SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

An American National Standard

SAE J637

REV. AUG1997

Issued 1954-01
Revised 1997-08

Superseding J637 FEB89

(R) AUTOMOTIVE V-BELT DRIVES

Foreword—Selection and specification of belts have been major problems due to the lack of a recognized industry standard for classifying V-belts according to performance and quality level.

From the very beginning of the use of V-belts on automotive drives, the automotive manufacturers and the V-belt manufacturers have employed laboratory tests on the products for such purposes as product development, source approval, and quality verification. This standard is the result of the combined effort of the users and suppliers.

1. Scope—The following information is intended as a guide to be used for evaluating belt construction, source approval, and quality audit. This recommendation has been prepared from existing literature, including standards, specifications, and data supplied by both producers and users.

These recommendations cover drive layout details and V-belt testing methods, including test layout, pulley diameters, torque loads, and guidance for interpreting test data. The application of these automotive V-belts is to power engine or vehicle accessories that are physically attached to the engine.

2. References

2.1 Applicable Publication—The following publication forms a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J636—V-Belts and Pulleys

2.1.2 RMA PUBLICATIONS—Available from Rubber Manufacturer's Association

IP-20—Classical Multi-V-Belts (A, B, C, and D) Belt Sections
IP-22—Narrow Multi-V-Belts (3 V , 5 V, and 8 V)
IP-23—Light Duty Single V-Belts (2 L, 3 L, 4 L, and 5 L)

2.1.3 ASAE PUBLICATION—Available from ASAE, 2950 Niles Road, St. Joseph, MI 49085-9569.

ASAE S211.4—V-Belt Drives for Farm Machines

3. General Drive Layout Considerations

3.1 Power Transmission—When the engine is used to drive an external unit equipped with industrial type pulleys and belts, it is recommended that the power takeoff pulley on the engine be grooved according to the appropriate industrial standard. There are four such standards. Three of these standards are published by the RMA-MPTA (Rubber Manufacturers Association-Mechanical Power Transmission Association) and include Classical Multi-V-Belt (A, B, C, and D belt sections), Narrow Multi-V-Belts (3 V, 5 V, and 8 V), and Single V-Belts (2 L, 3 L, 4 L, and 5 L). The fourth is published as an American Society of Agricultural Engineers standard, V-Belt Drives for Farm Machines.

The grooves in these four standards differ from each other in the reference dimensions. They are not interchangeable with SAE grooves which were standardized for engine accessory and other engine compartment drives.

3.2 Belt Speed—It is recommended that pulleys be as large as possible without continuously exceeding 35.6 m/s (7000 ft/min) belt speed. It is possible to have peak belt speeds of 43.2 m/s (8500 ft/min) but special pulleys may be needed. Consult the pulley manufacturer to verify the pulleys can handle the required rim speed.

3.3 Pulley Sizes—No pulley in the drive should be smaller than the recommended minimum effective diameters listed in SAE J636, Tables 1A and 1B.

3.4 Belt Length—Calculation of the belt effective length for a specific drive involves several design considerations, including provision for adequate installation and takeup.

To allow for belt installation and takeup, one pulley should be adjustable from its initial position with the mean length belt at installation tension. This formula gives the absolute minimum allowance for easy installation of the belt without prying it over the sides of the grooves.

3.4.1 Equation 1 can be used to calculate the recommended minimum belt effective length for installation:

$$\text{Min Belt EL} = (1.005)(L_1) + L_2 + C_I \qquad \text{(Eq. 1)}$$

where:

L_1 = Effective belt length (addition of span lengths and effective arc lengths on the pulleys) around the drive with the tensioning pulley in the minimum position. The 1.005 factor provides for length change from slack to measuring tension.
L_2 = 2 X negative belt manufacturing center distance tolerance. (SAE J636, Tables 4A and 4B)
C_I = Length to account for belt worked into groove. Installation constant (C_I) found in Table 3.

