APPENDIX D. ENGINEERING DATA

D-1. Alignment.

Normally, curvature of track should be limited to a minimum radius of approximately 300 feet or to the minimum recommended by the serving railroad. The following rules for alignment should be followed:

D-1.1. Running tracks and body tracks are 15 feet center to center from parallel tracks. For siding tracks, allow 13 feet between parallel tracks. For siding and main line tracks, allow 15 feet between parallel tracks. Figures D-1 through D-4 and Tables D-1 through D-4 are engineering drawings and information concerning turnouts and track layouts. Figures D-5 and D-6 show names of parts for bolted frogs and split switches, respectively.

D-1.2. Beginning with a 10-degree curve, track centers are widened 1 inch for each degree of curvature, to allow for overhanging and tilting of cars. A special engineering analysis should be made when longer than standard (60 feet) cars are moved. (Middle ordinates for curved rails for various lengths of rail and degrees of curves are shown in Table D-5.)

D-2. Superelevation.

Superelevation is, in general, based on the degree of curvature and the train speed. Usually, an elevation of 6 inches is not exceeded for tracks carrying both fast and slow traffic. Speed of trains is reduced if necessary. See Table D-6 for the maximum allowable operating speeds for curved track. **NOTE:** Curves in industrial or heavily congested areas may be installed level without superelevation.

D-2.1. Simple Curves. Full elevation will be carried uniformly throughout the length of simple curves.

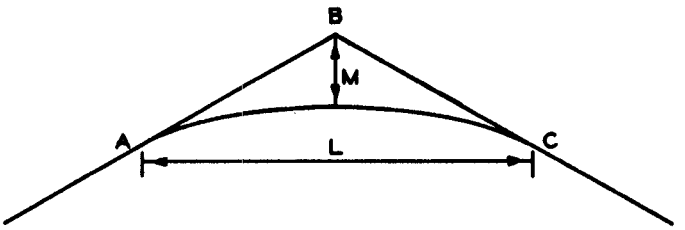
D-2.2. Compound Curves. Each section of a compound curve will be given its correct elevation, but the change from one elevation to another will be uniformly distributed.

D-2.3. Reverse Curves. The elevation from one rail to the other will be changed so that rails are level at the point of reversal.

D-2.4. Transition Approach. Superelevation of a spiral easement or tangent transition approach to a simple curve will be made in successive stages at a rate of 1/4 to 1/2 inch in 30 feet for a maximum length of 360 feet. Changes from zero to full elevation at the start of a simple unspiraled curve will be made within the transition approach so that full elevation is attained at the start of the curve. Spiral easements will be given to all curves where layout conditions permit. Table D-7 gives spiral lengths for various elevations and train speeds.

D-3. Vertical Curves.

Vertical curves are used for all changes in gradient. The maximum allowable rate of change is 0.10 foot per 100 feet in sags and 0.20 foot per 100 feet in summits. For tracks of lesser importance, the rate of change may be larger but shall be not greater than practicable considerations will permit. One such form of vertical curve is developed as follows:



L = Length of vertical curve in 100-foot stations
M = Correction in elevation at B
R = Rate of change per station
D = Algebraic difference of rates at grade
L = D/R

When vertical curve is concave downwards:

$$M = \frac{(\text{el. B} \times 2) - (\text{el. A} + \text{el. C})}{4}$$

When vertical curve is concave upwards:

$$M = \frac{(\text{el. A} + \text{el. C}) - (\text{el. B} \times 2)}{4}$$

The correction for any other point on a vertical curve is proportional to the square of the distance from A or C to B. Corrections are minus (−) when the vertical curve is concave downwards and plus (+) when the vertical curve is concave upwards.

D–4. Grades.

Maximum grades of 0.5 percent (6 inches in 100 feet) are recommended for house and storage tracks; grades will not exceed 0.8 percent (9-1/2 inches in 100 feet). Grades on access or running tracks are limited to those recommended by the serving railroad. All changes in gradient are made through vertical curves (para D–3).

D–5. Space Allowance for Rail Expansion.

