Specification for Oil-Field V-Belt

API SPECIFICATION 1B
SIXTH EDITION, JANUARY 1, 1995

American Petroleum Institute
1220 L Street, Northwest
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Exploration and Production Department

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FOREWORD

This specification is under the jurisdiction of the API Committee on Standardization of Production Equipment.

The purpose of this specification is to provide specifications for V-belts and V-belt sheaves suitable for use in oil-field drilling and producing operations.

Much of the engineering material pertaining to V-belts and V-belt sheaves was taken from two standards published jointly by the Rubber Manufacturers Association, the Mechanical Power Transmission Association, and the Rubber Association of Canada. These standards are:

Specifications for Drives Using Narrow Multiple V-Belts - IP22 Latest Edition.

Specifications for Drives Using Classical Multiple V-Belts - IP20 Latest Edition.

This standard shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

Specification for Oil-Field V-Belting

1 Scope

1.1 COVERAGE

This specification covers dimensional and marking requirements on V-belts and V-belt sheaves of both the narrow multiple and classical multiple type. This specification also includes recommended practices for:

- Design of V-belt drives.
- Care and use of V-belts
- Measuring tension in V-belt drives
- Calculating the load imposed by V-belts on shafts and bearings

This document does not include alternate belt types such as those listed below.

	RMA Standards	ISO Standards
• ISO V-Belts (I.E., SP Sections)	—	4183 & 4184
• Synchronous (timing)	IP 24	5294 & 5296
• V-Ribbed	IP 26	9982
• Flat	—	22, 63, 99, 100

However, these other forms of belt power transmission may be acceptable, provided that they are designed according to the belt manufacturer's recommendations and/or an existing industry standard.

2 V-Belts

2.1 QUALITY

V-belts furnished to this specification shall at least satisfy the power ratings formulae listed in Table B9 & B10 of Appendix B.

2.2 WORKMANSHIP

Belts shall give good service under normal working conditions and when operated within an ambient temperature range of -32°F (0°C) to 140°F (60°C).

2.3 SURFACE

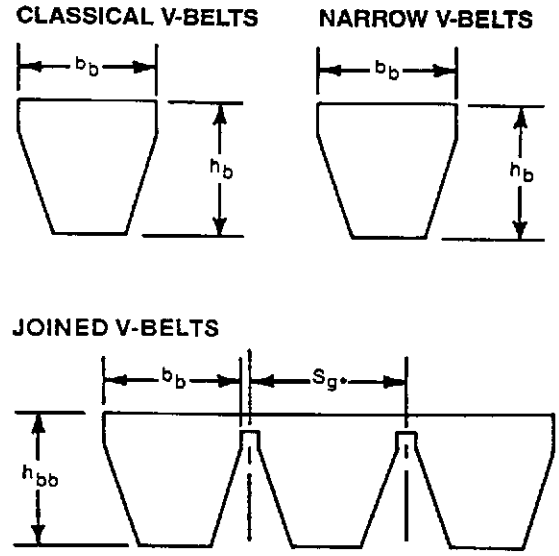
The surface of the finished belts shall be so impregnated with vulcanizing material that the internal structure of the belt will not be unduly affected by moisture and oil, under normal operating conditions.

2.4 STATIC CONDUCTIVITY

If Belts are to be static conductive, conductivity shall be measured using the method and value described in Rubber Manufacturers Association (RMA) Bulletin IP 3-3.
WARNING: Operating environments should be reviewed to determine if additional special grounding techniques are required. Please refer to the NEC and API Recommended Practice 500.

2.5 CROSS SECTION

Nominal cross sectional dimensions for V-belts and joined V-belts are shown in Fig. 1 and Tables 1 and 2. (See Appendix C for the use of joined V-belts.) These dimensions along with cross-sectional shapes (also nominal), may vary for belts of the same belt section as made by different manufacturers. Standard V-belts, regardless of variations in dimensions and cross-sectional shapes shall be designed to operate on standard sheaves.



*Sg is sheave groove spacing dimension. Refer to Table 1, 2, 3 or 4.

Figure 1—V-Belt Cross Sections

Table 1—Nominal Dimension of Cross Sections, Inches

Belt Type	Cross Section	b_b	h_b	h_{bb}*	S_g+
Classical V-Belts	A, AX	0.50	0.31	0.41	0.625
	B, BX	0.66	0.41	0.50	0.750
	C, CX	0.88	0.53	0.66	1.000
	D	1.25	0.75	0.84	1.438
Narrow V-Belts	3V, 3VX	0.38	0.31	0.38	0.406
	5V, 5VX, 5VA	0.62	0.53	0.62	0.688
	8V, 8VA	1.00	0.91	1.00	1.125

*Classical and narrow V-Belts are also available in the joined belt configuration as illustrated in Fig. 2.1.
+S_g is specified sheave groove spacing (See Tables 1 and 2.)

Table 2—Nominal Dimension of Cross Sections, Millimeters

Belt Type	Cross Section	b_b	h_b	h_{bb}*	S_g+
Classical V-Belts	13C, 13CX	13	8	10	15.9
	16C, 16CX	16	10	13	19.0
	22C, 22CX	22	13	17	25.4
	32C	32	19	21	36.5
Narrow V-Belts	9N, 9NX	9	8	10	10.3
	15N, 15NX, 15NA	15	13	16	17.5
	25N, 25NA	25	23	25	28.6

*Classical and narrow V-Belts are also available in the joined belt configuration as illustrated in Fig. 2.1.
+S_g is specified sheave groove spacing (See Table 3 and 4)

2.6 LENGTHS

The standard lengths of classical and narrow belts are specified in Tables 3, 4, 5 and 6. Tables 3 and 5 represent current practice in inches. Datum length referenced in Table 3 identifies the length previously called pitch length. Tables 4 and 6 show belt lengths using metric (SI) dimensions. The classical belts have been changed to the "effective" or "constant top width" system used for narrow belts, when they are specified in metric (SI) dimensions.

2.7 LENGTH DETERMINATION

The belt length (effective and datum) shall be determined by placing the belt on a measuring fixture comprising: two

Table 3—Classical V-Belts Standard Datum Lengths—Inches

Standard Length Designation	Standard Datum Lengths — Cross Section A, AX	B, BX	C, CX	D	Permissible Deviations From Standard Datum Length	Matching Limits For One Set
26	27.3				± 0.60	0.15
31	32.3				± 0.60	0.15
35	36.3	36.8			± 0.60	0.15
38	39.3	39.8			± 0.70	0.15
42	43.3	43.8			± 0.70	0.15
46	47.3	47.8			± 0.70	0.15
51	52.3	52.8	53.9		± 0.70	0.15
55	56.3	56.8			± 0.70	0.15
60	61.3	61.8	62.9		± 0.70	0.15
68	69.3	69.8	70.9		± 0.70	0.30
75	76.3	76.8	77.9		± 0.70	0.30
80	81.3				± 0.70	0.30
81		82.8	83.9		± 0.70	0.30
85	86.3	86.8	87.9		± 0.70	0.30
90	91.3	91.8	92.9		± 0.80	0.30
96	97.3		98.9		± 0.80	0.30
97		98.8			± 0.80	0.30
105	106.3	106.8	107.9		± 0.80	0.30
112	113.3	113.8	114.9		± 0.80	0.30
120	121.3	121.8	122.9	123.3		0.30
128	129.3	129.8	130.9	131.3	± 0.80	0.30
144		145.8	146.9	147.3	± 0.80	0.30
158		159.8	160.9	161.3	± 1.00	0.45
173		174.8	175.9	176.3	± 1.00	0.45
180		181.8	182.9	183.3	± 1.00	0.45
195		196.8	197.9	198.3	± 1.10	0.45
210		211.8	212.9	213.3	± 1.10	0.45
240		240.3	240.9	240.8	± 1.30	0.45
270		270.3	270.9	270.8	± 1.60	0.60
300		300.3	300.9	300.8	± 1.60	0.60
330			330.9	330.8	± 2.00	0.60
360			360.9	360.8	± 2.00	0.60
390			390.9	390.8	± 2.00	0.75
420			420.9	420.8	± 3.30	0.75
480				480.8	± 3.30	0.75
540				540.8	± 3.30	0.90
600				600.8	± 3.30	0.90
660				660.8	± 3.30	0.90

Note: AX, BX and CX may not be available in all lengths. Check with manufacturer for availability.
To specify belt size use the Standard Length Designation prefixed by the letter indicating cross Section; example: B90.

sheaves of equal diameter, a method of applying force, and a means of measuring the center distance between the two sheaves. One of the two sheaves is fixed in position while the other is movable along a graduated scale. The fixture is shown schematically in Fig. 2. Specifications for diameter and groove dimensions (including tolerances) of the measuring sheaves are given in Tables 7, 8, 9 or 10.

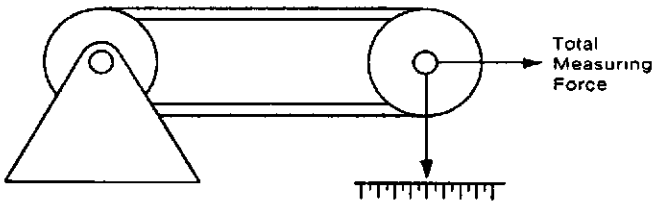


Figure 2—Diagram of a Fixture for Measuring V-Belts

a. In measuring the length of a V-belt, the belt shall be rotated around the sheaves at least two revolutions of the belt: to seat the belt properly in the sheave grooves; to divide equally the total force between the two strands of the belt; and to determine the midpoint of the center distance travel of the movable sheave, which shall define the center distance.
b. The V-belt length (effective or datum) shall be calculated by adding the appropriate circumference of one of the measuring sheaves to twice the measured center distance between the two sheaves. V-belts are not acceptable when the determined length varies from the standard length more than the values given in Tables 3, 4, 5 and 6.
c. The belt ride shall not exceed the values given in Tables 7, 8, 9, and 10.

2.8 MATCHED BELTS

Belts indicated as matched belts shall not have length variations in any one set in excess of the limits given in Tables 3, 4, 5 or 6.

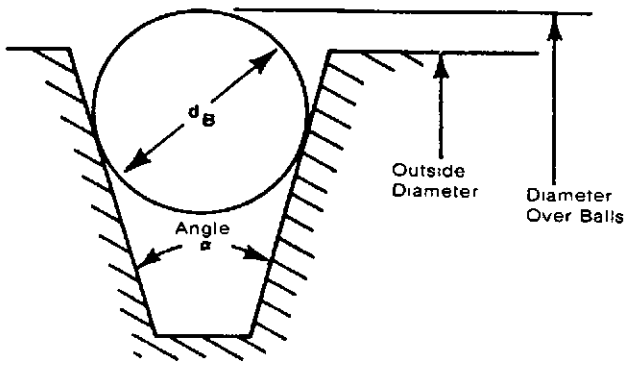


Figure 3—Method for Measuring Sheaves

Table 4—Classical V-Belts Standard Effective Lengths—Millimeters

Standard Effective Length — Cross Sections				Permissible Deviations From Standard Length	Matching Limits For One Set
13C 13CX	16C 16CX	22C 22CX	32C		
710				± 15	4
750				± 15	4
800				± 15	4
850				± 15	4
900				± 15	4
950	960			± 15	4
1000	1040			± 15	4
1075	1090			± 15	4
1120	1120			± 15	4
1150	1190			± 15	4
1230	1250			± 15	4
1300	1320			± 15	4
1400	1400	1400		± 15	6
1500	1500	1500		± 15	6
1585	1600	1630		± 15	6
1710	1700			± 15	6
1790	1800	1830		± 20	6
1865	1900	1900		± 20	6
1965	1980	2000		± 20	6
2120	2110	2160		± 20	6
2220	2240	2260		± 20	6
2350	2360	2390		± 20	6
2500	2500	2540		± 20	6
2600	2620	2650		± 20	6
2730	2820	2800		± 20	6
2910	2920	3030		± 20	10
3110	3130	3150	3190	± 20	10
3310	3330	3350	3390	± 20	10
	3530	3550		± 20	10
	3740	3760	3800	± 25	10
	4090	4120	4160	± 25	10
	4200	4220	4250	± 25	10
	4480	4500	4540	± 25	10
	4650	4680	4720	± 25	10
	5040	5060	5100	± 30	10
	5300	5440	5480	± 30	10
	5760	5770	5800	± 30	10
	6140	6150	6180	± 30	16
	6520	6540	6560	± 40	16
	6910	6920	6940	± 40	16
	7290	7300	7330	± 40	16
	7670	7680		± 40	16
		8060	8090	± 40	16
		8440	8470	± 40	16
		8820	8850	± 40	16
		9200	9240	± 60	16
			10000	± 60	16
			10760	± 60	16
			11530	± 80	16
			12290	± 80	24

Note: 13CX, 16CX and 22CX may not be available in all lengths. Check with manufacturer for availability.
To specify belt size use the Standard Effective Length prefixed by the cross section; for example: 16C4200.

2.9 NOMENCLATURE

This standard covers Classical V-belts and sheaves (A, B, C and D cross sections) and Narrow V-belts and sheaves (3V, 5V and 8V) which are generally used in multiple sets for power transmission applications. Appropriate information is provided for the use of joined V-belts in these cross-sections. Power rating formulas and design information is also included for molded notch V-belts (AX, BX, CX, 3VX and 5VX) and V-belts with aramid tensile member (5VA and AVA) which have greater power capacity than the conventional belts.

2.10 DETAILS FOR DIMENSIONAL CHECKING OF BELTS

The two methods of establishing the dimensions of measuring sheaves as specified in 2.7.A, 2.7.B and 2.7.C shall be by either:

a. Fixing the outside diameter, the groove angle, and the groove top width.
b. Fixing a diameter-over-balls or rods, and the outside diameter, and either the groove angle or groove top width. (See Figure 3).

The diameter-over-balls, groove angle dimensions are given in Tables 7, 8, 9 or 10. The diameter-over-balls, groove angle method is considered to be the most accurate way of fixing groove dimensions and is recommended. The cross section dimensions of the belt shall be checked by measuring the distance from the top of the belt to the top of the sheave groove (Figure 4). This measurement provides the "ride" of the belt with respect to the top of the groove which shall be within the limits given in Tables 7, 8, 9 or 10.

3 Marking

3.1 OTHER NAME

Belting made in accordance with this specification by an authorized manufacturer may be marked with the name of a jobber or distributor instead of the name of the manufacturer.

3.2 METHOD

Belting purchased to this specification shall be marked as specified hereinafter. Markings shall be applied on the side of the belt to be run away from the sheave. Markings shall be applied by vulcanizing, stamping, or stenciling. Markings shall be applied in such a manner that the belt is not damaged.

