SURFACE VEHICLE RECOMMENDED PRACTICE

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Superseding J2432 NOV2012

Performance Testing of PK Section V-Ribbed Belts

RATIONALE

This latest revision of SAE J2432 accomplishes the following:

- Revised backside pulley sizes in durability tests to properly replicate real world failure modes.
- Increased belt dryout time in the noise test to accommodate all belt constructions.
- Revise cold temperature tolerance specification to align with the accuracy and calibration limits of the test equipment.

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. Belt construction definitions are also documented. 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 of V-ribbed belt constructions.

1.2 Test Sample Size

The number of test samples should be agreed between each Producer and User.

1.3 Test Conditions

Any variation or change in the test conditions outlined in this specification must be agreed between the Producer and User.

1.4 Belt Test Lengths

The test belt length is 1200 mm ± 10 mm. Test data from belts of this length will be considered valid for all belt lengths of the same construction and specification.

1.5 Definition of Construction Specification

The belt Producer's test data on belts of a certain construction shall be considered valid for evaluation of all belts, with respect to the Producer's cross section dimensions, material specifications, and method of manufacture.

1.6 Pulley Construction

Unless otherwise specified, all pulleys used on test fixtures should be machined steel pulleys.

1.7 Pulley Tolerances

Pulleys should be manufactured to SAE measurement pulley tolerances as shown in SAE J1459, except diameter over balls (DOB) tolerance must be held to ±0.1mm and the groove angles must be held to ±0.5 degrees.

1.8 Definitions

1.8.1 Profiled (Cut/Ground) Belts

a. Rib layer - Outer layer of belt typically in contact with pulley grooves. The rib layer consists of rubber mixed with fiber. Ribs may be on one side or both sides of the belt. The rib layer provides the friction to carry the load between the accessory and the belt.

b. Adhesion layer(s) - Interior layer(s) of material between the cord and adjacent layers. Its purpose is to provide a bond between individual cords, the cord layer, and adjacent layers. It can be on one side of the cord, both sides of the cord, or not present at all.

c. Cord layer - Interior layer consisting of individual strands of yarn that carry the tensile load on the belt. The cord layer defines the tensile modulus of the belt.

d. Back layer - Outer layer of belt material opposite of the rib layer. The back layer has no rib profile. The purpose of the back layer is to provide a running surface for routing pulleys and may also provide friction to carry the load between flat pulleys and the belt. The back layer also provides support for the cord layer.

e. Fabric layer - Optional internal or external to the back layer of the belt. Typically used to provide support for the cord layer.

1.8.2 Molded Belts - otherwise same as profiled belts with the exception of:

a. Rib layer - Outer layer of belt material typically in contact with the pulley grooves. For molded belts, the rib layer consists of a fiber free rubber rib cross section with a surface layer for noise abatement. The surface layer can be a fabric sheet, glued on flock, a polymer sheet, a cellulose sheet, rubber, or potentially other treatments.

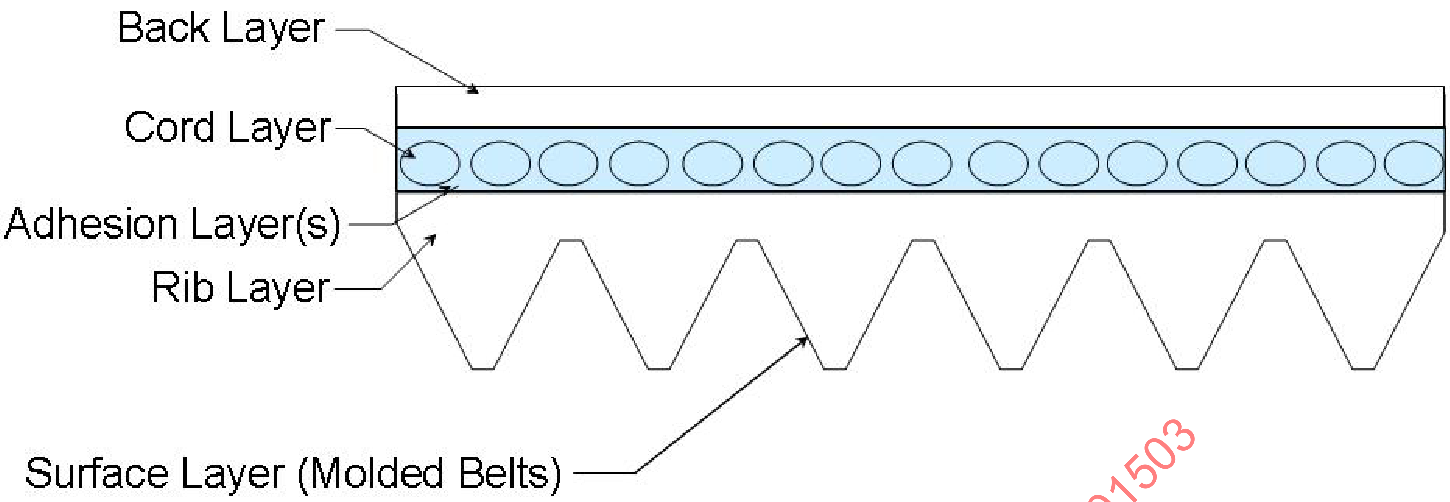


Figure 1 - Belt cross-section

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply. Specification SAE J2432 shall prevail in the event of any conflict relative to belt testing between the publications below and Specification SAE J2432.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1459 V-Ribbed Belts and Pulleys

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

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 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

ASTM D 4485 Standard Specification for Performance of Engine Oils

3. HIGH TEMPERATURE, CONSTANT TENSION TEST

3.1 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.