To insure proper space allowance for expansion when laying or replacing rail, the openings between the ends of rail listed in Table D–8 shall be developed through the use of standard metal, fiber, or wood shims placed between the ends of adjacent rails. When shims are used they shall be removed to within 12 rails of the laying.

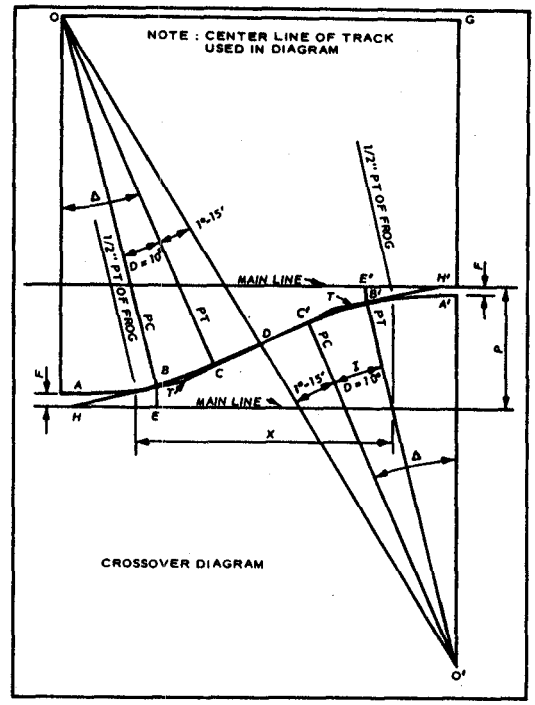


Figure D-2. Curve details for standard No. 8 crossover (see Table D-2 for dimensions).

Table D-2. Dimensions of Standard No. 8 Crossover

Dimensions are between parallel tracks, at P distance apart, using 10-degree curves and 25-foot tangent between frogs.
R = 573.69; Frog angle = 7°09';
CC' (tangent) = 25.00;
$OD = O'D = \sqrt{R^2 + 125^2} = 573.83$
Continue curve I to tangent parallel to main track.

Then F = BE - 573.69 versine 7°09' = 1.48'. O'G = 2R - P + 2F = 1,150.34 - P

$\Delta = \cos^{-1} \frac{1150.34}{1147.66} - P - 1°15'$

I = Δ - 7°09'; T = R tan 1/2 I
X = Distance between actual points of frogs = (2T + 25) cos Δ + 2T cos 7°09' + 18.75.

P	X	I	P	X	I
30	124.75	4°07'	51	205.35	8°17'
31	129.21	4°21'	52	208.67	8°27'
32	133.60	4°35'	53	211.95	8°38'
33	137.90	4°48'	54	215.20	8°48'
34	142.12	5°01'	55	218.42	8°58'
35	146.28	5°14'	56	221.60	9°08'
36	150.37	5°26'	57	224.74	9°18'
37	154.40	5°39'	58	227.87	9°28'
38	158.37	5°51'	59	230.96	9°37'
39	162.28	6°03'	60	234.01	9°47'
40	166.13	6°15'	61	237.04	9°56'
41	169.93	6°27'	62	240.04	10°06'
42	173.68	6°38'	63	243.02	10°15'
43	177.37	6°50'	64	245.97	10°25'
44	181.03	7°01'	65	248.89	10°34'
45	184.62	7°12'	66	251.78	10°43'
46	188.18	7°23'	67	254.66	10°52'
47	191.70	7°34'	68	257.51	11°01'
48	195.17	7°45'	69	260.33	11°10'
49	198.60	7°56'	70	263.13	11°19'
50	201.99	8°06'			

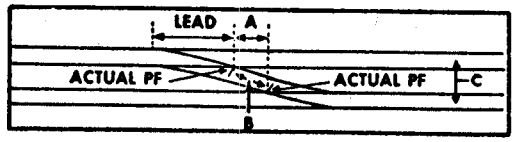


Figure D-3. Diagram of lead and coordinates of crossovers (see Table D-4 for dimensions).