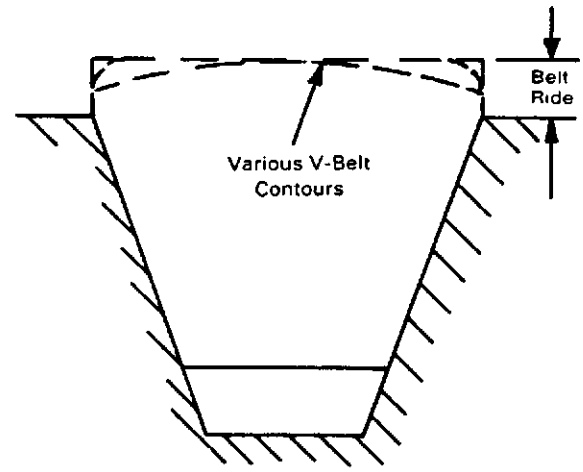


Figure 4—Measuring Belt Ride

3.3 MARKING

Markings for belting shall be as follows:

a. Manufacturer's, Jobber's or Distributor's Name or Mark.
b. Belt Cross Section. Belts shall be marked with the cross-sections as referenced in this standard.
c. Standard Length. Belts shall be marked with the Standard length designation in Tables 3, 4, 5 and 6.

3.4 This section shall be superseded by Appendix F of this specification when applicable

Table 5—Narrow V-Belts Standard Effective Lengths-Inches

Standard Length Designation	Standard Effective Outside Length — Cross Sections			Permissible Deviations From Standard Length	Matching Limits For One Set	
	3V, 3VX	5V, 5VX 5VA	8V, 8VA		Normal Tensile Modulus	5VA, 8VA
250	25.0			±0.3	0.15	0.08
265	26.5			±0.3	0.15	0.08
280	28.0			±0.3	0.15	0.08
300	30.0			±0.3	0.15	0.08
315	31.5			±0.3	0.15	0.08

Table 5—Narrow V-Belts Standard Effective Lengths—Inches

Standard Length Designation	Standard Effective Outside Length — Cross Sections			Permissible Deviations From Standard Length	Matching Limits For One Set	
	3V, 3VX	5V, 5VX 5VA	8V, 8VA		Normal Tensile Modulus	5VA, 8VA
335	33.5			± 0.3	0.15	0.08
355	35.5			± 0.3	0.15	0.08
375	37.5			± 0.3	0.15	0.08
400	40.0			± 0.3	0.15	0.08
425	42.5			± 0.3	0.15	0.08
450	45.0			± 0.3	0.15	0.08
475	47.5			± 0.3	0.15	0.08
500	50.0	50.0		± 0.3	0.15	0.08
530	53.0	53.0		± 0.4	0.15	0.08
560	56.0	56.0		± 0.4	0.15	0.12
600	60.0	60.0		± 0.4	0.15	0.12
630	63.0	63.0		± 0.4	0.15	0.12
670	67.0	67.0		± 0.4	0.30	0.12
710	71.0	71.0		± 0.4	0.30	0.12
750	75.0	75.0		± 0.4	0.30	0.12
800	80.0	80.0		± 0.4	0.30	0.12
850	85.0	85.0		± 0.5	0.30	0.12
900	90.0	90.0		± 0.5	0.30	0.12
950	95.0	95.0		± 0.5	0.30	0.12
1000	100.0	100.0	100.0	± 0.5	0.30	0.12
1060	106.0	106.0	106.0	± 0.6	0.30	0.12
1120	112.0	112.0	112.0	± 0.6	0.30	0.20
1180	118.0	118.0	118.0	± 0.6	0.30	0.20
1250	125.0	125.0	125.0	± 0.6	0.30	0.20
1320	132.0	132.0	132.0	± 0.6	0.30	0.20
1400	140.0	140.0	140.0	± 0.6	0.30	0.20
1500	150.0	150.0	150.0	± 0.8	0.30	0.20
1600		160.0	160.0	± 0.8	0.45	0.20
1700		170.0	170.0	± 0.8	0.45	0.20
1800		180.0	180.0	± 0.8	0.45	0.20
1900		190.0	190.0	± 0.8	0.45	0.20
2000		200.0	200.0	± 0.8	0.45	0.20
2120		212.0	212.0	± 0.8	0.45	0.20
2240		224.0	224.0	± 0.8	0.45	0.20
2360		236.0	236.0	± 0.8	0.45	0.20
2500		250.0	250.0	± 0.8	0.45	0.24
2650		265.0	265.0	± 0.8	0.60	0.24
2800		280.0	280.0	± 0.8	0.60	0.24
3000		300.0	300.0	± 0.8	0.60	0.24
3150		315.0	315.0	± 1.0	0.60	0.24
3350		335.0	335.0	± 1.0	0.60	0.24
3550		355.0	355.0	± 1.0	0.60	0.24
3750			375.0	± 1.0	0.60	0.24
4000			400.0	± 1.0	0.75	0.24
4250			425.0	± 1.2	0.75	0.24
4500			450.0	± 1.2	0.75	0.24
4750			475.0	± 1.2	0.75	0.24
5000			500.0	± 1.2	0.75	0.24

Note: 3VX, 5VX, 5VA and 8VA may not be available in all lengths. Check with manufacturer for availability. To specify belt size use the Standard Effective Length prefixed by the cross section; for example: 5V850.

Table 6—Narrow V-Belts Standard Effective Lengths—Millimeters

Standard Length Designation	Standard Effective Outside Length — Cross Sections: 9N 9NX	15N 15NX 15NA	25N 25NA	Permissible Deviations From Standard Length	Matching Limits For One Set — Normal Tensile Modulus	15NA 25NA
630	630			± 8	4	2
670	670			± 8	4	2
710	710			± 8	4	2
760	760			± 8	4	2
800	800			± 8	4	2
850	850			± 8	4	2
900	900			± 8	4	2
950	950			± 8	4	2
1015	1015			± 8	4	2
1080	1080			± 8	4	2
1145	1145			± 8	4	2
1205	1205			± 8	4	2
1270	1270	1270		± 8	4	2
1345	1345	1345		± 10	4	2
1420	1420	1420		± 10	6	3
1525	1525	1525		± 10	6	3
1600	1600	1600		± 10	6	3
1700	1700	1700		± 10	6	3
1800	1800	1800		± 10	6	3
1900	1900	1900		± 10	6	3
2030	2030	2030		± 10	6	3
2160	2160	2160		± 13	6	3
2290	2290	2290		± 13	6	3
2410	2410	2410		± 13	6	3
2540	2540	2540	2540	± 13	6	3
2690	2690	2690	2690	± 15	6	3
2840	2840	2840	2840	± 15	10	5
3000	3000	3000	3000	± 15	10	5
3180	3180	3180	3180	± 15	10	5
3350	3350	3350	3350	± 15	10	5
3550	3550	3550	3550	± 15	10	5
3810		3810	3810	± 20	10	5
4060		4060	4060	± 20	10	5
4320		4320	4320	± 20	10	5
4570		4570	4570	± 20	10	5
4830		4830	4830	± 20	10	5
5080		5080	5080	± 20	10	5
5380		5380	5380	± 20	10	5
5690		5690	5690	± 20	10	5
6000		6000	6000	± 20	10	5
6350		6350	6350	± 20	16	6
6730		6730	6730	± 20	16	6
7100		7100	7100	± 20	16	6
7620		7620	7620	± 20	16	6
8000		8000	8000	± 25	16	6
8500		8500	8500	± 25	16	6
9000		9000	9000	± 25	16	6
9500		9500	9500	± 25	16	6
10160			10160	± 25	16	6
10800			10800	± 30	16	6
11430			11430	± 30	16	6
12060			12060	± 30	24	6
12700			12700	± 30	24	6

Note: 9NX, 15NX, 15NA and 25NA may not be available in all lengths. Check with manufacturer for availability.
To specify belt size use the Standard Effective Length prefixed by the cross section; for example: 15N2160.

Table 7—Complete Measuring Conditions Using Diameter Over Balls Sheave Inspection for Classical Belts, Inches

Cross Section	Outside Diameter ±0.005 (inches)	Datum Circumference (inches)	Groove Angle ∝ ±0.33 (degrees)	b_g Groove Top Width (Reference) (inches)	d_c Ball Or Rod Diameter ±0.005 (inches)	Diameter Over Balls Or Rods ±0.005 (inches)	h_g Groove Depth (minimum) (inches)	Total Measuring Force per belt (pounds)	Maximum Ride Position Of Belt With Respect To Top Of Groove (inches)	
									Not Joined	Joined
A, AX	4.138	12.214	34	0.494	0.4375	4.456	0.460	50	+0.10	+0.18
B, BX	5.730	16.902	34	.637	0.5625	6.133	0.550	65	+0.10	+0.20
C, CX	7.958	23.744	34	0.879	0.7812	8.536	0.750	165	+0.10	+0.25

Note: Grooves of Master Inspection Sheaves shall be machined to tolerances shown in Table 7 and checked at least annually for wear and damage.

Table 8—Complete Measuring Conditions Using Diameter Over Balls Sheave Inspection for Classical Belts, Millimeters

Cross Section	Effective Diameter ±0.1 (mm)	Effective Circumference (mm)	Groove Angle ∝ ±0.25 (degrees)	b_g Groove Top Width (Reference) (mm)	d_B Ball Or Rod Diameter (mm)	Diameter Over Balls Or Rods ±0.1 (mm)	h_g Groove Depth (minimum) (mm)	Total Measuring Force per belt (Newtons)	Maximum Ride Position Of Belt With Respect To Top Of Groove (mm)	
									Not Joined	Joined
13C 13CX	95.5	300.0	34	13	12.5 ± 0.01	108.2	12	300	+2.5	+4.5
16C, 16CX	143.2	450.0	34	16.5	15.5 ± 0.02	157.7	14	450	+2.5	+5.0
22C, 22CX	222.8	700.00	34	22.4	21.0 ± 0.02	242.2	19	850	+2.5	+6.5
32C	318.3	1000.0	36	32.8	30.5 ± 0.02	346.6	26	1800	+3.0	+7.0

Note: Grooves of Master Inspection Sheaves shall be machined to tolerances shown in Table 8 and checked at least annually for wear and damage.

Table 9—Complete Measuring Conditions Using Diameter Over Balls Sheave Inspection for Classical Narrow Belts, Inches

Cross Section	Outside Diameter ± 0.005 (inches)	Effective Outside Circumference (inches)	∝ Groove Angle ± 0.33 (degrees)	b_e Groove Top Width (Reference) (inches)	d_c Ball or Rod Diameter ± 0.005 (inches)	Diameter Over Balls Or Rods ± 0.005 (inches)	h_g Groove Depth (minimum) (inches)	Total Measuring Force per belt (pounds)	Maximum Ride Position Of Belt With Respect To Top Of Groove (inches)	
									Not Joined	Joined
3V, 3VX	3.820	12.000	38	0.350	0.3438	4.203	0.340	100	+0.10	+0.20
5V, 5VX, 5VA	7.958	25.000	38	0.600	0.5938	8.633	0.590	225	+0.12	+0.25
8V, 8VA	15.916	50.000	38	1.000	1.0000	17.083	0.990	500	+0.16	+0.30

Note: Grooves of Master Inspection Sheaves shall be machined to tolerances shown in Table 9 and checked at least annually for wear and damage.

Table 10—Complete Measuring Conditions Using Diameter Over Balls Sheave Inspection for Narrow Belts, Millimeters

Cross Section	Effective Diameter ±0.1 (mm)	Effective Outside Circum-ference (mm)	∝ Groove Angle ±0.25 (degrees)	b_e Groove Effective Width (Reference) (mm)	d_B Ball Or Rod Diameter (mm)	Diameter Over Balls Or Rods ±0.1 (mm)	h_g Groove Depth (minimum) (mm)	Total Measuring Force per belt (newtons)	Maximum Ride Position Of Belt With Respect To Top Of Groove (mm)	
									Not Joined	Joined
9N 9NX	95.5	300	38	8.89	8.50 ± 0.01	104.3	8.6	445	2.5	5.1
15N, 15NX, 15NA	191.0	600	38	15.24	15.00 ± 0.02	207.8	15.0	1000	3.0	6.4
25N, 25NA	318.3	1000	38	25.40	25.00 ±.02	346.3	25.1	2225	4.1	7.6

Note: Grooves of Master Inspection Sheaves shall be machined to tolerances shown in Table 10 and checked at least annually for wear and damage.

APPENDIX A—SHEAVES FOR V-BELTS

A.1 Grooves

Sheaves furnished for use with v-belts manufactured to this specification should be standard groove or deep groove as shown in Table A-1 through A-4.

WARNING: Do not use commercially available sheaves for drives using aramid fiber reinforced belts designated 5VA, 8VA, 15NA and 25NA without an engineering analysis and approval by the sheave manufacturer.

The manufacturer may recommend a specially designed sheave to march drive specifications.

A.2 Finish

Sheave grooves should be finished to 125 microinches (3.2 micrometers) roughness height Ra or smoother (arithmetic average). The edges of all grooves shall be rounded smoothly and the crests between grooves shall be flush with the outside edges of the sheave.

A.3 Dimensions

Sheave face and grooves shall conform to dimensions and tolerances shown in Figures A-1 through A-3 and Tables A-1 through A-4. Keyways in solid sheaves and sheave hubs shall conform to dimensions and tolerances shown in Tables A-5 through A-8 (Figs. A-4 through A-7).

Tables A-1 and A-2 represent current practice in inches. Datum Diameter referenced in Table A-1 and Figure A-1 identifies that diameter previously called "pitch diameter." The pitch diameter location has been corrected to more accurately represent true pitch line location for speed ratio calculation.

Table A-3 shows metric dimensions for classical A, B, C and D sheaves.The profiles have been changed to the "effective" or "constant top width" system used for Narrow 3V, 5V and 8V belts. They are however completely interchangeable with the sheaves in Table G-1.

