

Submitted for recognition as an American National Standard

Performance Testing of PK Section V-Ribbed Belts

- 1. Scope**—The following information covers accessory drive belt testing methods and includes test configurations, pulley diameters, power loads, and guidance for interpreting test data. This information has been prepared from existing literature, including standards and data supplied by producers and users of V-ribbed belts.
- 1.1 Purpose**—This SAE Standard is intended to provide methods to evaluate the performance, source approval, and/or quality audit of V-ribbed belt constructions.
- 1.2 Test Sample Size**—The number of test samples should be statistically significant based on the requirements agreed to between each manufacturer and user.
- 1.3 Belt Test Lengths**—The test belt range is 1200 mm $\pm$ 10 mm. Test data from belts of this length will be considered valid for all belt lengths of the same construction and specification.
- 1.4 Definition of Construction Specification**—The belt manufacturers test data on belts of a certain construction shall be considered valid for evaluation of all belts, with respect to the manufacturer's cross section dimensions, material specifications, and method of manufacture.
- 1.5 Belt Temperature Rating**—Belts shall be rated according to temperature capability. Belt types have been defined in 4.2 and 5.2. Belts capable of passing the extreme temperature tests shall be given a two letter designation, the first letter being the High Temperature capability and the second letter being the low temperature capability. For example, an 'AA' belt is rated for 121 °C to -43 °C, a 'BA' belt is for 107 °C to -43 °C.
- 1.6 Pulley Construction**—Unless otherwise specified, all pulleys used on test fixtures should be machined steel pulleys, manufactured to SAE measurement pulley tolerances as shown in SAE J1459.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS <http://www.sae.org>

2. References

2.1 Applicable Publications—The following publications form 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 PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J636—V-belts and Pulleys

SAE J1459—V-ribbed Belts and Pulleys

SAE J1596—Automotive V-ribbed Belt Drives and Test Methods

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 412—Test Methods for Rubber Properties in Tension

ASTM D 573—Test Method for Rubber—Deterioration in an Air Oven

ASTM D 575—Test Methods for Rubber Properties in Compression

ASTM D 1149-91—Test Method for Rubber Deterioration—Surface Ozone Cracking in a Chamber (Flat Specimens)

3. General Drive Layout Considerations—For general information on Accessory Drive Layout considerations, please refer to SAE J1596.

4. High Temperature, Constant Tension, Test

4.1 Purpose—To test the belt's durability under high temperature, high load conditions. This test was developed to reflect the increased use of automatic tensioners on automotive accessory drives. These systems have constant tension and therefore do not exhibit slip conditions resulting from loss of tension due to belt stretch.

Increased belt length will increase belt life on the test stand. Therefore, belt length has been limited to reduce test variability and provide comparable data from each manufacturer to the users.

4.2 Belt Type Designation—The belts for the High Temperature, Constant Tension Test are designated as follows:

Type A_{hot} Belt: 121 °C

Type B_{hot} Belt: 107 °C

Type C_{hot} Belt: 93 °C

4.3 Test Configuration—See Figure 1.

4.3.1 EQUIPMENT PARAMETERS

Driven Torque = 20 Nm ± 1 Nm

Belt Effective Length = 1200 mm ± 10 mm

Driver Speed = 4900 rpm ± 100 rpm

Number of Belt Ribs = 6

Grooved Pulley Diameters (across 2.50 mm gauge balls, all ±0.25 mm)

Driver (Pulley 1) = 121.6 mm

Driven (Pulley 3) = 121.6 mm

Idler (Pulley 2) = 61.0 mm

Backside Idler (Pulley 4) = 76.2 mm ± 0.25 mm (actual diameter)

Belt Tension = 629 N ± 31 N

Belt Hubload:

Option 1: Belt Horizontal Hubload W_1 = 904 N ± 44 N

Option 2: Belt Vertical Hubload at W_2 = 655 N ± 33 N

4.3.2 TEST CHAMBER TEMPERATURE

Type A_{hot} Belt: 121 °C ± 2 °CType B_{hot} Belt: 107 °C ± 2 °CType C_{hot} Belt: 93 °C ± 2 °C

Pulley	DIA	X	Y	Notes:
1	121.6 DOB	0.0	0.0	Driver Pulley
2	61.0 DOB	200.0	150.5	Idler Pulley
3	121.6 DOB	0.0	301.0	Driven Pulley
4	76.2	0.0	150.5	Idler Pulley
Effective Belt Length = 1200 mm				