NOTE: This test can be run in conjunction with 9) Noise Test. Interruptions for inspections or noise testing are allowed.

3.2 Test Configuration

See Figure 2.

3.2.1 Test Parameters

Driven Torque = 20 Nm ± 1 Nm
Belt Effective Length = 1200 mm ± 10 mm
Steady State Driver Speed = 4900 rpm, within ± 100 rpm
Number of Belt Ribs = 6
Operating Belt Tension (around pulley 2) = 629 N ± 31 N
Belt load setup, as per Figure 2:
Option 1: Belt loaded at W_1 (reference) = 923 N ± 5%, as needed to obtain proper operating belt tension
Option 2: Belt loaded at W_2 (reference) = 713 N ± 5%, as needed to obtain proper operating belt tension

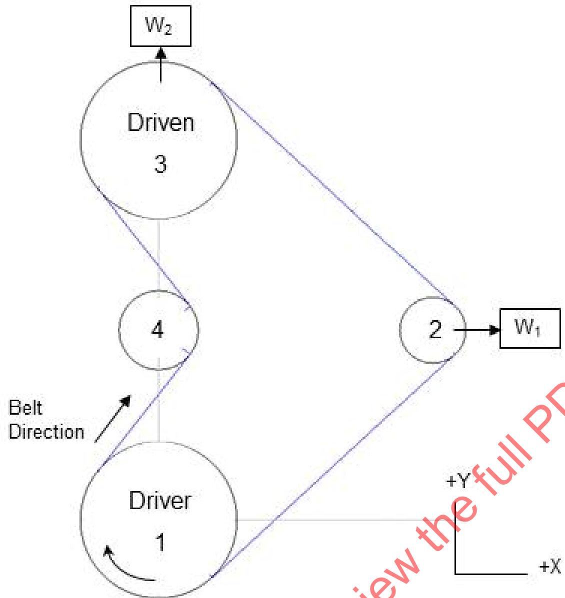
3.2.2 Test Chamber Temperature

121 °C ± 5 °C

3.3 Test Stand

The Four Pulley Hot Test stand is shown in Figure 2.

Pulley	DIA(mm)	X	Y	Notes:
1	121.6 DOB	0.0	0.0	Driver Pulley
2 [W_1]	50.0 DOB	200.0 (~215.5)	150.5	Idler Pulley (x-coordinate ~215.5 if tension at [W_1]
3 [W_2]	121.6 DOB	0.0	301.0 (~315.0)	Driven Pulley (y-coordinate ~315.0 if tension at [W_2]
4	60.0	0.0	150.5	Back side Idler
Effective Belt Length = 1200mm. All pulleys groove side except pulley 4				



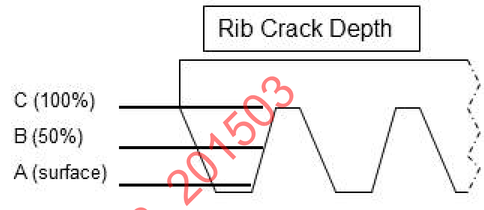


Figure 2 - High temperature, constant tension test layout

3.3.1 Tension

Constant tension will be maintained with a dead weight device or equivalent. The operating belt tension (steady state, loaded, dynamic) should be obtained at either span around pulley 2, having applied the 20Nm of torque at pulley 3 and the recommended load at either W1 or W2. The static tension may be measured on the belt, with the stand at rest, noting however that it will be a different value depending on the chosen loading option (W1 vs. W2).

3.3.2 Motor

The test stand is driven by a motor sized to handle a minimum of the sustained torque applied to the driven pulley plus system losses at the RPM indicated in 3.2.1.

3.3.3 Power Absorber

The driven pulley is to be attached to a power absorption unit capable of handling the torque indicated in 3.2.1.

3.3.4 Temperature Control

The test stand temperature should be mapped with a running belt, over a 2 h period, and proven to be capable of no more than ±5°C variation throughout the test area. The test stand must have at least five thermocouples; one near each of the four pulleys, and one in the center of the drive layout. It is recommended that stands be recertified when modified or annually if no modifications are performed.

3.3.5 Miscellaneous

A control capable of shutting down the test under specified conditions is required. The test stand belt alignment entry angle should be less than 0.5 degrees at each grooved pulley.

3.4 Test Description

3.4.1 Prior to start of test, remove any grease, rubber, or other foreign material from the pulley grooves.

3.4.2 Weigh the belt and install the belt on the test fixture. Apply the required belt tension. The belt tension must be constant throughout the test.