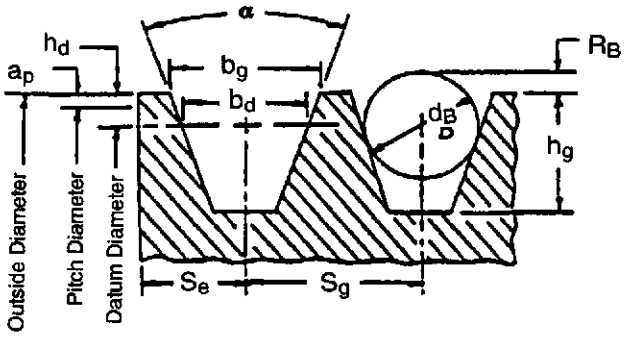


Figure A-1—Classical Groove Cross-Section—Current Practice

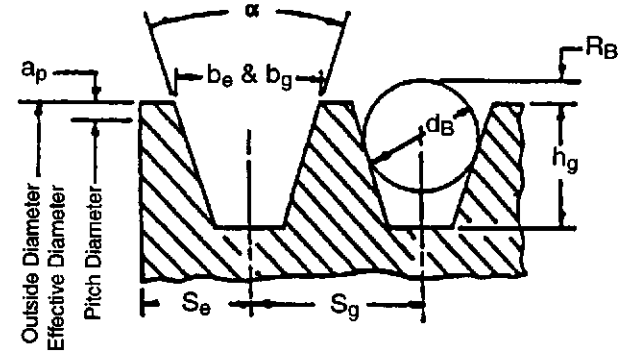


Figure A-2—Standard Classical Groove Cross-Section, Recommended Practice—Standard Narrow Groove Cross-Section

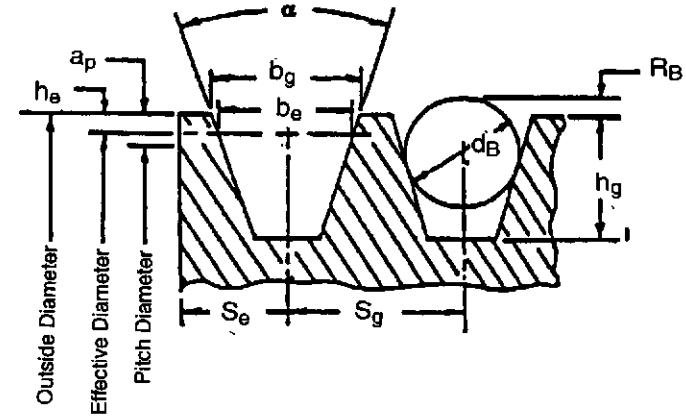


Figure A-3—Deep Classical Groove Cross-Section, Recommended Practice—Deep Narrow Groove Cross-Section

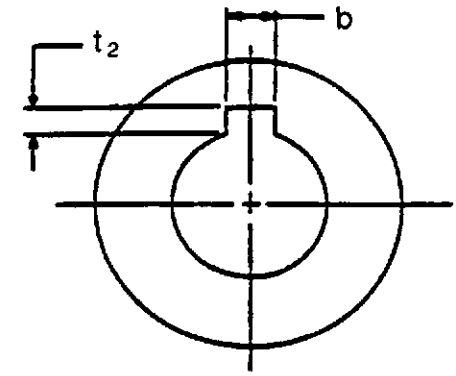


Figure A-4—Keyway Dimensions

Table A-4 shows Narrow 3V, 5V and 8V belts using metric dimensions and this represents a soft conversion from Table A-2.

Table A-1—Groove Dimensions for Classical V-Belt Sheaves (See Fig. A-1)

Current Practice—Dimensions in Inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
												Design Factors	
	Cross Section	Datum Diameter Range	∝ Angle Groove ± 0.33"	b_d Ref	b_g	h_g Min	$2h_d$ Ref	R_g Min	d_g ±0.0008	S_g ±0.025	S_c	Minimum Recommended Datum Diameter	$2a_p$
STANDARD GROOVES	A, AX	Up thru 5.4	34	0.418	0.494 ± 0.005	0.460	0.250	0.148	0.4375	0.625	0.375 +0.090 -0.062	A 3.0	0
		Over 5.4	38		0.504			0.149	(7/18)			AX 2.2	
	B, BX	Up thru 7.0	34	0.530	0.637 ± 0.006	0.550	0.350	0.189	0.5625	0.750	0.500 +0.120 -0.065	B 5.4	0
		Over 7.0	38		0650			0.190	(9/16)			BX 4.0	
	A, AX Belt B, BBX Belt (A, AX & B, BX Combin.)	Up thru 7.4[1]	34	0.508[2]	0.612 ± 0.006	0.612	0.634[3]	0.230	0.5625 (9/16)	0.750	+0.120 0.500 -0.065	A 3.6[1]	0.37
		Over 7.4	38		0.625		0.602	0.226				AX 2.8	
		Up thru 7.4[1]	34		0.612 ± 0.006		0.268[3]	0.230				B 5.7[1]	-0.08
		Over 7.4	38		0.625		0.276	0.228				BX 4.3	
	C,CX	Up thru 7.99	34	0.757	0.879	0.750	0.400	0.274	0.7812 (23/32)	1,000	0.680 ±0.160 -0.070	C 9.0	0
		Over 7.99 to and incl. 12.0	36		0.887 ± 0.007			0.276				CX 6.8	
		Over 12.0	38		0.895			0.277					
	D	Up thru 12.99	34	1.078	1.259	1.020	0.600	0.410	1.1250 (1 1/6)	1.438	0.875 +0.220 -0.080	13.0	0
		Over 12.99 to and incl. 17.0	36		1.271 ± 0.008			0.410					
		Over 17.0	38		1.283			0.411					

	Cross Section	Datum[1] Diameter Range	∝ Groove Angle ± 0.33"	b_d Ref	b_g	h_g Min	$2h_d$ Ref	R_g Min	d_g ±0.0008	S_g ±0.025	S_c	Minimum Recommended Datum Diameter	$2a_p$
DEEP GROOVES	B, BX	Up thru 7.0	34	0.530	0.747 ±0.006	0.730	0.710	0.007	0.5825 (9/18)	0.875	0.562 +0.120 -0.065	B 5.4	0.36
		Over 7.0	38		0.774			0.006				BX 4.0	
	C, CX	Up thru 7.99	34	0.757	1.066	1.065	1.010	-0.035	0.7812 (25/32)	1.250	0.812 +0.160 -0.070	C 9.0	0.61
		Over 7.99 to and incl. 12.0	36		1.065 ±0.007			-0.032				CX 6.8	
		Over 12.0	38		1.105			-0.031					
	D	Up thru 12.99	34	1.078	1.513	1.435	1.430	-0.010	1.1250 (1 1/8)	1.750	1.062 +0.220 -0.080	13.0	0.83
		Over 12.99 to and incl. 17.0	36		1.541 ±0.008			-0.009 -0.006					
		Over 17.0	38		1.508			-0.006					

[1]Diameters shown for combination grooves are outside diameters. A specific datum diameter does not exist for either A or B belts in combination grooves.
[2]The b_d value shown for combination grooves is the "constant width" point but does not represent a datum width for either A or B belts (2hd 0.340 reference).
[3]$2h_d$ values for combination groove are calculated based on b_d for A and B grooves.
[4]The A/AX, B/BX combination groove should be used when deep grooves are required for A or AX belts.
[5]Joined belts will not operate in deep grooves.
Summation of the deviations from "S_g" for all grooves in any one sheave shall not exceed ± 0.050".

Table A-2—Groove Dimensions for Narrow V-Belt Sheaves

Dimensions In Inches

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
											Design Factor	
	Cross Section	Effective Diameter Range	Groove Angle ± 0.25 Degrees	b_g ± 0.005	b_e Ref.	h_g Min.	R_e Min.	d_e ± 0.0005	S_g ± 0.015	S_e	Minimum Recommended Effective Diameter	$2h_e$ $2a_p$
SEE FIG A2	STANDARD GROOVES	3V 3VX	Up Through 3.49	36			0.181					
			Over 3.49 to and including 6.00	38			0.183	0.3438	0.406	0.344 +0.094	3V 2.65 3VX 2.20	0
			Over 6.00 to and Including 12.00	40	0.350	0.350	0.340	0.186		0.031		
			Over 12.00	42				0.188				
		5V 5VX 5VA	Up Through 9.99	38				0.329				0
			Over 9.99 to and Including 16.00	40	0.600	0.600	0.590	0.332	0.5938	0.688	0.500 +0.125	5V, 5VA 7.10 5VX, 4.40
			Over 16.00	42				0.336			-0.062	
		8V 8VA	Up Through 15.99	38				0.575				
			Over 15.99 to and Including 22.40	40	1.000	1.000	0.990	0.580	1.0000	1.125	0.750 +0.250	12.50 0
			Over 22.40	42				0.585			-0.062	
SEE FIG A3	DEEP GROOVE	3V 3X	Up through 3.49	36	0.421			0.070				
			Over 3.49 to and Including 6.00	38	0.425			0.073			3V 2.65	
			Over 6.00 to and Including 12.00	40	0.429	0.350	0.449	0.076	0.3438	0.500	0.375 +0.094	3VX 2.20 0.218
			Over 12.00	42	0.434			0.078			-0.031	
		5V 5VX 5VA	Up Through 9.99	38	0.710			0.168				
			Over 9.99 to and Including 16.00	40	0.716	0.600	0.750	0.172	0.5938	0.812	0.562 +0.125	5V, 5VA 7.10 5VX 4.40 0.320
			Over 16.00	42	0.723			0.175			-0.047	
		8V 8VA	Up Through 15.99	38	1.180			0.312				
			Over 15.99 to and Including 22.40	40	1.191	1.000	1.252	0.316	1.0000	1.312	0.844 +0.280	12.50 0.524
			Over 22.40	42	1.201			0.321			-0.062	

[1]Joined belts will not operate in deep grooves

Summation of the deviations from "S_g" for all grooves in any one sheave shall not exceed ±0.031.

WARNING: Special construction sheaves may be required for 5VA and 8VA belts. Refer to a sheave manufacturer.

Table A-3—Groove Dimensions for Classical V-Belt Sheaves

Recommended Practice—Dimensions in Millimeters

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
SEE FIG A2	STANDARD GROOVES	Cross Section	Effective Diameter Range	Groove Angle ±0.33°	b_e	b_e Ref	h_g Min.	$2h_e$ & $2a_f$	R_e Min.	d_e	S_3	S_d	Minimum Recommended Effective Diameter
		13C	Up thru 125	34	13				6.11	12.50	15.9	+2	13C = 80
		13CX	Over 125	38	±013	13	12	0	6.34	±0.01	±0.3	10.0	13CX = 60
					0.22								
		16C	Up thru 195	34	16.5				6.92	15.50	19.0	+2	16X = 140
		16CX	Over 195	38	+0.17	16.5	14	0	7.28	±0.02	±0.4	12.5	16CX = 112
					-026							-1	
	13C 13CX and 16, 16CX Combination	13C,	Up thru 185	34				9.81					13C = 80
		13CX	Over 185	38		13		8.71				+2	13CX = 60
		Belt			16		17		7.78	15.50	19.0	12.5	
		16C,	Up thru 195	34	± 0.15	16.5		-1.6	8.04	±0.02	±0.04	-1	16C = 140
		16CX	Over 195	38	16.5			-1.5					16CX = 112
		Belt											
		22C,	Up thru 325	34	22.4				9.37	21.00	25.4	+2	22C = 224
		22CX	Over 325	38	+0.20	22.4	19	0	9.86	±0.02	±0.5	17.0	22CX = 180
					-0.29							-1	
		32C	Up thru 490	36	32.8				13.72	30.50	36.5	+3	
			Over 490	38	+0.20	32.8	26	0	14.07	±0.02	±0.6	24.0	355
					-0.37							-1	

		Cross Section	Effective Diameter Range	Groove Angle ±0.33°	b_e	b_e Ref	h_g Min.	$2h_e$ & $2a_f$	R_e Min.	d_e	S_3 ±0.5	S_d	Minimum Recommended Effective Diameter
SEE FIG A3	DEEP GROOVE (1) (2)	16C	Up thru 195	34	19.56	16.5	19	10	1.90	15.50	22	+2	16C = 140
		16CX	Over 195	38	19.94				2.27	±0.02		14	16CX = 112
					±0.15							-1	
		22C,	Up thru 325	34	26.66	22.4	26	14	2.34	21.00	30	+2	22C = 224
		22CX	Over 325	38	27.22				2.82	±0.02		20	22CX = 180
					±0.18							-1	
			Up thru 490	36	38.65	32.8	35	18	4.62	30.50	43	+3	
		32C	Over 490	38	39.00				4.99	±0.02		29	355
					±0.20							-1	

Summation of the deviations "S_g" for all grooves in any one sheave shall not exceed the following:

Cross Section:	Tolerance
13C, 13CX	± 0.6
16C, 16CX	± 0.8
22C, 22CX	± 1.0
32C	± 1.2

[1]The 13C/13CX and 16C/16CX combination groove should be used when deep grooves are required for 13C or 13CX belts.
[2]Joined belts will not operate in deep grooves.

Table A-4—Groove Dimensions for Narrow V-Belt Sheaves

Dimensions In Millimeters

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
											Design Factor	
SEE FIG A2 STANDARD GROOVES	Cross Section	Effective Diameter Range	Groove Angle ± 0.25 Degrees	b_g	b_e Ref.	h_g Min.	R_e Min.	d_e	S_g	S_e	Minumum Recommended Effective Diameter	2he 2ap
	9N 9NX	Up Through 90	36				4.06			+2		
		Over 90 to and including 150	38	8.9			4.15	8.50	10.3	10	9N 67	0
		Over 150 to and including 300	40	+ 0.14 -0.20	8.9	8.9	4.23	±0.01	± 0.25	-1	9NX 56	
		Over 300	42				4.31					
	15N 15NX 15NA	Up Through 250	38	15.2			8.16					
		Over 250 to and Including 400	40	+0.1 -0.28	15.2	15.2	8.26	15.00 ±0.02	7.5 ±0.25	-3 14 -1	15N, 15NA 180 15NX 112	0
		Over 400	42				8.36					
SEE FIG A3 DEEP GROOVE (1)	25N 25NA	Up Through 400	38	25.4			13.68	25.00	28.6	+6		
		Over 400 to and Including 560	40	+0.20 -0.34	25.4	25.4	13.82	±0.02	±0.40	21 -2	315	0
		Over 560	42				13.98					
	9N 9NX	Up Through 90	36	10.68			1.28			+2		
		Over 90 to and including 150	38	10.79			1.37	8.50	12.7	10 -1	9N 67	5.54
		Over 150 to and Including 300	40	± 0.15 10.90	89	1.16	1.45	±0.01	± 0.4		-19NX 56	
		Over 300	42	11.01			1.53					
	15N 15NX 15NA	Up Through 250	38	17.99			4.04					
		Over 250 to and Including 400	40	18.15 ±0.20	15.2	19.2	4.14	15.00 ±0.20	20.6 ±0.04	+3 14 -1	15N, 15NA 180 15NX, 112	811
		Over 400	42	18.31			4.24					
	25N 25NA	Up Through 400	38	29.98			6.89			+6		
		Over 400 to and Including 560	40	30.24 ± 0.25	25.4	32.0	7.06	25.00 ±0.02	33.3 ±0.04	21 -2	315	13.30
		Over 560	42	30.51			7.21					

Summation of the deviations "S_g" for all grooves in any one sheave shall not exceed the following:

Cross Section:	Tolerance
9N, 9NX	± 0.5
15N, 15NX	± 0.5
25N	± 0.8

[1]Joined belts will not operate in deep grooves.

WARNING: Special construction sheaves may be required for SVA and 8VA belts. Refer to a sheave manufacturer.

Tables A-9 and A-10 show commonly available sheave diameters.