Table D-3. Lead and Coordinate Distances by Frog Number and Distance Between Tracks

Frog No.	Leads ft	Leads in.	Frog Angles deg	Frog Angles ft	Distance Between Track Centers(C) 12 Feet A ft	12 Feet A in.	12 Feet B ft	12 Feet B in.	13 Feet A ft	13 Feet A in.	13 Feet B ft	13 Feet B in.	14 Feet A ft	14 Feet A in.	14 Feet B ft	14 Feet B in.
5	42	6	11	25	11	10-3/4	13	1-1/4	16	10-1/4	18	1-3/4	21	9-3/4	23	2-1/2
6	47	6	9	32	14	6	15	6	20	5-1/2	21	6-1/2	26	5	27	7
7	62	1	8	10	17	1	17	11	24	0-1/2	24	11-3/4	31	0	32	0
8	68	0	7	09	19	7-1/2	20	4-1/2	27	7	28	5	35	6-3/4	36	5-1/4
9	72	3	6	22	22	2	22	10	31	1-3/4	31	10-1/2	40	1-1/2	40	10-3/4
10	78	9	5	43	24	8-1/4	25	3-3/4	34	8	35	4	44	8	45	4-1/4
12	96	8	4	46	29	9	30	3	41	8-3/4	42	3-1/4	53	8-1/2	54	3-1/2
14	107	1	4	05	34	9-1/2	35	2-1/2	48	9-1/4	49	2-3/4	62	9	63	3
15	126	4	3	49	37	3-1/4	37	8-1/2	52	3-1/2	52	8-1/2	67	3-1/4	67	8-3/4
16	131	4	3	35	39	9-1/2	40	2-1/4	55	9-3/4	56	2-1/2	71	9-1/2	72	2-3/4
18	140	11	3	11	44	10	45	2	62	10	63	2-1/4	80	9-3/4	81	2-1/2
20	151	11	2	52	49	10	50	1-3/4	69	10	70	2	89	10	90	2

Frog No.	Leads ft	Leads in.	Frog Angles deg	Frog Angles ft	Distance Between Track Centers(C) 15 Feet A ft	15 Feet A in.	15 Feet B ft	15 Feet B in.	18 Feet A ft	18 Feet A in.	18 Feet B ft	18 Feet B in.	20 Feet A ft	20 Feet A in.	20 Feet B ft	20 Feet B in.
5	42	6	11	25	26	9	28	3	41	7-1/4	43	5	51	6	53	6
6	47	6	9	32	32	4-1/2	33	7-1/2	50	3	51	9	62	2	63	10
7	62	1	8	10	37	11-3/4	39	0-1/2	58	10-1/4	60	2	72	9-1/2	74	2-3/4
8	68	0	7	09	43	6-1/2	44	5-3/4	67	5-1/4	68	6-3/4	83	4-1/2	84	7-1/2
9	72	3	6	22	49	1	49	11	76	0	77	0	93	11-1/2	95	0-1/2
10	78	9	5	43	54	7-1/2	55	4-1/2	84	6-1/2	85	5-1/2	104	6-1/4	105	6
12	96	8	4	46	65	8-1/4	66	3-3/4	101	7-1/2	102	4-1/2	125	4-1/2	126	5
14	107	1	4	05	76	9	77	3-1/4	118	8-1/4	119	4	146	8	147	4-1/2
15	126	4	3	49	82	3	82	9	127	2-1/2	127	9-3/4	157	2	157	10
16	131	4	3	35	87	9-1/4	88	3	135	8-3/4	136	3-1/2	167	8-1/4	168	3-3/4
18	140	11	3	11	98	9-1/2	99	2-1/2	152	9	153	3	188	8-1/2	189	3-1/2
20	151	11	2	52	109	9-3/4	110	2-1/4	169	9-1/2	170	2-3/4	209	9	210	3

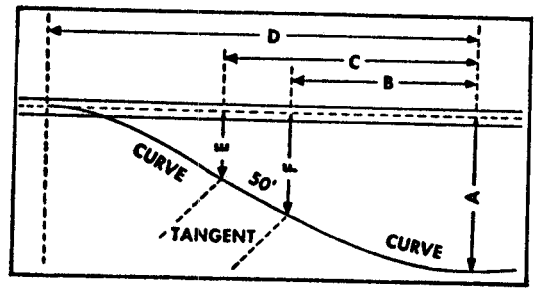


Figure D-4. Diagram for laying temporary tracks around obstructions.

