subballast Specification (Generic)) is required in new track construction when any one of the following is present:

2.3.2. Poor drainage, such as standing water in ditches, and no drainage improvements are anticipated.

2.3.3. The existing subgrade soils contain soil fines in excess of 5% passing the # 200 sieve.

2.3.3.1. The existing subgrade soils contain cinders or coal dust in excess of 10% passing the # 40 sieve.

2.3.3.2. The subgrade soils are moisture sensitive (e.g., frost heave, expansive soils, etc.).

2.3.3.3. The existing site is subject to a seasonal high or perched water table.

2.3.3.4. The subgrade soils exhibit bearing capacity insufficiencies or stability problems including pumping, rutting, and weaving.

2.3.3.5. The compacted subgrade has a bearing capacity of less than 40.The required thickness of the subballast is generally 12 inches depending on the anticipated load. The compacted subballast should never be less than 8 inches thick unless a geotechnical investigation and analysis so indicates.

2.3.5. Where the subgrade is soft or yielding, corrective action of the subgrade soils will be required regardless of whether or not subballast is used.

2.3.6. Subballast must be placed so that the bottom of the subballast is sloped 2% towards the adjacent ditch or embankment slope. In single or multiple new track construction the subballast may be crowned in the center of the embankment in tangent construction. The requirement of the crown in the subballast may be omitted if the subgrade is crowned. On curved track, the subgrade and subballast construction must reflect the direction and amount of super-elevation of the proposed track but in no case should the slope of the subballast be less than 2%.

2.4. Ballast

2.4.1. Ballast used in new track construction must meet either Amtak's Specification 200: Ballast- Specification for Purchase Main Line Track, or Amtrak's Specification 201: Ballast- Specification for Purchase Yard and Siding.

2.4.2. Ballast and sub-ballast cross sections shall conform to Amtrak Standard Track Plan AM 70003. 12" shoulders, 2:1 slopes.

2.4.3. The ballast layer must be at least 12 inches thick under wood ties and 15 inches under concrete ties. Per LAB 3-10-03 These thicknesses may be increased if conditions warrant, or decreased if a geotechnical investigation and analysis so indicates.

2.4.4. In areas where track is to be rehabilitated, the existing ballast should be cleaned so that a thickness of 12 inches of clean ballast will exist under wood ties and 15 inches under concrete ties.

2.4.5. On bridge decks where ballast mats are used the ballast depth may be reduced upon review and approval of the Deputy Chief Engineer Track on a case by case basis.

2.5. Drainage

2.5.1. Drainage facilities, at a minimum, shall conform to Amtrak Standard Track Plan AM 70003 and to Amtrak's Specification No. 150, "Stormwater Management Policy".

2.5.2. Drainage facilities must be designed for a storm with a 100-year recurrence interval.

3. Right-of-Way

3.1. Highway Grade Crossings

3.1.1. Grade crossing should be avoided or eliminated wherever possible. Grade crossings create potential hazards both to the public and to the railroad, are costly to construct, and difficult to maintain.

3.1.2. Public and private grade crossings are to be constructed in accordance with Amtrak Track Standard Plans and Engineering Practices and AASHTO and state highway specifications.

3.1.3. New crossings should be constructed with continuous welded rail.

3.1.3.1. Continuous welded rail shall extend a minimum of 120 feet on both sides of grade crossings.

3.1.3.2. Bonded insulated joints are preferred.

3.1.3.3. Because grade crossings must have an elevation that is fixed by both the track and the road, track must be surfaced to make a smooth approach to the crossing. Designers should provide a track approach length of at least 100 feet without other surface-limiting items such as open deck bridges, turnouts or station platforms.

Similarly, the driving surface of the road must be in the same plane as the tops of rails. The profile gradient on the road may need modifying so that it approaches 0% when crossing tangent track or a steeper grade when crossing super-elevated track. The angle of the crossing will also affect the gradient adjustment.

3.1.4. The desired type of grade crossing material varies with local conditions and the density of use. Light duty crossings such as private crossings, yard and shop crossings without excessive petroleum drippings should be asphalt with flangeway timbers per Amtrak Standard Plan AM 70123. Light duty crossings - with excessive petroleum dripping in shop areas should be concrete panel sections. Asphalt-surface crossings should have extruded rubber flangeways. Heavy duty and public crossings should be rubber or concrete panels as approved.

3.2. Right-of-Way Fencing

3.2.1. Fencing shall be for safety and security purposes. For specific design purposes, refer to Amtrak's Structures Department.

3.3. Inter-track Fencing

3.3.1. The fence is to be installed as shown on the appropriate Structures Department standard plans and in accordance with the clearance diagram in Amtrak Standard Track Plan AM 70050.

4. Track Geometry

4.1. Gauge

4.1.1. The standard gauge for track, measured between the running rails at right angles to the alignment of the track 5/8" below the top of rail, is 56-1/2".

4.1.2. The Deputy Chief Engineer Track must be consulted to determine the gauge on curves over 13° and through turnouts less than No. 8.

4.2. Horizontal Alignments

4.2.1. Horizontal alignment is the physical appearance of the railroad in plan view, consisting of a series of straight lengths of track, referred to as tangents, connected by simple, compound, reverse, and transition (spiral) curves.

4.2.2. Clearances along proposed alignments must meet minimum roadway clearances prescribed in Amtrak Standard Track Plan AM 70050.

4.2.3. At locations where a new alignment is proposed for existing track, both the proposed and existing track alignments must be determined and shown on the plans.

4.2.4. At locations where a new alignment connects to an existing track, the existing alignment must be shown for a distance of 200 feet or three times the maximum authorized train speed [mph], whichever is greater, beyond the point of connection. For example, an intended speed of 90 mph would therefore require alignment information along the existing track for at least 270 feet beyond the point of connection to the proposed track.

4.2.5. Tangents and the constant-radius portions of horizontal curves must have a minimum length, measured in feet, of three times the maximum velocity in miles per hour or 100 feet, whichever is longer.

4.3. Curves

4.3.1. Curves shall be designated by the chord method of degree of curve. The degree of curve is the angle subtended by the radii at both ends of a 100-foot long chord.

The radius (R) [feet] for a given degree of curve is: R = 50 / (Sine (Dc / 2)).

The degree of curve (Dc) [degrees] for a given radius (R) is: Dc = 2 Arcsine (50 / R).

4.3.2. The length of a curve (L_c) is determined using the number of 100 foot long chords in the curve, not the arc length. The formula for a simple curve is $L_c = 100\ \Delta / D_c$.

4.3.3. No curves shall be constructed or realigned resulting in smaller than existing radii. Every opportunity should be taken to lessen curvature.

4.3.4. In yards and sidetracks, the minimum radius of curvature shall be 459.28 feet (maximum curvature 12°-30'). The tangent distance between reverse curves or facing same hand turnouts shall be no less than 100 feet. The minimum distance along the tangent between two adjacent curves should be the greater of 100 feet of tangent track (with zero cross-level throughout) and three times the velocity (expressed in miles per hour).

4.3.5. The minimum distance along the tangent between a point of switch and the beginning of an adjacent spiral should be the greater of 100 feet and three times the velocity through the diverging side of the turnout (expressed in miles per hour). In track with direct-fixation and where the curve is in the same direction as the diverging side of the turnout, this distance may be reduced to ten feet.

The minimum distance along the tangent between the last long tie on the straight side of a turnout and the beginning of an adjacent spiral should be 100 feet. In track with direct-fixation, this distance may be reduced to ten feet beyond the heel of the frog.

4.3.6. Curves must be whole numbers of degrees, minutes, and seconds. The practice of specifying a radius and then determining the resulting degrees, minutes, and seconds (and thereby creating fractional seconds) is not acceptable. Wherever possible, the degrees of curves should be simplified so that the seconds are zero and the minutes are zero or multiples of five.

4.4. Curve Descriptions

4.4.1. Details of curves (or each segment of a compound curve) must be shown on the drawings and must include the following information:

For the overall curve, details must include:
Design speed (mph)
Overall delta including all spirals and all simple curves (degrees, minutes, and seconds)
Length from T.S. (or T.C. (P.C.)) to S.T. (or C.T. (P.T.)) (feet)

For simple curves or the simple curve portion of a spiraled curve, details must include:
Degree of curve (degrees, minutes, and seconds)
Delta (degrees, minutes, and seconds)
Radius of centerline of track through the curve (feet)
Tangent distance (feet)
Length of curve (feet)
Actual super-elevation, E_a, (inches)
Underbalance for both the highest and lowest classes of trains, E_u, (inches)

For spirals, the following information must be provided:
Spiral length (feet)
Super-elevation runoff rate (inches per 31 feet)
Jerk rate $\left(\dfrac{Length\ of\ Spiral}{Speed * Underbalance}\right)$
Spiral delta (degrees, minutes, and seconds)

4.4.2. Control points such as the tangent-spiral (T.S.), spiral-curve (S.C.), point of compound curve (P.C.C.), curve-spiral (C.S.), spiral-tangent (S.T.), point of tangent (P.T.), and point of curve (P.C.) must be shown on drawings. A table showing the baseline stations and offsets of each of these points should be included.

4.5. Compound Curves

4.5.1. The desirable minimum length in feet of each element of a compound curve (each segment that has a constant degree of curve) is three times the maximum velocity in miles per hour or 100 feet, whichever is longer.

4.5.2. Compound curves should be designed so that the underbalance is constant throughout the curve between the initial S.C. and the final C.S. The change in superelevation between one constant-radius portion and the next must be accomplished in a spiral that meets the requirements detailed in section 4.9.

4.5.3. Compound curves with small differences in the degree of curve should be re-designed so that a non-compounded curve with a single degree of curve is used.

4.6. Superelevation

4.6.1. Superelevation is the vertical distance of the outer rail of a curve above the inner rail. It is provided to overcome or partially overcome the effects of curvature and speed.

4.6.2. Equilibrium superelevation, E_e, is that elevation that exactly overcomes the effect of negotiating a curve at a given speed and degree of curvature, by placing the resultant of the centrifugal force and normal force created by the weight of the equipment in a direction perpendicular to the plane of the track.

4.6.3. Superelevation on the outside rail of a curve shall not exceed 5 1/2 inches. Alignments that include curves greater than 3° or that have superelevation greater than 4 inches should be avoided wherever freight trains are operated. Superelevation in these areas should be limited by increasing the underbalance where possible.

4.6.4. All curves should have at least ½ inch of superelevation with the following exceptions:
a. Curves that are no sharper than 0°-15' may have a minimum of ¼ inch superelevation if the resulting underbalance is not less than 0;
b. Curves that have less than ¼ inch of balanced elevation (Ee) should have no superelevation thereby making the outside rail the line rail;
c. Curves that connect the diverging sides of turnouts with tracks that are parallel to the normal side of the turnout may have no superelevation.

4.6.5. Superelevation runoff must be at a constant rate and should be completely bounded by the limits of the spiral. All exceptions must be approved by the Deputy Chief Engineer Track.

4.7. Underbalance and Overbalance

Underbalance (cant deficiency), Eu, is the amount of superelevation less than equilibrium superelevation for any given combination of speed and curvature. The maximum allowable amounts of underbalance on the Northeast Corridor are: **East End between New Haven, CT and Boston, MA**			
Timetable Column	Equipment and conditions	Maximum E_u	Maximum Speed (mph)
A	Acela with tilt active on tangents and curves up to 0°-16'	7"	150
A	Acela with tilt active on curves greater than 0°-16'	7"	130
B	Acela with tilt disabled, AEM7, HHP, F40, Amfleet, Horizon, and Capitoliner cars on tangents and curves up to 0°-16'	5"	150
B	Acela with tilt disabled, AEM7, HHP, F40, Amfleet, Horizon, and Capitoliner cars on curves greater than 0°-16'	5"	130
C	Any passenger car not meeting A, B or D	4"	110
D	Mail and express cars	3"	90
E	Freight	1.5"	50
West and South End between New Rochelle, NY and Washington, DC			
Timetable Column	Equipment and conditions	Maximum E_u	Maximum Speed (mph)

A	Acela with tilt active on tangents and curves up to 0°-16’	7”	135
A	Acela with tilt active on curves greater than 0°-16’	7”	130
B	Acela with tilt disabled, AEM7, HHP, P32, P40, P42 Amfleet, Horizon, and Capitoliner cars on tangents and curves up to 0°-16’	5”	135
B	Acela with tilt disabled, AEM7, HHP, P32, P40, P42 Amfleet, Horizon, and Captioliner cars on tangents and curves greater than 0°-16’	5”	130
C	Any passenger car not meeting A, B or D	4”	110
D	Mail and express cars	3”	90
E	Freight	1.5”	50

For other areas, the maximum underbalance will be specified in the project documents.