A.4 Marking

Sheaves shall be marked with the number of grooves, groove section, diameter[2], and manufacturer's name or mark. At the option of the manufacturer, this information shall be placed either on the rim of the sheave, on the end of the sheave hub or sheave arm in such a location as to be visible when the sheave is in its installed position. This information shall be printed legibly and in a permanent form by casting, stamping or etching. Additional markings may be applied at the option of the manufacturer. These requirements shall apply to both taper-bushed and made-to-order sheaves.

1. Deep-groove sheaves are intended for quarter-turn drives and for long center vertical-shaft drives. They may also be necessary for applications where oscillations in the center distance may occur.
2. Classical A, B, C and D sheaves in inches will be marked

Table A-5—Keyway Dimensions (See Fig. A.4)

All Dimensions in Inches

(1)	(2)		(3)	
Shaft Diameter (Inches)	Width. b (Inches)		Depth. t_2 +0.015 -0.000 (Inches)	
Up Through 7/16 (0.44)				
Over 7/16 (0.44) To and Incl. 9/16 (0.56)	3/32	(0.094)	3/64	(0.047)
Over 9/16 (0.56) To and Incl. 7/8 (0.88)	3/16	(0.188)	1/16	(0.062)
Over 7/8 (0.88) To and Incl. 1 1/4 (1.25)	1/4	(0.250)	1/8	(0.125)
Over 1 1/4 (1.25) To and Incl. 1 3/8 (1.38)	5/16	(0.312)	5/32	(0.156)
Over 1/38 (1.38) To and Incl. 1 3/4 (1.75)	3/8	(0.375)	3/16	(0.188)
Over 1/34 (1.75) To and incl. 2 1/4 (2.25)	1/2	(0.500)	1/4	(0.250)
Over 2 1/4 (2.25) To and Incl. 2 3/4 (2.75)	5/8	(0.625)	5/16	(0.312)
Over 2 3/4 (2.75) To and Incl. 3 1/4 (3.25)	3/4	(0.750)	3/8	(0.375)
Over 3 1/4 (3.25) To and Incl. 3 3/4 (3.75)	7/8	(0.875)	7/16	(0.438)
Over 3 3/4 (3.75) To and Incl. 4 1/2 (4.50)	1	(1.000)	1/2	(0.500)
Over 4 1/2 (4.50) To and Incl. 5 1/2 (5.50)	1 1/4	(1.250)	5/8	(0.625)
Over 5 1/2 (5.50) To and Incl. 6 1/2 (6.50)	1 1/2	(1.500)	3/4	(0.750)
Over 6 1/2 (6.50) To and Incl. 7 1/2 (7.50)	1 3/4	(1.750)	3/4	(0.750)
Over 7 1/2 (7.50) To and Incl. 9 (9.00)	2	(2.000)	3/4	(0.750)
Over 9 (9.00) To and Incl. 11 (11.00)	2 1/2	(2.500)	7/8	(0.875)
Over 11 (11.00) To and Incl. 13 (13.00)	3	(3.000)	I	(1.000)

Tolerance on Width b for widths up through 1/2" (0.500) ..... +0.002, -0.000
For widths over 1/2", (0.500) through 1" (1.000) ..... +0.003, -0.000
For widths over 1" (1.000) ..... +0.004, -0.000

Table A-6—Keyway Dimensions (See Fig. A.5)

All Dimensions in Inches

(1)	(2)		(3)	
Shaft Diameter (Inches)	Width. b (Inches)		Depth. t_2 (Inches)	
Over 7/8 (0.88) To and Incl. 1 3/16 (1.19)	1/4	(0.250)	1/8	(0.13)
Over 1 3/16 (1.19) To and Incl. 1 1/16 (1.31)	5/16	(0.313)	5/32	(0.156)
Over 1 5/16 (1.31) To and Incl. 1 3/8 (1.62)	3/8	(0.375)	3/16	(0.188)
Over 1 5/8 (1.62) To and Incl. 1 7/8 (1.88)	1/2	(0.500)	1/4	(0.250)
Over 1 7/8 (1.88) To and Incl. 2 3/16 (2.19)	9/16	(0.562)	1/4	(0.250)
Over 2 3/16 (2.19) To and Incl. 2 3/8 (2.38)	5/8	(0.625)	5/8	(0.312)
Over 2 3/8 (2.38) To and incl. 2 3/4 (2.75)	11/16	(0.688)	5/16	(0.312)
Over 2 3/4 (2.75) To and Incl. 2 1/4 (3.25)	13/16	(0.812)	3/8	(0.375)
Over 1 1/4 (3.25) To and Incl. 3 3/4 (3.75)	7/8	(0.875)	3/8	(0.375)
Over 3 3/4 (3.75) To and Incl. 4 1/2 (4.50)	1	(1.000)	7/16	(0.438)
Over 4 1/2 (4.50) To and incl. 5 1/2 (5.50)	1 1/4	(1.250)	5/16	(0.438)
Over 5 1/2 (5.50) To and Incl. 6 1/2 (6.50)	1 1/2	(1.500)	1/2	(0.500)

Tolerance on Width b for widths up through 1 1/4" (1.250) ..... +0.003, -0.002
For widths over 1 1/4" (1.250) ..... +0.004, -0.003
Tolerance on Depth—t_2 for shaft dia. thru 4 1/2" (4.500) ..... +0.0035. -0.0035
For shaft dia. over 4 1/2" (4.500) thru 6 1/2" (6.500) ..... +0.0085. -0.0085

with Datum diameter or "nominal diameter" corresponding to the previous pitch diameter. All narrow belts sheaves (3V, 5V and 8V) and classical sheaves in metric dimensions will be marked with "Effective Diameter."

OTHER SHEAVE TOLERANCES

Dimensions In Inches

Datum or Effective Groove Diameter Variation. The variations in diameter between the grooves in any one sheave must be within the following limits when measured by comparing "diameter over balls or rods":

Up through 19.9 inches diameter and up through 6 grooves: 0.010 inch (add 000.5 inch for each additional groove).

20.0 inches and over diameter and up through 10 grooves: 0.15 inch (add 0.0005 inch for each additional groove).

Datum or Effective Sheave Diameter. Up through 8.0 inches diameter: ± 0.020 inches (add ± 0.0025 inch for each additional inch of diameter).

Radial Runout (total indicator reading). Up through 10.0 inches diameter: 0.010 inch (add 10005 for each additional inch of diameter).

Axial Runout (total indicator reading). Up through 5.0 inches diameter: 0.005 inch (add 0.001 inch for each additional inch of diameter).

Table A-7—Keyway Dimensions (See Fig. A.6)

All Dimensions in Millimeters

Shaft Diameter					
Over	up to and including	Width b	Tolerance on b	Depth t_2	Tolerance on t_2
6	8	2	+0.060	1	
8	10	3	+0.020	1.4	
10	12	4	+0.078	1.8	+0.1
12	17	5	+0.030	2.3	-0
17	22	6		2.8	
22	30	8	+0.098	3.3	
30	38	10	+0.040	3.3	
38	44	12		3.3	
44	50	14	+0.120	3.8	
50	58	16	+0.050	4.3	+0.2
58	65	18		4.4	-0
65	75	20		4.9	
75	85	22	+0.149	5.4	
85	95	25	+0.065	5.4	
95	110	128		6.4	
110	130	32		7.4	
130	150	36		8.4	
150	170	40	+0.180	9.4	
170	200	45	+0.080	10.4	
200	230	50		11.4	+0.3
230	260	56		12.4	-0
260	290	63	+0.220	12.4	
290	330	70	+0.100	14.4	
330	380	80		15.4	

Table A-8—Tapered Keyway Dimensions Metric (In Millimeters) (See Figure A-7)

Shaft Diameter	Width b	Tolerance For b	Depth t_2
Over 122 to and incl. 320	8	+0.098	2.4
Over 30 to and incl. 38	10	+00.40	2.4
Over 38 to and incl. 44	12		2.4
Over 44 to and incl. 50	14	+0.120	2.9
Over 50 to and incl. 58	16	+0.050	3.4
Over 58 to and incl. 65	18		3.4
Over 65 to and incl. 75	20		3.9
Over 75 to and incl. 85	22	+0.149	4.4
Over 85 to and incl. 95	25	+0.065	4.4
Over 95 to and incl. 110	28		5.4
Over 110 to and incl. 130	32		6.4
Over 130 to and incl. 150	36	+0.180	7.1
Over 150 to and incl. 170	40	+0.080	8.1

Tolerance on depth—t2. For depths up thru 130mm.....+0.2, -0
For Depths Over 130mm.....+0.3, -0

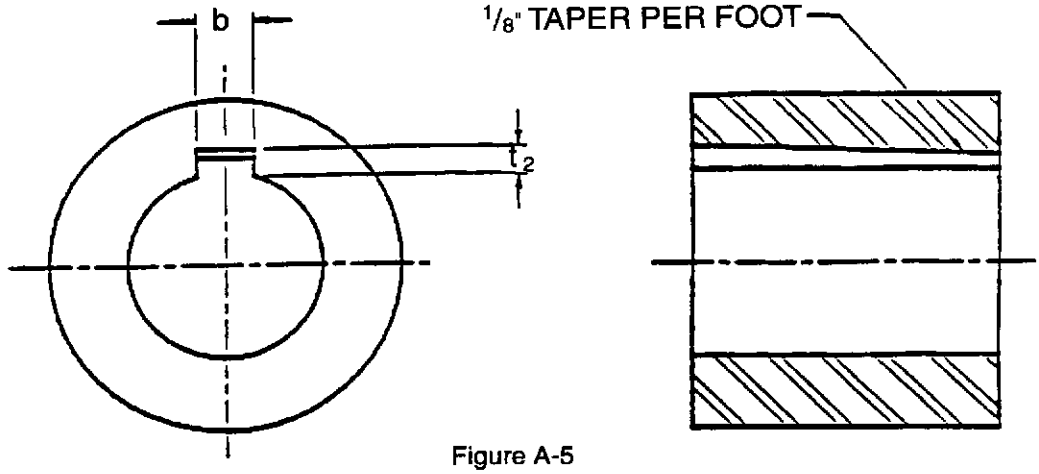


Figure A-5

Dimensions in Millimeters

Effective Groove Diameter Variation. Up through 499 mm diameter and up through 6 grooves: 0.25 mm (add 0.01 mm for each additional groove).

500 mm and over diameter and up through 10 grooves: 0.38 mm (add 0.01 mm for each additional grooves).

Effective Sheave Diameter. Up through 200 mm diameter: ± 0.5 mm (add ± 0.05 mm for each additional 25 mm diameter).

Radial Runout (total indicator reading). Up through 250 mm diameter: 0.25mm (add 0.01 mm for each additional 25 mm diameter).

Axial Runout (total indicator reading). Up through 125 mm diameter: 0.13mm (add 0.03 mm for each additional 25 mm diameter.

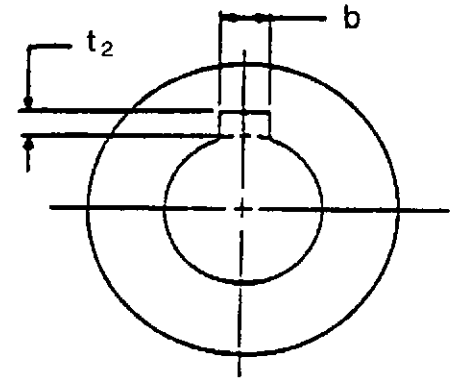


Figure A-6

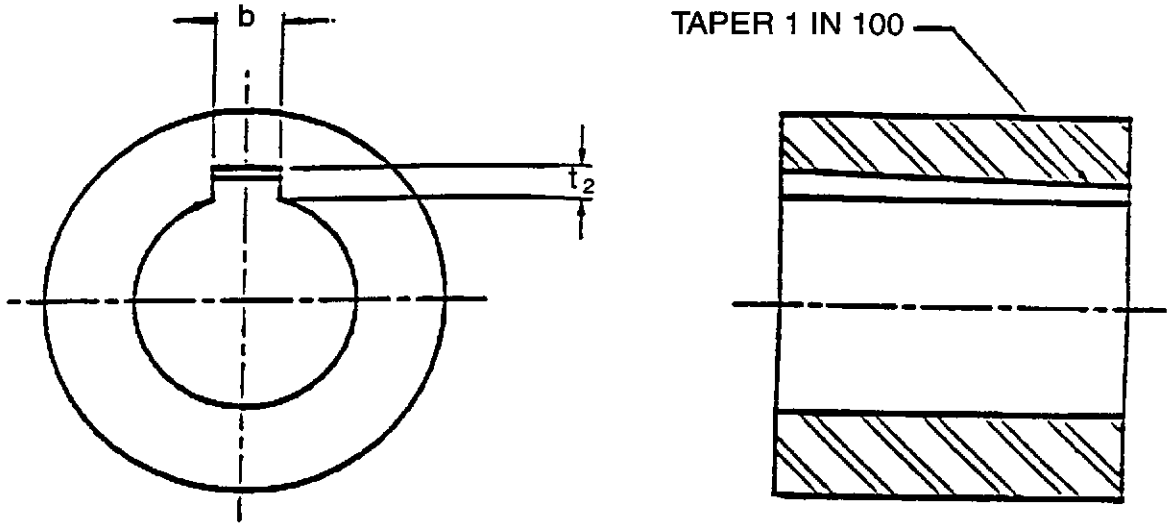


Figure A-7

APPENDIX B—DESIGN PROCEDURE FOR POWER APPLICATION OF V-BELTS

B.1 Information Required

a. Average horsepower transmitted.
b. RPM driver shaft.
c. RPM driven shaft.
d. Approximate desired center-to-center distance.
e. Environmental conditions and type of drive, i.e., ambient temperatures, dust, grease, continuous operation, frequency of peak loads, etc.

B.2 Determine Design Power

Design power (horsepower or kilowatts) equals average power transmitted multiplied by the service factor. Use Table B-1 as a guide to proper selection of service factors. Values in Table B-1 should be adjusted for unusual ambient or drive conditions (Par. B.1.e).

a. Average Power Transmitted. Average power transmitted refers to the estimated average power which will be transmitted over the life of the drive.
b. Service Factors. Service factors are shown in Table B-1. Except for slush pumps, the service factors are for drives that operate continuously 24 hr per day. The designer should check with the belt and sheave suppliers when service factors lower than those listed are contemplated.
c. Design Power for Beam Pumping Units. The design power for drives for beam pumping units is determined by the following formula.

$$\text{Design Horsepower} = \frac{\text{Peak Crankshaft Torque (lb-in.)} \times \text{Strokes Per Minute}}{70{,}000}$$

$$\text{Design Kilowatts} = \frac{\text{Peak Crankshaft Torque (N-m)} \times \text{Strokes Per Minute}}{10{,}600}$$

Notes:
1. Use API Specification 11E for calculating peak torque of existing drives.
2. Use API Recommended Practice 11L for calculating peak torque of new drives.

d. Design Power for Slush Pumps. In the application of V-belts to slush pumps, the average power transmitted shall be based upon the slush pump rated name plate input power, except in special cases where speeds or powers are altered, in which case the average power transmitted shall be calculated by the formula:

$$\text{Average Horsepower Transmitted} = \frac{\text{Displacement (US gal per min)} \times \text{Discharge Pressure (psi)}}{1714 \times 0.85^*}$$

$$\text{Average Kilowatts Transmitted} = \frac{\text{Displacement (Liters per min)} \times \text{Discharge Pressure (kPa)}}{60{,}000 \times 0.85^*}$$

*Mechanical efficiency of pump and drive.