3.4.3 Start the machine. Adjust the torque to the proper setting. Temperatures should be properly monitored to maintain constant temperature. Set the test stand control to stop the machine if the temperature goes outside of the specified tolerance. Use the thermocouple in the center of the drive layout for temperature monitoring.

3.4.4 Set the test stand control to stop the machine if the driven pulley speed has dropped 4% from the target driver pulley speed.

3.4.5 Inspect belts daily (minimum), recording test h, chamber temperature and belt temperature. Note any evidence of edge cord pop out, pilling, and belt cracks. When belt is found to be failed (see 3.5.1), weigh the belt and revert to the last inspection for time to failure. Belts should be weighed upon completion of all testing. Belt weights should be taken when the belt reaches ambient temperature.

3.5 High Temperature, Constant Tension Test Performance Guidelines

3.5.1 Failure Criteria

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

a. Belt breakage, (fracture of cord)

b. Belt chunking, loss of rib stock

c. Delamination of belt layers

d. Belt fraying or tensile cord separation (edge cord popout – in 2 places, 25mm long)

e. Maximum number of B or C level cracks = 8 (see Figure 2)

f. Loss of belt traction capacity (4% slip)

g. In-line crack across the belt rib cross section

h. Weight loss in excess of 10% of original weight at end of test

i. Pilling rating "high" (see 7.6 for definition)

3.5.2 Acceptance Criteria

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

4. HOT AND COLD CYCLING TEST

4.1 Purpose

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

4.2 Test Specification Summary

NOTE: The Hot and Cold Segments of this test use the same geometric configuration as shown in Figure 2.

4.2.1 Test Parameters (Hot Segment)

Driven Torque = 20 Nm ± 1 Nm
Temperature = 121 ± 5 °C
Belt Effective Length = 1200 mm ± 10 mm
Steady State Driver Speed = 4900 rpm, within ± 100 rpm
Number of Belt Ribs = 6
Operating Belt Tension (around pulley 2) = 629 N ± 31 N
Belt load setup, as per Figure 2:
Option 1: Belt loaded at W_1 (reference) = 923 N ± 5%, as needed to obtain proper operating belt tension
Option 2: Belt loaded at W_2 (reference) = 713 N ± 5%, as needed to obtain proper operating belt tension

4.2.2 Test Parameters (Cold Segment)

Driven Torque = no torque reaction load is to be applied
Temperature = -40°C +0°C / -5°C Belt Effective Length = 1200 mm ± 10 mm
Driver Speed = 1500 rpm, within ± 30 rpm
Number of Belt Ribs = 6
Belt Tension = 267 N ± 13 N
Belt Hubload setup, per Figure 2:
Option 1: Belt loaded at W_1 (reference) = 392 N ± 5%, as needed to obtain proper operating belt tension
Option 2: Belt loaded at W_2 (reference) = 417 N ± 5%, as needed to obtain proper operating belt tension

4.3 Test Fixture Setup

4.3.1 Hot Fixture Setup

The four pulley stand is shown in Figure 2.

4.3.1.1 Tension

Constant tension will be maintained with a dead weight device or equivalent. For the Hot Segment, the operating belt tension (steady state, loaded, dynamic) should be obtained at either span around pulley 2, having applied the 20Nm of torque at pulley 3 and the recommended load at either W1 or W2. The static tension may be measured on the belt, with the stand at rest, noting however that it will be a different value depending on the chosen loading option (W1 vs. W2).

4.3.1.2 Motor

The test stand is driven by a motor sized to handle a minimum of the sustained torque applied to the driven pulley plus system losses at the RPM indicated in 4.2.1.

4.3.1.3 Power Absorber

The driven pulley is to be attached to a power absorption unit capable of handling the torque indicated in 4.2.1.

4.3.1.4 Temperature Control

The test stand temperature should be mapped with a running belt, over a 2 h period, and proven to be capable of no more than ±5 °C variation throughout the test area. The test stand must have at least five thermocouples; one near each of the four pulleys, and one in the center of the drive layout. Use a thermocouple in the center of the drive layout for temperature monitoring. It is recommended that stands be recertified when modified or annually if no modifications are performed.

4.3.1.5 Miscellaneous

A control capable of shutting down the test under specified conditions is required. Test stand belt alignment entry angle should be less than 0.5 degrees at each grooved pulley.

4.3.2 Cold Fixture Setup

The four pulley stand is shown in Figure 2.

4.3.2.1 Tension

The tension will be maintained with a dead weight device or equivalent. For the Cold Segment, since no torque is applied at any pulley during the test, a static tension measurement is acceptable.

4.3.2.2 Motor

The test stand is driven by a motor capable of meeting RPM requirements indicated in 4.2.2.

4.3.2.3 Miscellaneous

A control capable of shutting down the test under specified conditions is required. The test stand belt entry angle should be less than 0.5 degrees at each grooved pulley.

4.4 Test Procedure

4.4.1 Hot Test Procedure

4.4.1.1 Prior to start of test, remove any grease, rubber, or other foreign material from the pulley grooves.

4.4.1.2 Weigh the belt and install the belt on the test fixture. Apply the required belt tension. The belt tension must be constant throughout the life of the test.