4.7.1. Overbalance is the amount of a superelevation that exceeds equilibrium elevation and is produced by the operation of a train around a curve at less than equilibrium speed.

4.7.2. Curves on open deck bridges should not have more than 5 inches of underbalance.

4.7.3. Curves through grade crossings should not have more than 5 inches of underbalance.

4.7.4. The outside rail of a curve may not be lower than the inside rail.

4.8. Speed

4.8.1. Operating speed is as specified in the project documents.

4.8.2. Curves must be designed so that a train moving five miles per hour faster than the operating speed will be able to safely negotiate the curve. (The maximum underbalance experienced must be no greater than is allowed for the type of equipment. The curve length, spiral length and jerk rate must be designed for the operating speed, but not necessarily for the five miles per hour increase.)

4.8.3. Curves that are designed to meet the operating speed must be maintainable without requiring frequent slow-orders necessitated by track cross-level or alignment deficiencies. The design must not use the maximum limits of both superelevation and underbalance in combination in the same curve. The actual superelevation (Ea) added to the underbalance (Eu) must be at least 1 inch less than the sum of the maximum allowable superelevation and the maximum allowable underbalance for the type of equipment specified.

4.8.4. Speeds shall be computed using the following formula:

V_{max} = Maximum allowable operating speed [mph] = $\sqrt{\frac{E_a + E_u}{0.0007D}}$

E_a = Actual superelevation of the outside rail [inches]

E_u = Underbalance [inches]

D_c = Degree of curvature [degrees]

Example: Find the maximum allowable operating speed for a 1°-15' curve with 2-1/2" of actual superelevation (E_a) and 3" of underbalance (E_u).

$$V_{max} = \sqrt{\frac{E_a + E_u}{0.0007D}} = \sqrt{\frac{(2.5)+(3.0)}{0.0007(1.25)}} = \sqrt{\frac{5.5}{0.000875}} = \sqrt{6285.71} = 79.28 \cong 79 \text{ mph}$$

4.9. Spirals

4.9.1. Spirals shall be provided at the ends of simple curves and between segments of compound curves.

4.9.2. A spiral should be used so that the degree of curvature and the amount of elevation at any point will change uniformly.

4.9.3. Superelevation runoff must be at a uniform rate and must extend the full length of the spirals.

4.9.4. The length of spiral needed to accommodate the minimum elevation runoff may not be sufficient to provide the desired ride quality. The minimum spiral length for comfortable high-speed train operation should be determined from the formula, $L_s = 1.63\ E_u\ V_{max}$.

L_s = Minimum desirable length of spiral [feet].
E_u = Underbalance [inches].
V_{max} = Maximum authorized train speed [mph].

4.9.5. The change in superelevation should be in uniform increments, and the rate of change per 31 feet of track should not be more than the following:

Change in Superelevation	
Track Class	**Maximum Rate of Change (inch)**
1-3	1/2
4-7	3/8
8-9	¼

4.9.6. Main line spiral lengths shall be integer multiples of 31 feet and shall be at least 62 feet long. In track with direct-fixation, the spiral length does not have to be 62 feet long and does not have to be in integer multiples of 31 feet.

4.9.7. Spirals should use the equations published by the American Railway Engineering and Maintenance of Way Association, Chapter 5, Part 3.1.4.

4.10. Angle Points

4.10.1. <u>Definition</u>: Angle points are the points where two elements of an alignment (tangents, spirals curves and turnouts) intersect each other as opposed to becoming co-linear.

4.10.2. Angle points must be avoided wherever possible, and are not considered to be a part of acceptable designs. As such, a formal request for a Design Exception must be made to Amtrak for each angle point, with the reason and justification for the angle point clearly described. These requests may be denied.

4.10.3. Angle points must never be used if a turnout, curve or a spiral is involved.

4.10.4. Angle points between two tangents must not be used unless the use of a properly-designed curve is impossible.

4.10.5. The angle between two tangents at an angle point must not exceed the values in the following table:

Angle Points between Tangents		
Track Class:	**Max. Speed**	**Maximum Angle**
1	15	0°-30'-00"
2	30	0°-20'-00"
3	60	0°-11'-00"
4	80	0°-7'-00"
5	90	0°-5'-30"
6	110	0°-4'-00"
7	125	0°-3'-00"
8	160	0°-2'-00"
9	200	0°-1'-30"

4.10.6. Successive angle points must be separated by the greater of 100 feet and 6 V where V is the maximum authorized speed [mph].

4.11. Track Centers

4.11.1. Track centers, including equivalent centers on curves, must not be reduced below the minimum established for the territory.

4.11.2. The following track centers should be used on tangents and then increased for curves:

Track Centers	
Between:	**Track Centers on Tangents**
Adjacent Main, Yard, Industrial and other Side Tracks where the speed is 80 mph or less	14 feet
Adjacent Main Tracks where the speed is between 80 mph and 125 mph	15 feet
Adjacent Main Tracks where the speed is 125 mph or more	16 feet
Main Track and any adjacent track, other than another main track or a yard ladder track	17 feet
Secondary, Running, Industrial or Passing Track and any adjacent track, other than a yard ladder track	17 feet
Yard Ladder Track and adjacent track, except other yard ladder	18 feet
Adjacent Yard Ladder Tracks	19 feet

4.11.3. Equivalent track centers: On curves, to provide clearance between cars and locomotives equivalent to that obtained on adjacent tangent track, track center distances should be increased as follows:

4.11.3.1. Where the amount of superelevation is the same on adjacent tracks or the superelevation of the inner track is greater than that of the outer track, increase the tangent track center distance 1" for each 0°-30' of curvature.

4.11.3.2. Where the superelevation of the outer track is greater than that of the inner track, the tangent track center distance should be increased 1" for each 0°-30' of curvature, plus 3-1/2" for each 1" of difference in superelevation of the two tracks considered.

4.11.4. In situations where the state Public Utilities Commission or Public Service Commission requirements differ from those listed herein, the larger of the two shall be used.

4.12. Inter-track Clearance-Limiting Objects

4.12.1. For the following signals placed between the tracks, track center distances shall not be less than 25 feet:

4.12.1.1. One-head position light signals, where the center of the background is less than 18 feet above top of rail.

4.12.1.2. Two head position light signals, where a bottom arm other than a marker or vertical aspect is used, and the center of the bottom arm aspect is less than 18 feet above the top of rail.

4.12.1.3. Searchlight or color light signals, where the overall width of the signal is in excess of 24 inches at any point less than 18 feet above the top of rail.

4.12.2. For signals other than dwarf and those described above, the track center distance shall not be less than 19 feet.

4.12.3. For signal bridge supports, pedestal signals or switch stands with intermediate or high staff, the track center distance shall not be less than 19 feet.

4.12.4. No encroachment upon the published minimum overhead or side clearances from a track will be permitted.

4.13. Abutments, Buildings, and other Clearance-Limiting Objects

4.13.1. For clearance limiting-objects other than those described above, see Amtrak Standard Track Plan AM 70050.

4.14. Clearance Points A clearance point is the point where equipment will be clear of the fouling point on adjacent tracks, plus 15 feet.

4.14.2. The <u>fouling point</u> is the point on a track beyond which equipment will foul an adjacent track. The insulated joints in or adjacent to signaled track should be located at the clearance point.

4.14.3. The fouling point should be considered as the point where the track centers become 13 feet or, in locations where the prevailing track centers are less than 13 feet, the point where the track centers become equal to the prevailing track centers.

4.14.4. At interlockings, signals must be located as follows:

Signals governing a facing point switch must be at least 100 feet from the point of switch.

Signals governing a trailing point switch must be located at the clearance point. (Where track circuits adjoin, insulated joints must not be staggered more than 56" under any circumstances. Effective insulated joints shall not be placed less than 5 feet or more than 13 feet in advance of the signal.

5. Grades Definition and limits

5.1.1. Grades shall be expressed (to three decimal digits) as the change in elevation in feet per 100 feet of horizontal distance. For example, a decrease in elevation of 1.5 feet in a distance of 200 feet would be a –0.750% grade.

5.1.2. Main line grades shall not exceed 1.500% compensated. No grades shall exceed a rate of 2.500% compensated.

5.1.3. Grades through station platforms should be equal to or very close to 0.000% so that cars will not roll when the brakes are released. An easy-rolling car can start rolling on a grade as low as 0.08%. Consequently, grades in terminals and on other single-ended (stub) tracks must have grades no steeper than 0.08%.

5.2. Profiles

5.2.1. A profile must include all grades, vertical curves, and points of vertical curves, points of vertical intersections and points of vertical tangents. These points must include both the horizontal station and the elevation of the top of rail.

5.2.2. Profiles must indicate locations of fixed elevations. These include over-grade and under-grade bridges, grade crossings, station platforms, crossing diamonds, and turnouts.

5.2.3. The numeric grade value of each discrete profile section must be shown on the plans.

5.3. New Profiles

5.3.1. At locations where a new profile will replace the existing, both the proposed and the existing profiles must be determined and shown on the plans.

5.3.2. All vertical tangents must have a minimum length (measured in feet) of three times the maximum velocity in miles per hour or 100 feet, whichever is longer. Vertical tangents between vertical curves in the same direction (either both sag, or both summit) must be no less than 900 feet long. (Vertical curves are not required to have these minimum lengths.)

5.3.3. Successions of vertical curves must be avoided. They must be combined wherever possible so that a series of hills and valleys is smoothed into a longer vertical tangent.

5.3.4. At locations where a new profile will connect to the existing track, the existing profile must be shown for a distance of three times the maximum velocity in miles per hour or 200 feet, whichever is longer, beyond the point of connection. If the existing track is on a vertical tangent then the percent of grade must be shown; if on a vertical curve then the parameters of the vertical curve must be shown. The parameters must include the vertical curve length, PVC, PVI, PVT, r value, and acceleration for both freight and passenger trains using the maximum authorized speeds for those trains.

5.3.5. New profiles that involve turnouts must show the horizontal stations and elevations of the point of switch and the last long timber of the turnout.

5.3.6. Proposed vertical curves must show the ‘r’ value and acceleration expressed in feet per second^2, as described in Section 5.5, Vertical Curves.

5.4. Grade Compensation for Horizontal Curves

5.4.1. Where a curve is located on a grade, the grade on the curve should be reduced at the rate of 0.04% for each degree of curvature.

5.4.2. At places where trains frequently stop, the grade should be reduced at the rate of 0.05% for each degree of curvature.

5.5. Vertical Curves

5.5.1. Where changes in grade occur, gradient lines should be connected by vertical curves, observing the following provisions:

5.5.1.1. The length of a vertical curve is a function of the authorized track speed, the difference in grades to be connected, and the vertical acceleration. The formula for the length is: $L = \frac{2.15 * D * V^2}{A}$ where L is the length [feet], D is the algebraic difference in grade, V is the velocity [mph], and A is the vertical acceleration [feet per second^2]. The maximum allowable acceleration is 0.6 ft/sec2 for passenger only, and 0.1 ft/sec^2 for freight.

5.5.1.2. For main tracks, the rate of change may not be more than 0.400% per 100 feet of length without approval of the Deputy Chief Engineer Track.

5.5.1.3. On yard tracks, the maximum allowable rate of change may be increased up to 1.0% per 100 feet of length.

5.5.2. On curves, the low rail is the grade rail. On tangents, either rail can be used as the grade rail. However, the line rail is often used as the grade rail.

5.5.3. Turnouts should not be located on vertical curves. Vertical curves within turnouts require the approval of the Deputy Chief Engineer Track and, in no case shall the ‘r’ values exceed 0.10% change in grade per 100 feet of length.

5.5.3.1. In locations where a vertical curve is located adjacent to a turnout, the vertical curve should end no closer than 10 feet (and preferably 25 feet) from the point of switch.