Table B-1—Service Factors

Types of Service	Service Factor
Compressors, reciprocating	1.6
Fans, propeller	1.5
Pumps, centrifugal	1.4
Pumps, rotary or vane	1.4
Pumps, duplex piston, except slush pumps	1.6
Pumps, duplex piston slush pumps	1.0*
Pumps, triplex plunger	1.5
Generators serving beam-pumping units	1.8
Generators with no beam-pumping load	1.5

*See Par B.5.c

B.3 Select V-Belt Type

Selection of belt cross section can be based on several factors:

- Space availability
- Drive cost
- Bearing Loads
- Parts availability

In general, all of the cross sections presented in this Standard are capable of providing excellent service on the wide variety of equipment covered by API Standards, provided:

- Drives are designed according to the procedures specified in this Standard.
- Drives are properly installed and maintained

Belt vendors can be contacted for further assistance on cross section selection.

B.4 Select Proper V-Belt Cross Section

After finding the design horsepower and knowing the rpm of the faster shaft, use Figures B-1, B-2, B-3 or B-4 (depending on belt type) as a guide in selecting the proper V-belt cross section. Cross sections other than the one selected from these charts may be necessary when:

1. The rpm/design power point is near a dividing line.
2. Flexibility in changing the speeds of the driven unit is desired. This may necessitate the use of sheave diameters too small for the cross section selected.

B.5 Select Sheave Diameters

Follow the procedure below to select the sheave diameters. Since the number of grooves required is not yet determined, it may be necessary to repeat this step if the number of grooves required is not available on a stock sheave.

a. Determine Speed Ratio. Determine the speed ratio required for your drive by this formula:

$$\text{Speed Ratio} = \frac{\text{RPM of Faster Shaft}}{\text{RPM of Slower Shaft}}$$

b. Choose the Sheave Diameters. Tables G-1 and G-2 in Appendix G show the stock sheave diameters generally listed in manufacturers' catalogs for the classical and narrow belts, respectively. Select a set of stock sheave diameters that will give a speed ratio close to the required speed ratio calculated in step a.

$$\text{Speed Ratio} = \frac{\text{Pitch Diameter of Larger Sheave}}{\text{Pitch Diameter of Larger Sheave}}$$

1. Care should be taken to assure that:
   a. The smaller sheave diameter is equal to or greater than the minimum recommended values given in Table A-1, A-2, A-3 or A-4.
   b. The rim speed of the sheaves does not exceed 6500 feet per minute (33 meters per second).

$$\text{Rim Speed (fpm)} = \frac{\text{rpm} \times \text{Outside Diameter (inches)}}{3.82}$$

$$\text{Rim Speed (m/sec)} = \frac{\text{rpm} \times \text{Outside Diameter (mm)}}{19100}$$

   Relatively wide sheaves operating toward the high end of the allowable rim speed range may need dynamic balancing. Consult the sheave supplier.
2. The pitch diameter of sheaves that are on hand can be determined by measuring the outside diameter and subtracting the $2a_P$ given in Table A.1, A.2, A.3 or A.4.
3. For reasons of economy, select the larger sheave from stock and machine the smaller sheave to the necessary diameter if both sheaves cannot be selected from stock because of the speed ratio requirement.

c. Slush Pump Sheaves. Sheaves used for slush pump drives may require special construction. Such applications should be checked with the manufacturer.

B.6 Select Belt Length: Calculate Center Distance

A desirable center distance between sheaves is the sum of the diameters of the driver and driven sheaves. The center distance should not be less than the diameter of the large sheave. Knowing sheave diameters and the approximate center distance, the approximate belt length can be determined from the following formula:

$$L = 2C + 1.57\,(D + d) + \frac{(D-d)^2}{4C}$$

Where:

L = belt length, (datum length for classical and effective length for narrow belts)

D = diameter of larger sheave

d = diameter of smaller sheave (use datum diameters for classical and outside diameters for narrow belts)

C = center distance

If possible, use a standard belt length. (See Tables 2.2, 2.3, 2.4 or 2.5 for a listing of standard lengths.) Then the actual center distance can be found from the following formula:

$$C = \frac{b + \sqrt{b^2 - 32(D-d)^2}}{16}$$

Where:

$$b = 4L - 6.28\,(D + d)$$

B.7 Power Formula

The formula in Tables B-9 and B-10, together with the speed ratio factors in Table B-11, can be used to calculate the belt power rating. The power rating must be corrected as noted in Paragraph B-8.

B.8 Find Number of Belts Required

Multiply the power rating calculated in Section B.7 by the arc correction factor obtained from Table B-2 and the length correction factor obtained from Tables B-3 and B-4. This will give the corrected power rating per belt. The number of belts required is determined by dividing the design power (Section B.2) by the corrected power rating per belt. If the answer is a whole number and a fraction, the next higher whole number of belts should be used.

B.9 Provide Installation and Take-Up Allowance

The drive should permit adjustment of the center distance according to Tables B-5, B-6, B-7 and B-8. The amount below the required center distance (see Par. B.6) is to provide for installation of the belts. The amount above the required center distance is to allow for stretch and wear. The installation and take-up allowances established also provide for: (1) the permissible variation in belt length; and (2) adjusting the belt to working tension.

B.10 Tabulate and Check Results

Tabulate sheave diameter, number of grooves, belt size, number of belts, and center distance. Check sheave requirements to insure that at least the number of grooves required on the large sheave is available from stock. A more economical drive usually results when both sheaves are available as stock in the required number of grooves. Consider the possibility of slight modifications, if necessary, to accomplish this.

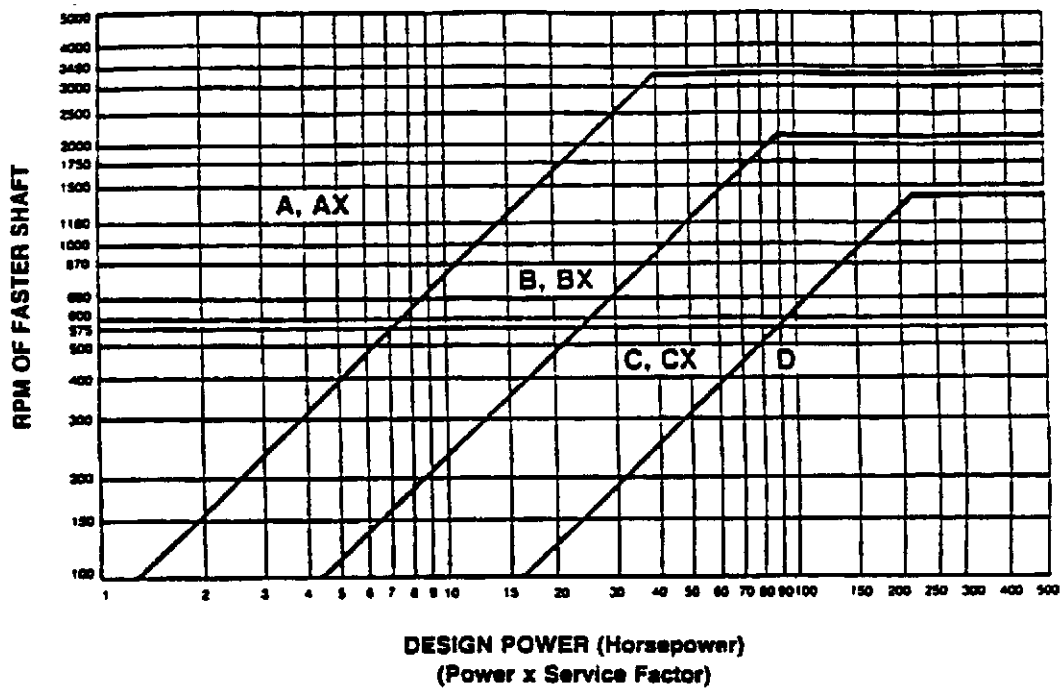


Figure B-1—Guide for Selecting Classical V-Belt Cross Section

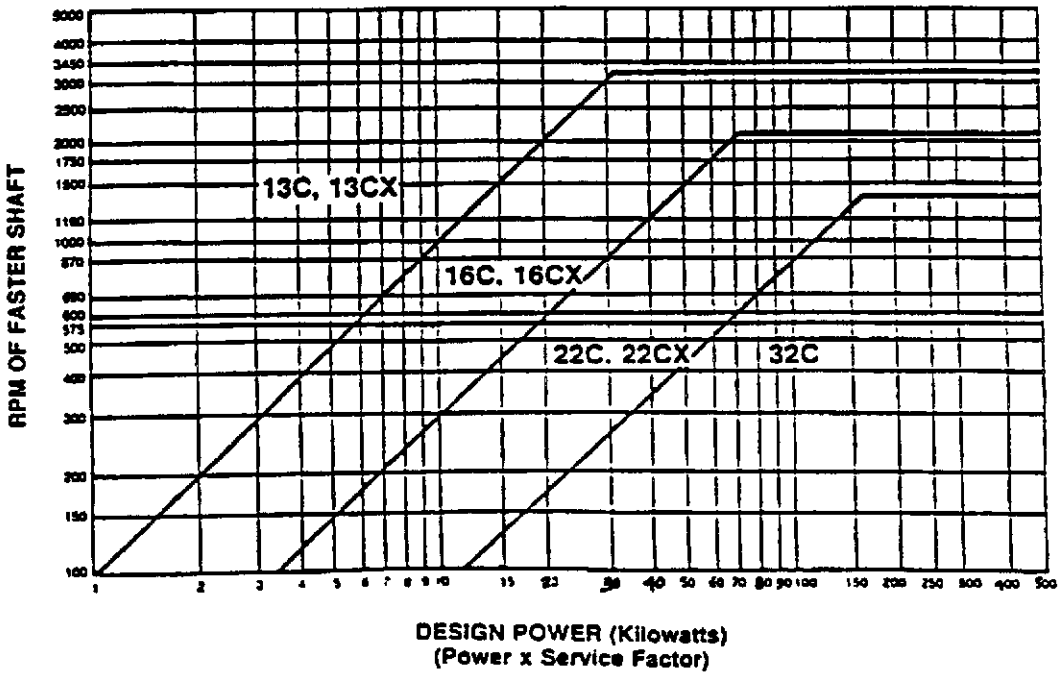


Figure B-2—Guide for Selecting Classical V-Belt Cross Section

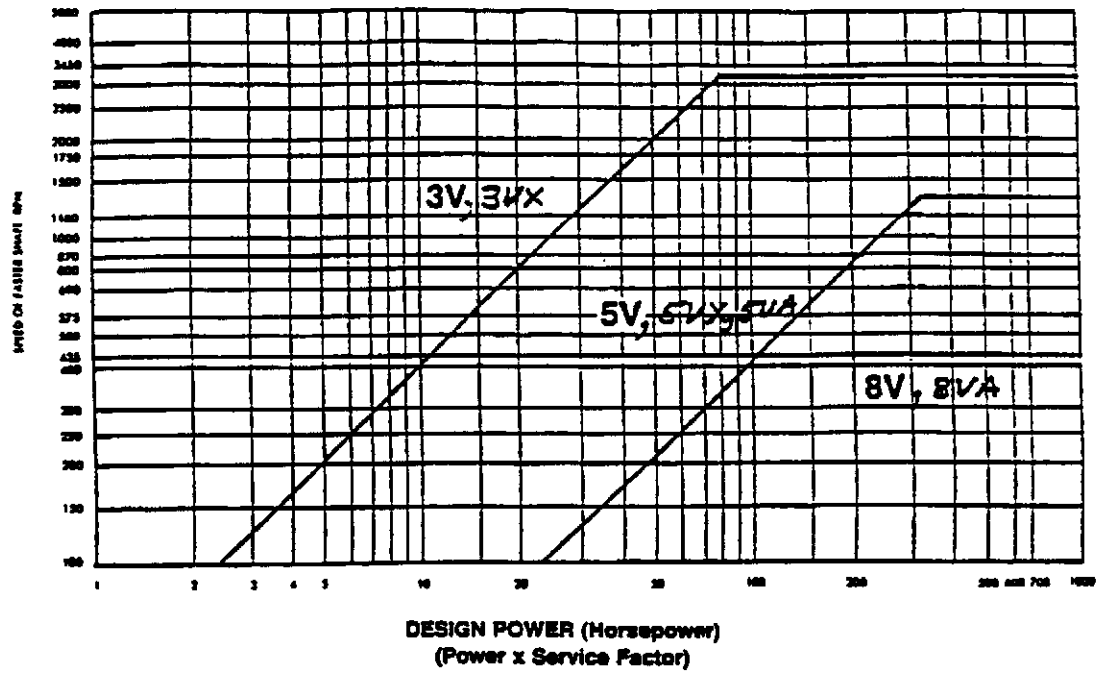


Figure B-3—Guide for Selecting Narrow V-Belt Cross Section

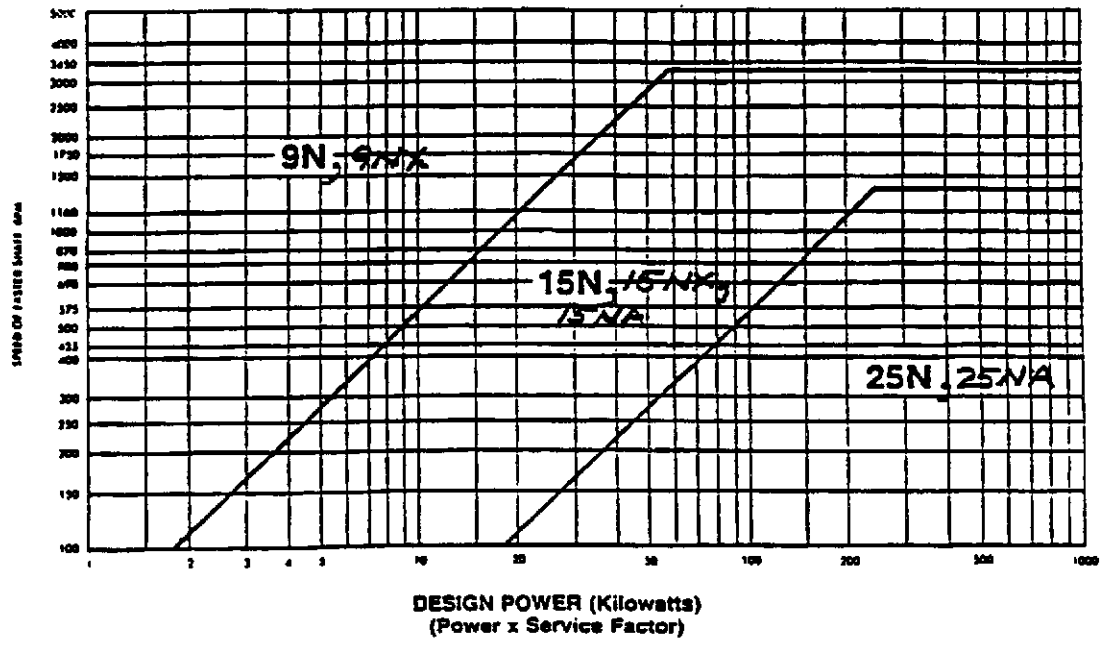


Figure B-4—Guide for Selecting Narrow V-Belt Cross Section

Table B-2—Arc-Of-Contact Correction Factor

(1)	(2)	(3)	(4)
D–d* / C	Arc-of-Contact on Small Sheave Degrees	Kθ Correction Factor V-V	Kθ Correction Factor V-Flat**
0.00	180	1.00	0.75
0.10	174	0.99	0.76
0.20	169	0.97	0.78
0.30	163	0.96	0.79
0.40	157	0.94	0.80
0.50	151	0.93	0.81
0.60	145	0.91	0.83
0.70	139	0.89	0.84
0.80	133	0.87	0.85
0.90	127	0.85	0.85
1.00	120	0.82	0.82
1.10	113	0.80	0.80
1.20	106	0.77	0.77
1.30	99	0.73	0.73
1.40	91	0.70	0.70
1.50	83	0.65	0.65

*In the expression

$$\frac{D-d}{C}$$

C = center distance of drive
D = diameter of larger sheave
d = diameter of smaller sheave (Use datum diameters for classical and outside diameters for narrow belts).