4.4.1.3 Set the driver pulley to the specified speed.

4.4.1.4 Adjust the torque to the proper setting. Temperature should be properly monitored to maintain constant temperature and reduce test variability. Set the test stand control to stop the machine if the temperature goes outside of the specified tolerance. Use the thermocouple in the center of the drive layout for temperature monitoring.

4.4.1.5 Set the test stand control to stop the machine if the driven pulley speed has dropped 4% from the target driver pulley speed.

4.4.1.6 Run for 20 h at the specified temperature and load condition. Inspect belts, recording test h, chamber temperature and belt temperature. Note any evidence of edge cord pop out, pilling, and belt cracks.

4.4.1.7 Allow the belt to cool on the stand until it reaches ambient room temperature. Weigh the belt. When the belt is found to be failed (see 4.5.1), identify the cycle during which the failure occurred.

4.4.2 Cold Test Procedure

4.4.2.1 Install the same belt on the cold chamber equipment.

4.4.2.2 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 h.

4.4.2.3 Run the driver pulley at 1500 rpm for 10 s. 1500 rpm must be achieved in 1 s. Stop driver pulley.

4.4.2.4 Resoak the belt until belt temperature stabilizes.

4.4.2.5 Rerun 4.4.2.3 through 4.4.2.4 nine times with the same belt and pulley at the specified temperature each time.

4.4.2.6 Note any evidence of edge cord pop out, pilling, and belt cracks. End test if failed (see 4.5.1).

4.4.3 Remove belt and rerun steps 4.4.1 (Hot Test Procedure) and 4.4.2 (Cold Test Procedure) until belt failure (see 4.5.1).

NOTE: One cycle is equal to one Hot Test Procedure (4.4.1) and One Cold Test Procedure (4.4.2).

4.5 Hot and Cold Cycling Test Performance Guidelines

4.5.1 Failure Criteria

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

a. Belt breakage, (fracture of cord)

b. Belt chunking, loss of rib stock

c. Delamination of belt layers

d. Belt fraying or tensile cord separation (edge cord popout – in 2 places, 25mm long)

e. Maximum number of B or C level cracks = 8 (see Figure 2)

f. Loss of belt traction capacity (4% slip)

g. In-line crack across the belt rib cross section

h. Weight loss in excess of 10% of original weight at end of test

i. Pilling rating "high" (see 7.6 for definition)

4.5.2 Acceptance Criteria

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

5. CONTAMINATION TEST

5.1 Purpose

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

5.2 Test Specification Summary

Use the identical test equipment specified in Figure 2. Use the identical test parameters as shown in section 3.2.1

5.3 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.

* For motor oil, it is recommended to use ASTM Service Oil 105. This oil has been established as an aggressive oil toward rubber components by the SAE Committee on Automotive Rubber Specifications (CARS). It is also recommended to use an OEM specified full synthetic motor oil, such as Mobil 1® SAE 5W-30.

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.

5.4 Test Procedure

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

5.4.2 Weigh the belt and install the belt on the test fixture. Apply the required belt tension. The tension will be maintained with a dead weight device or equivalent. Tension should be measured at either span around pulley 2.

5.4.3 Start the machine. Adjust the torque to the proper setting. Temperatures should be properly monitored to maintain constant temperature. Set the test stand control to stop the machine if the temperature goes outside of the specified tolerance. Use the thermocouple in the center of the drive layout for temperature monitoring.

5.4.4 Set the test stand control to stop the machine if the driven pulley speed has dropped 4% from the target driven pulley speed and terminate the test, record as a failure.

5.4.5 Run the belt for 48 h at the specified temperature in 3.2.2.

5.4.6 Remove the 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.

5.4.7 Hang the belt for 5 min and then reinstall the belt on the stand in the same direction as it was removed. Restart the test as specified in steps 5.4.1 through 5.4.4. Run until failure.

5.4.8 Inspect belts daily (minimum), recording test h, chamber temperature, and belt temperature. Note any evidence of edge cord pop out, pilling, and belt cracks. When the belt is found to be failed, weigh the belt and revert to the last inspection for time to failure. Belts should be weighed upon completion of all testing. Belt weights should be taken when the belt reaches ambient temperature.

5.5 Contamination Test Guidelines:

5.5.1 Failure Criteria

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

a. Belt breakage, (fracture of cord)

b. Belt chunking, loss of rib stock

c. Delamination of belt layers

d. Belt fraying or tensile cord separation (edge cord popout – in 2 places, 25mm long)

e. Maximum number of B or C level cracks = 8 (see Figure 2)

f. Loss of belt traction capacity (4% slip)

g. In-line crack across the belt rib cross section

h. Weight loss in excess of 10% of original weight at end of test

i. Pilling rating "high" (see 7.6 for definition)

5.5.2 Acceptance Criteria

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

6. STATIONARY OVEN TEST

6.1 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 the rubber is adequate.

6.2 Test Specification Summary

Test Specimen = Dumbbell Shape Per ASTM D 412
Test Time = 1000 h
Test Chamber Temperature = 150 ± 2 °C

6.3 Test Fixture

6.3.1 Oven

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

6.3.2 Stress/Strain Test Fixture

Fixture should be designed such that equal forces are maintained on the test specimen.