5.5.3.2. In locations where the speed is 15 mph or less and a vertical curve with an ‘r’ value greater than 0.10% is located within a turnout, the vertical curve should end no closer than 10 feet from the heel block or the end of the switch rails if no heel block is present.

5.5.3.3. Vertical curves with ‘r’ values greater than 0.10% must not pass through any part of the switch points or frog.

5.6. Track Surface Track surface is the relationship of opposite rails to each other in profile and cross-level. Track profile is the running surface along the top of the grade rail. Cross level is the difference in elevation across opposite rail heads measured at right angles to the track alignment. The ideal surface is a uniform profile consisting of constant grades connected by vertical curves, with zero cross level on tangents and predetermined cross level on curves.

5.7. Secondary, Yard and Industrial Tracks, and Sidings

5.7.1. The weight and size of cars and locomotives and requirements for satisfactory negotiation of curves, reverse curves, crossovers, ladder tracks and side track connections by long cars must be considered in the design of all tracks, so that they will not lose their utility for the desired use due to the increasing size of equipment.

5.7.2. Unconnected ends of secondary and yard tracks must be curved away from adjacent main tracks.

5.7.3. A bumping post or wheel stop, of approved type, shall be provided at the end of the track. Wheel stops shall not be used on tracks used by passenger equipment.

5.7.4. Derails must be used as specified in §213.205(TO) and §205(TOM) of Amtrak's MW-1000.

6. Track Structure

6.1. Crossties - Size and Use

6.1.1. The crosstie material (concrete or wood) shall be as specified by the Deputy Chief Engineer Track.

6.1.2. 7" by 9" by 8'-6" wood crossties or 8'-6" concrete crossties shall be used in main tracks.. The material shall be determined by the Deputy Chief Engineer Track.

6.1.2.1. Ties in all grade crossings shall be as follows:
For crossings with a concrete driving surface, ties shall be wood, 7" by 9" by 10' long;
For asphalt surface crossings, ties in wood tie track shall be 7" by 9" by 8'-6" long;
For asphalt surface crossings, ties in concrete track shall be 7" by 9" by 10' long.

6.1.2.2. Bridge ties used in open-decked structures shall comply with Amtrak Standard Structures Plans.

6.1.3. The number and type of ties for use in each class of track shall be based on the following spacing from center to center:

All tracks - concrete	24"
Main tracks - wood	19-1/2"
Other tracks - wood	24"

6.1.4. In third rail territory, power rail supports are spaced at every fifth wood tie and every fourth concrete tie. In locations where long ties are used to support the third rail, the ties will be a minimum of 9 feet 6 inches in length.

7. Turnouts

7.1. Criteria Turnouts and crossovers are designated by their frog number. The frog number is the number of units from the point where the gauge lines intersect along a line that bisects the acute angle formed by the intersection of the gauge lines, to the point where the two gauge lines are one unit apart.

7.1.2. Turnouts should be used as follows or as designated by the Deputy Chief Engineer Track.

7.1.3. The No. 32.75, No. 20 advanced technology and No. 15 advanced technology turnouts have a long lead and should only be used where approved by the Deputy Chief Engineer Track.

7.1.4. Wherever possible, turnouts should be oriented as “trailing point” so that trains moving in the predominant direction will move over the frog before moving over the point of switch. On single track railroads, there is no predominant direction of traffic. On multiple track railroads, the predominant traffic is usually to the right.

7.1.5. The points of switch of turnouts that are adjacent to each other and of the same hand must be located no closer than the greater of 100 feet and three times the velocity through the diverging side of the turnout.

7.1.6. The points of switch of turnouts that are adjacent to each other and of opposite hand must be located no closer than 100 feet. In direct-fixation turnouts, this distance may be reduced to twice the longer distance between the point of switch and the end of the stock rail.

7.2. Use

7.2.1. **Advanced technology turnouts:** Advanced technology turnouts provide superior ride quality compared to conventional turnouts through the straight and diverging moves.

7.2.1.1. Number 32.75 advanced technology concrete tie turnout -- Use in interlocking plants for diverging from one main track to another main track where the desired diverging speed is up to 80 mph.

7.2.1.2. Frog numbers other than 8, 10, 15, 20, and 32.75 must not be used without the approval of the Deputy Chief Engineer Track.

7.2.1.3. Number 20 advanced technology concrete tie turnout -- Use in interlocking plants for diverging from one main line track to another main track or secondary track where the needed diverging speed is up to 45 mph. They may also be used to connect to side tracks or in other special wayside situations where it is not practical to use a No. 10 spring frog advanced technology turnout due to design or speed limitations.

7.2.1.4. No. 15 advanced technology concrete tie turnout -- Use in interlocking plants for diverging from one main track to another main track or secondary track where the desired diverging speed is up to 30 mph. They may also be used to connect to side tracks or other wayside tracks where it is not practical to use a No. 10 spring frog advanced technology turnout due to design or speed limitations. Note: The No. 15 movable point frog requires a slip or sliding joint through its diverging side making it a "handed frog."

7.2.1.5. No. 10 spring frog advanced technology concrete tie turnout -- Generally used at wayside locations on main track territory where the diverging speed is up to 15 mph. Unless otherwise approved by the Deputy Chief Engineer Track, a spring frog will only be used in locations where diverging moves over the turnout, as measured by wheel axle count, are 30 percent or less of the total axle count over the turnout. Spring frogs should not be used in locations where the siding diverges from the outside of the curve.

7.2.2. **Conventional Turnouts:** Construction of conventional wood-tie turnouts is generally limited to use in Track Class 3 or less or in wood tie territory. It is not desirable to place a single wood tie turnout if it is surrounded by concrete tie track. To further reduce inventory and maintenance costs and to improve ride quality, all new conventional turnouts are to be of welded design, with floating switch heels, RBM frogs, and guard rails or movable-point frogs without guard rails.

7.2.2.1. No. 20 conventional turnout -- Use at interlocking plants for crossing over from one main track to another main track where the desired diverging speed is up to 45 mph.

7.2.2.2. No. 15 conventional turnout -- Use at interlocking plants for crossing over from one main track to another main track where the desired diverging speed is up to 30 mph or where the conditions do not justify or afford the lead distances required for No. 20 conventional turnouts.

7.2.2.3. No. 10 conventional turnout with spring frog -- Use in main tracks where the desired diverging speed is up to 15 mph. (No. 8 turnouts should not be used on main tracks.) Spring frogs should not be used in locations where the siding diverges from the outside of the curve.

7.2.2.4. No. 10 conventional turnout with RBM frog -- Use in main tracks, sidings, terminals and yards where the desired diverging speed is up to 15 mph. This is preferred over a No. 8 conventional turnout.

7.2.2.5. No. 8 conventional turnout with RBM frog -- Use in yards and terminals where the desired diverging speed is up to 15 mph. These turnouts should only be used where the use of a No. 10 or greater size turnout is not practical.

7.2.2.6. No. 8 and No. 10 self-guarded frog (SG) turnouts -- Use in yards and terminals only where the desired speed for both straight and diverging is no more than 15 mph. SG turnouts are only to be used when the use of an RBM frog turnout is not possible

7.2.2.7. Turnouts smaller than No. 8 may be used only with the approval of the Deputy Chief Engineer Track.

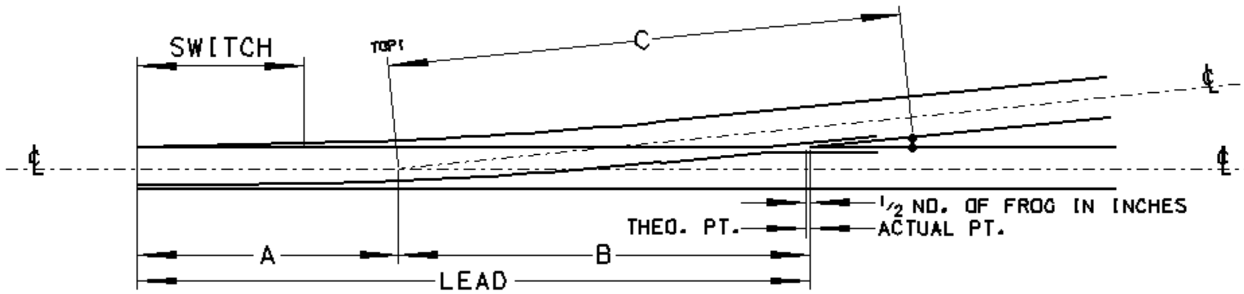
7.3. Turnout Speeds The maximum authorized speeds through diverging movements on level turnouts, located on tangent track will be as follows (unless otherwise restricted):

Frog No.	6	8	10	15	20	32.75
Maximum Authorized Speed (mph)	5	15	15	30	45	80

7.3.2. Exceptions to the above table, including special trackwork or frogs greater than a No. 32.75 or less than a No. 8, must have the approval of the Deputy Chief Engineer-Track.

7.4. Geometry

7.4.1. The diagram below should be used in conjunction with the table of dimensions on the next page.



The following notes apply to the diagram and to the table of dimensions:

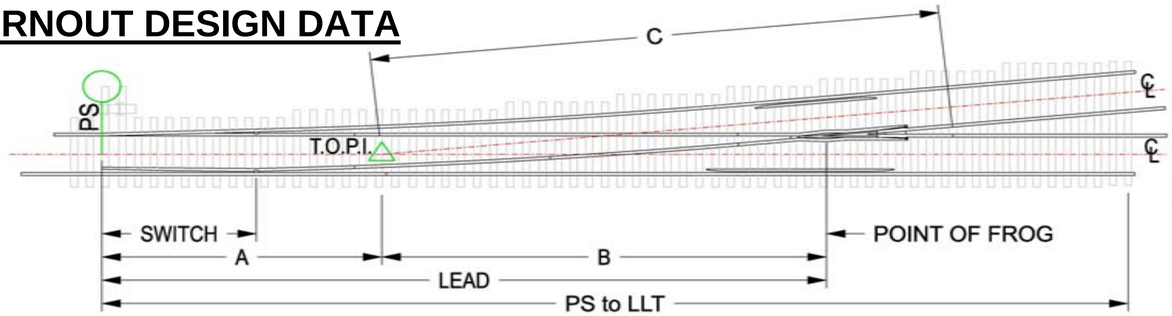
a) Switch point length is the length from point of switch to the heel block or point of fixation.

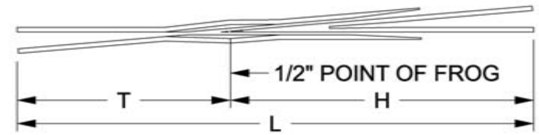
b) For tangential geometry turnouts with moveable point frogs, the lead length is measured from the point of switch to the theoretical point of frog (TPF).

c) Turnout Classifications: RBM = rail bound manganese; T = tangential; SF = spring frog; MPF - moveable point frog; SMPF = straight moveable point frog; CMPF = curved moveable point frog

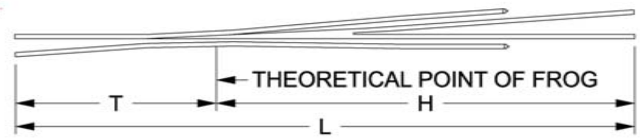
d) There may be conditions that warrant the use of a concrete tie conventional turnout. Examples would be where concrete ties exist on both ends of the turnout and there is not enough room for a tangential turnout or a tangential turnout would not be practical because of low track speeds.