**A V-flat drive is one using a small sheave and a large diameter flat pulley.

Table B-3—Length Correction Factors (Inches)

Classical V-Belts					Narrow V-Belts			
Standard Length Designation	V-Belt Cross Section A, AX	B, BX	C, CX	D	Standard Length Designation*	V-Belt Cross Section 3V, 3VX	5V, 5VX, 5Va	8V, 8VA
26	0.78	—	—	—	250	0.83	—	—
31	0.82	—	—	—	265	0.84	—	—
35	0.85	0.80	—	—	280	0.85	—	—
38	0.87	0.82	—	—	300	0.86	—	—
42	0.89	0.84	—	—	315	0.87	—	—
46	0.91	0.86	—	—	335	0.88	—	—
51	0.93	0.88	0.80	—	355	0.89	—	—
55	0.95	0.89	—	—	375	0.90	—	—
60	0.97	0.91	0.83	—	400	0.92	—	—
68	1.00	0.94	0.85	—	425	0.93	—	—
75	1.02	0.96	0.87	—	450	0.94	—	—
80	1.04	—	—	—	475	0.95	—	—
81	—	0.98	0.89	—	500	0.96	0.85	—
85	1.05	0.99	0.90	—	530	0.97	0.86	—
90	1.07	1.00	0.91	—	560	0.98	0.87	—
96	1.08	—	0.92	—	600	0.99	0.88	—
97	—	1.02	—	—	630	1.00	0.89	—
105	1.10	1.03	0.94	—	670	1.01	0.90	—
112	1.12	1.05	0.95	—	710	1.02	0.91	—
120	1.13	1.06	0.96	0.88	750	1.03	0.92	—
128	1.15	1.08	0.98	0.89	800	1.04	0.93	—
144	—	1.10	1.00	0.91	850	1.06	0.94	—
158	—	1.12	1.02	0.93	900	1.07	0.95	—
173	—	1.14	1.04	0.94	950	1.08	0.96	—
180	—	1.15	1.05	0.95	1000	1.09	0.96	0.87
195	—	1.17	1.06	0.96	1060	1.10	0.97	0.88
210	—	1.18	1.07	0.98	1120	1.11	0.98	0.88
240	—	1.22	1.10	1.00	1180	1.12	0.99	0.89
270	—	1.24	1.13	1.02	1250	1.13	1.00	0.90
300	—	1.27	1.15	1.04	1320	1.14	1.01	0.91
330	—	—	1.17	1.06	1400	1.15	1.02	0.92
360	—	—	1.18	1.07	1500	—	1.03	0.93
390	—	—	1.20	1.09	1600	—	1.04	0.94
420	—	—	1.21	1.10	1700	—	1.05	0.94
480	—	—	—	1.13	1800	—	1.06	0.95

Table B-3—Length Correction Factors (Inches) (Continued)

Classical V-Belts					Narrow V-Belts			
Standard Length Designation	V-Belt Cross Section			D	Standard Length Designation*	V-Belt Cross Section		
	A, AX	B, BX	C, CX			3V, 3VX	5V, 5VX, 5Va	8V, 8VA
540	—	—	—	1.15	1900	—	1.07	0.96
600	—	—	—	1.17	2000	—	1.08	0.97
660	—	—	—	1.18	2120	—	1.09	0.98
					2240	—	1.09	0.98
					2360	—	1.10	0.99
					2500	—	1.11	1.00
					2650	—	1.12	1.00
					2800	—	1.13	1.02
					3000	—	1.14	1.03
					3150	—	1.15	1.03
					3350	—	1.16	1.04
					3550	—	1.17	1.05
					3750	—	—	1.06
					4000	—	—	1.07
					4250	—	—	1.08
					4500	—	—	1.09
					4750	—	—	1.09
					5000	—	—	1.10

*Standard length designation is the effective length multiplied by ten.

B-4—Length Correction Factor (Metric)

Classical V-Belts								Narrow V-Belts			
13C, 13CX		16C, 16CX		22C, 22CX		32C			Cross-Section		
Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Standard Length Designation	9N	15N, 15NX, 15NA	25N, 25NX, 25NA
710	0.78	960	0.80	1400	0.80	3190	0.88	630	0.83	—	—
750	0.80	1040	0.82	1500	0.81	3390	0.89	670	0.84	—	—
800	0.82	1090	0.83	1630	0.83	3800	0.91	710	0.85	—	—
850	0.83	1120	0.84	1830	0.85	4160	0.93	760	0.86	—	—
900	0.84	1190	0.85	1900	0.87	4250	0.93	800	0.87	—	—
950	0.85	1250	0.86	2000	0.88	4540	0.94	850	0.88	—	—
1000	0.87	1320	0.87	2160	0.89	4720	0.95	900	0.89	—	—
1075	0.88	1400	0.89	2260	0.90	5100	0.96	950	0.90	—	—
1120	0.89	1500	0.90	2390	0.91	5480	0.98	1015	0.92	—	—
1150	0.90	1600	0.91	2540	0.92	5800	0.99	1080	0.93	—	—
1230	0.91	1700	0.93	2650	0.92	6180	1.00	1145	0.94	—	—
1300	0.92	1800	0.94	2800	0.94	6560	1.01	1205	0.95	—	—
1400	0.94	1900	0.95	3030	0.95	6940	1.02	1270	0.96	0.85	—
1500	0.96	1980	0.96	3150	0.96	7330	1.03	1345	0.97	0.86	—
1585	0.97	2110	0.98	3350	0.97	8090	1.04	1420	0.98	0.87	—
1710	0.99	2240	0.99	3550	0.98	8470	1.05	1525	0.99	0.88	—
1790	1.00	2360	1.00	3760	1.00	8850	1.06	1600	1.00	0.89	
1865	1.01	2500	1.01	4120	1.02	9240	1.07	1700	1.01	0.90	—
1965	1.02	2320	1.02	4220	1.03	10000	1.09	1800	1.02	0.91	—
2120	1.04	2820	1.04	4500	1.04	10760	1.10	1900	1.03	0.92	—
2220	1.05	2920	1.05	4680	1.05	11530	1.12	2030	1.04	0.93	—
2350	1.07	3130	1.06	5060	1.06	12290	1.13	2160	1.06	0.94	—
2500	1.08	3330	1.08	5440	1.07	—	—	2290	1.07	0.95	—

B-4—Length Correction Factor (Metric) (Continued)

Classical V-Belts								Narrow V-Belts			
13C, 13CX		16C, 16CX		22C, 22CX		32C			Cross-Section		
Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Std. Length Designation	Length Correction Factor	Standard Length Designation	9N	15N, 15NX, 15NA	25N, 25NX, 25NA
2600	1.09	3530	1.09	5770	1.09	—	—	2410	1.08	0.96	—
2730	1.10	3740	1.10	6150	1.10	—	—	2540	1.09	0.96	0.87
2910	1.12	4090	1.12	6540	1.12	—	—	2690	1.10	0.97	0.88
3110	1.13	4200	1.13	6920	1.13	—	—	2840	1.11	0.98	0.88
3310	1.15	4480	1.14	7300	1.14	—	—	3000	1.12	0.99	0.89
		4650	1.15	7680	1.15	—	—	3180	1.13	1.00	0.90
		5040	1.17	8060	1.16	—	—	3350	1.14	1.01	0.91
		5300	1.18	8440	1.17	—	—	3550	1.15	1.02	0.92
		5760	1.20	8820	1.18	—	—	3810	—	1.03	0.93
		6140	1.22	9200	1.19	—	—	4060	—	1.04	0.94
		6520	1.23	—	—	—	—	4320	—	1.05	0.94
		6910	1.24	—	—	—	—	4570	—	1.06	0.94
		7290	1.25	—	—	—	—				
		7670	126	—	—	—	—	4830	—	1.07	0.96
								5080	—	1.08	0.97
								5380	—	1.09	0.98
								5690	—	1.09	0.98
								6000	—	1.10	0.99
								6350	—	1.11	1.00
								6730	—	1.12	1.01
								7100	—	1.13	1.02
								7620	—	1.14	1.03
								8000	—	1.15	1.03
								8500	—	1.16	1.04
								9000	—	1.17	1.05
								9500	—	—	1.06
								10160	—	—	1.07
								10800	—	—	1.08
								11430	—	—	1.09
								12060	—	—	1.09
								12700	—	—	1.10

Table B-5—Classical V-Belt Center Distance Allowance for Installation and Take-Up Inches

Standard Length Designation	Minimum Allowance Below Standard Center Distance for Installation of Belts								Minimum Allowance Above Standard Center Distance for Maintaining Tension All Cross Sections
	A AX	A, AX Joined	B BX	B, BX Joined	C CX	C, CX Joined	D	D Joined	
Up to and incl. 35	0.75	1.20	1.00	1.50					1.00
Over 35 to and incl. 55	0.75	1.20	1.00	1.50	1.50	2.00			1.50
Over 55 to and incl. 85	0.75	1.30	1.25	1.60	1.50	2.00			2.00
Over 85 to and incl. 112	1.00	1.30	1.25	1.60	1.50	2.00			2.50
Over 112 to and incl. 144	1.00	1.50	1.25	1.80	1.50	2.10	2.00	2.90	3.00
Over 144 to and incl. 180			1.25	1.80	2.00	2.20	2.00	3.00	3.50
Over 180 to and incl. 210			1.50	1.90	2.00	2.30	2.00	3.20	4.00
Over 210 to and incl. 240			1.50	2.00	2.00	2.50	2.50	3.20	4.50
Over 240 to and incl. 300			1.50	2.20	2.00	2.50	2.50	3.50	5.00
Over 300 to and incl. 390					2.00	2.70	2.60	3.60	6.00
Over 390					2.50	2.90	3.00	4.10	1.5% of belt length

Table B-6—Classical V-Belt Center Distance Allowance for Installation and Take-Up Millimeters

Standard Length Designation	Minimum Allowance Below Standard Center Distance for Installation of Belts: 13C 13CX	13C, 13CX Joined	16C 16CX	16C, 16CX Joined	22C 22CX	22C, 22CX, Joined	32C	32C Joined	Minimum Allowance Above Standard Center Distance for Maintaining Tension All Cross Sections
Up to and incl. 960	19	30	25	38					25
Over 960 to and incl. 1585	19	30	25	38	38	51			38
Over 1585 to and incl. 2360	19	33	32	41	38	51			51
Over 2360 to and incl. 3150	25	33	32	41	38	51			64
Over 3150 to and incl. 4120	25	38	32	46	38	53	51	74	76
Over 4120 to and incl. 5060			32	46	51	56	51	76	89
Over 5060 to and incl. 6150			38	48	51	58	51	81	102
Over 6150 to and incl. 6920			38	51	51	64	64	81	114
Over 6920 to and incl. 8440			38	51	51	64	64	89	127
Over 8440 to and incl. 10000					51	69	64	91	152
Over 10000							76	104	1.5% of belt length

Table B-7—Narrow-V-Belt Center Distance Allowance for Installation and Take-Up Inches

Standard Length Designation	Minimum Allowance Below Standard Center Distance for Installation of Belts: 3V 3VX	3V, 3VX Joined	5V 5VX, 5VA	5V, 5VX Joined 5VA	8V 8VA	8V, Joined 8VA	Minimum Allowance Center Distance for Installation Of Belts: 3V, 3VX, 5V, 5VX, 8V	5VA, 8VA
Up to and incl. 475	0.5	1.2					1.0	—
Over 475 to and incl. 710	0.8	1.4	1.0	2.1			1.2	0.7
Over 710 to and incl. 1060	0.8	1.4	1.0	2.1	1.5	3.4	1.5	1.1
Over 1060 to and incl. 1250	0.8	1.4	1.0	2.1	1.5	3.4	1.8	1.3
Over 1250 to and incl. 1700	0.8	1.4	1.0	2.1	1.5	3.4	2.2	1.7
Over 1700 to and incl. 2000			1.0	2.1	1.8	3.6	2.5	2.0
Over 2000 to and incl. 2360			1.2	2.4	1.8	3.6	3.0	2.4
Over 2360 to and incl. 2650			1.2	2.4	1.8	3.6	3.2	2.7
Over 2650 to and incl. 3000			1.2	2.4	1.8	3.6	3.5	3.0
Over 3000 to and incl. 3550			1.2	2.4	2.0	4.0	4.0	3.6
Over 3550 to and incl. 3750					2.0	4.0	4.5	3.8
Over 3750 to and incl. 5000					2.0	4.0	5.5	5.0

Table B-8—Narrow-V-Belt Center Distance Allowance for Installation and Take-Up Millimeters