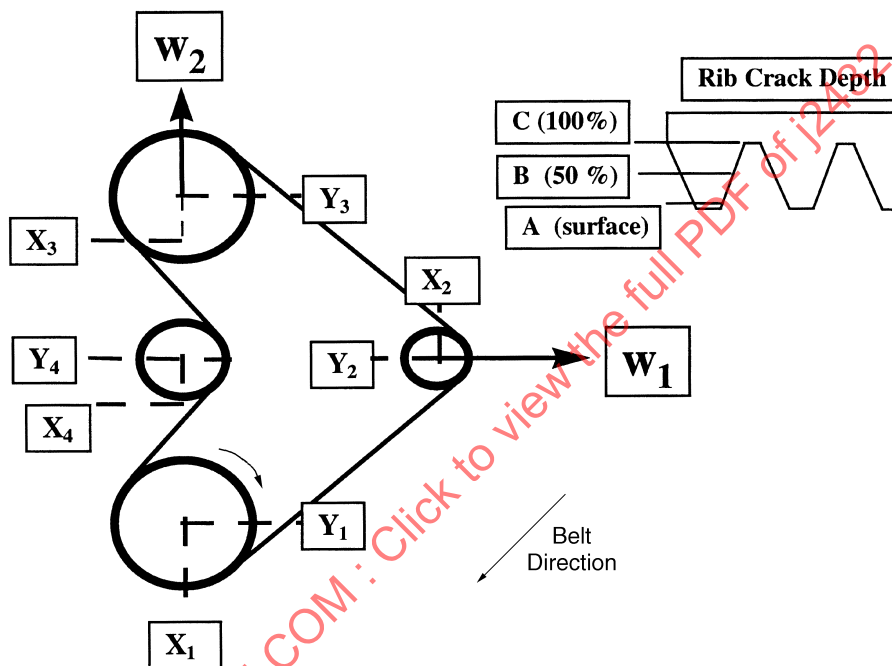


FIGURE 1—FOUR PULLEY DURABILITY TEST STAND CONFIGURATION

4.4 Test Fixture—The Four Pulley Hot Test stand is shown in Figure 1.

- 4.4.1 **TENSION**—The tension will be maintained either with a dead weight device or an automatic tensioner. If an automatic tensioner is used, the tension must be within $\pm 5\%$ at all times.
- 4.4.2 **MOTOR**—The life testing unit is driven by a motor sized to handle the sustained horsepower load plus system losses at the RPM indicated in 4.3.1. A torque recovery system may be used.
- 4.4.3 **POWER ABSORBER**—The driven pulley is to be attached to a power absorption unit capable of handling the torque indicated in 4.3.1.
- 4.4.4 **TEMPERATURE CONTROL**—The test stand should be mapped and proven to be capable of no more than ± 2 °C variation throughout the test area, statically. Test stand must have at least one thermocouple centered on the horizontal centerline of the small pulleys (pulleys 2 and 4), midway between the centers of these pulleys for test stand control. It is recommended that stands be recertified when modified or annually if no modifications are performed.

- 4.4.5 MISCELLANEOUS—A governor capable of stopping the driver motor is to be mounted on the driven pulley. Test stand pulley misalignment should be less than 0.5 degree.

4.5 **Test Load**—The Torque (Nm) to be absorbed at the driven pulley shall be as shown in Table 1.

TABLE 1—TEST CONDITIONS—METRIC

SAE Belt Size	Belt Type	Test Temp. °C	Diameter Over Balls (mm) (Idler Is Actual Diameter) Driver and Driven Pulleys ±0.25	Diameter Over Balls (mm) (Idler Is Actual Diameter) Tension Pulley ±0.25	Diameter Over Balls (mm) (Idler Is Actual Diameter) Idler Pulley OD ±0.25	Driver Pulley Speed rpm ±2%	Load (NM)	Number of Ribs	Belt Length Range (mm) Length	Belt Length Range (mm) Tolerance
PK	Type A	121	121.6	61	76.2	4900	20	6	1200	±10
PK	Type B	107	121.6	61	76.2	4900	20	6	1200	±10
PK	Type C	93	121.6	61	76.2	4900	20	6	1200	±10

- 4.5.1 TORQUE CALCULATION—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.

$$\text{Torque, NM} = \frac{\text{Specified Kilowatts} \times 9549}{\text{Driver rpm}} \quad (\text{Eq. 1})$$

4.6 Test Procedure

- 4.6.1 Remove any grease, rubber, or other foreign material from the pulley grooves.
- 4.6.2 Weigh belt and install the belt on the test fixture and apply the required belt tension. The belt tension must be maintained constant throughout the life of the test. Tension tolerance is ±5% for the constant tension test.
- 4.6.3 START THE MACHINE—Adjust the torque to the proper setting. Adjust the torque to the proper setting, based on belt type chosen. Temperatures should be properly monitored to maintain constant temperature and reduce test variability.
- 4.6.4 Adjust the driven pulley governor to stop the machine when the driven pulley speed has dropped 10% from the target speed.
- 4.6.5 Inspect belts daily (minimum), recording test hours, chamber temperature, and belt temperature. When belt is found to be failed, weigh belt and revert to last inspection for time to failure. Belts should be weighed upon completion of all testing. Belts should be tested to customers requirements.

4.7 High Temperature, Constant Tension, Test Performance Guidelines

- 4.7.1 FAILURE CRITERIA—A belt shall be considered failed when one or more of the following conditions occur:

- Belt breakage, (fracture of cord anywhere)
- Belt chunking, loss of rib stock anywhere
- Delamination of belt layers
- Belt fraying or tensile cord separation
- Maximum number of B or C level cracks = 8 (see Figure 1)
- Loss of belt traction capacity (10% slip)
- In-line crack across the belt cross section
- Weight loss in excess of 10% of original weight at end of test
- Pilling in excess of level 7 (see 9.6)

The belt manufacturer and user may agree on other acceptance/rejection criteria

5. Hot and Cold Cycling Test

5.1 Purpose—To test a belt's durability under high temperature, high load; and low temperature, no load conditions.

5.2 Belt Type Designation—Belt type designation for the Hot and Cold Cycling test is as follows:

5.2.1 HOT TEST

Type A_{hot} Belt: 121 °C

Type B_{hot} Belt: 107 °C

Type C_{hot} Belt: 93 °C

5.2.2 COLD TEST

Type A_{cold} Belt = -43 °C ± 1 °C

Type B_{cold} Belt = -35 °C ± 1 °C

5.3 Test Specification Summary

NOTE—The Hot and Cold Segments of this test use the same geometric configuration as shown in Figure 1.