6.3.3 Compression Fixture

Per ASTM D 575, Test Method A.

6.4 Test Procedure

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

Mix and cure samples of rib material, adhesion material, backside material, etc. (each unique rubber compound within the belt construction). Do not include any fiber in the test samples. Test each unique rubber compound individually.

6.4.1 Randomly cut dumbbell size specimens per ASTM D 412. For the compression test, cut specimens per ASTM D 575.

6.4.2 Hang dumbbells in test chamber. Place compression specimens in same test chamber to ensure equal exposure to the heated environment.

6.4.3 Set and maintain temperature to specified level.

6.4.4 The following characteristics should be measured on at least 3 specimens at each of the following intervals: 0 h, 500 h, and end of test (1000 h).

a. Durometer Hardness (Shore A) .

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.

d. Retention of elongation per ASTM D 412, Die C.

6.4.5 Do not return the tested specimens to the oven.

6.4.6 Data Reporting

a. Comparison data at 0 h, 500 h, 1000 h inspection intervals.

6.4.7 Acceptance Criteria

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

7. PILLING TEST

7.1 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 test pulleys are not coated, this test will not identify pilling caused by the interaction between the belt and pulley coating.

7.2 Test Specification Summary

7.2.1 Equipment Parameters

Driver Pulley Speed = 700 rpm ± 14 rpm
Amplitude = ±150 rpm (±7.5 rpm). Adjust if necessary to meet Driven Pulley Amplitude requirement.
Frequency = 32 Hz ± 2 Hz
Wave Type: Sinusoidal
Driven Pulley Amplitude = ±65 RPM minimum
Temperature = Ambient room temperature, 21 °C (±5°C) or as specified.
Belt Effective Length = 1200 mm ± 10 mm
Belt = 3 Ribs, polyester cord
Grooved Pulley Diameter = 76.2 mm DOB
Belt Hubload (F) = 668 N ± 33 N, increase if macro slip is detected on the driven pulley during the test.
Pulley Coating = None
Pulley Surface Finish = 3.2 µm RA max
Driven Inertia = 1.32 x 10^{-2} kg·m^2

7.3 Test Fixture

The Pilling Test Stand Configuration is shown in Figure 3.

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

7.3.1 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.

7.3.2 Test Equipment

The test equipment must be capable of controlling the stand speed as defined previously. Driver pulley angular vibration and driven pulley angular vibration must be measured to show that they meet the requirements shown in 7.2.1 at the start and end of the test. If test conditions at the end of the test fail to meet the requirements shown in 7.2.1, then the test must be re run with new samples.

7.4 Test Procedure

7.4.1 Weigh the belt to the nearest 0.1 g. Belt weights should be taken when the belt is at ambient temperature.

7.4.2 Remove any grease, rubber, or other foreign materials from the pulley grooves.

7.4.3 Install the belt on the fixture and apply tension as specified in 7.3.1.

7.4.4 Run the belt for 20 min at the specified speed and torsional activities.

7.4.5 Stop the test and remove the belt from the stand.

7.4.6 Inspect the belt for signs of pilling. Record the pilling level as specified in 7.6.

7.4.7 Weigh the belt to the nearest 0.1 g. The belt should be weighed after temperature stabilization.

7.5 Pilling 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)

b. Belt chunking, loss of rib stock

c. Delamination of belt layers

d. Belt fraying or tensile cord separation (edge cord popout – in 2 places, 25mm long)

e. Maximum number of B or C level cracks = 8 (see Figure 2)

f. In-line crack across the belt rib cross section

g. Weight loss in excess of 10% of original weight at end of test

h. Pilling rating "high" (see 7.6 for definition)

7.5.2 Acceptance Criteria

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

7.6 Pilling Rating

a. Low – clean to evidence of buildup in one or more ribs. Insignificant height.

b. Medium – Significant evidence of buildup in one or more ribs, approximately 1/3 height of rib. Not enough buildup to displace the belt when it contacts the pulley.

c. High – Significant, measureable buildup in one or more ribs, over ½ the height of the rib. Displaces belt when it contacts the pulley. Potential cause of noise.

NOTE: Acceptable length and coverage of pilling is to be agreed on by the Producer and User.