3.4.2 Select a belt to be used that has a nominal effective length equal to or greater than the recommended minimum EL.

3.4.3 Calculate the maximum required effective length around the drive to provide for take-up (see Equation 2):

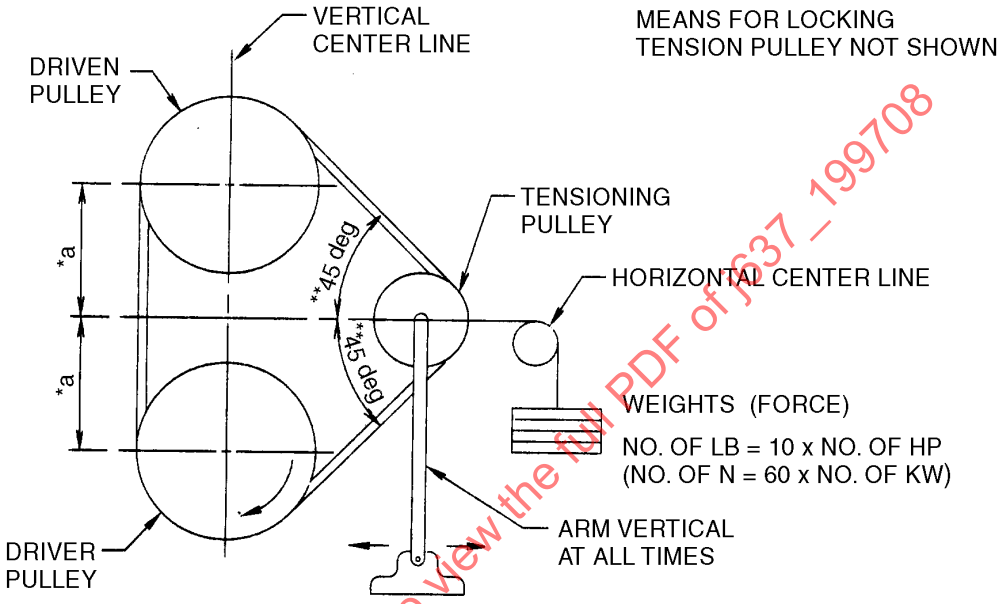
$$\text{Maximum required belt path length} = (1.005)L_3 + L_4 + L_5 + L_6 \qquad \text{(Eq. 2)}$$

where:

L_3 = Nominal Belt EL as defined in 3.4.2. The 1.005 factor accounts for elongation from measuring to installation tension.
L_4 = (0.01) (EL) -- Allows 1% for tensile member growth and belt wear during service life.
L_5 = 2 X positive belt manufacturing center distance tolerance. (SAE J636, Tables 4a and 4B)
L_6 = Belt seating factor (9.6 mm, 0.38 in)

3.5 Pulley Misalignment—The recommended maximum misalignment between pulleys is 1.6 mm per 300 mm span length (1/16 in/ft of span length) or approximately 1/3 of 1 degree.

4. V-Belt Fatigue Test Method—The belt shall be mounted on a test layout as shown in Figure 1 with pulley diameters and speeds as given in Tables 1A, 1B, 2A, and 2B. The horsepower (kilowatts) to be absorbed at the driven pulley shall be compatible with the tension pulley diameter and belt length as shown in Tables 1A, 1B, 2A, and 2B.



* Dimension a is adjusted for various length belts to maintain tension pulley midway vertically between driver and driven pulleys.
** 45 degrees is specified for initial test configuration and may change slightly with resets as test progresses.

FIGURE 1—V-BELT FATIGUE TEST

The driver pulley speed (rpm) shall be used in the torque load calculation and the torque load shall be kept constant without compensation for loss of driven pulley rpm resulting from belt slippage and creep. See Equations 4 and 3.

$$\text{Torque, N·m} = \frac{\text{Specified kilowatts} \times 9549}{\text{Driver rpm}} \qquad \text{(Eq. 3)}$$

$$\text{Torque, lb·in} = \frac{\text{Specified horsepower} \times 63025}{\text{Driver rpm}} \qquad \text{(Eq. 4)}$$

Measurable parasitic loads due to bearing losses, lubricants, etc., shall be deducted from the specified horsepower (kilowatts) in the previous calculation.

The tension shall be applied by weights equal in number of pounds to 10 times the number of units of the specified horsepower (in number of Newtons to 60 times the number of units of the specified kilowatts).

4.1 The test procedure shall be as follows:

4.1.1 Condition the belt by running 5 min under the prescribed test details but without the dynamometer load. Maintain a constant tension during this period by operating with the tension pulley center position unlocked.

4.1.2 Stop the machine, allow to stand for a minimum of 10 min and lock the tension pulley center position midway of the limits of travel during belt rotation.

4.1.3 Restart with the dynamometer load and run until the slip reaches 8% or until the belt will no longer transmit the load uniformly because of breakage or rough running.

4.1.4 Whenever the slip reaches 8%, stop the machine, allow to stand for a minimum of 20 min, unlock the tension pulley center, restore the initial tension, relock, and restart the machine.

4.1.5 Record the number of hours run and the number of resets (exclusive of the 5 min run-in).

4.1.6 The ambient temperature shall be 27 to 32 °C (80 to 90 °F). An increase in internal belt temperature will reduce belt life. Internal belt temperature is dependent upon ambient temperature as well as other test conditions.