5.3.1 EQUIPMENT PARAMETERS (HOT SEGMENT)

Driven Torque = 20 Nm ± 1 Nm

Belt Effective Length = 1200 mm ± 10 mm

Driver Speed = 4900 rpm ± 100 rpm

Number of Belt Ribs = 6

Grooved Pulley Diameters (across 2.50 mm gauge balls, all ±0.25 mm)

Driver (Pulley 1) = 121.6 mm

Driven (Pulley 3) = 121.6 mm

Idler (Pulley 2) = 61.0 mm

Backside Idler (Pulley 4) = 76.2 mm ± 0.25 mm

Test Chamber Temperature

Type A_{hot} Belt: 121 °C ± 2 °C

Type B_{hot} Belt: 107 °C ± 2 °C

Type C_{hot} Belt: 93 °C ± 2 °C

Belt Tension = 629 N ± 31 N

Belt Hubload:

Option 1: Belt Horizontal Hubload W_1 = 904 N ± 44 N

Option 2: Belt Vertical Hubload at W_2 = 655 N ± 33 N

5.3.2 EQUIPMENT PARAMETERS (COLD SEGMENT)

Driver Speed = 100 rpm ± 4 rpm

Belt Effective Length = 1200 mm ± 10 mm

Number of Belt Ribs = 6

Test Chamber Temperature

Type A_{cold} = -43 °C ± 1 °C

Type B_{cold} = -35 °C ± 1 °C

Belt Tension = 267 N ± 13 N

Belt Hubload:

Horizontal Hubload at $W_1 = 385 \text{ N} \pm 19 \text{ N}$
 Vertical Hubload at $W_2 = 378 \text{ N} \pm 19 \text{ N}$
 No Torque Reaction Load is to be Applied

5.4 Test Fixture Setup

5.4.1 HOT FIXTURE SETUP—The four pulley stand is shown in Figure 1.

5.4.1.1 *Tension*—The tension will be maintained either with a dead weight device or an automatic tensioner. If an automatic tensioner is used, the tension must be within $\pm 5\%$ at all times, or the test must be started over with a new belt.

5.4.1.2 *Power Absorber*—The driven pulley is to be attached to a power absorption unit capable of handling the power indicated previously.

5.4.1.3 *Motor*—The life testing unit is driven by a motor sized to handle the sustained horsepower load plus system losses at the RPM indicated previously. A torque recovery system may be used.

5.4.1.4 *Temperature Control*—The test stand should be mapped and proven to be capable of no more than $\pm 2^\circ \text{C}$ variation throughout the test area, statically. Test stand must have at least one thermocouple centered on the horizontal centerline of the small pulleys, midway between the centers of these pulleys for test stand control. It is recommended that stands be recertified when modified or annually if no modifications are performed.

5.4.1.5 *Miscellaneous*—A governor capable of stopping the driver motor is to be mounted on the driven pulley. Test stand pulley misalignment should be less than 0.5 degree.

5.4.2 COLD FIXTURE SETUP—The four pulley stand is shown in Figure 1.

5.4.2.1 *Tension*—The tension will be maintained either with a dead weight device or an automatic tensioner. If an automatic tensioner is used, the tension must be within $\pm 5\%$ at all times, or the test must be started over with a new belt.

5.4.2.2 *Temperature Control*—Thermocouples to be located at each of the 4 pulley interfaces. No greater than 2°C variation among these 4 thermocouples at the end of the presoak will be allowed to assure the minimization of thermal gradients.

5.4.2.3 *Motor*—The life testing unit is driven by a motor sized to handle system losses at the RPM indicated previously.

5.4.2.4 *Miscellaneous*—A governor capable of stopping the driver motor is to be mounted on the driven pulley. Belt misalignment should be less than 0.5 degree.

5.5 Test Procedure

5.5.1 HOT TEST PROCEDURE

5.5.1.1 Remove any grease, rubber, or other foreign material from the pulley grooves.

5.5.1.2 Weigh belt and install the belt on the test fixture and apply the required belt tension. The belt tension must be maintained constant throughout the life of the test. Tension tolerance is $\pm 5\%$ for the constant tension test.

5.5.1.3 Set and maintain the driver pulley at speed.

- 5.5.1.4 Set the torque on the fixture motor by adjusting the power absorption unit. 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.
- 5.5.1.5 Adjust the driven pulley governor to stop the machine when the driven pulley speed has dropped 10% from the target speed, and terminate the test, record as a failure.
- 5.5.1.6 Run for 48 h at the specified temperature and load condition.
- 5.5.1.7 Allow the belt to cool on the stand at ambient room temperature for 1/2 h. Note number of rib cracks if any and weigh belt. End test if failed.

5.5.2 COLD TEST PROCEDURE

- 5.5.2.1 Install the same belt on the cold chamber equipment.
 - 5.5.2.2 Pre-cool the belt and stand until the specified temperature is reached at the belt and pulley interface. After the belt and pulley interfaces reach the specified temperature, soak the belt a minimum of one additional hour.
 - 5.5.2.3 Run the driver pulley at 100 rpm for ten belt revolutions. 100 rpm must be achieved within 2 s.
 - 5.5.2.4 Soak belt for 25 min at the specified temperature after cycling.
 - 5.5.2.5 Rerun 5.5.2.3 through 5.5.2.4 nine times with the same belt and pulley at the specified temperature each time.
 - 5.5.2.6 Note the number of rib cracks if any and record. End test if failed.
- 5.5.3 Remove belt and rerun steps 5.5.1 (Hot Test Procedure) and 5.5.2 (Cold Test Procedure). It is recommended that belts be able to pass a minimum of 2 cycles.

NOTE—One cycle is equal to one Hot Test Procedure (5.5.1) and One Cold Test Procedure (5.5.2).

5.6 Hot and Cold Cycling Test Guidelines

- 5.6.1 FAILURE CRITERIA—A belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage, (fracture of cord anywhere)
- b. Belt chunking, loss of rib stock anywhere
- c. Delamination of belt layers
- d. Belt fraying or tensile cord separation
- e. Maximum number of B or C level cracks = 8 (see Figure 1)
- f. Loss of belt traction capacity (10% slip)
- g. In-line crack across the belt cross section
- h. Weight loss in excess of 10% of original weight
- i. Pilling in excess of 7 (see 9.6)

The belt manufacturer and user may agree on other acceptance/rejection criteria.

