

CHAPTER 3

GEOMETRIC DESIGN

3-1. Curvature.

a. The curvature will be limited to preclude any requirement for superelevation in excess of 5-1/2 inches at the design train speed. Curves of less than 1 degree 30 minutes will be avoided for tracks where design speed requires the use of superelevation.

b. Where the design train speed is less than 20 miles per hour, the maximum degree of curvature should, in most cases, be limited to curvature of the turnout being used. With the standard No. 8 turnout this curvature will be 11 degrees 46 minutes 44 seconds (nearly 12 degrees). In congested areas where sharp curves cannot be avoided, the curvature will not exceed 15 degrees.

c. Standard gage will be used on all curves up to 8 degrees and then widened 1/8 of an inch for each increment of 2 degrees to a maximum of 4 feet 9-1/2 inches.

3-2. Superelevation. Superelevation will not be used on curves where the speed is less than 20 miles per hour except when required by the serving railroad. Superelevation will be provided on access or main running tracks where the speed is 20 miles per hour or more. Table 3-1 gives some practical superelevations in inches which may be provided where the speed justifies their use. The low rail will hold the grade of the track. The superelevation figures shown in table 3-1 were derived from the following equation:

$$E = CDV^2$$

where:

E = superelevation, inches

C = constant with following values:

C = 0.0005 for 1-degree 30-minute curve

C = 0.0004 for 3 degrees and above

D = actual degree of curve

V = Maximum speed, miles per hour

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Table 3-1. Superelevation in Inches

Degree	Speed in Miles Per Hour					
	45	40	35	30	25	20
1 deg 30 min	1-1/2	1-1/4	1			
2 deg 00 min	1-3/4	1-1/4	1			
2 deg 30 min	2	1-1/2	1-1/4			
3 deg 00 min	2-1/2	2	1-1/2	1		
3 deg 30 min	3	2-1/2	2	1-1/4		
4 deg 00 min	3-1/4	2-1/2	2	1-1/2	1	
4 deg 30 min	3-1/2	3	2-1/2	1-1/2	1	
5 deg 00 min	4	3-1/4	2-1/2	1-3/4	1-1/4	
5 deg 30 min	4-1/2	3-1/2	2-1/2	2	1-1/4	1
6 deg 00 min	5	4	3	2-1/4	1-1/2	1
6 deg 30 min	5-1/4	4-1/4	3-1/4	2-1/4	1-1/2	1
7 deg 00 min	5-1/2	4-1/2	3-1/2	2-1/2	1-3/4	1

A spiral easement will be used where superelevation is required. The minimum length of the spiral will be derived from the following formula:

$$L = 1.17EV$$

where:

L = spiral length, feet (minimum length)

E = superelevation, inches

V = Maximum train speed, miles per hour

3-3. Grades. The maximum grade on access lines will be determined by the tonnage handled in one train unit. Reduction of the ruling grade will depend on the initial cost of construction compared with the savings in cost of operation. Usually the grades on all tracks can be kept well below 2 percent. In some cases, light train units and rough terrain may require some grades over 2 percent. Grades should not exceed 3 percent. Grades in the body (parallel tracks of a yard upon which cars are placed or stored) or yards and on standing tracks will not exceed 0.4 percent except at warehouses or storehouses, where the grade can be 0.5 percent.

a. Compensating grades for curvature. Maximum grades on access lines will be compensated 0.04 percent per degree of curvature. Compensation will also be applied when heavy traffic or large tonnage units will be handled.

b. Vertical curves. Usually, a vertical curve will be needed to provide a smooth transition between grades. Vertical curves will not

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be shorter than the length established by the formula and rates of grade change outlined below:

$$L = \frac{G_1 - G_2}{R} \times 100$$

where:

L = minimum length of vertical curve, feet

G₁ and G₂ = gradients in feet per 100 feet, with the proper algebraic sign for each

R = rate of change of grade per 100 feet

(1) Access or running tracks. Vertical curves will connect all grades where the algebraic difference in gradient exceeds 0.15 percent in sags and 0.3 percent on summits. Using the formula shown above, the minimum length vertical curve will be based on a rate of grade change per 100 feet of 0.15 (R = 0.15) on sags and 0.30 (R = 0.30) on summits.

(2) Spurs and sidings. Vertical curves will connect all grades where the algebraic difference in gradient exceeds 0.35 percent. Using the formula shown above, the minimum length vertical curve will be based on a rate of grade change per 100 feet of 0.40 percent (R = 0.40).

c. Stub-end tracks. If practicable, grades on stub-end tracks should have a slight descending grade from the switch.

d. Derails. Provide for the protection of main line, access, and running tracks by the use of derails on tracks which descend toward switches.

3-4. Clearances. Clearances for tangent track will not be less than those listed below. Side clearances will be measured horizontally from the center line of tracks. Side clearances on the outside of curves will be increased 1 inch for each degree of track curvature over that shown for tangent track. Side clearances on the inside of curves will be increased 1 inch for each degree of track curvature and also 3-1/2 times the amount of superelevation of the high rail.

a. Overhead wires.

- Open supply wires, arc wires, and service drops	
0 to 750 volts	27 feet
750 to 15,000 volts	28 feet
Exceeding 15,000 volts	30 feet

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- Guys, messenger, communication, span, and lightning protection wires and all voltage of effectively grounded continuous-metal sheath cables 27 feet
 - Trolley wires 22 feet
- b. Miscellaneous overhead obstructions.
- Other than wires and building entrances 22 feet
 - Building entrance (including engine-houses) 18 feet
- c. Side clearances.
- Buildings (other than for delivery) 8 feet 6 inches
 - Buildings, without platforms (where delivery is required) 8 feet
 - Canopies over platform, 16 feet or less (delivery to platform required) 8 feet
 - Freight platforms to 4 feet (maximum) (or 5 feet 9 inches if there is an 8-foot clearance on other side of the track) 6 feet 2 inches
 - Refrigerator car platforms, 3 feet 3 inches or less or 5 feet 9 inches if there is an 8-foot clearance on other side of track) 6 feet 2 inches
 - Refrigerator car platforms, between 3 feet 3 inches and 4 feet 8 feet
 - Low platforms, 8 inches or less 5 feet
 - Engine-house entrances 6 feet 6 inches

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- Building entrances (other than engine-house) 8 feet

d. Track centers. Yard tracks will be a minimum of 13 feet center to center, and when parallel to a main track or running track, will be not less than 15 feet from such track. Ladder tracks will be not less than 15 feet from any parallel track and will be not less than 18 feet when such parallel track is another ladder track. Tracks in pairs for operation of locomotive cranes will be not less than 18 feet on centers.

e. Safety requirements. Overhead clearances less than 22 feet will be protected by warning signs and telltales or by standards of the serving railroad or local state laws. No overhead clearance will be less than 18 feet. All overhead clearances less than 22 feet will be included in operating contracts made with the serving railroad or others. Side clearances for immovable obstructions, such as buildings, canopies, platforms, poles, etc., other than railroad track appurtenances, which are less than 8 feet 6 inches from the center line of track, will be protected by appropriate close-clearance signs.