TURNOUT DESIGN DATA





RAIL BOUND MANGANESE FROG



MOVABLE POINT FROG

A.R.E.M.A. LEAD **RAIL BOUND MANGANESE** TURNOUTS (REFER TO 1/2" POINT OF FROG)

FROG No.	**FROG ANGLE**	**SWITCH LENGTH**	**SWITCH ANGLE**	**PS to LLT**	**LEAD** (PS TO PF)	**A** (PS to TOPI)	**B** (TOPI to PF)	**C**	**L** (Frog Length)	**T** (Toe of Frog)	**H** (Heel of Frog)	STANDARD **PLAN**
8 RBM	7°-09’-10” 7.15277°	16’ – 6”	1°-48’-32” 1.80889°	92.83’	68.00’	30.00’	38.00’	49.00’	18’ – 0”	7’ – 0”	11’ – 0”	AM73184
10 RBM	5°-43’-29” 5.72472°	16’ – 6”	1°-48’-32” 1.80889°	109.60’	77.40’	29.90’	47.50’	61.00’	23’ – 0”	9’ – 6”	13’ – 6”	AM73185
15 RBM	3°-49’-06” 3.81833°	26’ – 0”	0°-44’-47” 0.74639°	159.27’	111.23’	39.98’	71.25’	87.58’	26’ – 8”	10’ – 4”	16’ – 4”	AM73186
20 RBM	2°-51’-51” 2.86417°	39’ – 0”	0°-25’-32” 0.42556°	218.71’	154.54’	59.54’	95.00’	116.08’	34’ – 2”	13’ – 1”	21’ – 1”	AM73187

A.R.E.M.A. LEAD SPRING FROG – SF TURNOUT (REFER TO **1/2" POINT OF FROG**)

10 SF	5°-43’-29” 5.72472°	16’ – 6”	1°-48’-32” 1.80889°	109.06’	77.40’	29.90’	47.50’	62.00’	39’–10 1/2”	25’–4 1/2”	14’ – 6”	AM73241

A.R.E.M.A. LEAD ***MOVABLE POINT FROG*** – MPF TURNOUT (REFER TO THEORETICAL POINT OF FROG)

15 MPF	3°-49’-06” 3.81833°	26’ – 0”	0°-44’-47” 0.74639°	159.83’	110.60’	39.98’	71.25’	94.91’	36’ – 0”	11’–8 1/2”	24’–3 1/2”	AM73237
20 MPF	2°-51’-51” 2.86417°	39’ – 0”	0°-25’-32” 0.42556°	220.46’	153.71’	59.54’	94.17’	123.92’	44’ – 2”	14’ – 5”	29’ – 9”	AM73239

ADVANCED TECHNOLOGY ***MOVABLE POINT FROG*** – MPF TURNOUTS (REFER TO THEORETICAL POINT OF FROG)

15 MPF	3°-49’-06” 3.81833°	See AM73231	0°-44’-47” 0.74639°	171.32’	122.03’	51.41’	70.62’	94.91’	36’ – 0”	11’–8 1/2"	24’–3 1/2"	AM73230
20 MPF	2°-51’-51” 2.86417°	See AM73221	0°-25’-32” 0.42556°	235.05’’	170.30’	76.13’	94.17’	123.92’	44’ – 2”	14’ – 5”	29’ – 9”	AM73220
32.7 MPF	1°44’52.4” 1.74789°	See AM73201	0°-03’-00” 0.05000°	406.58’	299.73’	145.42’	154.31’	202.05’	72’ – 0”	24’-4 9/32”	47’-7 23/32”	AM73200

7.4.2. The introduction of curvature between the heel of frog and the last long turnout tie should be avoided. In direct-fixation track, curves in the same direction as the diverging side of the turnout should begin at a point ten feet from the heel joint of the frog so as to minimize the effects of broken-backed curves.

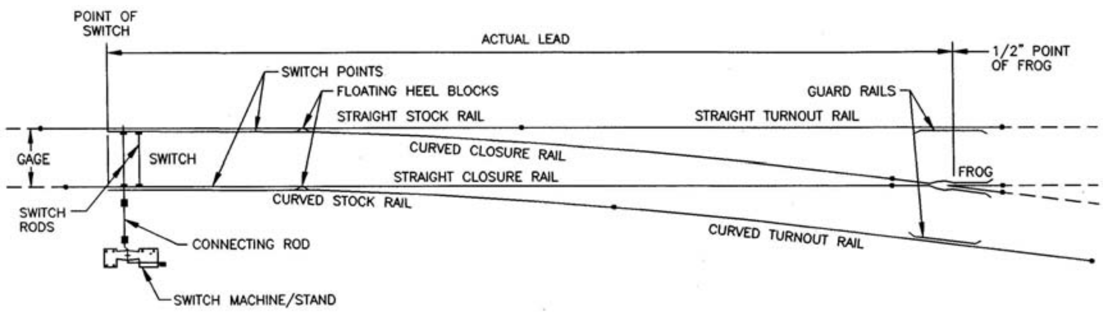
7.4.3. The recommended tangent distance (in feet) between reverse curves or facing same hand turnouts is a minimum of 100 feet and preferably three times the maximum authorized speed in mph.

7.4.4. Do not place turnouts and crossovers on curves, spirals, or elevation runoffs at the ends of curves.

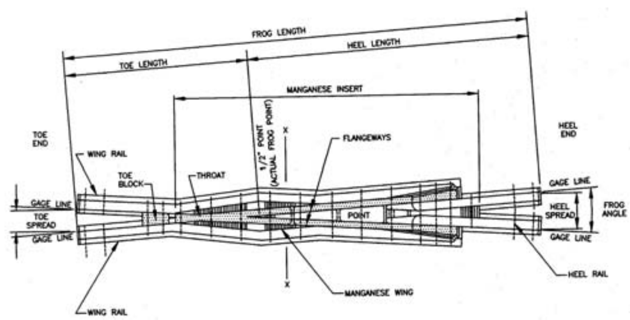
7.4.5. Crossovers must connect two tracks that are designed to be exactly parallel. If the tracks are not parallel, then curves must be introduced as needed to make the tracks parallel.

7.5. Drawings

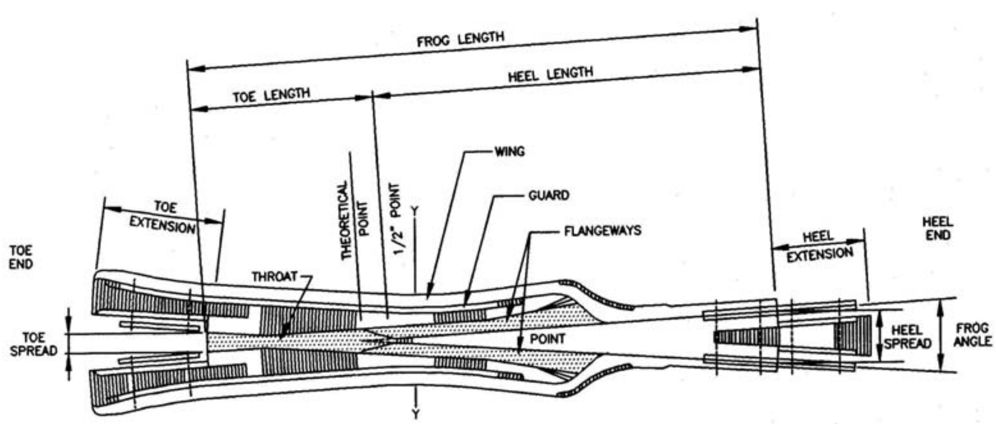
7.5.1. Conventional Turnout.



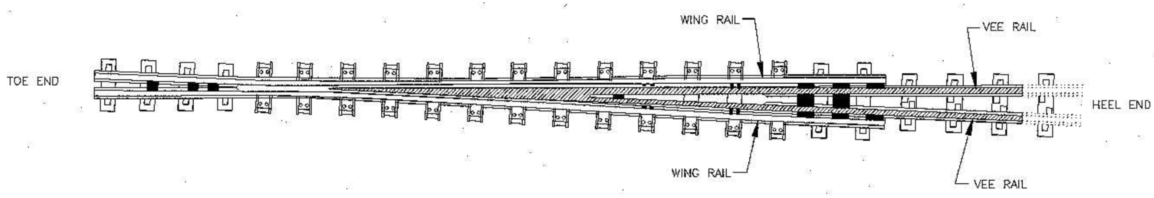
7.5.2. Rail bound Manganese Frog



7.5.3. Self-Guarded Manganese Frog



7.5.4. Moveable Point Frog (Advanced Technology)



7.6. Turnouts on Horizontal Curves

7.6.1. Turnouts shall not be placed in curves without the approval of the Deputy Chief Engineer Track. If turnouts must be built in curves, the reverse elevation limits shall comply with the limits shown in the table under the section, “Turnouts Diverging to High Sides of Curves ” or be approved by the Deputy Chief Engineer Track.

7.6.2. When turnouts or crossovers are located in curved tracks, speeds must comply with the requirements for curves, superelevation, underbalance, spirals, and turnouts on curves.

7.6.3. Unless otherwise restricted, the maximum speed through the diverging route must be determined by using the V_{max} formula under the Speed section of Track Geometry.

7.6.4. Turnouts with spring frogs may not be placed on curves or spirals.

7.7. Turnouts on Vertical Curves

7.7.1. Turnouts must be located along the profile to comply with the Vertical Curves section of Grades.

7.8. Turnouts Diverging to High Sides of Curves Turnouts and crossovers in curves that have the diverging route (turnout side) to the outside of the curve shall meet the following conditions:

Class of track	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
The reverse elevation on curves may not be more than (inches):	3	2	1¾	1¼	1	½	½	½	½
The difference in cross level between any two points less than 62' apart may not be more than (inches):	3	2¼	2	1¾	1½	1½	1½	1½	1½

7.8.2. When the diverging route of a turnout or crossover is located to the outside of a curve, the maximum allowable operating speed of the straight route through the turnout shall be determined in accordance with the V_{max} formula as shown in the following example:

The crossover to Shoreline Junction on the New England Division turns out or diverges to the high side of a 1°-48' curve. The desired diverging route speed through the crossover is 10 mph (F) and 15 mph (P); or Class 1 speed. Determine the maximum amount of superelevation that can be put in the main line curve and the maximum operating speed on the main line curve.

For a diverging route that is Class 1 (15 mph (P)), the maximum reverse cross-level elevation permitted in the diverging route of the turnout may not be more than 3" (see above table).

The main line/straight through curve may not be elevated more than 3". The maximum main line operating speed is:

V_{max} = Maximum allowable operating speed (mph) = $\sqrt{\frac{E_a + E_u}{0.0007D}}$

E_a = Actual superelevation of the outside rail (inches)

E_u = Underbalance (inches)

D_c = Degree of curvature (degrees)

For Eu = 3 inches underbalance and D = 1°-48'=1.80°

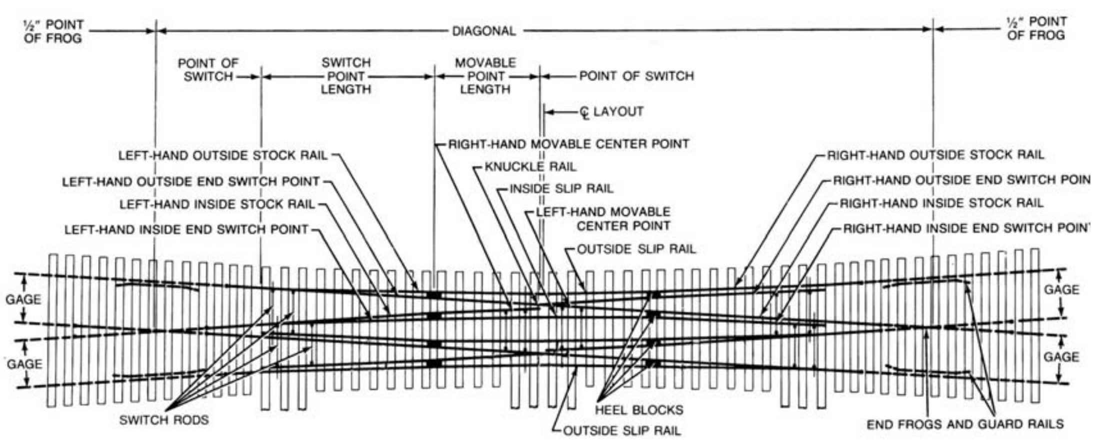
$$V_{max} = \sqrt{\frac{(3.0)+(3.0)}{0.0007(1.80)}} = \sqrt{\frac{6.0}{0.00126}} = \sqrt{4761.90} \cong 69 \text{ mph}$$

7.9. Turnouts with Spring Frogs Turnouts with spring frogs must only be used tracks that are on both horizontal and vertical tangents. The use of spring frogs on vertical curves reduces the ability of the spring wing rail to operate properly and is not permitted.

7.9.2. Spring frogs may only be used in locations where the diverging movements through the turnout as measured by wheel axle count are 30 percent or less of the total axle count.