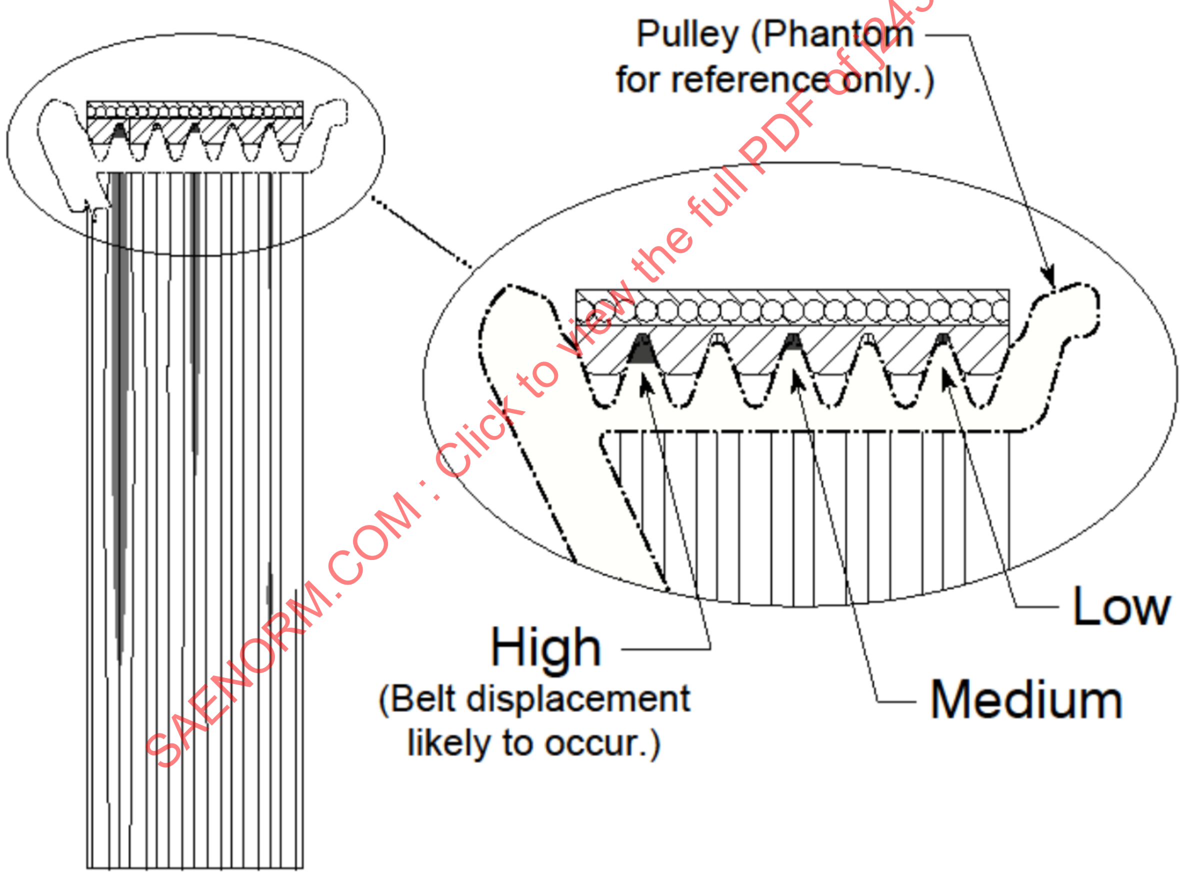


FIGURE 4

8. DYNAMIC OZONE TESTING

8.1 Purpose

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

8.2 Test Specification Summary

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

NOTE: Dynamic Ozone Testing is considered optional for EPDM based belts.

8.3 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.

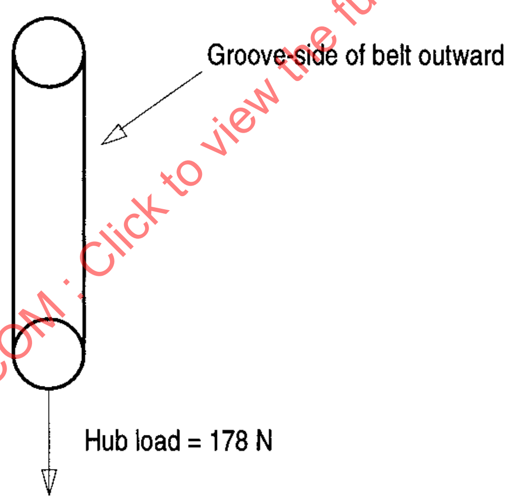


Figure 5 - Dynamic ozone test - belt installation

8.4 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.

8.4.1 Set and stabilize the ozone partial pressure to 200 mPa.

8.4.2 Set and maintain chamber temperature as specified.

8.4.3 Start the belt and run at specified speed.

8.4.4 Inspect belt at 6 h, 24 h, and every 24 h thereafter until cracking is observed.

8.4.5 Record time of cracking and terminate test after 1st B/C level crack (Figure 2) has appeared. Terminate test after 150 h if no cracking has occurred.

8.5 Acceptance Criteria

Data acquisition only.

9. BELT MISALIGNMENT NOISE TEST

9.1 Purpose

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

9.2 Test Fixture

The Noise Test stand is shown in Figure 6.