Standard Length Designation	Minimum Allowance Below Standard Center Distance for Installation of Belts: 9N 9NX	9N 9NX Joined	15N, 15NX, 15NA	15N 15NX Joined 15NA	25N, 25NX 25NA	25N, Joined 25NA	Minimum Allowance Center Distance for Installation Of Belts: 9N, 9NX, 15N, 15NX, 25N	15NA, 25NA
Up to and incl. 1205	15	30					25	—
Over 1205 to and incl. 1800	20	35	25	55			30	20
Over 1800 to and incl. 2690	20	35	25	55	40	85	40	30
Over 2690 to and incl. 3180	20	35	25	55	40	85	45	35
Over 3180 to and incl. 4320	20	35	25	55	40	85	55	45
Over 4320 to and incl. 5080			25	55	45	90	65	50
Over 5080 to and incl. 6000			30	60	45	90	75	60
Over 6000 to and incl. 6730			30	60	45	90	80	70
Over 6730 to and incl. 7620			30	60	45	90	90	80
Over 7620 to and incl. 9000			30	60	50	100	100	90
Over 9000 to and incl. 9500					50	100	115	95
Over 9500 to and incl. 12700					50	100	140	130

Table B-9—Power Rating (Horsepower)

$$P_r = d_p r\left[K_1 - \frac{K_2}{d_p} - K_3(d_p r)^2 - K_4 LOG(d_p r)\right] + K_2 r\left(1 - \frac{1}{K_{SR}}\right)$$

Section	K_1	K_2	K_3	K_4
A	1.004	1.652	15.547×10^{-4}	0.2126
AX	1.462	2.239	2.198×10^{-4}	0.4238
B	1.769	4.372	3.081×10^{-4}	0.3658
BX	2.051	3.532	3.097×10^{-4}	0.5735
C	3.325	12.070	5.828×10^{-4}	0.6886
CX	3.272	6.655	5.298×10^{-4}	0.8637
D	7.160	43.210	1.384×10^{-4}	1.4540
3V	1.204	1.904	2.069×10^{-4}	0.1763
3VX	1.169	1.530	1.523×10^{-4}	0.1596
5V	3.314	10.120	5.876×10^{-4}	0.4653
5VX	3.304	7.781	3.643×10^{-4}	0.4334
8V	8.663	49.320	15.810×10^{-4}	1.1670
*5VA	5.304	21.510	5.870×10^{-4}	0.8136
*8VA	15.440	132.600	15.800×10^{-4}	2.0650

Where:

P_r = The maximum power (Horsepower) recommended at 180° arc of contact for a belt of average length. For other lengths and arcs of contact the power rating obtained from the formula must be multiplied by the appropriate correction factors for length and arc of contact as found in Tables B-2 and B-3.

d_p = Pitch diameter of the small sheave (inches)

r = RPM of the faster shaft 1000

K_{sr} = Speed ratio factor (See Table B-11)

WARNING: Do not use commercially available sheaves for drives using aramid fiber reinforced belts designated 5VA, 8VA, 15NA and 25NA without an engineering analysis and approval by the sheave manufacturer. Higher power ratings of aramid fiber reinforced belts may cause excessive arm stress and catastrophic sheave failure. Serious personal injury and/or equipment damage may result.

Table B-10—Power Rating (Kilowatts)

$$P_r = d_p r\left[K_1 - \frac{K_2}{d_p} - K_3 (d_p r)^2 - K_4 LOG(d_p r)\right] + K_2 r\left(1 - \frac{1}{K_{SR}}\right)$$

Section	K_1	K_2	K_3	K_4
13C	0.03826	1.232	7.043×10^{-8}	0.006244
13 CX	0.05848	1.482	1.001×10^{-8}	0.01192

Table B-10—Power Rating (Kilowatts) (Continued)

Section	K_1	K_2	K_3	K_4
16C	0.06784	3.261	1.403×10^{-8}	0.01074
16CX	0.0839	2.635	1.410×10^{-8}	0.01684
22C	0.1261	9.004	2.653×10^{-8}	0.02022
22CX	0.1317	4.965	2.412×10^{-8}	0.02537
32C	0.2703	32.230	6.301×10^{-8}	0.04270
9N	0.0426	1.420	9.413×10^{-8}	0.00518
9NX	0.0409	1.140	6.943×10^{-8}	0.00468
15N	0.1165	7.549	2.674×10^{-8}	0.01366
15NX	0.1148	5.800	1.660×10^{-8}	0.01271
25N	0.3025	36.780	7.192×10^{-8}	0.03426
*15NA	0.1893	16.050	2.672×10^{-8}	0.02390
*25NA	0.5387	98.920	7.190×10^{-8}	0.06065

Where:

P_r = The maximum power (Kilowatts) recommended at 180° arc of contact for a belt of average length. For other lengths and arcs of contact the power rating obtained from the formula must be multiplied by the appropriate correction factors for length and arc of contact as found in Tables B-2 and B-4.

d_p = Pitch diameter of the small sheave (inches)

r = RPM of the faster shaft/1000

K_{sr} = Speed ratio factor (See Table B-11)

WARNING: Do not use commercially available sheaves for drives using aramid fiber reinforced belts designated 5VA, 8VA, 15NA and 25NA without an engineering analysis and approval by the sheave manufacturer. Higher power ratings of aramid fiber reinforced belts may cause excessive arm stress and catastrophic sheave failure. Serious personal injury and/or equipment damage may result.

Table B-11—Speed Ratio Constants (All Belts)

Second Ratio, D/d Range	Factor K_{SR}
1.00 to and incl. 1.01	1.0000
Over 1.01 to and incl. 1.05	1.0096
Over 1.05 to and incl. 1.11	1.0266
Over 1.11 to and incl. 1.18	1.0473
Over 1.18 to and incl. 1.26	1.0655
Over 1.26 to and incl. 1.38	1.0805
Over 1.38 to and incl. 1.57	1.0956
Over 1.57 to and incl. 1.94	1.1089
Over 1.94 to and incl. 3.38	1.1198
Over 3.38	1.1278

APPENDIX C—RECOMMENDED PRACTICE FOR CARE AND USE OF V-BELTS

C.1 Storage of V-Belts

Power transmission belts should be stored in a cool and dry environment with no direct sunlight. When stacked on shelves, the stacks should be small enough to avoid excess weight on the bottom belts which may cause distortion. When stored in containers, the container size and contents should be sufficiently limited to avoid distortion, particularly to those belts at the bottom of the container.

Some things to avoid:

Do not store belts on floors unless a suitable container is provided. They may be susceptible to waterleaks or moisture or otherwise damaged due to traffic.

Do not store belts near windows which may permit exposure to sunlight or moisture. Do not store belts near radiators or heaters or in the air flow from heating devices.

Do not store belts in the vicinity of transformers, electric motors, or other electrical devices that may generate ozone. Also avoid areas where evaporating solvents or other chemicals are present in the atmosphere.

C.2 Installation

Proper attention should be given to the following items during the installation of V-belts:

a. Before attempting to work on any powered equipment, shut the machine down and "lock out" the disconnect device.
b. Inspect drive components at this time. Whether you are installing new belts or a completely new drive, worn bearings, bent shafts or other components that might cause future problems should be replaced at this time. If installing belts only, check existing sheaves carefully for worn grooves or other damage. Sheaves should be in alignment and shafts should be parallel and free to rotate. Rusty or dirty sheaves also impair a drive's efficiency. Clean existing sheaves thoroughly before installing a new set of belts.
c. V-belts should never be run on or forced over sheaves. Centers should be slacked off until belts can be placed in the grooves by hand. Before initially tightening any set of belts, care should be taken to trace the slack in each belt to the same side of the drive. Tightening the drive before this is done can result in damage to the belts. Tension in V-belts should be such that when the drive is idle the belts appear snug, and when drive is under full speed and load, a slight sag is noticeable on the slack side. Vertical drives, extremely short center high ratio drives, and drives carrying pulsating loads need additional tension. See Appendix D for method of measuring tension in V-belt drives.

C.3 Maintenance and Operating Practices

V-belts require very little maintenance, but lack of attention to the following items will result in reduced service life:

a. Lubricate the bearings of sheave and idler shafts to prevent freezing.
b. Maintain operating tension by periodic adjustment of centers or idlers. Changes take place more rapidly when new belts are first installed, and these should be checked after 24 and 48 hours of operation.
c. Keep the shafts parallel. Keep sheaves in alignment and running true. Excessive wobble or eccentricity may result in vibration and overload and cause damage to belts.
d. Do not permit the belts to rub or strike sharp edges or belt guard while operating.
e. Keep belts and sheaves reasonably free of lubricating oil and other foreign material.
f. Belt dressing should not be used with V-belts. If slippage occurs due to an oily or dirty condition of belts or sheaves, both the belts and the sheaves should be thoroughly cleaned with a cloth and volatile cleaning fluid.
g. The practice of using a pipe wrench to turn a sheave by hand should be avoided, as the groove rims can be severely damaged.
h. Rough, broken, or chipped grooves result in reduced belt life. Worn sheaves should be replaced or regrooved to dimensions shown in Table A-1 or A-2, Section A.
i. Dampen impulse loads as much as possible by balancing the equipment. Belt vibration may often be reduced or eliminated by slight changes in speed or tension.
j. If the tension section of a belt is ruptured by installation, accident, or use, the condition is evidenced by a "necked down" section. The entire set of belts should be replaced as soon as possible.
k. Belts should not be allowed to run turned over in the sheave grooves. The tension section of a turned belt is severely stressed and therefore subject to rupture or permanent damage.
l. Only matched belts should be used on multiple drives. New and used belts should not be used in the same drive.
m. Belts of different makes should not be mixed in the same drive.
n. Guards should be kept in position and properly ventilated and drained.
o. Provision should be made for applying tension, either by adjusting the center distance or by the use of idlers. Application of idlers to V-belt drives should generally be avoided due to increased cost and reduced belt service life to be expected. However, when location and arrangement of V-belt drive equipment is such that neither the driver nor driven units can be moved, a grooved inside idler or a flat outside idler may be used to provide the necessary adjustments for belt installation and takeup. See Par. B.9. Sufficient idler movement must be provided to affect belt length by amounts

double in values shown in Tables B-4 and B-5 which are in terms of center distance between small and large sheaves.

1. Grooved idler (Inside Type). Inside idlers should be grooved in accordance with tables of Appendix A for the particular belt cross-section involved. Idler diameter should not be less than the smallest loaded sheave on the drive. This size is recommended because an idler diameter less than that of the small sheave may adversely affect drive horsepower capacity or expected service life. An inside idler should be located on the slack side of the drive as close to the large sheave as practical. See Sketch 1, Fig. C-1.
2. Flat Idler (Reverse Bend Type). Reverse bend idlers should be uncrowned flat pulleys preferably located on the drive slack side close to the driver sheave. Refer to Sketch 2, Fig. C-1. Minimum pulley diameter should be one-third larger than the smallest loaded sheave but never less than the diameters shown in Table C-1. Flat idlers may be flanged or nonflanged. Flanged idlers should be at least 15% wider than the face width of the grooved sheaves and have square corners between the running surface and the flange. Unflanged idlers should have a face width 25% greater than the face width of the grooved sheaves.

p. For pump drives with separate skid mounting, it is recommended that the pump skid be mounted in a cradle equipped with screws or turnbuckles to provide ample take-up for center adjustment. The cradle should be anchored to the substructure base and arranged to float on a pad of such size and design as to resist shifting and settling out of alignment.

q. Wide and narrow grooves resulting from poor machining or uneven wear in service will result in "differential driving" and reduced belt life. Such sheaves should be replaced.

r. Some V-belt drives on slush pumps exhibit strong vibration of the belts, thus contributing to premature belt failures. On many such drives the difficulty has been overcome by the use of Joined V-belts. (See Par. C.4 for information regarding Joined V-belts.) If the problem cannot be solved with the use of Joined V-belts, idlers may be used to reduce the belt spans and resulting belt whip. The rules for idler use should be followed as specified in Par. C.3.0 and as illustrated in Sketches 1 and 2, Fig C-1.

s. It is recommended that an accurate belt service record be maintained.

C.4 Use of Joined V-belts

Joined V-belts are units where two or more V-belts have been joined together by a top band as illustrated in Fig. 2-1. Joined V-belts effectively overcome many of the destructive aspects of belt vibration. Belt interference is minimized and turnover is eliminated.

a. Design flexibility is achieved by applying Joined V-belts in matched sets. Consult a V-belt supplier for availability of specific sizes and widths.

b. The following rules should be observed in the use of Joined V-belts.

1. Sheave grooves must conform to the standard groove dimensions and groove spacing as specified in Appendix A. JOINED V-BELTS WILL NOT OPERATE IN DEEP GROOVE SHEAVES.
2. Joined V-belts are less tolerant of worn or damaged sheaves. Inspect sheaves regularly for optimum performance.
3. Greater center distance movement is required for Joined V-belt installation. Refer to Tables B-4 and B-5 for proper installation allowance.
4. A slightly greater clearance is required around the sheave to accommodate the higher ride-out of Joined V-belts. Make sure that guards and other equipment are adjusted accordingly.

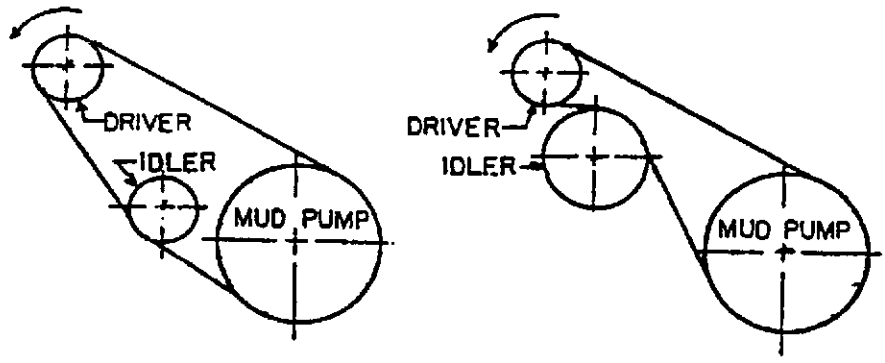


Figure C-1—Typical Usage of Idlers for Tensioning or Reducing Plan Vibration

Table C-1—Minimum Recommended Outside Idlers

English Units		SI Units	
Belt Cross Section	Min. Idler Diameter (inches)	Belt Cross Section	Min. Idler Diameter (mm)
A, AX	4.3	13C, 13CX	109
B, BX	7.7	16C, 16CX	196
C, CX	12.5	22C, 22CX	318
D	18.1	32C	460
3V, 3VX	4.0	9N, 9NX	102
5V, 5VX, 5VA	12.0	15N, 15NX, 15NA	305
8V, 8VA	18.0	25N, 25NA	457

APPENDIX D—RECOMMENDED PRACTICE FOR MEASURING TENSION IN V-BELT DRIVES

D.1 General

V-belts will transmit power satisfactorily over a wide range of tension. Experience indicates that in a majority of cases drives are tensioned satisfactorily within this range; however, there are cases in which it is desirable to know actual belt operating tensions. For example, bearing trouble may indicate excessively high tensions, and belt slippage may indicate tensions which are too low.

D.2 V-Belt Tensioning Method

Use the following procedure to determine proper tensioning parameters. Refer to Figure D-1 for explanation of terminology.