8. Slip Switches

8.1. Double Slip Switch Parts



8.2. Slip Switch Characteristics

General Characteristics of Standard Slip Switches								
No.	**End Frog to End Frog (1/2" points)**	**Radius**	**Outside Switch Point Length**	**Center Switch Point Length**	**Switch Angle**	**Frog Angle**	**End Frog Length**	**Center Frog Length**
8	76'-1¾"	678.5'	20'-3 7/16"	N/A	1°-46'-22"	7°-09'-10"	18'-0"	15'
10	95'-1 3/8"	1,135.5'	20'-0"	14'-3 3/16"	1°-10'-00"	5°-43'-29"	23'-0"	N/A
		1,222.3'						
15	142'-7"	2,009.2'	30'-0"	11'-5 11/16"	0°-41'-00"	3°-49'-06"	33'-0"	N/A
		3,390.8'						

Note: Data may not be consistent with all existing slip switches.

8.3. Construction of single or double slip switches is generally limited to terminal and yard areas where the speeds will not exceed 15 mph (P). Use in areas where speeds will be in excess of 15 mph (P) requires the authorization of the Deputy Chief Engineer Track.

8.4. No. 8 slip switches can consist of either moveable center points with knuckle and easer rail assemblies or solid center frogs. Solid center frog slip switches are the preferred design as they have few moving parts, require less maintenance, and have fewer switch machines.

8.5. No. 10 slip switches or greater consist of moveable center points with knuckle and easer rail assemblies. Solid center frogs are not permitted with these slip switches because of the reduced frog angle.

8.6. Construction of less than No. 8 slip switches requires the approval of the Deputy Chief Engineer Track.

8.7. Whenever possible, the approaches to slip switches should be on tangent. In general, slip switches are sensitive to curved approaches resulting in increased maintenance of alignment and wear of components. If curved approaches are required, slip switch design and degree of curvature must be approved by the Deputy Chief Engineer Track.

9. Crossings (Diamonds)

9.1. Use

9.1.1. Crossings are generally found on Amtrak in low-speed areas such as terminals and yards.

9.1.2. Crossings should be avoided if possible. If space is available, scissors (double) crossovers should be replaced with separate right hand and left hand crossovers.

9.2. Angles

9.2.1. Crossings are categorized as low, medium, and high angle design as follows:
Low angle: less than or equal to 30°
Medium angle: 31° to 60°
High angle: 61° to 90°

9.3. Crossings on Curves

9.3.1. Curved crossings, where one or both tracks are curved, should only be used on low speed tracks where super-elevation is not required, and where the underbalance is low.

9.3.2. Curved crossings may require the use of movable point frogs, depending on the crossing angle and the degrees of curve. The American Railway Engineering and Maintenance-of-Way Association's plan number 820-68 should be used to determine which type of frog to use.

9.4. Rigid Crossing Frog Types

9.4.1. There are three major designs: manganese steel inserts, solid manganese steel castings, and bolted rail crossings with 1, 2 and 3 rails.
There are potential applications for all of these designs. The selection depends upon location, speed, cumulative tonnage, and tonnage variation between the different routes.

9.4.2. In general, for most applications a manganese steel insert design is preferred. It is easily adaptable to either low or high angle crossing conditions.

9.4.3. Solid manganese steel crossing designs are generally used at medium to high angle crossing locations. They require a rail-to-manganese connection.

9.4.4. The bolted rail crossing design should not be used at low angle crossing locations. This type of crossing is sensitive to tonnage variations over its routes due to multiple rail construction. If used at higher angles, it should be of the two or three rail design.

9.5. Movable Point Crossings

9.5.1. Movable point crossings provide a better ride because of the elimination of some of the flangeway openings. However, they require switch motors to move the rails and are therefore more costly to buy and maintain than rigid crossings.

9.5.2. Movable point crossings are required on all crossings where the crossing angle is small. Refer to the American Railway Engineering and Maintenance-of-Way Association's plan number 820-68 to determine where movable point crossings are required.

10. Interlockings

10.1. Approval Schematics

10.1.1. Purpose: The proposed configuration of each interlocking must be approved before detailed design engineering has begun. Approval schematics must show the existing and proposed track configuration, operating characteristics and general engineering details of the track layout. They are used for obtaining approvals of the engineering, planning, and operating departments of Amtrak, other railroads, and the Federal Railroad Administration.

10.1.1.1. Operating characteristics include:

- Maximum operating speeds for the various classes of equipment. The classes and speeds for existing conditions are found in the employees timetable. Maximum proposed speeds are based on a combination of the physical properties of the track alignment and the signal aspects and spacing.

- Station names with an outlined yellow rectangle indicating the platform(s).
- Interlocking names, mile posts, and name of the controlling dispatcher or interlocking if remotely controlled.
- Siding names for industrial sidings;
- A diagram of the next interlocking to the left and the next interlocking to the right. If more than one interlocking must be shown to depict operating flexibility then that interlocking should also be shown.
- The name of the next major station to the right and to the left

10.1.1.2. General engineering details include:

- Track number or name
- Turnout types
- Frog numbers and types
- Maximum Authorized Speed in miles per hour
- Switch numbers
- Interlocking limits
- Signals
- Derails
- Mile posts
- Grade crossings, bridges, and culverts should generally not be shown on schematics unless there is some aspect of their location or existence that affects the operating characteristics of the project.

10.1.1.3. Format: Approval schematics should generally follow the format shown in the Sample Schematic.

- Schematics must fit on a standard 8 ½ by 11 inch sheet of paper and use line attributes (styles and weights) that do not require color to differentiate between the various types of information to be shown.
- The line attributes specified elsewhere in this document, including colors, must be used wherever possible.
- Tracks with catenary or third rail have a yellow line that underlies and is wider than the track line.
- Construction intended as part of a future project at a later date must be shown in the color gray.
- The drawings should show the turnouts with either a W or C for wood or concrete ties, either a T or A for tangential or AREMA leads, and MPF RBM or SG for mova-

ble point frog, rail-bound manganese frog, or self-guarded. For a #10, the schematic would show, "#10, AREMA-WOOD-RBM, 15 MPH." Presumably, the turnouts on Amtrak will be concrete ties, and the #15s will be MPFs.

- Tracks owned by a foreign railroad are differentiated with a different line code, such as diamond. The legend must be modified accordingly.

10.1.2. Schematic component details:

10.1.2.1. The track number or name must include "TRK" before the number or name. Track numbers must be shown on each schematic, preferably on both ends.

10.1.2.2. Turnout types (T or A for tangential or AREMA leads)

10.1.2.3. Frog numbers and types (MPF, RBM, or SG for movable point, rail-bound manganese, or self-guarded)

10.1.2.4. Maximum Authorized Speed in miles per hour. The speed allowed through the diverging sides of turnouts must be included with the turnout type. Maximum Authorized Speeds as listed in the employees timetable must be shown for each track at both ends of the interlocking. If the proposed speeds will be different than existing speeds, then these must also be shown. If necessary, the various speeds may be shown in a table.

10.1.2.5. Switch numbers. For manned interlockings, switch numbers correspond to the operating rod number that controls the particular switch. For remotely controlled interlockings, the switch number consists of two numbers: the number of the track on which the western-most or southern-most portion of the crossover or turnout lies (this is the switch end of crossovers), followed by the track number that the diverging side of the turnout leads to or becomes.

Branch-lines and un-signaled sidings generally are given the track number 9. In interlockings where the combination of branch line tracks and un-signaled sidings is more than one numbers lower than 9 are used such as 8 or 7.

Individual turnouts in a crossover are distinguished by adding the letter, "A" or "B" to the number. The westward or southward switch is designated by the "A" and the other end by the letter "B."

Some interlockings have more than one crossover between the same pair of tracks. The western crossover name would begin with the letter, "W" and the eastern crossover name would begin with the letter, "E."

Slip-switches are designated as if they were two separate crossovers with a slash between the two crossover names. In a location where three parallel tracks (Tracks 1, 2 and 4) are in an east-west direction, and starting from the west end are connected by a left hand turnout on Track 1, a slip-switch on Track 2, and a left hand turnout on Track 4, the switch on Track 1 would be the 12A. The switch on Track 4 would be the 24B, and the slip-switch would be designated 12/24. Slip-switches do not use the letters "A" and "B."

10.1.2.6. Interlocking limits are indicated by a dashed purple line completely surrounding the interlocking. For clarity, the line should cross each track at 90°.

10.1.2.7. Signals are placed with the signal base at the interlocking limit for the track it governs. Signals are generally named using the track number and the direction they govern. A home signal for eastbound trains on Track 3 would be the "3E" signal. In some locations, the signal name is the number of the lever in the interlocking tower that controls that specific signal. For example, if lever number 10 is used, then the signal would be number 10.

Signals heads are shown as a colored circle with a thin black outline. The circle diameter is one-seventh of the distance between tracks. The number of heads shown on the schematic should correspond with the number of heads in the field. Circles for signals with more than one head should be separated so that the minimum distance between two signal circles is one-quarter of the signal circle diameter.

Signal masts are thin black lines for existing signals, and thicker green lines for proposed signals. Signals to be removed are shown with dashed red masts. The mast is on the same side of the track as the signal in the field, and is located one third of the track center distance away from the track.

For high signals, the mast is drawn to the left of the circle and tangent with the signal circle(s). The lowest signal circle edge is twice the diameter of the circle above the signal base.

Dwarf signals have the lowest signal circle edge one circle diameter above the signal base. The mast is drawn through the center of the signal circle instead of to the left, and is behind the circle.

Signal bases are the same width as the signal circle diameter, and located so their centers are at the base of the signal mast.

Signal bridges are shown as a line that is perpendicular to the track and extending one-half of the track center distance beyond the outside track. This line acts as the base for the signals. Cantilever signal bridges have a foundation line parallel to the track at the end of the signal bridge line and extending one signal-circle diameter on both sides of the signal bridge line. Signal bridges that are not cantilevered have a similar foundation line on both ends of the signal bridge line.

10.1.2.8. Derails are designated by an equilateral triangle with the side closest to the track parallel to the track. The derail should be located on the same side of the track as the side where a derailed car would land.

If the triangle is open, it designates a hand-operated derail. If the triangle is filled-in, it designates a power-operated derail.

10.1.2.9. Mile posts are designated with a square turned 45° and a stem leading from the bottom of the square toward the nearest mainline track. The number should be placed adjacent to the square. The stem should be at the actual milepost location.

10.1.3. Information that must be included

- In addition to the operating characteristics and General Engineering data, each schematic must show the track layouts and names of the interlockings on both sides of the subject interlocking. The direction arrow pointing toward the name of the next interlocking or major city name must be on the right-hand side of the tracks.
- Interlockings must have the name of the interlocking, the milepost, and if the interlocking is remotely controlled, the title of the dispatcher or name of the interlocking that is controlling the subject interlocking doing the control.

10.1.4. Approvals – Each schematic must include a signature block including the position title, and date signed. The block should fit generally in the lower middle of the sheet. Three sets of approvals are generally required:

- A signature block for the deputy chief engineers of Track, Structures, Electric Traction, Communication and Signals, Maintenance, and Section Improvements.
- A signature block for the Chief Engineer, planning officer, Division Superintendent, and General Manager.
- A signature block for Amtrak, non-Amtrak railroad(s) and the Federal Railroad Administration.

10.2. Construction Phase Schematics

10.2.1. Construction phase schematics show which tracks will be in service and which tracks will be under construction during all phases of construction.

10.2.2. All phases of construction must be shown. If the work in a given phase will require track to be in service during part of the phase and out of service during another part of the phase, then the work must be broken down into additional phases until this condition no longer exists.

10.2.3. Construction phase schematics do not need to be as detailed as Approval schematics, but should follow the same rules for line attributes and general engineering details.

10.3. Accessibility – M of W Roadways

10.3.1. Maintenance of the special trackwork that is a part of all interlockings requires more effort than conventional track. Maintenance crews must be able to drive highway type vehicles to locations adjacent to the track and on the same relative elevation as the track so that inspectors have easy access to the track and so that materials and equipment can be readily moved to the needed locations.

10.3.2. Maintenance vehicles are often large trucks that have extended mirrors. Access roadways must be wide enough to reduce the likelihood of these mirrors being struck by adjacent catenary poles, signal masts, guy-wires, or other clearance-restricting structures. A clear width of 12 feet is desirable, but 10 feet is the minimum acceptable clear road width if it is for a short distance.