Table D-4. Dimensions for Laying Temporary Tracks Around Obstructions

A	B	C	D	E	F
		10-Degree Curves			
10	53.6	103.3	156.9	2.5	7.5
20	84.0	133.5	217.5	6.3	13.7
30	107.3	156.5	263.8	10.3	19.7
40	127.3	176.0	303.3	14.4	25.6
50	144.8	193.1	337.9	18.7	31.3
60	160.3	208.3	368.6	23.0	37.0
70	174.5	222.1	396.6	27.4	42.6
80	187.8	235.0	422.8	31.8	48.2
90	200.2	247.0	447.2	36.2	53.8
100	211.9	258.3	470.2	40.7	59.3
		15-Degree Curves			
10	42.2	92.0	134.2	2.3	7.7
20	66.2	115.4	181.6	5.7	14.3
30	85.0	133.7	218.7	9.5	20.5
40	100.8	149.2	250.0	13.5	26.5
50	114.7	162.6	277.3	17.5	32.5
60	127.2	174.4	301.6	21.5	38.3
70	138.7	185.6	324.3	26.0	44.0
80	149.4	195.6	345.0	30.3	49.7
90	159.2	204.8	364.0	34.6	55.4
100	168.5	213.5	382.0	39.0	61.0

Note: All dimensions in feet.

Table D-5. Radius of Curves and Middle Ordinates for Curved Rails

Radius of Curve (ft)	Degree of Curve	Middle Ordinate (in.) for Rail Length (ft)		
		30	33	39
955.4	6	1-3/8	1-3/4	2-3/8
819.0	7	1-5/8	2-7/8	2-3/4
716.8	8	1-7/8	2-1/4	3-1/8
637.3	9	2-1/8	2-1/2	3-5/8
573.7	10	2-3/8	2	4
521.7	11	2-5/8	3-1/8	4-3/8
478.3	12	2-7/8	3-3/8	4-3/4
441.7	13	3	3-3/4	5-1/8
410.3	14	3-1/4	4	5-1/2
383.1	15	3-1/2	4-1/4	6

NOTE: To find the middle ordinate of a curved rail, stretch a line from ends of rail on inside of curvature. Distance from edge of rail to line at exact center of rail is middle ordinate.

Table D-6. Maximum Allowable Operating Speeds for Curved Track

Degree of Curvature	Elevation of Outer Rail (in.)												
	0	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
	Maximum Allowable Operating Speed (mph)												
0°30'	93	100	107	--	--	--	--	--	--	--	--	--	--
0°40'	80	87	93	98	103	109	--	--	--	--	--	--	--
0°50'	72	78	83	88	93	97	101	106	110	--	--	--	--
1°00'	66	71	76	80	85	89	93	96	100	104	107	110	--
1°15'	59	63	68	72	76	79	83	86	89	93	96	99	101
1°30'	54	58	62	66	69	72	76	79	82	85	87	90	93
1°45'	50	54	57	61	64	67	70	73	76	78	81	83	86
2°00'	46	50	54	57	60	63	66	68	71	73	76	78	80
2°15'	44	47	50	54	56	59	62	64	67	69	71	74	76
2°30'	41	45	48	51	54	56	59	61	63	66	68	70	72
2°45'	40	43	46	48	51	54	56	58	60	62	65	66	68
3°00'	38	41	44	46	49	51	54	56	58	60	62	64	66
3°15'	36	39	42	45	47	49	51	54	56	57	59	61	63
3°30'	35	38	40	43	45	47	50	52	54	55	57	59	61
3°45'	34	37	39	41	44	46	48	50	52	54	55	57	59
4°00'	33	35	38	40	42	44	46	48	50	52	54	55	57
4°30'	31	33	36	38	40	42	44	45	47	49	50	52	54
5°00'	29	32	34	36	38	40	41	43	45	46	48	49	51
5°30'	28	30	32	34	36	38	40	41	43	44	46	47	48
6°00'	27	29	31	33	35	36	38	39	41	42	44	45	46
6°30'	26	28	30	31	33	35	36	38	39	41	42	43	45
7°00'	25	27	29	30	32	34	35	36	38	39	40	42	43
8°00'	23	25	27	28	30	31	33	34	35	37	38	39	40
9°00'	22	24	25	27	28	30	31	32	33	35	36	37	38
10°00'	21	22	24	25	27	28	29	31	32	33	34	35	36
11°00'	20	21	23	24	26	27	28	29	30	31	32	33	34
12°00'	19	20	22	23	24	26	27	28	29	30	31	32	33