6. Contamination Test

6.1 Purpose—To determine the effect of underhood fluids on the accessory drive belt.

6.2 Test Specification Summary—Use the identical test equipment specified in Section 4.

6.3 Fluid Requirements—Fluids that should be considered for this test should be those that may be spilled on the belt in the underhood environment. These include but are not limited to the following:

- Antifreeze/Glycol
- Motor Oil
- P/S Fluid
- Brake Fluid
- Transmission Fluid
- Washer Fluid

The belt manufacturer and the user should specify which fluids to use, based on the application.

CAUTION—Extreme care should be taken to avoid potential hazards of bringing the hot belt into contact with any potentially volatile and/or flammable fluid.

6.4 Test Procedure

6.4.1 Remove any grease, rubber, or other foreign material from the pulley grooves.

6.4.2 Weigh belt and install the belt on the test fixture and apply the required belt tension. The belt tension must be maintained constant throughout the life of the test. Tension tolerance is $\pm 5\%$ for the constant tension test.

6.4.3 Start the machine. Adjust the torque to the proper setting. Adjust the temperature to the proper setting. Temperatures should be properly monitored to maintain constant temperature and reduce test variability. Test stand must maintain specified temperature within $\pm 2^\circ\text{C}$ throughout belt operating area.

6.4.4 Adjust the driven pulley governor to stop the machine when the driven pulley speed has dropped 10% from the target speed, and terminate the test, record as a failure.

6.4.5 Run belt for 48 h at the specified temperatures in Table 1.

6.4.6 Remove belt while hot, mark a 75 mm section on the side of the belt and dip the section of the belt in the underhood fluid agreed to by the supplier and OEM.

6.4.7 Hang belt for 5 min and then reinstall the belt on the stand in the same direction as when it was removed and restart the test as specified in steps 6.4.1 through 6.4.5.

6.4.8 Inspect belts daily (minimum), recording test hours, chamber temperature, and belt temperature. When belt is found to be failed, weigh belt and revert to last inspection for time to failure. Belts should be weighed upon completion of all testing. Belts should be tested to customers requirements.

6.5 Contamination Test Guidelines:

6.5.1 FAILURE CRITERIA—A belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage, (fracture of cord anywhere)
- b. Belt chunking, loss of rib stock anywhere
- c. Delamination of belt layers
- d. Belt fraying or tensile cord separation
- e. Maximum number of B or C level cracks = 8 (see Figure 1)
- f. Loss of belt traction capacity (10% slip)
- g. In-line crack across the belt cross section
- h. Weight loss in excess of 10% of original weight at end of test
- i. Pilling in excess of 7 (see 9.6)

The belt manufacturer and user may agree on other acceptance/rejection criteria

7. Five Pulley Flex Test

7.1 Purpose—To test the belt's flex durability under high-temperature, high-speed conditions.

7.2 Test Specification Summary—See Figure 2.

Belt Length = 1200 mm $\pm$ 10 mm
 Driver Speed (D_1) = 3300 rpm
 Optional Driver Speed (D_3) = 3900 rpm
 Belt Speed = 10.4 m/s
 Temperature = 100 °C to 130 °C
 Belt Width = 6 ribs
 Grooved Pulley Diameters (across 2.5 mm gauge balls, all $\pm$ 0.25 mm)
 D_1 = 60 mm
 D_3 = 50 mm
 D_4 = 50 mm
 Backside Idler Pulley (D_2 and D_5) = 50 mm
 Vertical Hubload = 800 N $\pm$ 40 N
 Belt Tension = 400 N $\pm$ 20 N

7.3 Test Fixture—The Five Pulley Flex stand is shown in Figure 2.

7.3.1 TENSION—The tension will be maintained with a dead weight device or equivalent.

7.3.2 TEMPERATURE CONTROL—The test stand should be mapped and proven to be capable of no more than ± 2 °C variation throughout the test area. Test stand must have at least one thermocouple for test stand control while running. The thermocouple shall be located on the vertical centerline, midway between the top pair of the grooved idler pulleys and the bottom pair of the backside idler pulleys. It is recommended that stands be recertified when modified or annually if no modifications are performed.

Pulley	DIA	X	Y	Description
1	60 DOB	0.0	0.0	Dead Weight/Driver
2	50 (Actual)	52.5	260.0	Idler Back Side
3	50 DOB	111.5	323.0	Optional Driver
4	50 DOB	-111.5	323.0	Idler
5	50 (Actual)	-52.5	260.0	Idler Back Side
F = 800 N		Belt Tension = 400.5 N		
Belt Effective Length = 1200 mm		Belt Speed = 10.4 m/sec		

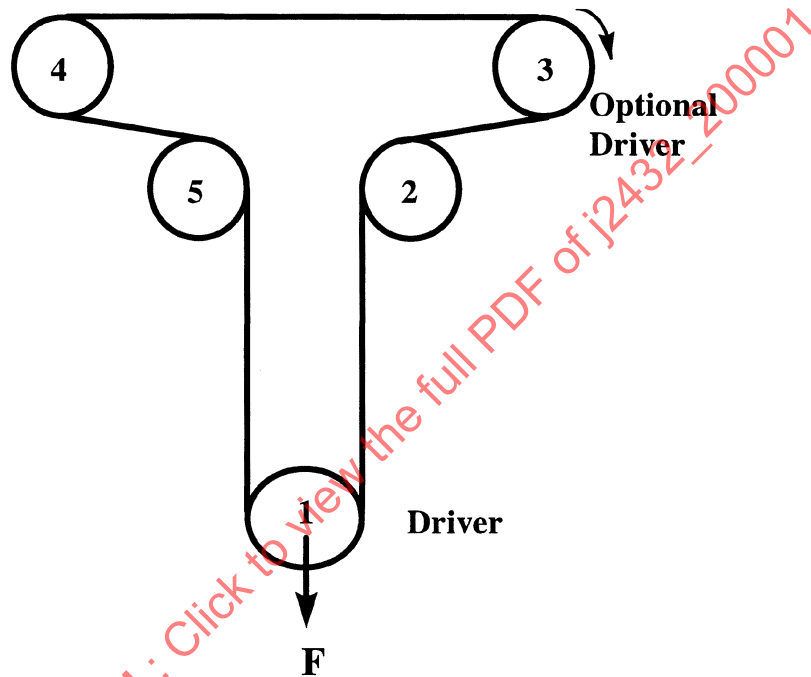


FIGURE 2—FIVE PULLEY FLEX TEST STAND CONFIGURATION

7.4 Test Procedure—Remove any grease, rubber, or other foreign material from the pulley grooves.

7.4.1 Set and maintain the temperature of the fixture box at 100 °C.

7.4.2 Weigh belt and install the belt on the test fixture noting the direction of installation. Set and maintain the driver pulley at speed.