10.3.3. The maintenance road must have at least 14’-6” of vertical clearance.

10.3.4. The maintenance road must be far enough away from the track to provide a clear driving path that does not encroach on the ballast section of the nearest track.

10.3.5. Track drainage is always a primary consideration. The maintenance road must not impede track drainage, and must slope away from the track. The maintenance road should be designed to drain away from the railroad track or towards a purposely constructed drainage point of adequate volume.

10.3.6. If possible, the driving surface should be below the elevation of the sub-ballast, and it must never be higher than the bottom of ballast elevation.

10.3.7. The driving surface may be gravel, crushed stone, or asphalt. The thicknesses of the various layers must be sufficient to withstand H-20 highway truck loadings.

10.3.8. Maintenance roads must not be located between adjacent tracks.

10.3.9. Grades on the maintenance roads must not be excessive and must never exceed 10%.

10.3.10. Vehicles must not be required to back out onto public roads. The maintenance road must either connect to a public road on both ends of the access road, or else have an area that is sufficient for safely turning vehicles so they can be headed in the opposite direction. The turning area must be far enough away from the track so that the overhang of a vehicle will not come within fouling distance of the track.

In turn-around areas or areas where a clear view of vehicles may be obstructed, the roadway must be protected with metal guiderails or concrete barriers placed no closer than 9'-0" from the centerline of the nearest track, maintaining standard ballast section and adequate drainage.

10.3.11. All access points to public highways must be protected with locked gates. The gate must be set back a minimum of 20' from the edge of the highway to allow a vehicle to safely exit the highway, stop and unlock the gate, without impeding traffic on the highway. Wherever practical, the grade on the pull off area should be no steeper than 5%. The design must take into account local drainage conditions so as not to cause a hazard by channeling runoff water towards either the railroad or the highway.

10.3.12. Maintenance road grade crossings must use a timber and ballast crossing generally in accord with Amtrak Standard Plan AM-70123[]. All crossings must be protected with locked gates in addition to those at the access point(s).

11. Engineering Documents

11.1. Deliverables

11.1.1. Project development is usually broken down into several distinct steps or phases, each one having its own deliverables. These steps can be thought of as Idea, Concept, Preliminary Design, Final Design, and Contract Documents. If percentages are used, they correspond roughly to 10% - Idea, 15% - Concept, 30% - Preliminary Design, 90% - Final Design, and 100% - Contract Documents. The Idea and Concept phases are often combined into one submission, and after Amtrak approval of the concept, this should be used to develop the 30% or so-called Preliminary Engineering submission. Because of the necessity for the track alignment portion of a project to be essentially complete before beginning on other aspects of a design, it is necessary to have the track alignment portion complete at the 30% level of work. So-called Final Design from a track alignment standpoint is usually done in two phases, 60% and 90%; for track alignments these are making corrections and developing details that have very little or no effect on other design disciplines.

11.1.2. Deliverables for each phase of development are listed in the following Track Alignment Deliverables Chart. Each item listed for a particular phase must be delivered to Amtrak in order for that phase to be considered as having been completed.

Description	10%	15%	30%	60%	90%	100%
Basis of Design		X	X	X	X	X
Title Sheet		X	X	X	X	X
Signature Sheet		X	X	X	X	X
Index of Drawings and General Notes		X	X	X	X	X
General Abbreviations (Civil and Track)			X	X	X	X
General Symbols (Civil and Track)		X	X	X	X	X
Interlocking Approval Schematic		X	X	X	X	X
Construction Phase Schematics		X	X	X	X	X
CIVIL	**10%**	**15%**	**30%**	**60%**	**90%**	**100%**
Existing Conditions, Right of Way, and Survey Control Map			X	X	X	X
Site Plans			X	X	X	X
Existing Utility Plans			X	X	X	X
Demolition Plans				X	X	X
Platform Plan and Elevations (Proposed)			X	X	X	X
Platform Canopy Foundation Details				X	X	X
Platform Canopy Sections			X	X	X	X
Platform Service Road & Crossing Plan			X	X	X	X
Miscellaneous Civil Details				X	X	X
Drainage Plan			X	X	X	X
Track Underdrain Profiles				X	X	X
Drainage Misc. Details				X	X	X
Temporary Erosion and Sediment Control				X	X	X
Cross Sections at 100 feet intervals				X	X	X
TRACK	**10%**	**15%**	**30%**	**60%**	**90%**	**100%**
Track Plan			X	X	X	X
Track Profiles			X	X	X	X
Track Alignment Data Table			X	X	X	X
Typical Sections			X	X	X	X
Miscellaneous Trackwork Details			X	X	X	X
Construction Phase Plans			X	X	X	X

11.1.3. 10% - Idea Phase – This phase is effectively used to develop the initial idea into something suitable for further development. The project's feasibility must consider the physical layout of the area including approximate grades and track centers plus the operating parameters that will be affected by the completed construction work.

If this is a separate submission from the 15% submission then a report outlining the aspects listed above is the only deliverable.

11.1.4. 15% - Concept Phase

This phase requires definition of functional requirements and feasibility analysis, initial/estimated right of way impacts as well as other potential impacts, site constraints identified through a rough sketch of the track alignment (for example buildings, roadways, catenary poles), the initial proposed site access plan, unique considerations for the individual trackwork items, identification of all safety, health, historic, environmental, aesthetic, and security requirements, at least three conceptual options and one recommended option.

The Basis of Design (BOD) must include the various standards that will be used for creating the design. It is expected that Amtrak Specification 63 will be included and that it will take precedence over the recommendations of the American Railway Engineering and Maintenance of Way Association (AREMA), the American Society of Civil Engineers (ASCE), the American Society for Testing Materials (ASTM), and others. All special considerations that are intended to be used and that are outside of the above-mentioned specifications must be included. Although the BOD must be submitted in subsequent phases, it must remain the same throughout all phases.

The Title Sheet will be the same general title sheet used throughout the project, but the date and particular phase of the submission must be clearly shown.

The Signature Sheet for this phase only is the Interlocking Approval Schematic. A separate Signature Sheet is not required for the 15% phase.

General Notes must include the source for the existing conditions plan.

The Construction Phase Schematics must clearly show what tracks will be in service and what tracks will be out of service for each phase. The first phase will show things as they currently exist. Subsequent phases must also show the work under construction in that phase, the work being removed in that phase, and the estimated duration of the phase. If track has been removed in a phase then it must not be shown in subsequent phases; similarly, track that has been constructed in a phase will be shown as existing in future phases. The final phase will show the completed project with everything to be constructed as existing and nothing further to be removed or constructed.

Construction phase schematics should generally follow the format of Interlocking Approval Schematics specified elsewhere in Specification 63.

All deliverables submitted in previous phases must be revised as necessary and re-submitted as indicated in the Track Alignment Deliverables Chart.

11.1.5. 30% Phase - Amtrak requires the 30 percent track alignment submission to be completely designed and highly developed in terms of track layout. The economic development of all other work is dependent upon the submission of an accurate final track alignment at the 30 percent level.

<u>30-Percent Design Document Requirements</u> (Includes all requirements of the 15% - Conceptual Design Phase)

A clear and concise description of the project including a description of the planned work in a narrative form

Calculations supporting the basis for the design including assumptions, standards, specifications, codes and other constraints used to determine the final selections

A design narrative is included describing the design approach and rationale for it

The submission demonstrates compliance with relevant standards, specifications, codes, site (building envelope) and functional requirements

All efforts must be taken to comply with Amtrak's standards and specifications, if compliance is not possible (or in some cases not practical) a completed Design Exception Request with proper supporting information to justify the exception must be submitted

Existing Conditions, Right of Way, and Survey Control plans illustrating existing site conditions including survey control points, wetlands, utilities, structures and access roads. This plan must be prepared by a professional land surveyor duly licensed in that state in accordance with the "National Railroad Passenger Corporation (AMTRAK) Land Surveying Standards and Procedures Manual." Finalized horizontal track layout including relevant degree of curvature, spiral lengths, underbalance, superelevation, curve limits, jerk rate, and V_{max}

Vertical track layout including percent grade, acceleration, curve limits, rate of change, and relevant infrastructure (stations, turnouts, crossovers, bridges, crossings)

Identification of any restrictive clearance points

Turnout identification including hand, type and number

11.1.6. 60-Percent Design Document Requirements (Includes all requirements of the 30-Percent Design Phase)

All track elements/components are selected, defined, and incorporated into the design documents

Outline specifications are produced and included

Final roadbed, drainage and fencing design/layout are completed

Clearance issues are fully defined and solutions are incorporated into the design

Proposed grades are finalized, cross-sections and profile drawings are included showing underground utilities and drainage facilities

Operation and maintenance manuals and training on installed systems are included where applicable

Specifications for material and equipment testing performed at the construction site or at an offsite location are defined

11.1.7. 90-Percent Design Document Requirements (Includes all requirements of the 60-Percent Design Phase)

Detailed set of technical design documents in final form

Drawings and specifications with sufficient detail to complete the work

Construction phases and material requirements are clearly delineated

Production of the working drawings for the project identifying all the necessary details

Engineering disciplines are coordinated and incorporated into the documents

The drawings are consistent with the specifications

The notes on these drawings result in a single interpretation of a specific set of data or facts and, become the basis of a competitive price proposal

11.1.8. 100-Percent Design Document Requirements

This is the refinement and completion of the previous phase, especially in the area of specifications

11.2. Plans

11.2.1. All plans must include the name of the town and state. If an interlocking plant is shown, then the railroad name of the interlocking must also be shown.

11.2.2. All sheets must clearly indicate the submission percentage or other identifier. If the information on a sheet has not changed since the previous submission, the sheet must still be updated to show the submission of which it is a part.

11.2.3. Plans must show railroad mileposts and all existing facilities near the proposed work including signals, relay houses, catenary poles, utility poles, grade crossings, street names, bridge numbers, retaining walls, and other pertinent topography.

11.2.4. Plans must clearly show both the existing and proposed track alignments. A straight-line diagram should be added when necessary to clearly illustrate the proposal.

11.2.5. Plans should be oriented with the North direction either to the top or to the right on the plan.

11.2.6. Scales should be 1 inch equals integer multiples of 1, 2 or 5. Graphic scales should be shown on each sheet.

11.2.7. Locations of mile posts must include both the mile post number, and the stationing in feet. If a station equation exists at the mile post, that equation must be shown with the equivalent stations on both sides of the mile post.

11.2.8. Drainage plans must show both the existing and the proposed pipes, manholes, and other facilities. Details must include pipe size, material, inverts, and grades.

11.2.9. Except for detail drawings, tracks should be shown using the centerline, not the rails. The following colors, line types, and line weights should be used:

Existing track (Black)
Raise and surface (Orange)
Construct New (Green)
Track to be shifted (Blue)
As shifted (Blue)
Relocate up to 14’ (Brown)
As Relocated (Brown)
Remove (Red)
Rehabilitate (Cyan)

Many designers use mathematic regression analysis to determine a close approximation to the tangent line that is followed by several hundred feet of an existing track. The point where the new or modified alignment meets the existing alignment, or this regression line representing the existing alignment, should be considered and labeled as the point where the alignment meets the existing alignment. At this point, the regression line must not be more than 0.02 feet from the actual line.

The existing alignment beyond the point where it meets the proposed alignment should not be colored in yellow. The only use of the yellow line is where an existing track’s profile is to be raised or undercut and there is no other intended change in the horizontal track alignment.

11.2.10. Detail plans must clearly show the limits of spirals, curves, and turnouts.

11.2.10.1. Limits of spirals and curves should be designated with a small circle and the letters PC, TS, etc. at the appropriate locations. The plan view of curves must have the degree of curve and length of spiral drawn adjacent to the track.

Curve details may also be placed in a table, and must include the information detailed in Section 4.4, Curve Descriptions.

11.2.10.2. The points where the proposed horizontal alignment meets the existing alignment must be marked, "MEET EXISTING" on the plans.

11.2.10.3. Turnout designations must also be adjacent to the track and must have the frog number and additional nomenclature necessary to clearly define the intended turnout type. The additional nomenclature should follow the abbreviations listed previously.