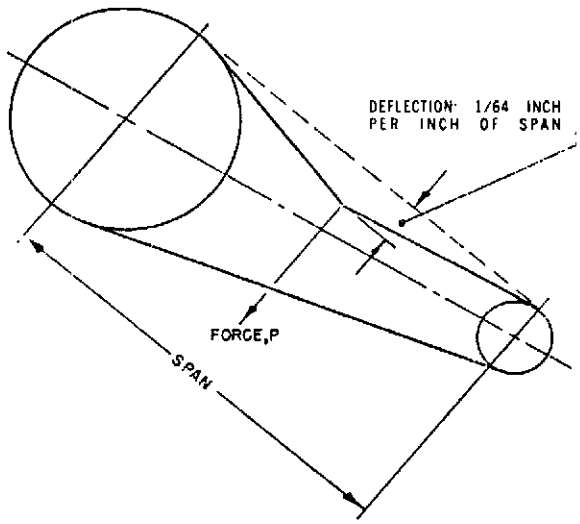


Figure D-1—Belt Deflection Measurement

a. Span Length

Measure length of span (L_s) or calculate by the formula:

$$L_s = \sqrt{C^2 - \frac{D - d^2}{2}}$$

Where:

C = drive center distance
D = larger sheave diameter
d = smaller sheave diameter

b. Required Static Tension. Determine the static tension (T_{st}), (tension in a strand of belt at rest) by one of the following formulas:

$$T_{st}\text{ (pounds)} = 15\left(\frac{2.5 - K_\theta}{K_\theta}\right)\left(\frac{P_d}{N_b \times V/1000}\right) + \frac{K_M V^2}{10^6}$$

Where:

K_θ = arc of contact correction factor from Table B-2
V = belt speed in feet per minute = $\dfrac{(\text{rpm of faster shaft}) \quad \text{pitch diameter of smaller sheave (inches)}}{3.82}$
K_M = constant from Table D-1 depending on belt cross-section
N_b = number of belts on drive (total number of belt strands for joined belts)
P_d = Design Power (horsepower) calculated in Section B.2

$$\text{or, } T_{st}\text{ (newtons)} = 4.55\left(\frac{2.5 - K_\theta}{K_\theta}\right)\left(\frac{P_d}{N_b \times V}\right) + K_M V^2$$

Where:

K_θ = arc of contact correction factor from Table B-2
V = belt speed in meters per second = $\dfrac{(\text{rpm of faster shaft}) \left(\text{pitch diameter of smaller sheave (millimeters)}\right)}{19{,}100}$
K_M = constant from Table D-2 depending on belt cross-section
N_b = number of belts on drive (total number of belt strands for joined belts)
P_d = Design Power (kilowatts) calculated in Section B.2

Note: When the peak power of the drive is transmitted for a significant portion of the time and it exceeds the value calculated for Design Power, substitute the peak power into the formula.

c. Belt Deflection Force. Determine the minimum and maximum deflection forces as follows:

1. If the drive uses two or more individual V-belts, or two or more Joined V-belts, calculate the minimum and maximum deflection force (P) using these formulas:

$$P_{min} = \frac{T_{st} + K_Y}{16}$$

$$P_{max} = \frac{1.5\,T_{st} + K_Y}{16}$$

Where:

T_{st} = static tension per strand as calculated in D.2.b.
K_Y = constant from Table D-1 (or D-2 if metric)

2. If the drive uses only one individual V-belt or Joined V-Belt, calculate the minimum and maximum deflection forces using these formulas:

$$P_{min} = \frac{T_{st} + \left(\frac{L_s}{L}\right) K_Y}{16}$$

$$P_{max} = \frac{1.5\ T_{st} + \left(\frac{L_s}{L}\right)\ K_Y}{16}$$

Where:

T_{st} = static tension per strand as calculated in D.2.b
K_Y = constant from Table D-1 (or D-2 if metric)
L_s = span length
L = belt length

d. Belt Deflection (q). At the center of the belt span apply a force p (see Figure D-1) in a direction perpendicular to the span, until the belt is deflected (usually in reference to a straight edge) an amount equal to:

- 1/64 inch for every inch of span length (L_s), or
- 1.6mm for every 100 of span length (L_s)

For example, the deflection for a 100 inch span would be 100/64 or 1 9/16 inch.

If the force p is between the values calculated for the minimum and maximum in D.2.c, the belt tension should be satisfactory. A force below the minimum value indicates an under-tensioned drive. If the force exceeds the maximum value the drive is tighter than necessary.

The drive may be tightened initially to two times the minimum force as the tension drops rapidly during the run-in period. A used belt should be tensioned near, but not less than, the minimum force.

WARNING: Do not install aramid cord belts at higher tension than the maximum deflection force (p_{max}) calculated above. Higher tension may result in damage to bearings, shafts, or sheaves. The higher power ratings of aramid fiber reinforced belts may cause excessive arm stress and catastrophic sheave failure. Serious personal injury and/or equipment damage may result.

Table D-1—Factors K_M and K_Y for Use in Tensioning Formulas (Inch-Pound Units)

Belt Cross-Section	Factor K_M	Factor K_Y
A, AX	0.6	6.0
B, BX	1.1	9.0
C, CX	2.0	16.0
D	3.6	30.0
3V, 3VX	0.4	4.0
5V, 5VX	1.2	12.0
8V	3.2	22.0
5VA	1.4	75.0
8VA	3.4	125.0

Table D-2—Factors K_M and K_Y for Use in Tensioning Formulas (Metric SI Units)

Belt Cross-Section	Factor K_M	Factor K_Y
13C, 13CX	0.10	27.00
16C, 16CX	0.19	40.0
22C, 22CX	0.34	71.0
32C	0.62	133.0
9N, 9NX	0.07	18.0
15N, 15NX	0.21	53.0
25N	0.55	98.0
15NA	0.24	334.0
25NA	0.59	556.0

APPENDIX E—RECOMMENDED PRACTICE FOR CALCULATION OF LOAD IMPOSED BY A V-BELT DRIVE ON SHAFTS AND BEARINGS

E.1 Force Determination

It is necessary at times for a designer to determine the force imposed on a shaft by a V-belt drive in order to calculate bearing load. This force is the vector sum of three forces: (1) tight-side tension in drive (T_T). (2) slack-side tension in drive (T_S) and (3) weight of sheave.

$T_T = 41{,}250 \frac{P_d}{K_\theta V}$ in pounds force

$T_S = 33{,}000\ (1.25 - K_\theta) \frac{P_d}{K_\theta V}$ in pounds force

W_s = Mass of the sheave, in pounds

Where:

K_θ = Arc of contact correction factor (Table B-2)

P_d = Design power of the drive (See Section B.2) in Horsepower

V = belt speed, feet/minute

$T_T = 1250 \frac{P_d}{K_\theta V}$ in newtons

$T_S = 1{,}000\ (1.25 - K_\theta) \frac{P_d}{K_\theta V}$ in newtons.

W_s = Mass of the sheave, in kilograms

Where:

K_θ = Arc of contact correction factor (Table B-2)

P_d = Design power of the drive (See Section B.2), in kilowatts

V = belt speed, in meters/sec.

Notes:
1. If the drive may be subjected to extreme overloads, use peak power in place of P_d in the above formula.
2. If idlers are used, the Arc of Contact correction Factor (K_θ) must be corrected to the resultant arc of contact.

E.2 Resultant Force

Using the two forces and the mass defined in Par. E.1, solve graphically or analytically for resultant force at center of sheave.

APPENDIX F—MARKING REQUIREMENTS FOR API MONOGRAM LICENSEES

F.1

This appendix is a requirement only for this manufactures licensed to use the API monogram. The marking requirements of this section supersede the marking requirements of Section 3 of Specification 1B, Specification for Oil-Field V-Belts, for API licensees only.

F.2

The Api Monogram shall be applied only by licensed manufacturers. See API Bulletin S1, Bulletin on policy and Procedures for Standardization of Oilfield Equipment and Materials, for regulations governing the use of the API monogram. API Specification Q1, Specification for Quality Programs, paragraph 2.2.3 gives the requirements for marking products using the API monogram.

F.3

Marking requirements for monogrammed V-Belts. Markings for belting shall be as follows:

a. Manufacturer's, Jobber's or Distributor's Name or Mark
b. Belt Cross Section. Belts shall be marked with the cross-sections as referenced in this standard.
c. Standard Length. Belts shall be marked with the Standard length designation in Tables 3, 4, 5 and 6.
d. API Monogram.
e. API License Number.
f. Date of Manufacture. Month and Year of manufacturer shall be marked on each belt.

F.4 Other Name

Belting made in accordance with this specification by an authorized manufacturer may be marked with the name of a jobber or distributor instead of the name of the manufacturer. All other markings shall pertain to the original authorized manufacturer.

F.5 Method

Belting purchased to this specification shall be marked as specified hereinafter. Markings shall be applied on the side of the belt to be run away from the sheave. Markings shall be applied by vulcanizing, stamping, or stenciling. Markings shall be applied in such a manner that the belt is not damaged.

APPENDIX G1

Table G-1—Narrow V-Belt Sheave Sizes Generally Available*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Combination A-B Section			B Section		C Section		D Section	
Diameter								
Datum Using A Section	Datum Using B Section	Grooves	Diameter Datum	Grooves	Diameter Datum	Grooves	Diameter Datum	Groove
3.0	—	1 thru 6	20.0	2 thru 6, 8, 10	7.0	2 thru 6	12.0	4 thru 6, 8, 10, 12
3.2	—	1 thru 6						
3.4	—	1 thru 6	25.0	2 thru 6, 8, 10	7.5	2 thru 6	13.0	4 thru 6, 8, 10, 12
3.6	—	1 thru 6						
3.8	—	1 thru 6	30.0	2 thru 6, 8, 10	8.0	2 thru 6, 8, 10	13.5	4 thru 6, 8, 10, 12
4.0	—	1 thru 6						
4.2	—	1 thru 6	38.0	2 thru 6, 8, 10	8.5	2 thru 6, 8,10	14.0	4 thru 6, 8, 10, 12
4.4	4.8	1 thru 6						
4.6	5.0	1 thru 6			9.0	2 thru 6, 8, 10, 12	14.5	4 thru 6, 8, 10, 12
4.8	5.2	1 thru 6						
5.0	5.4	1 thru 6			9.5	2 thru 6, 8, 10, 12	15.0	4 thru 6, 8, 10, 12
5.2	5.6	1 thur 6						
5.4	5.8	1 thru 6			10.0	2 thru 6, 8, 10, 12	15.5	4 thru 6, 8, 10, 12
5.6	6.0	1 thru 6						
5.8	6.2	1 thru 6			10.5	2 thru 6, 8, 10, 12	16.0	4 thru 6, 8, 10, 12
6.0	6.4	1 thru 6						
6.2	6.6	1 thru 6			11.0	2 thru 6, 8, 10, 12	18.0	4 thru 6, 8, 10, 12
6.4	6.8	1 thru 6						
7.0	7.4	1 thru 6			12.0	2 thru 6, 8, 10, 12	20.0	4 thru 6, 8, 10, 12
8.2	8.6	1 thru 6						
9.0	9.4	1 thru 6			13.0	2 thru 6, 8, 10, 12	22.0	4 thru 6, 8, 10, 12
10.6	11.0	1 thru 6						
12.0	12.4	1 thru 6			14.0	2 thru 6, 8, 10, 12	27.0	4 thru 6, 8, 10, 12
15.0	15.4	1 thru 6						
18.0	18.4	1 thru 6			16.0	2 thru 6, 8, 10, 12	33.0	4 thru 6, 8, 10, 12
					18.0	2 thru 6, 8, 10, 12	40.0	4 thru 6, 8, 10, 12
					20.0	2 thru 6, 8, 10, 12	48.0	5, 6, 8, 10
					24.0	2 thru 6, 8, 10, 12	58.0	5, 6, 8, 10
					27.0	2 thru 6, 8		
					30.0	2 thru 6, 8, 10, 12		
					36	2 thru 6, 8, 10, 12		
					44.0	2 thru 6, 8, 10, 12		
					50.0	2 thru 6, 8, 10, 12		

*Note: This information is shown here as an aid to the drive designer. It does not constitute a rigid standard, and is not intended to preclude future additions or deletions of sheave sizes.

Table G-2—Narrow V-Belt Sheave Sizes Generally Available*

(1)	(2)	(3)	(4)	(5)	(6)
3V Section		5V Section		8V Section	
Diameter Effective Outside	Grooves	Diameter Effective Outside	Grooves	Diameter Effective Outside	Grooves
2.65	1 thru 4	7.1	2 thru 6, 8	12.5	4 thru 6, 8, 10
2.80	1 thru 4	7.5	2 thru 6, 8	13.2	4 thru 6, 8, 10
3.00	1 thru 4	8.0	2 thru 6, 8, 10	14.0	4 thru 6, 8, 10
3.15	1 thru 4	8.5	2 thru 6, 8, 10	15.0	4 thru 6, 8, 10
3.35	1 thru 4	9.0	2 thru 6, 8, 10	16.0	4 thru 6, 8, 10
3.65	1 thru 4	9.25	2 thru 6, 8, 10	17.0	4 thru 6, 8, 10
4.12	1 thru 4	9.75	2 thru 6, 8, 10	18.0	4 thru 6, 8, 10
4.50	1 thru 4	10.3	2 thru 6, 8, 10	19.0	4 thru 6, 8, 10
4.75	1 thru 6, 8, 10	10.9	2 thru 6, 8, 10	20.0	4 thru 6, 8, 10
5.00	1 thru 6, 8, 10	11.3	2 thru 6, 8, 10	21.2	4 thru 6, 8, 10
5.30	1 thru 6, 8, 10	11.8	2 thru 6, 8, 10	22.4	4 thru 6, 8, 10
5.60	1 thru 6, 8, 10	12.5	2 thru 6, 8, 10	30.0	4 thru 6, 8, 10
6.00	1 thru 6, 8, 10	13.2	2 thru 6, 8, 10	40.0	4 thru 6, 8, 10
6.50	1 thru 6, 8, 10	14.0	2 thru 6, 8, 10	53.0	4 thru 6, 8, 10
6.90	1 thru 6, 8, 10	15.0	2 thru 6, 8, 10		
8.00	1 thru 6, 8, 10	16.0	2 thru 6, 8, 10		
10.6	1 thru 6, 8, 10	18.7	2 thru 6, 8, 10		
14.0	1 thru 6, 8, 10	21.2	2 thru 6, 8, 10		
19.0	1 thru 6, 8, 10	23.6	2 thru 6, 8, 10		
25.00	2 thru 6, 8, 10	28.0	3 thru 6, 8, 10		
33.5	3 thru 6, 8, 10	31.5	3 thru 6, 8, 10		
		37.5	3 thru 6, 8, 10		
		50.0	3 thru 6, 8, 10		

*Note: This information is shown here as an aid to the drive designer. It does not constitute a rigid standard, and is not intended to preclude future additions or deletions of sheave sizes.

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