Table D-7. Spiral Lengths on Curves for Various Elevations and Train Speeds

Elevation	Spiral Length (ft) for Train speeds (mph)											
in.	15	20	25	30	35	40	45	50	55	60	65	70
1	18	23	29	35	41	47	53	59	64	70	76	82
1-1/2	26	35	44	53	62	70	79	88	97	106	114	123
2		47	59	70	82	94	106	117	129	141	152	164
2-1/2		59	73	88	103	117	132	147	161	176	191	205
3		70	88	106	123	141	158	176	193	211	229	246
3-1/2			103	123	144	164	185	205	226	246	267	288
4			117	141	164	188	211	235	258	282	305	
4-1/2			132	158	185	211	238	264	290	317	343	
5				176	205	235			322		381	
5-1/2				194	225						419	

Table D-8. Space Allowance for Rail Expansion

33-Foot Rail 160 Joints per Mile		39-Foot Rail 135 Joints per Mile	
Rail Temperature °F	Rail Expansion in.	Rail Temperature °F	Rail Expansion in.
Below −10	5/16	Below 6	5/16
−10 to 14	1/4	6 to 25	1/4
15 to 34	3/16	26 to 45	3/16
35 to 59	1/8	46 to 65	1/8
60 to 85	1/16	66 to 85	1/16
Over 85	None	Over 85	None

D-6. Derails.

Derails are installed on sidings to derail any cars rolling beyond a specified safe distance from the adjacent running track. The use of derails is governed by such local conditions as the relative grades of turnout and running tracks, and the amount and type of traffic on the track to be protected. Derails are installed on the rail farthest from the running track and far enough from the clearance point to insure that derailed equipment will not foul the running track (Chapter 3).

D-7. Guardrails Over Bridges or Trestles.

D-7.1. Installation. Guardrails are installed between running rails over open deck bridges and trestles, on all curves over 4 degrees, or on tangents and curves under 4 degrees if the clear span is 40 feet or more. They are installed according to the following rules:

D-7.1.1. Single Track. Two guardrails placed on the ties between traffic rails to provide a 10-inch space between the head of the guardrail and the gage side of the traffic rail.

D-7.1.2. Two Tracks. One guardrail for each track, placed on the ties 10 inches from the gage of the traffic rails farthest from the parapets.

D-7.1.3. Three or More Tracks. One guardrail for each outside track, placed on the ties 10 inches from the gage of the traffic rails farthest from the parapets.

D-7.2. Weights. The relationship between weights of guardrails and traffic rails is as follows:

Traffic Rail	Guardrail
130	100
100	85
90	75
85	70
75	60

D-8. General.

Tables D-9 thrugh D-12 give information regarding rail and track accessories.