7.4.3 After 50 h, stop the test and remove the belt.

7.4.4 Inspect and weigh the belt. If belt passes, repeat test with new belt and temperature in chamber increased by 5 °C

7.4.5 Repeat steps 7.4.2 through 7.4.5, increasing temperature by 5 °C until 130 °C is reached.

7.4.6 If belt passes 50 h at 130 °C, continue test until belt failure or agreed upon specified time with OEM.

7.5 Five Pulley Flex Test Guidelines

7.5.1 FAILURE CRITERIA—A belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage, (fracture of cord anywhere)
- b. Belt chunking, loss of rib stock anywhere
- c. Delamination of belt layers
- d. Belt fraying or tensile cord separation
- e. Maximum number of B or C level cracks = 8 (see Figure 1)
- f. In-line crack across the belt cross section
- g. Weight loss in excess of 10% of original weight at end of test
- h. Pilling in excess of level 7 (see 9.6)

The belt manufacturer and user may agree on other acceptance/rejection criteria

8. Stationary Oven Test

8.1 **Purpose**—The purpose of this test is to determine the influence of elevated temperatures on the physical properties of vulcanized rubber. Rubber and rubber products must resist the deterioration of physical properties with time caused by oxidative and thermal aging. This test is intended to confirm that the retention of physical properties of production belts is adequate.

8.2 Test Specification Summary

Test Specimen = Dumbbell Shape Per ASTM D 412

Test Time = 1012 h

Test Chamber Temperature = 121 °C ± 2 °C

8.3 Test Fixture

8.3.1 OVEN—Test apparatus and measurement equipment should conform to those described in ASTM D 573, Section 5.

8.3.2 STRESS/STRAIN TEST FIXTURE—Fixture should be designed such that equal forces are maintained on the test specimen.

8.3.3 COMPRESSION FIXTURE—Per ASTM D 575, Test Method A.

8.4 **Test Procedure**—Test procedure should conform to those described in ASTM D 573 with the following exceptions:

8.4.1 Build two 1200 mm length belt sleeves from two separate batches with the production process. For compression testing, build slab using the production process per ASTM D 575.

8.4.2 Cure sleeves with production process.

8.4.3 After curing the sleeves, separate the cord layer from the rib stock by slicing. Lightly buff both sides of the rib stock and throw away the cord layer.

8.4.4 Randomly cut 35 dumbbell size specimens with correct fiber orientation, from each sleeve of rib stock per ASTM D 412. Label the specimens such that their build batch can easily be identified. From the slab to be used for the compression test, cut specimens per ASTM D 575 and label the specimens such that their build batch can easily be identified.

- 8.4.5 Hang dumbbells in test chamber. Place compression specimens in same test chamber to insure equal exposure to the heated environment.
- 8.4.6 Set and maintain temperature to specified level.
- 8.4.7 The following characteristics should be measured on 5 randomly selected specimens from each batch at 0, 2, 4, 8, 16, 32 days and again at 1000 to 1012 h:
 - a. Durometer Hardness with a micro-hardness measurement.
 - b. Compression stress/strain per ASTM D 575, Test Method A. Provide a stress/strain curve.
 - c. Tensile Stress/Strain per ASTM D 412. Provide a Stress/Strain curve.
- 8.4.8 Do not return the tested specimens to the oven.

8.5 Heat Aging Test Guidelines

- 8.5.1 ACCEPTANCE CRITERIA—Data collection until acceptance criteria can be established for each characteristic.

9. Pilling Test

- 9.1 **Purpose**—The purpose of this test is to determine the belts resistance to pilling. Pilling results in the belt not seating correctly onto the pulley which could result in belt noise if severe enough. Since pilling is a phenomenon associated with new belts, this test will not need to be run on aged belts.

CAUTION—Since the pulleys are not coated, this test will not identify pilling caused by the interaction between the belt and pulley coating. Test should be repeated and run with production intent coated pulleys.

9.2 Test Specification Summary

9.2.1 EQUIPMENT PARAMETERS

Driver Pulley Speed = 700 rpm $\pm$ 14 rpm
 Torque Pulse Definition:
 Amplitude = $\pm$ 150 rpm ($\pm$ 7.5 rpm)
 Frequency = 32 Hz $\pm$ 2 Hz
 Wave Type: Sinusoidal
 Belt Effective Length = 1200 mm $\pm$ 10 mm
 Belt Width = 3 Ribs
 Grooved Pulley Diameter = 76.2 mm DOB
 Belt Hubload (F) = 667 N $\pm$ 33 N
 Pulley Coating = None
 Pulley Surface Finish = 3.2 μ m RA max
 Driven Inertia = 1.32×10^{-2} kg·m²

- 9.3 **Test Fixture**—The Pilling Test Stand Configuration is shown in Figure 3.

- 9.3.1 TENSION—The tension will be set using a dead weight, pneumatic cylinder, or equivalent, rotated 3 revolutions of the belts and then locked for testing.
- 9.3.2 TEST EQUIPMENT—The test equipment must be capable of controlling the stand speed as defined previously. Torque pulses must be monitored to show that they meet the previous requirements.
- 9.3.3 TEST CHAMBER—Ambient room temperature, 21 °C or as specified.