Pulley	Pulley Material	Diam (mm)	X	Y	Description
1	303 Stainless Steel	101 DOB	0	0	Driver Pulley
2	303 Stainless Steel	61 DOB	-140	239	Tension Pulley
3	303 Stainless Steel	140 DOB	-300	0	Adjustable Pulley
4	303 Stainless Steel	50 actual	-240	-82.3	Idler Pulley, No Free Rock

Belt Effective Length = 1200mm	Belt Tension = 267 N

All X,Y dimensions approximate
Minimum Wrap on Pulley 4 = 25 degrees
Belt Span Length, Pulleys 3-4 = 90mm +/- 2mm
Mist Nozzle 50mm above groove side of belt

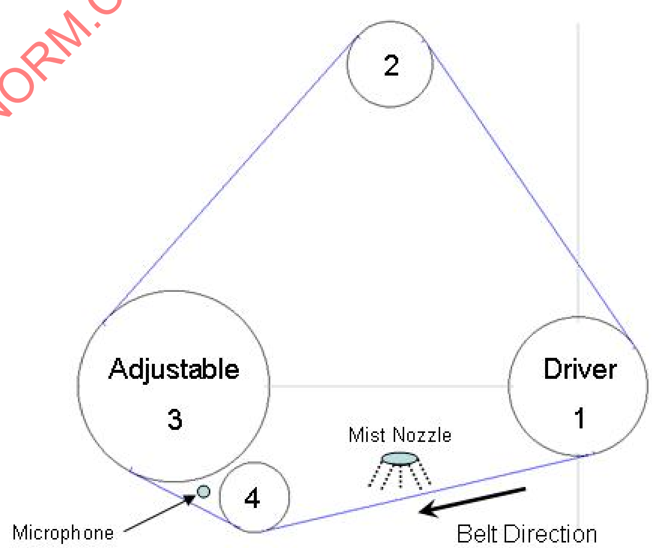


Figure 6 - Noise test stand configuration

9.2.1 Equipment Parameters

Tension: 267N ±13N

Driver Pulley Speed: 1000 RPM ±100RPM sinusoidal input, 33.33 hz (2nd order)

Water Misting Air Pressure (Water Mist test point only): 0.8 bar

Water Misting Flow Rate (Water Mist test point only): 20ml/min

Water Misting Water Temperature (Water Mist test point only) (reference): Cold tap water

Water Misting Nozzle Specifications: Pressure fed, external mist flat fan spray nozzle, siphon type. Spray angle = 45 degrees @1.5 bar. Air capacity: 40l/min @35bar air pressure. Liquid capacity: 1.36l/hr @35bar air pressure. Spray pattern distance 0.9 m max @0.35 bar air pressure.

9.2.2 Tension

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

9.2.3 Temperature Control

The test stand temperature should be mapped and proven to be capable of no more than ±5 °C variation throughout the test area. Test stand must have at least one thermocouple for test stand control while running. It is recommended that stands be recertified when modified or annually if no modifications are performed.

9.2.4 Adjustable Pulley (Pulley #3)

The stand must be designed so that the adjustable pulley alignment can be changed up to at least ±3.0 degrees. Axial misalignment is defined as the misalignment angle in the span between pulleys 4 and 3.

9.2.5 Idler Pulley (Pulley #4)

Idler pulley #4 must be designed to have zero bearing free rock for proper control of belt entry angle.

9.2.6 Water Misting Test Point (reference)

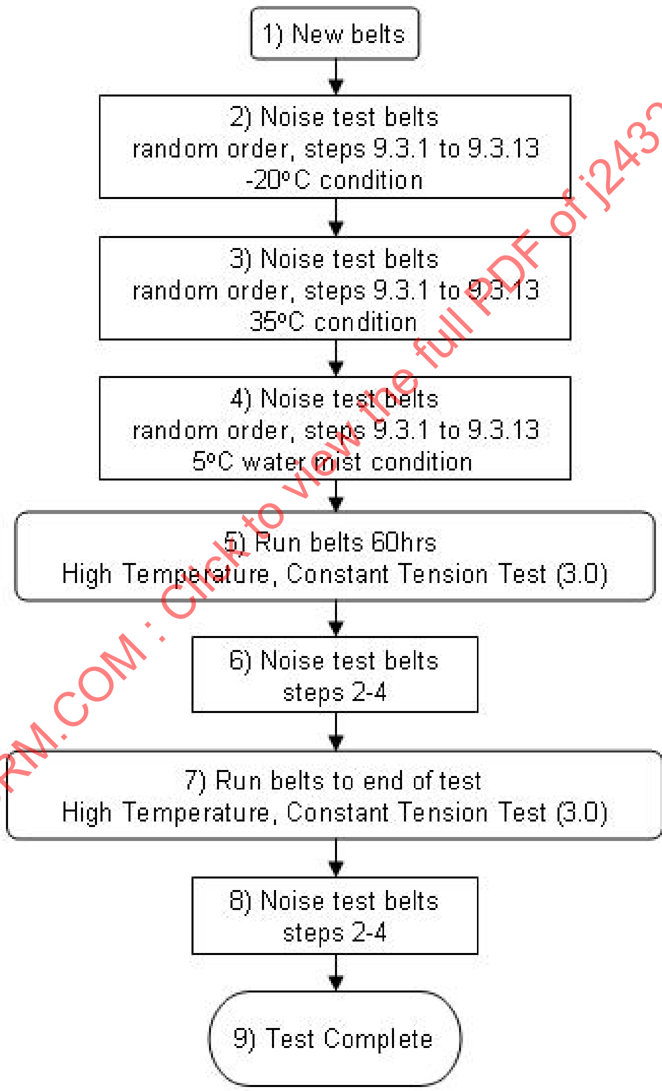
Water for Water Misting test point must be clean filtered cold tap water.