Table D-9. Rail Accessories for 1,000 Feet of Track

Weight of Rail		No. of Ties		Joint-Bars[a]		Bolts (Square Nuts), 4 per Joint		Lock Washers		Spikes[b] (4 per Tie)				Ballast	Tie Plates
										16 Ties per 39-Foot Rail		18 Ties per 39-Foot Rail			
Weight per Yard lb	Weight Long Tons	16 per 39-Foot Rail	18 per 39-Foot Rail	No. of Pairs	Weight Net Tons	Kegs	Weight Net Tons	No.	Weight Net Tons	Kegs	Weight Net Tons	Kegs	Weight Net Tons	15% Shrinkage Allowed 6 inches Deep, cu yd	Weight Net Tons
75	22.32	410	461	51.13	1.1	1.38	0.138	205	0.0171	4.97	0.497	5.59	0.559	391.10	3.946
80	23.81	410	461	51.13	1.1	1.473	0.1473	205	0.0171	4.97	0.497	5.59	0.559	391.10	3.946
85	25.30	410	461	51.13	1.38	1.473	0.1473	205	0.0171	4.97	0.497	5.59	0.559	391.10	3.946
90	26.79	410	461	51.13	1.38	1.76	0.176	205	0.0184	4.97	0.497	5.59	0.559	391.10	5.887
100	29.76	410	461	51.13	1.71	1.76	0.176	205	0.0184	4.97	0.497	5.59	0.559	391.10	6.550
115	34.76	410	461	51.13	1.61	2.47	0.247	205	0.0184	6.98	0.698	7.85	0.785	391.10	7.914

NOTES: Corrections in track materials to be made for each turnout:

1. Measure track to switch point.
2. On standard turnout, add 59 feet of track or 118 feet of rail.
3. Deduct 95 cross.
4. Add 7 pairs of joint bars.
5. Add 28 track bolts.
6. Add 28 lock washers.
7. Add 1/3 keg of spikes.
8. Standard turnout plan shows D-bars for joints in turnouts. When angle bars can be used, it is preferable to use them.
9. Add 136 tie plates.
10. Measurement of standard track begins at end of switch ties (87 feet from PS).

[a] No allowance made for shorts.

[b] Additional spikes needed on curves (2 per tie).

Table D-10. Size and Weight of Rail Accessories

Weight of Rail lb	Joint Bars: Length (4 Hole) in.	Joint Bars: Weight per Pair lb	Bolts (Square Nuts): Average Number in 200-lb Keg	Bolts (Square Nuts): Size in.	Bolts (Square Nuts): Weight Each lb	Lock Washers (1/2 in. Wide, 1/4 in. Thick): Size in.[a]	Lock Washers (1/2 in. Wide, 1/4 in. Thick): Weight Each in.	Spikes (5/8×6 in.)
75	24	43	148	7/8×4	1.35	1 ID 2 OD	0.16705	Weight each 0.8264 lb
80	24	43	139	7/8×4-1/2	1.44	1 ID 2 OD	0.16705	
85	24	54	139	7/8×4-1/2	1.44	1 ID 2 OD	0.16705	Average number per 200-lb keg = 242
90	24	62	109	1×5-1/4	1.724[b]	1-1/8 ID 2-1/8 OD	0.18097	
100	24	67	109	1×5-1/2	1.724[b]	1-1/8 ID 2-1/8 OD	0.18097	
115	24	63	109	1×5-1/2	1.724	1-1/8 ID 2-1/8 OD	0.18097	

[a] Inside dimension; outside dimension.
[b] Hexagonal nuts.

Table D-11. Dimensins and Weights of Standard Railroad Spikes

Dimensions, in.: Diameter	Length	Head: Length	Head: Width	Head: Thickness	Thickness of Heel	Length of Hook	Taper of Point, in.	Approximate Number per 200-lb Keg	Number of Kegs per Mile of Single Track	Rails Used, Weight per Yard lb
1/2	3-1/2	1-5/16	1-1/8	1/2	5/16	11/16	7/8	624	17.9	20 to 30
1/2	4	1-5/16	1-1/8	1/2	5/16	11/16	7/8	550	18.0	20 to 30
1/2	4-1/2	1-5/16	1-1/8	1/2	5/16	11/16	7/8	504	20.0	30 to 40
1/2	5	1-5/16	1-1/8	1/2	5/16	11/16	7/8	472	21.6	30 to 40
9/16	4-1/2	1-1/2	1-1/4	9/16	5/32	3/4	1-1/8	408	25.8	40 to 50
9/16	5	1-1/2	1-1/4	9/16	5/32	3/4	1-1/8	365	32.6	50 to 60
9/16	5-1/2	1-1/2	1-1/4	9/16	5/32	3/4	1-1/8	330	37.1	60 to 100
5/8	5	1-9/16	1-5/16	21/32	7/32	3/4	1-1/4	288	38.4	85 to 100
5/8	5-1/2	1-9/16	1-5/16	21/32	7/32	3/4	1-1/4	272	42.7	85 to 130
5/8	6	1-9/16	1-5/16	21/32	7/32	3/4	1-1/4	242	47.6	85 to 130