Pulley	DIA	X	Y	Description
1	76.2 DOB	0.0	0.0	Driver Pulley
2	76.2 DOB	456.4	0.0	Tensioner Pulley
Belt Length = 1200 mm			Belt Tension = 334 N	
			F = 668 N	
Torque Pulse Definition = ± 150 RPM @ 32 Hz				

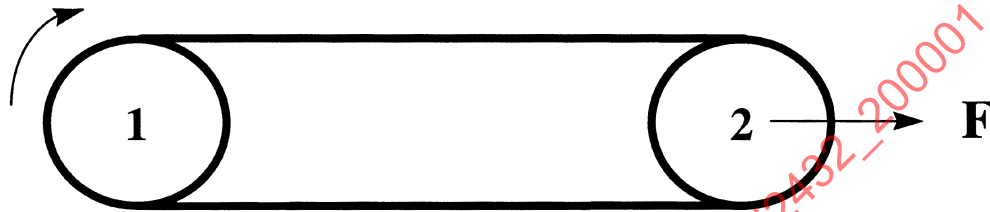


FIGURE 3—BELT PILLING TEST STAND CONFIGURATION

9.4 Test Procedure

- 9.4.1 Weigh belt to nearest gram. Belt should be weighed after soaking at 49 °C in a dry oven for 12 h.
- 9.4.2 Remove any grease, rubber, or other foreign materials from the pulley grooves.
- 9.4.3 Install belt on fixture and apply tension as specified in 9.3.1.
- 9.4.4 Run the belt for 20 min at the specified speed and torsional activities.
- 9.4.5 Stop the test and remove the belt from the stand.
- 9.4.6 Inspect the belt for signs of pilling. Record the pilling level as shown in 9.6.
- 9.4.7 Weigh the belt to the nearest gram. If the belt can not be weighed immediately, then belt should be weighed after soaking at 49 °C in a dry oven for 12 h.

9.5 Failure Criteria—After 20 min of testing, a belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage, (fracture of cord anywhere)
- b. Belt chunking, loss of rib stock anywhere
- c. Delamination of belt layers
- d. Belt fraying or tensile cord separation
- e. Maximum number of B or C level cracks = 8 (see Figure 1)
- f. In-line crack across the belt cross section
- g. Weight loss in excess of 10% of original weight at end of test
- h. Pilling in excess of level 7 (see 9.6)

The belt manufacturer and user may agree on other acceptance/rejection criteria

9.6 Pilling Rating—See Figure 4.

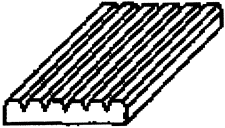
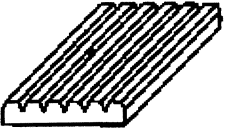
BELT PILLING RATING SCALE	
10 Clean 	9 Heavy dust Close to pilling 
8 One small Spot pill 	7 Widely scattered Spot pills, small in length and height 
6 Light pilling Numerous spots and longer spots 1/3 height of groove 	5 Larger spots 1/3 height of groove 
4 Medium Pilling Numerous longer spots 1/2 height of groove 	3 Almost continuous long spots 1/2 height of groove start of rib distortion 
2 Heavy pilling Filled grooves, rib distortion, strings of rubber may be in one area 	1 Extremely heavy pilling many areas of rib distortion, strings of rubber filled grooves 

FIGURE 4—BELT PILLING RATING SCALE

10. Dynamic Ozone Testing

10.1 Purpose—The purpose of this test is to determine the belts capability to resist ozone aging. Ozone can be a major contributor to rubber compound degradation which may result in belt cracking.

10.2 Test Specification Summary

Procedure = ASTM D 3395 - Method B
 Belt Length = 1200 mm $\pm$ 10 mm
 Test Chamber Temperature = 40 °C $\pm$ 2 °C
 Belt Width = 6 ribs
 Pulley Diameters = 63.5 mm
 Vertical Hubload = 178 N $\pm$ 9 N
 Standard Ozone Partial Pressure = 200 mPa $\pm$ 5 mPa
 Driver Pulley Speed = 62.5 rpm $\pm$ 3.0 rpm

10.3 Test Fixture—Test apparatus, measurement equipment, and ozone test chamber should conform to those described in ASTM D 3395, except entire belt to be installed rib side out, as shown in Figure 5.

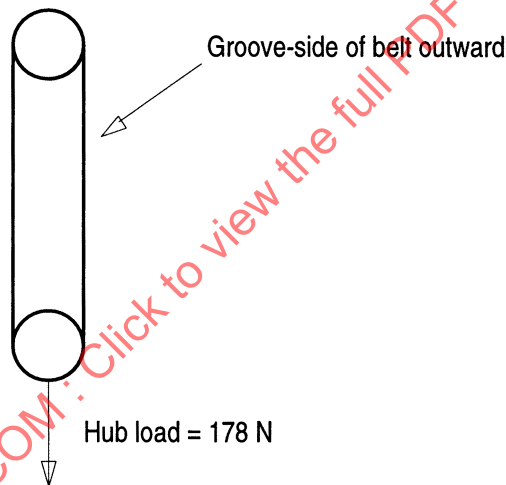


FIGURE 5—DYNAMIC OZONE TEST—BELT INSTALLATION

10.4 Test Procedure—Follow test procedure ASTM D 3395, Test Method B; except entire belt to be installed rib side out, as shown in Figure 5.

- 10.4.1 Set and stabilize the ozone partial pressure to 200 mPa.
- 10.4.2 Set and maintain chamber temperature as specified.
- 10.4.3 Start the belt and run at specified speed.
- 10.4.4 Inspect belt at 6 h, 24 h, and every 24 h thereafter until cracking is observed.
- 10.4.5 Record time of cracking and terminate test after 1st B/C level crack (Figure 1) has appeared. Terminate test after 150 h if no cracking has occurred.