11.2.10.4. Switches in turnouts are operated so that trains will move through either the normal route or the reverse route. The normal route is generally the straight side of the turn-out, and the reverse route generally follows the diverging route, and is limited by the allowable speed through that side. The switch stand must always be shown on the closed-point side of the turnout when the switch is in the normal position.

The switch points can be moved either by hand, by hand with an electric lock that works with the signal system, or by power. The symbol for the switch stand indicates the method for moving the switch; the position of the symbol indicates the closed-point side.

11.2.10.4.1. The designation of turnouts with hand-throw switches must have the point of switch indicated by a scaled line between 7.5 and 10 feet long drawn perpendicularly to the centerline of track and on the diverging side of the turnout.

11.2.10.4.2. The designation for turnouts with electric-lock switches must be similar to that of hand-throw switches but with an equilateral triangle starting at the mid-point of the point of switch line.

11.2.10.4.3. The point of switch for power switches must have a filled-in isosceles right-triangle with the lengths of the perpendicular sides between 7.5 and 10 feet, and on the diverging side of the turnout.

11.2.10.5. The area between the turnout point of intersection and the point of frog must be a filled-in quadrilateral with corners at the point of intersection of the two centerlines, the point where a line through the point of frog and perpendicular to the centerline meets the centerline, the actual (half inch) point of frog, and the point where a perpendicular meets the other centerline.

The last long timber must be designated by a line perpendicular to the parent track passing from one centerline of track to the other centerline.

11.2.10.6. The interlocking switch number must be shown near the point of switch. The interlocking switch number is either the interlocking tower lever number controlling the switch, or a number whose first digit is the number of the track to the west or south and whose second digit is the number of the track connecting to the diverging side of the turnout. The letters “A” or “B” are used to indicate the west or east (south or north) ends of a crossover respectively. Thus, in the example above, the “12A” indicates the turnout is on Track 1 on the west (south) end of a crossover with the diverging side leading toward Track 2.

11.2.11. If track capacity could be an issue, then the clearance points must be indicated for each track involved. The clearance point is defined in Section 4.

11.3. Stationing

11.3.1. Stationing must be provided using milepost stationing. This stationing must begin with 0 at the mile post preceding the beginning of work and increases continuously to the next mile post. Each mile post has an equation whereby the distance from each preceding mile post is equated to 0 at the succeeding mile post. For a point that is 356 feet away from MP 47 in the direction of MP 48, the station for that point would be expressed as

47+356. If the distance between MP 47 and 48 is 5360.28 feet, the equation at MP 48 would be station 47+5360.28 = MP 48. All points between MP 48 and 49 must have a station that begins with 48+ followed with the distance from MP 48.

11.3.2. All stationing must increase in the same direction as the mile post numbers increase. If the mile posts increase from east to west, then the stationing must increase from east to west. (The plan itself should still be oriented with the north direction either to the top or to the right. Profiles should be oriented with north or east to the right, so in some situations the stationing will increase to the left.)

11.3.3. Stationing must follow the centerline of track. The same track must be used throughout the project for stationing.

11.3.4. Cross-sections and profiles must be based on the same track as used for stationing.

11.3.5. Each track may also have its own project stationing without equations. These stations should be used for locating the cardinal points for both horizontal and vertical curves.

11.3.6. When taking existing top of rail elevations, the stationing for the points on all tracks should be assumed to be the same as the Track 2 stationing. This will effectively make all cross-sections perpendicular to Track 2. On tracks other than Track 2, the differences in the grades determined using true distances and stationing distances should be disregarded.

11.3.7. Stationing at interlockings must follow the Track 2 (or single track) stationing for all tracks. The station for a point is the station on Track 2 of a line perpendicular to Track 2 and passing through the point. Project stationing for all tracks is to continue through the interlocking without equations. For points of switch, the equivalent station of the project stationing on that track should be annotated as being equal to the Track 2 stationing.

11.4. Profiles

11.4.1. Profiles should have exaggerated vertical scales to adequately show grades and vertical curves.

11.4.2. Grades must be shown as a number, to three decimal places, adjacent to the profile line. Ascending grades (increasing elevations as the stations increase) must have a plus sign and descending grades (decreasing elevations as the stations increase) must have a negative sign.

11.4.3. Vertical curves must have a small circle at the beginning, point of intersection of the grade lines, and the end of the curve. The letters P.V.C., P.V.I. and P.V.T. must be shown at the appropriate points. The length of vertical curve, the “r” value, and the rate of vertical acceleration for the maximum speed expressed in feet per second squared must be shown near the mid-point of the vertical curve.

11.4.4. The limits of horizontal curves including the T.S., S.C., C.S., and S.T. must be shown on profiles, with the degree of horizontal curve delineated on the profile.

11.4.5. The limits of all turnouts, over and under-grade bridges, grade crossings, and station platforms must be clearly shown on profiles. The name of the turnout, bridge, road, or platform must also be shown.

11.4.6. All underground utilities and drainage facilities must be shown on profiles. The tops, diameters, and inverts of pipes must be noted on the profiles.

11.4.7. Existing grades must be shown as a dashed line. Proposed grades must be a solid, heavier weight line.

11.4.8. The point where the proposed profile meets the existing profile must be marked, "MEET EXISTING T/R" on the profile.

11.5. Cross Sections

11.5.1. Cross sections must have the same vertical and horizontal scales. Distorted sections may not be used. A scale of 1 inch = 10 feet is generally preferable.

11.5.2. Cross sections must extend to a point at least five feet beyond the construction limits. Cross sections must also extend to the next track beyond the construction limits, or to the property line, whichever is closer.

11.5.3. Property lines must be shown on the cross sections if they are within thirty feet of the limits of work.

11.5.4. Cross sections must have both the existing and proposed top of rail elevations shown on each cross section. Top of rail elevations must be shown to the nearest hundredth of a foot.

These elevations must be in accord with proposed design profiles, and with survey details of existing track. In areas where there is more than one track, the top of rail elevations of the immediately adjacent tracks must also be shown on each cross section.

11.5.5. Cross sections must have the invert elevations shown for proposed culverts, pipes and ditches, and for existing culverts and pipes. Ditch elevations must be shown to the nearest tenth of a foot; culvert and pipe elevations must be to the nearest hundredth of a foot.

11.5.6. Designed grades such as embankment slopes and ditch sides, other than those shown on typical sections, must be shown on all cross sections. Although a ratio such as 2:1 may be shown parallel to the slope, a small right triangle consisting of the slope, a horizontal line and a vertical line with the appropriate numbers adjacent to the lines is preferable.

11.6. CAD Files Amtrak's Track Department uses the Bentley MicroStation format as its standard. Accordingly, all CAD files submitted for Amtrak use or review must be a MicroStation "dgn" type file.

11.6.2. All CAD files must be created initially as a MicroStation format file. Files that were created in another format, such as AutoCAD, are not acceptable even if they are subsequently converted to MicroStation.

11.6.3. Files for a specific project must be separated and referenced to each other as needed:

11.6.3.1. The file containing the original survey information must be in a file with a name containing the word, "Survey." If additional survey files are necessary, such as for a survey that was done by a different firm or during a different date, then those files must be differentiated from each other using a different name or other identifier.

Surveyed points must be represented by a graphic point at the location of the surveyed point, a point number (corresponding with the text file containing the point number, description, and location), the description, and the elevation. The graphic point, the point number, the description, and the elevation must all be on separate levels.

11.6.3.2. Files containing design information must be in files with names containing the word, "Design." Designs must be in separate files with only one design in each file. The use of models with different designs or options in the same file is not permitted. Each design or option or scheme must be in its own file with the files differentiated from each other using a different name or other identifier.

11.6.3.3. Profile files must contain the name, "Profile." The profile of the existing item must be on its own level, separate from the level for the proposed profile. Each item, such as each track, pipe, ditch, etc., must be on its own level. Similarly, the temporary and proposed profile for each item must be on its own level.

The text for each item must be on its own unique level (separate existing, temporary and proposed text levels for each item).

11.6.3.4. Sheet files, if used, must contain the name, "Sheet." Each sheet should be a separate file. Sheet files should have the design files referenced to them so that all changes in the design will be reflected in the appropriate sheet file.

11.6.3.5. Index files must graphically show the location of each sheet within the project. Index files must contain the name, "Index." Index files should have the design or sheet files referenced to them so that all changes in the design will be reflected in the index file.

11.6.3.6. Cover sheets must be in a separate file containing the name, "Cover."

11.6.4. The name of the location should be the first part of each file name. Locations should be the place as known on the railroad and as shown on the track charts. If the location is an interlocking, then the name of the interlocking must be used. If it is between two communities, then the name of the closest community should be used.

Names of interlockings must be shown in all capital letters.

11.6.5. The second part of each file name is separated from the first part with a hyphen. The second part should indicate the type of file such as SURVEY, CONCEPT, DESIGN, etc.

A third or fourth part of the file name should be used to differentiate the file from others of the same type. The file name for the third option for the design of HUDSON interlocking would be, "HUDSON-DESIGN-Option 3.dgn."

11.6.6. Submissions that have files listing other files as reference files must include those referenced files. Files that include images must similarly include the image files as a part of the submission.

11.7. Contract Specifications

11.7.1. Specifications must use the CSI (Construction Standards Institute) numbering system.

11.7.2. Amtrak's standard specifications, plans, and Engineering Practices must be used wherever possible.

11.8. Specifications

11.8.1. Amtrak's MW-1000, "Limits and Specifications for the Safety, Maintenance and Construction of Track" is intended to be used in conjunction with this document.

11.8.2. Amtrak's standard specifications, plans, and Engineering Practices must be used wherever possible. AREMA (and other) standards may be used only in situations where Amtrak standards do not exist. Whenever non-Amtrak standards are used, the source of the standards should be stated.

11.9. Standard plans and forms

11.9.1. As detailed in § **Curve Descriptions** the data for simple horizontal curves that have no superelevation or spirals must be provided using the format:

CURVE XXX - TRACK X

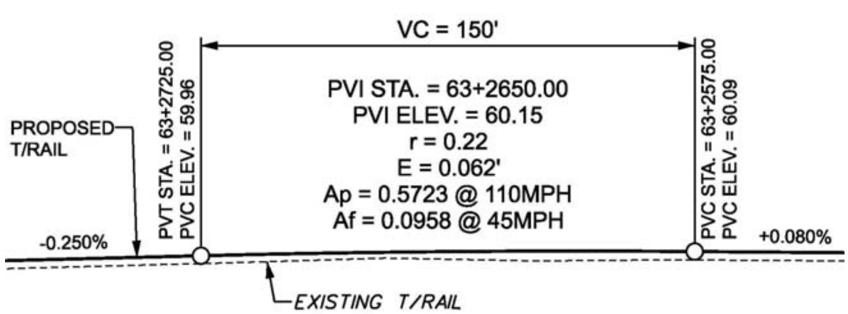
$\triangle$ = XX°-XX'-XX.XX"	L_C = XXX.XX'
D_C = XX°-XX'-XX.XX"	T = XXX.XX'
R = XXXX.XX'	E = X.XX'
E_U = X.XX"	V = XX MPH

11.9.2. Curve designs that have spirals may have different design speeds and related data that depends on the type of train equipment used. Horizontal curve and spiral data must be provided using the format:

CURVE XXX - TRACK X

D_C = XX°-XX'-XX.XX"	$\triangle_I$ = XX°-XX'-XX.XX"	
L_S = XXX'	θ_S = XX°-XX'-XX.XX"	
R = XXXX.XX'	$\triangle_C$ = XX°-XX'-XX.XX"	
L_C = XXX.XX'	θ_S = XX°-XX'-XX.XX"	
T_S = XXX.XX'	E = XX.XX'	
E_a = X $\frac{x}{x}$"	M = XX.XX'	
EQUIPMENT TYPE -	X	X
E_U =	X.XX"	X.XX"
V_{MPH} =	XXX	XXX
Jerk Rate =	X.XX	X.XX

11.9.3. The data for vertical curves must be provided using the following format:



11.10. Design Exceptions

11.10.1. Designs that do not meet Amtrak's standards and requirements should be modified so that they are in compliance. In situations where a solution is not apparent or is not practicable, a Design Exception may be required. Design Exceptions must not take the place of diligent design efforts; they should only be requested when Amtrak's requirements can not be accomplished or are impractical. Amtrak is under no obligation to approve any request for a Design Exception, and may require the designer to make additional efforts to bring the design into compliance. The design for a project will not be considered complete until all Design Exceptions have been resolved to Amtrak's satisfaction.