NOTE: Number of spikes in this table based on tie spacing of 24 inches for rails up to and including 45 pounds and 22 inches for rails 50 pounds and heavier.

Table D-12. Dimensions and Weights of Standard Track Bolts

Dimensions, in.									Nuts								
		Head				Shoulder					With Square Nuts			With Hexagon Nuts			
Diameter	Length	Wide	Deep	Diameter Side	Diameter Top	Deep	Wide	Length Thread	Thickness in.	Short Diameter of Square and Hexagon, in.	Weight, Pounds per 100	Number in 200-lb Keg	Number of Kegs per Mile of Track	Weight, Pounds per 100	Number in 200-lb Keg	Number of Kegs per Mile of Track	Rail Used on Weight lb/yd
1/2	1-3/4	15/16	5/16	9/32	15/16	5/16	11/16	1-1/8	1/2	7/8	22.0	909	1.6	20.3	986	1.5	12 to 20
1/2	2	15/16	5/16	9/32	15/16	5/16	11/16	1-1/8	1/2	7/8	22.7	881	1.7	21.7	923	1.6	12 to 20
1/2	2-1/4	15/16	5/16	9/32	15/16	5/16	11/16	1-1/8	1/2	7/8	24.0	834	1.8	22.9	874	1.7	12 to 20
5/8	2-3/4	1-1/8	13/32	3/8	1-1/8	3/8	7/8	1-1/4	5/8	1-1/16	44.5	448	3.2	43.0	466	3.1	25 to 35
5/8	3	1-1/8	13/32	3/8	1-1/8	3/8	7/8	1-1/4	5/8	1-1/16	47.3	439	3.3	45.5	440	3.3	25 to 35
3/4	3	1-3/8	17/32	1/2	1-3/8	1/2	1	1-3/4	3/4	1-1/4	73.5	273	5.3	70.0	286	5.0	40 to 45
3/4	3-1/4	1-3/8	17/32	1/2	1-3/8	1/2	1	1-3/4	3/4	1-1/4	76.0	264	5.0	72.3	277	4.8	50 to 75
3/4	3-1/2	1-3/8	17/32	1/2	1-3/8	1/2	1	1-3/4	3/4	1-1/4	80.3	249	5.3	76.0	264	5.0	50 to 75
3/4	3-3/4	1-3/8	17/32	1/2	1-1/8	1/2	1	1-3/4	3/4	1-1/4	83.7	239	5.5	79.1	252	5.2	50 to 75
3/4	4	1-3/8	17/32	1/2	1-3/8	1/2	1	1-3/4	3/4	1-1/4	86.9	231	5.7	81.9	245	5.4	50 to 75
7/8	4	1-9/16	19/32	9/16	1-9/16	9/16	1-3/16	2	7/8	1-7/16	124.1	162	8.0	118.5	169	7.7	75 to 85
7/8	4-1/4	1-9/16	19/32	9/16	1-9/16	9/16	1-3/16	2	7/8	1-7/16	129.4	155	8.4	122.2	164	8.0	75 to 85
1	4-1/2	1-23/32	5/8	19/32	1-23/32	5/8	1-5/16	2-1/4	1	1-5/8	175.0	115	11.3	166.3	121	10.8	90 to 100
1	4-3/4	1-23/32	5/8	19/32	1-23/32	5/8	1-5/16	2-1/4	1	1-5/8	187.9	109	12.0	187.9	109	12.0	90 to 100
1	5-1/2	1-11/32	5/8	19/32	1-11/16	9/16	1-3/8	2-1/4	1	1-5/8	187.9	109	12.0	187.9	109	12.0	115