5. Test Performance Guidelines—The test life which a belt must attain shall be according to agreement between user and manufacturer. However, typical curves of average test life versus belt length are shown in Figure 2. The typical curves of Figure 2 are constructed with the belt life varying as the 2.75 power of belt length for the test conditions given in Tables 1A, 1B, 2A, and 2B. The acceptable number of retensionings after the initial 5 min run-in shall be according to agreement between the manufacturer and user.

The belt manufacturer's test data on belts of a certain construction specification shall be considered valid for evaluation of all belts of the same construction specification regardless of the intended user. Belts shall be considered to be of the same construction specification when they are the same with respect to the manufacturer's cross section dimensions, material specifications, and method of manufacture.

In evaluating for part source approval and for production quality surveillance, test data for the entire length group containing a part in question shall be considered pertinent. The design of some test machines may not accommodate the shortest lengths shown in Figure 2. In such cases, test data on some longer belt(s) of the same construction specification and within the length group 710 to 1020 mm (28 to 40 in) shall be used. Similarly, test data on belt(s) within the length group 1420 to 1730 mm (56 to 68 in) shall be used for lengths beyond 1730 mm (68 in).

Whether testing is performed for part source approval or for production quality surveillance, a realistic statistical guide to acceptability would be "not more than 10% of test lives shall be permitted to fall below 50% of the specified average life."

For part source approval, test data of the immediately preceding three month period shall be considered pertinent. When such data are not sufficient for the statistical evaluation, the manufacturer may have the option of submitting data for source approval on a "sample" of the part under consideration or on samples of the same length group and construction specification. Because the data would be limited to this situation, a guide to approval could be to permit no test results to be below 50% of the specified average life.