11.10.2. The designer must request a Design Exception for all designs and specifications that do not meet Amtrak's standards and specifications. The Design Exception request(s) for each exception must accompany each submission.

11.10.3. The formal request for approval of a Design Exception must be made providing the following information:

1. The name of the project
2. The sequential number of the exception request
3. The date the request was initially made
4. The location of the exception using track number and engineering stationing or other easily determined identifier. If the exception involves a segment of the alignment, then the location must identify that segment such as, "The tangent between the end of Curve 462 and the P.S. of the 24 switch."
5. The sheet number or numbers on which the design exception is shown;
6. The standard that is not being met and the source reference for that standard
7. A brief description of the exception. The description should include the value that has been attained and a comparison with the value that the standard requires.
8. The reason for the exception;
9. The advantage to the project of allowing the design exception;
10. Safety impacts (if any);
11. Capital costs or savings;
12. Life cycle costs or savings;
13. Future maintenance impacts (if any);
14. Person and agency (or firm) making the request

The request form must include a place for recording Amtrak's resolution and the name of the Amtrak person making that resolution. After the Design Exception request has been resolved to Amtrak's satisfaction, the details of that resolution must appear on all subsequent copies of that particular Design Exception.

11.10.4. Requests must be supplied to Amtrak with the text in Microsoft Word format. Supporting documents, including the actual drawing sheet(s), must be supplied in Adobe pdf format. Each separate Design Exception request must be a separate set of files.

11.10.5. The number or other identifier for each Design Exception must be shown on the site key-plan for the project, and also on the individual sheet where the Design Exception is required. The individual sheets must have the area that the Design Exception covers outlined with a cloud and with "DER #__" and an arrow connecting to the cloud. The DER label, the arrow, and the cloud must all be shown in red if the DER has not been approved. When a DER is approved, the label, arrow, and cloud must be changed to green. If the design is modified to eliminate the exception then the annotation must be removed from the drawings.

12. Edits

12.1. October 15, 2011 Edition

Section 4.2.5 on minimum alignment lengths added.
Section 4.5.1 on compound curves modified
Section 4.5.2 on compound curves added
Section 4.7.1 modified to remove references to E-60 locomotives
Section 4.10 on angle points added
Section 4.11.2 on track center distances modified
Section 5.3.3 on minimum length vertical tangents added.
Section 7.1.3 on acceptable turnout designs modified
Section 7.3.2 through 7.3.2.6 on turnouts modified

12.2. August 1, 2013 Edition

Section 2.2.2 for using ground-penetrating radar.
Section 2.2.8 for subballast slopes and constructing along a uniform slope.
Section 2.3.1 on subballast material as required in Specification 57.
Section 2.4.1 requirement for using specified ballast material.
Section 4.7.1 on maximum underbalance, curvature and speeds.
Section 4.9.7 on distances from a spiral to other alignment points.
Section 4.14 on clearance points added.
Section 4.6.4 modified to reduce or eliminate superelevation on some curves.
Section 5.1.2 detailing permissible grades added.
Section 5.3.3 on vertical curve lengths clarified.
Section 5.3.5 on vertical curves clarified.
Section 5.5.1.1 on vertical acceleration clarified.
Section 7.3.1 on advanced technology turnouts modified.
Section 7.3.1.5 on spring frogs modified.
Section 7.3.2.3 on number 10 turnouts with spring frogs added.
Section 7.3.2.4 on number 10 turnouts with RBM frogs added.
Section 10.1.7.3 on drawings for electric-lock and power switches added.
Section 10.1.7.4 on interlocking switch numbers added.
Section 10.2.3 requiring vertical acceleration added.
Sections 10.3.2 and 10.3.3 on cross section limits and property lines.
Section 10.4 on CAD files added and subsequent portions of Section 10 renumbered.
Section 10.7 on Design Exceptions added.

12.3. June 1, 2015 Edition

Section 4.3.5 Moved from Section 4.9 and provision for direct-fixation track added.
Section 4.3.6 Make radius dependent on degree of curve.
Section 4.4.1 Requirement for equilibrium speed removed.
Section 4.5.3 Compound curve details
Section 4.6.3 Reduction in maximum allowable superelevation to 5½ inches.
Section 4.6.4 Reduction in maximum allowable underbalance.
Section 4.8.2 Designs must allow for speeds 5 mph over operating speed.

Section 4.8.3 Limits on superelevation and underbalance.
Section 4.14.2 Fouling point and clearance point descriptions
Section 4.14.3 Insulated joint locations and signal locations.
Section 5.1.3 Maximum grades on stub tracks and in terminals.
Section 5.3.2 Required profile data needed where the proposed meets existing.
Section 7.1.3 Turnout restrictions
Sections 7.1.5 and 7.1.6 Turnout locations
Section 7.1 Turnout Table Number 26.5 turnouts removed
Section 7.4.2 Relation of turnout and curves in direct fixation track
Section 7.4.5 Parent tracks of crossovers must be truly parallel.
Section 7.9.2 Use of spring frogs
Section 10 Interlockings sections added
Section 11.1 Deliverables sections added
Section 11.2.7 Limits of regression analysis and profile change details
Section 11.2.8 sub-sections – drawing details
Section 11.3 Stationing details added
Section 11.4.8 Profile requirements detailed
Section 11.5.3–11.5.5 Drawing details added
Section 11.9.1-11.9.2 Horizontal and vertical curve tables
Design Exception Request form, and sample interlocking approval schematic added

Chris Harding

Chris Harding

Director, Track Design and Layout

April 1, 2015

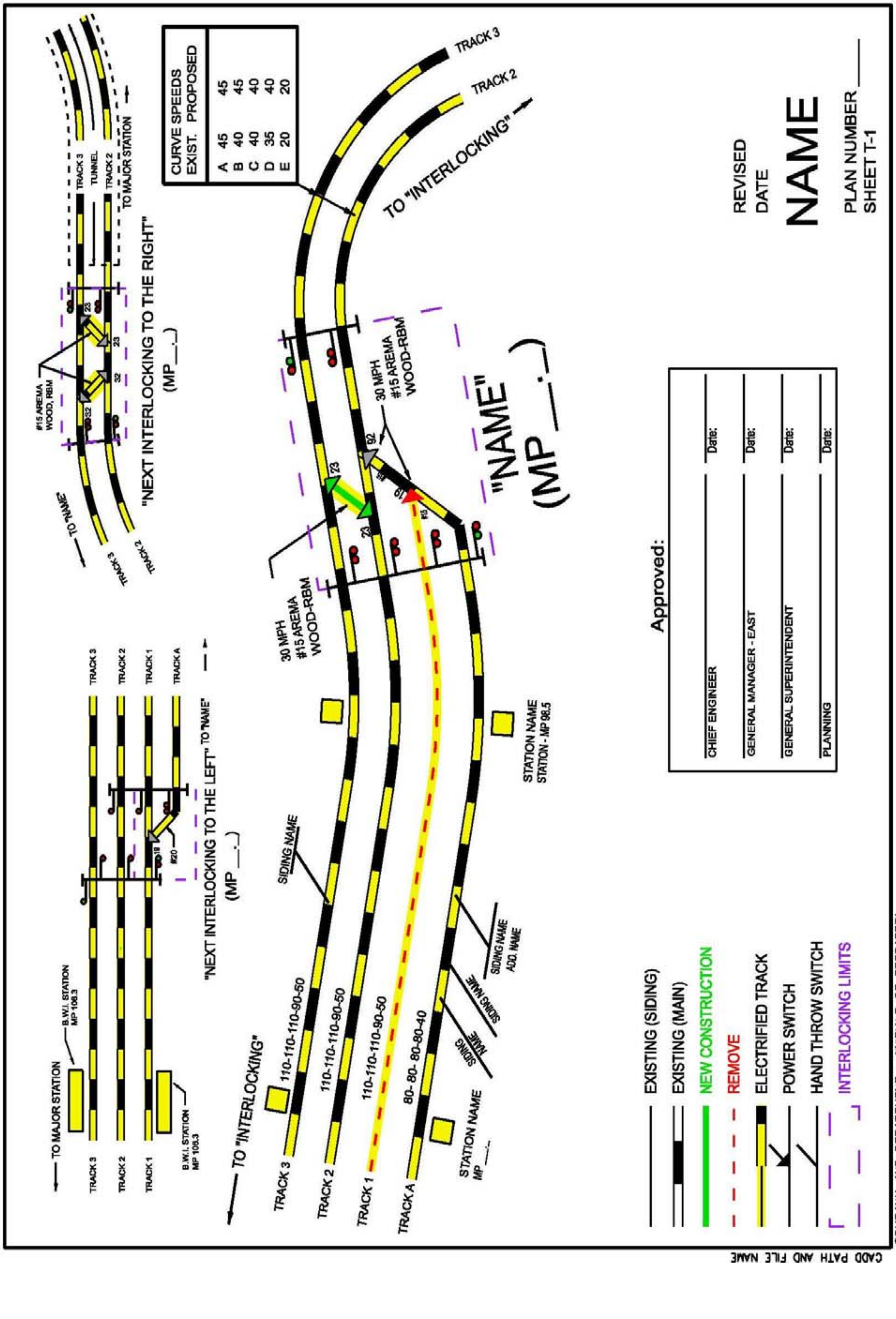
This form is to be used when a project warrants an exception to established design standards. Complete Section 1 and 2 and attach supporting documents prior to submission to Amtrak for consideration.

Section 1: Request Information			
Project Name			
Project DER No.		Date	
Exception Location			
Requesting Agency	Name of A/E Firm	Requester	A/E firm representative

Section 2: Design Exception Description (Provide brief concise statements)	
Excepted Design Standard and section No.	
Attach Design Standard, unless it is an Amtrak or AREMA Standard	
Description of Exception	
Reason for Request	
The potential impacts of a DER on: safety, capital costs, life cycle costs, future maintenance, or the right-of-way should be described in the Reason for Request field. Additional pages may be attached. Section 4 must always appear on the first page.	

Section 3: Amtrak Review Comments			
Comments and Recommendation			
Reviewer Name		Title	

Section 4: Amtrak Approval / Denial Status				
APPROVE or DENY	Signature		Date	
	Name		Title	


CURVE SPEEDS
EXIST. PROPOSED
A 45 45
B 40 45
C 40 40
D 35 40
E 20 20
"NEXT INTERLOCKING TO THE RIGHT"
(MP__._)
#15 AREMA WOOD, RBM
TRACK 3
TUNNEL
TRACK 2
TO MAJOR STATION
TO "NAME"
TRACK 3
TRACK 2
TO "INTERLOCKING"
30 MPH
#15 AREMA
WOOD-RBM
"NAME"
(MP__._)
30 MPH
#15 AREMA
WOOD-RBM
STATION NAME
STATION - MP 98.5
Approved:
CHIEF ENGINEER
Date:
GENERAL MANAGER - EAST
Date:
GENERAL SUPERINTENDENT
Date:
PLANNING
Date:
REVISED
DATE
NAME
PLAN NUMBER
SHEET T-1
TO MAJOR STATION
B.W.I. STATION
MP 108.3
TRACK 3
TRACK 2
TRACK 1
TRACK A
"NEXT INTERLOCKING TO THE LEFT"
TO "NAME"
(MP__._)
#20
SIDING NAME
TO "INTERLOCKING"
110-110-110-90-50
110-110-110-90-50
110-110-110-90-50
80-80-80-80-40
TRACK 3
TRACK 2
TRACK 1
TRACK A
STATION NAME
MP__._
SIDING NAME
SIDING NAME
SIDING NAME
ADD. NAME
EXISTING (SIDING)
EXISTING (MAIN)
NEW CONSTRUCTION
REMOVE
ELECTRIFIED TRACK
POWER SWITCH
HAND THROW SWITCH
INTERLOCKING LIMITS
COMPANY AND DEPARTMENT - (INITIALS OF PREPARER)
CADD PATH AND FILE NAME