10.5 Acceptance Criteria—Data acquisition only.

11. Belt Misalignment Noise Test

11.1 Purpose—The purpose of this test is to assess noise characteristics of the V-ribbed belt under various degrees of axial misalignment and environmental conditions.

11.2 Test Fixture—The Noise Test stand is shown in Figure 6.

Pulley	Pulley Material	DIA	X	Y	Description
1	303 Stainless Steel	101.0 DOB	0.0	0.0	Driver Pulley
2	303 Stainless Steel	61.0 DOB	-140.0	151.4	Adjustable Idler
3	Phenolic, Surface Finish = 0.8 μm RA Max	159.0 DOB	-301.0	0.0	Driven Pulley
4*	303 Stainless Steel	80.0 (Actual)	-155.0	20.0	Idler Pulley
Belt Effective Length = 1200 mm		Belt Tension = 267 N		T-Couple Location: X=-70.0, Y=72.5	

* Reference: Similar to Chrysler production pulley P/N 4536153

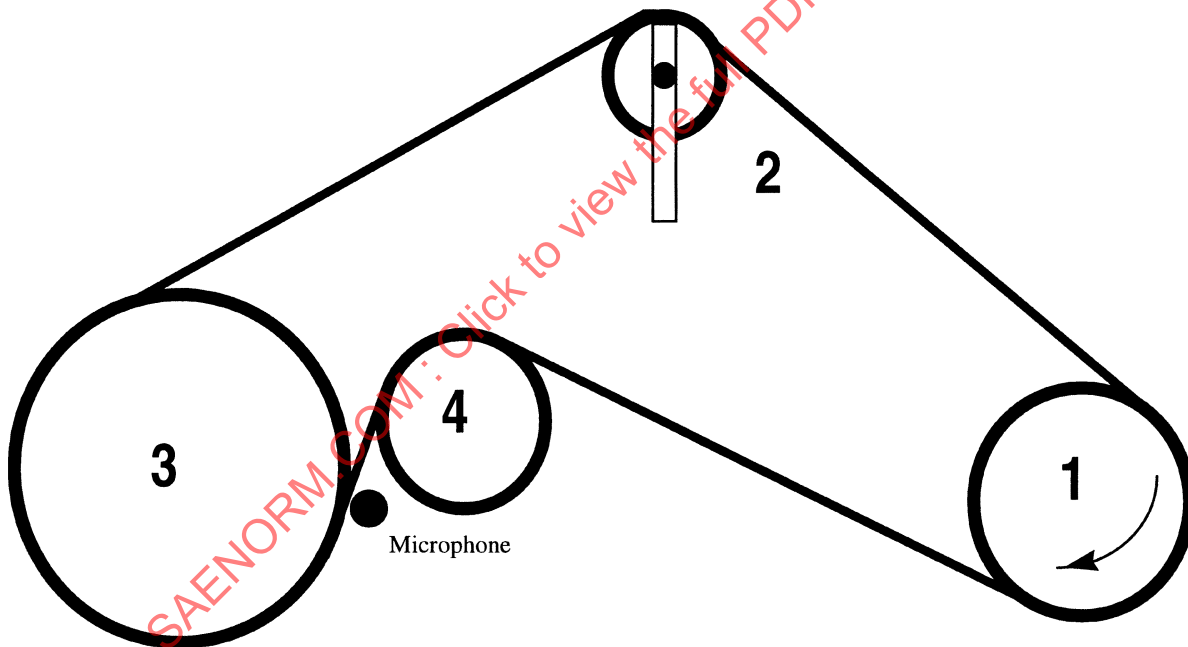


FIGURE 6—NOISE TEST STAND CONFIGURATION

11.2.1 TENSION—The tension will be maintained either with a dead weight device or an automatic tensioner. If an automatic tensioner is used, the tension must be within $\pm 5\%$ at all times.

11.2.2 TEMPERATURE CONTROL—The test stand should be mapped and proven to be capable of no more than $\pm 2^\circ\text{C}$ variation throughout the test area. Test stand must have at least one thermocouple for test stand control while running and shall be located as specified in Figure 6. It is recommended that stands be recertified when modified or annually if no modifications are performed

11.2.3 ADJUSTABLE PULLEY—The stand must be designed so that the adjustable pulley alignment can be changed up to and including ± 2.5 degrees while the stand is running.

11.3 Misalignment Noise Test Procedure—The noise test procedure will be run using the matrix shown in Table 2.

TABLE 2—NOISE TEST PROCEDURE MATRIX

Humidity	–5 °C	5 °C	15 °C	25 °C	35 °C	45 °C
50%		X	X	X	X	X
95% ± 5%		X	X	X	X	X

- 11.3.1 Set the stand and belt holding chamber temperature and humidity level to the Test Condition specified. For the –5 °C test point, it is difficult to control a specified humidity condition. For this reason, conduct testing at –5 °C temperature and the ambient humidity of the cold chamber.
- 11.3.2 Soak the belts on a belt rack in the holding chamber for 4 h prior to running the test.
- 11.3.3 Clean the pulleys with isopropyl alcohol or other nonresidue cleaner, before each test. Belts leave oils on the pulley surface which may have an effect on the noise test results.
- 11.3.4 Randomly select a belt, leaving the others in the holding chamber.
- 11.3.5 Install the belt on the noise test stand.
- 11.3.6 Set the offset of pulley 3, from the sheave line, so that $\tan^{-1}(\text{offset}/\text{span } 3-4) = 1.5$ degrees.
- 11.3.7 Run the test belt at 1700 rpm for 5 min at 1.5 degrees misalignment.
- 11.3.8 Reduce the speed to 750 rpm.
- 11.3.9 Measure the belt noise for 30 s with the microphone positioned 4 inches in front of, and aligned with, the entry span of the test pulley (see Figure 6). Record the maximum and average noise level (in dBA).
- 11.3.10 Remove the test belt from the stand and place back in the holding chamber.
- 11.3.11 Repeat steps 11.3.5 to 11.3.9 until all belts have been tested.
- 11.3.12 Repeat steps until each belt has been tested three times. Record the maximum and average noise level (in dBA).
- 11.3.13 Run belt for 24 h on the Hot test (4.4) and repeat noise test.
- 11.3.14 Repeat noise tests with individual belts that have run 100 h on the High Temperature, Constant Tension, Test (Section 4), 2 cycles of the Hot and Cold Cycling Test (Section 5), and 50 h of the Flex test at 121 °C (Section 7).
- 11.4 Acceptance Criteria**—Belts must not exhibit objectionable noise such as “chirp,” “pop,” “squeal,” etc., at specified test condition, new and aged at ±1.5 degrees misalignment.