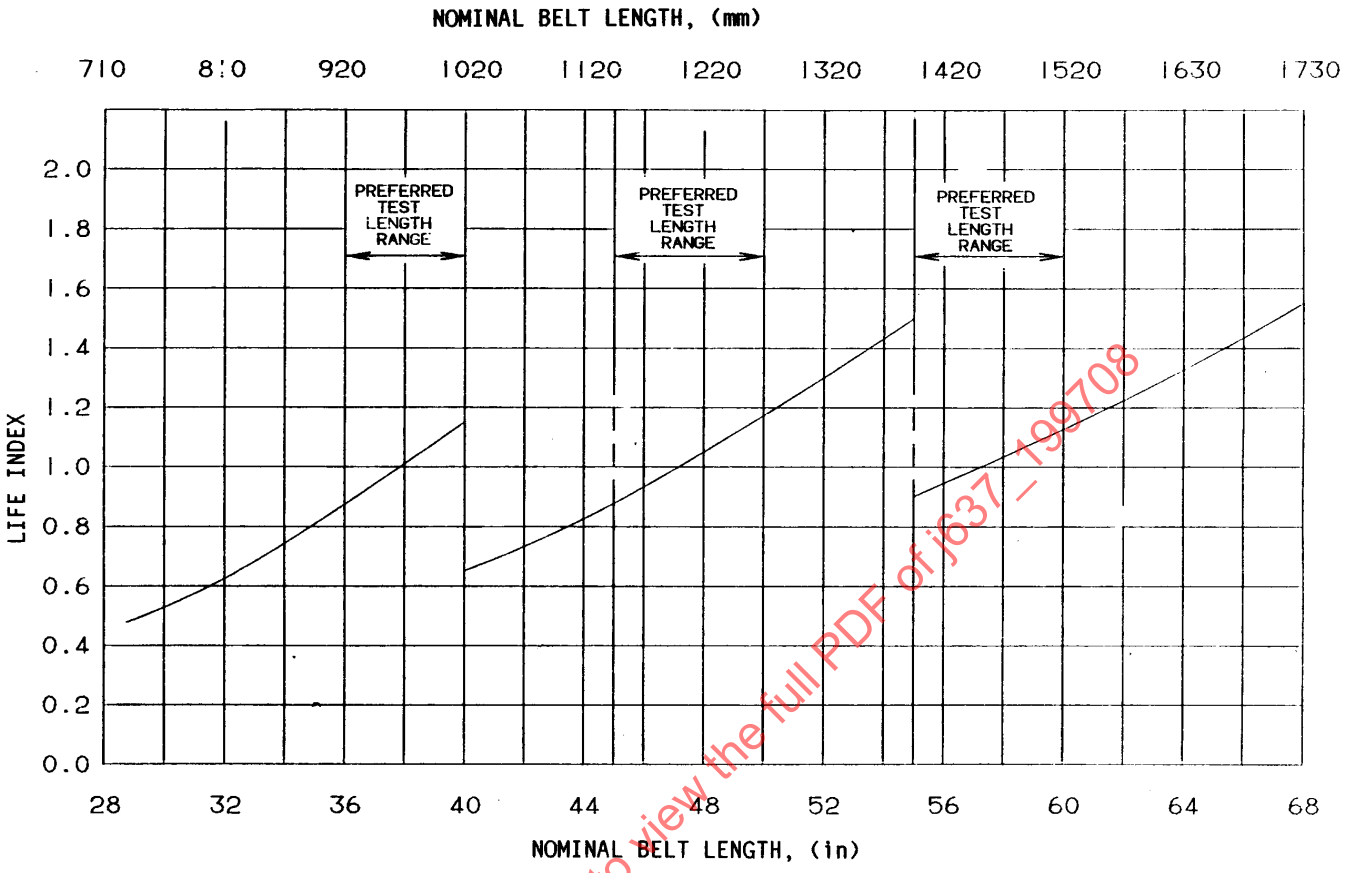


FIGURE 2—TYPICAL LIFE-LENGTH CURVES (FOR TEST CONDITIONS IN TABLES 1A, 1B, 2A, AND 2B)

TABLE 1A—TEST CONDITIONS[1] PLAIN SECTION BELTS, (mm)

SAE Belt Size	Standard Groove Width	Diameter Where Specified Groove Width Occurs (w/o Width Tol) DR & DN Pulley ±0.25	Diameter Where Specified Groove Width Occurs (w/o Width Tol) Tension Pulley ±0.25	Driver Pulley Speed RPM ±2%	Load kW	Length Range Total	Length Range Preferred
6A	6.3	120.65	57.15	4900	6.3	Under 1020	920 – 1020
					7.1	1020 – 1400	1140 – 1270
					[2]	Over 1400	1400 – 1520
8A	8.0	120.5	57.0	4900	6.9	Under 1020	920 – 1020
					7.6	1020 – 1400	1140 – 1270
					8.4	Over 1400	1400 – 1520
10A	9.7	120.5	63.5	4900	7.5	Under 1020	920 – 1020
					8.2	1020 – 1400	1140 – 1270
					8.9	Over 1400	1400 – 1520
11A	11.2	120.5	70.0	4900	8.0	Under 1020	920 – 1020
					8.8	1020 – 1400	1140 – 1270
					9.5	Over 1400	1400 – 1520
13A	12.7	127.0	76.0	4700	8.9	Under 1020	920 – 1020
					9.7	1020 – 1400	1140 – 1270
					10.4	Over 1400	1400 – 1520
15A	15.2	127.0	89.0	4700	9.7	Under 1020	920 – 1020
					10.4	1020 – 1400	1140 – 1270
					11.2	Over 1400	1400 – 1520
17A	16.8	127.0	92.0	4700	10.1	Under 1020	920 – 1020
					10.8	1020 – 1400	1140 – 1270
					11.6	Over 1400	1400 – 1520
20A	20.0	152.5	101.5	3900	[2]	[2]	[2]
23A	23.1	178.0	117.5	3350	[2]	[2]	[2]

1. Groove details as given in SAE J636, Table 1A, Figure 1
2. Values to be per agreement between user and manufacturer (insufficient usage for recommendations)

TABLE 1B—TEST CONDITIONS(1) PLAIN SECTION BELTS, (in)

SAE Belt Size	Standard Groove Width	Diameter Where Specified Groove Width Occurs (w/o Width Tol) DR & DN Pulleys ±0.010	Diameter Where Specified Groove Width Occurs (w/o Width Tol) Tension Pulley ±0.010	Driver Pulley Speed RPM ±2%	Load HP	Length Range Total	Length Range Preferred
0.250	0.248	4.750	2.250	4900	8.50	Under 40	36 – 40
					9.50	40 – 55	45 – 50
					(2)	Over 55	55 – 60
0.315	0.315	4.750	2.250	4900	9.25	Under 40	36 – 40
					10.25	40 – 55	45 – 50
					11.25	Over 55	55 – 60
0.380	0.380	4.750	2.500	4900	10.00	Under 40	36 – 40
					11.00	40 – 55	45 – 50
					12.00	Over 55	55 – 60
0.440	0.441	4.750	2.750	4900	10.75	Under 40	36 – 40
					11.75	40 – 55	45 – 50
					12.75	Over 55	55 – 60
0.500	0.500	5.000	3.000	4700	12.00	Under 40	36 – 40
					13.00	40 – 55	45 – 50
					14.00	Over 55	55 – 60
11/16 (0.600)	0.597	5.000	3.500	4700	13.00	Under 40	36 – 40
					14.00	40 – 55	45 – 50
					15.00	Over 55	55 – 60
3/4 (0.660)	0.660	5.000	3.625	4700	13.50	Under 40	36 – 40
					14.50	40 – 55	45 – 50
					15.50	Over 55	55 – 60
7/8 (0.790)	0.785	6.000	4.000	3900	(2)	(2)	(2)
1 (0.910)	0.910	7.000	4.625	3350	(2)	(2)	(2)