12. Belt Torque Capacity Test

12.1 Purpose—To determine the torque carrying capacity of a K section V-Ribbed belt without damaging the belt.

12.2 Reporting Requirements—The information in Table 3 should be reported after testing:

TABLE 3—REPORTING REQUIREMENTS

	Groove Side Dry Minimum Peak Torque (Nm)	Groove Side Wet Minimum Peak Torque (Nm)	Backside Dry Minimum Peak Torque (Nm)
New Belt	Minimum Peak Torque (Nm)	Minimum Peak Torque (Nm)	Minimum Peak Torque (Nm)
Aged Belt (100 h at 107 °C, High Temperature Test, Section 4)	Minimum Peak Torque (Nm)	Minimum Peak Torque (Nm)	Minimum Peak Torque (Nm)

12.3 Testing Parameters

12.3.1 DRY RIBBED SIDE (FIGURE 7)

- Temperature: Ambient, 21 °C or as specified
- Belt Tension, Slack Side: 180 N applied at pulley 5
- Test Pulley Speed: 400 rpm
- Pulley Material: Stainless Steel (303 or 17-4PH - ASTM A 564 Type 630)
- Pulley Surface Finish: 0.8 µm RA maximum
- Load: Variable
- Pulley Wrap: 20 degrees

12.3.2 DRY BACK SIDE (FIGURE 7)

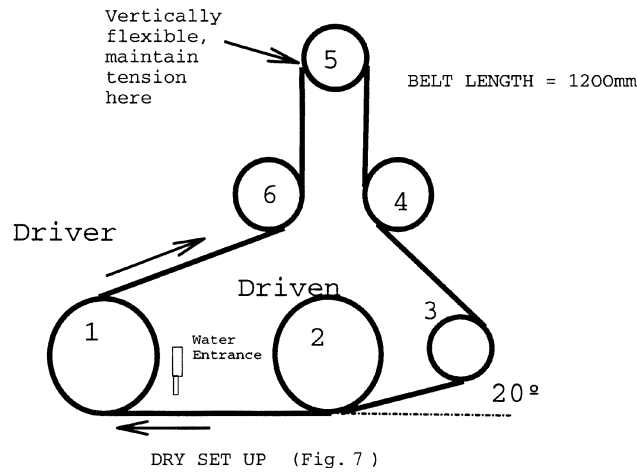
- Temperature: Ambient, or as specified
- Belt Tension, Slack Side: 180 N applied at pulley 5
- Test Pulley Speed: 400 rpm
- Pulley Material: Stainless Steel 303
- Pulley Surface Finish: 0.8 µm max.
- Load: Variable
- Initial Wrap: 20 degrees
- Pulley Profile: flat within 0.1 mm profile, no crown

12.3.3 WET RIBBED SIDE (FIGURE 7)

- Temperature: Ambient, or as specified
- Belt Tension, slack side: 180 N applied at pulley 5
- Test Pulley Speed: 800 rpm
- Pulley material: Stainless Steel 303
- Pulley Surface Finish: 0.8 µm RA maximum
- Load: Variable from 0 to 20 Nm
- Wrap: 45 degrees
- Water Flow onto Grooves: 300 mL/min

12.4 Test Fixture

- The test stand must be able to handle up to 40 Nm of driven and driver torque at 400 and 800 rpm.
- Must be able to increase torque at a rate of 0.5 Nm per second.
- Must take data at 40 samples per second (sample rate = 25 milliseconds)



Pulley	DOB or Actual*	Pitch Dia.	X (mm)	Y (mm)	Arc of Wrap (degrees)
RIBBED SIDE OF V-RIBBED BELT, DRY (Fig. 7)					
1	121.60	122.9 4	0.00	0.00	
2	121.60	122.9 4	200.00	0.00	20.0
3	77.0	78.34	314.00	17.80	
4	76.20*	78.28	300.61	160.00	
5	61.00	62.34	230.30	225.00	180.0
6	76.20*	78.28	160.00	160.00	

BACKSIDE OF V-RIBBED BELT, DRY (Fig. 7)					
1	120.86*	122.9 4	0.00	0.00	
2	120.86*	122.9 4	200.00	0.00	20.0
3	76.20*	63.08	314.00	17.80	
4	61.00	62.34	300.61	160.00	
5	76.20*	78.28	230.30	220.00	180.0
6	61.00	62.34	160.00	160.00	

Wrap angles are for a belt with $PB\Delta g = .67$, and $P\Delta b = 1.040$.

*Indicates a backside pulley, and the actual diameter.

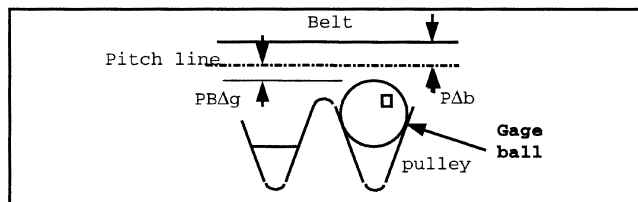


FIGURE 7—DRY SET UP