1. Groove details as given in SAE J636, Table 1B, Figure 1
2. Values to be per agreement between user and manufacturer (insufficient usage for recommendations)

TABLE 2A—TEST CONDITIONS[1] COG, OR NOTCHED BELTS, (mm)

SAE Belt Size	Standard Groove Width	Diameter Where Specified Groove Width Occurs (w/o Width Tol) DR & DN Pulleys ±0.010	Diameter Where Specified Groove Width Occurs (w/o Width Tol) Tension Pulley ±0.010	Driver Pulley Speed RPM ±2%	Load kW	Length Range Total	Length Range Preferred
6A	6.3	(2)	(2)	(2)	(2)	(2)	(2)
8A	8.0	(2)	(2)	(2)	(2)	(2)	(2)
10A	9.7	120.5	57.0	4900	7.5	Under 1020	920 – 1020
					8.2	1020 – 1400	1140 – 1270
					8.9	Over 1400	1400 – 1520
11A	11.2	120.5	63.5	4900	8.0	Under 1020	920 – 1020
					8.8	1020 – 1400	1140 – 1270
					9.5	Over 1400	1400 – 1520
13A	12.7	127.0	70.0	4700	8.9	Under 1020	920 – 1020
					9.7	1020 – 1400	1140 – 1270
					10.4	Over 1400	1400 – 1520
15A	15.2	127.0	82.5	4700	9.7	Under 1020	920 – 1020
					10.4	1020 – 1400	1140 – 1270
					11.2	Over 1400	1400 – 1520
17A	16.8	127.0	85.5	4700	10.1	Under 1020	920 – 1020
					10.8	1020 – 1400	1140 – 1270
					11.6	Over 1400	1400 – 1520
20A	20.0	152.5	95.0	3900	(2)	(2)	(2)
23A	23.1	178.0	111.0	3350	(2)	(2)	(2)

1. Groove details as given in SAE J636, Table 1A, Figure 1
2. Values to be per agreement between user and manufacturer (insufficient usage for recommendations)

TABLE 2B—TEST CONDITIONS(1) COG, OR NOTCHED BELTS, (in)

SAE Belt Size	Standard Groove Width	Diameter Where Specified Groove Width Occurs (w/o Width Tol) DR & DN Pulleys ±0.010	Diameter Where Specified Groove Width Occurs (w/o Width Tol) Tension Pulley ±0.010	Driver Pulley Speed RPM ±2%	Load HP	Length Range Total	Length Range Preferred
0.250	0.248	(2)	(2)	(2)	(2)	(2)	(2)
0.315	0.315	(2)	(2)	(2)	(2)	(2)	(2)
0.380	0.380	4.750	2.250	4900	10.00	Under 40	36 – 40
					11.00	40 – 55	45 – 50
					12.00	Over 55	55 – 60
0.440	0.441	4.750	2.500	4900	10.75	Under 40	36 – 40
					11.75	40 – 55	45 – 50
					12.75	Over 55	55 – 60
0.500	0.500	5.000	2.750	4700	12.00	Under 40	36 – 40
					13.00	40 – 55	45 – 50
					14.00	Over 55	55 – 60
11/16 (0.600)	0.597	5.000	3.250	4700	13.00	Under 40	36 – 40
					14.00	40 – 55	45 – 50
					15.00	Over 55	55 – 60
3/4 (0.660)	0.660	5.000	3.375	4700	13.50	Under 40	36 – 40
					14.50	40 – 55	45 – 50
					15.50	Over 55	55 – 60
7/8 (0.790)	0.785	6.000	3.750	3900	(2)	(2)	(2)
1 (0.910)	0.910	7.000	4.375	3350	(2)	(2)	(2)

1. Groove details as given in SAE J636, Table 1B, Figure 1
2. Values to be per agreement between user and manufacturer (insufficient usage for recommendations)