9.3 Misalignment Noise Test Procedure

The noise test procedure will be run using the matrix shown in Table 1.

Table 1 - Noise test procedure matrix

Temperature	–20 °C	5 °C	35 °C
Humidity	N/A	Water Mist	90% ±10%
Belt Run Time	10 s	Run dry for 10 s, apply mist for 10 s, stop mist and continue to run until belt dryout is complete*	10 s
Belt Condition	New, 60hr (High Temperature, Constant Tension Test), End of Test (High Temperature, Constant Tension Test)	New, 60hr (High Temperature, Constant Tension Test), End of Test (High Temperature, Constant Tension Test)	New, 60hr (High Temperature, Constant Tension Test), End of Test (High Temperature, Constant Tension Test)



*NOTE: Dryout time during the 5 °C water mist phase will vary based on the belt construction. Dryout may take up to 10 minues for some constructions.

9.3.1 Set the test stand and belt holding chamber temperature and humidity level to the Test Condition specified. For the –20 °C test point, it is difficult to control a specified humidity condition. For this reason, conduct testing at –20 °C temperature and the ambient humidity of the cold chamber. It is recommended to study soak times by thermocoupling the adjustable pulley.

9.3.2 Belt misalignment will be controlled by adjusting the offset of pulley 3, from the sheave line, so that $\tan^{-1}$ (offset/span 3-4) = desired belt misalignment angle in degrees.

9.3.3 Soak the belts on a belt rack in the holding chamber prior to running the test. Belt temperature and humidity exposure must be stabilized before running test.

9.3.4 Inspect and clean the pulleys as required with isopropyl alcohol or other nonresidue cleaner prior to the start of the tests. Test pulleys must be free of oils, dust, belt wear debris, contamination, etc.

9.3.5 Randomly select a belt, leaving the others in the holding chamber.

9.3.6 Install the belt on the noise test stand. Re-soak prior to starting test until the belt achieves the original soak parameters.

9.3.7 Set the test stand driver pulley speed to the specified condition.

9.3.8 Set the offset of pulley 3 to achieve the desired belt misalignment angle.

NOTE: For the 5 °C misting point test: Run the belt dry for 10 s while checking for noise, apply water mist to the belt for approximately 10 s (belt should be wet over entire length), then stop misting and continue test per 9.3.9. Water mist should be reapplied at each misalignment angle setting.

9.3.9 Measure the belt noise for the belt run time specified in Table 1 with the microphone positioned 100mm in front of, and aligned with, the entry span of the test pulley (see Figure 6). Record any noise. Identify maximum and average noise level (in dBA), duration of noise, noise type (subjective), sample number, and misalignment angle.

9.3.10 Adjust the misalignment angle to the next setting, re-soak the belt while on the noise test stand until the belt achieves the original soak parameters, and repeat 9.3.9. Repeat until all angles between +3 degrees and -3 degrees (in 0.5 degree increments) are tested or until belt jump occurs.

9.3.11 Remove the test belt from the stand and place back in the holding chamber.

9.3.12 Repeat steps 9.3.5 to 9.3.11 until all belts have been tested.

9.3.13 Repeat steps 9.3.5 to 9.3.12 until each belt has been tested three times. Belts should be run in random order for each repeat.

9.3.14 Run belts for 60 h on the High Temperature, Constant Tension test (3) and repeat noise test.

9.3.15 Run belts until completion on the High Temperature, Constant Tension test (3) and repeat noise test.

9.4 Failure Criteria

Any audible belt noise observed should be recorded. Examples of belt noise are “chirp,” “pop,” “squeal,” etc. Belt age and misalignment angle should be noted for any observed belt noise.

10. BELT EFFECTIVE COEFFICIENT OF FRICTION TEST

10.1 Purpose

To determine the front side dry, back side dry, and front side wet effective coefficient of friction of a K section V-Ribbed belt under dynamic conditions.

10.2 Reporting Requirements

The information in Figure 10 should be reported for both new belts and for end of test belts run on the High Temperature, Constant Tension Test (3). This information should be provided for dry rib side (10.3.1), dry back side (10.3.2), and wet rib side (10.3.3) testing.

10.3 Testing Parameters

10.3.1 Dry Ribbed Side (Figure 7)

a. Belt Temperature:32 °C (90 °F) or as specified

b. Belt Tension, slack side:180N applied at pulley 5.

c. Test Pulley Speed:400 rpm

d. Pulley material:Stainless Steel (303 or 17-4PH - ASTM A564 Type 630)

e. Pulley surface finish: 0.8 µm max.

f. Load:Variable

g. Driven Pulley Wrap: 20°

h. Initial belt condition:Dry

10.3.2 Dry Back Side (Figure 8)

a. Belt Temperature: 32 °C (90 °F) or as specified

b. Belt Tension, slack side:180N applied at pulley 5.

c. Test Pulley Speed:1900 rpm

d. Pulley material:Stainless Steel (303 or 17-4PH - ASTM A564 Type 630)

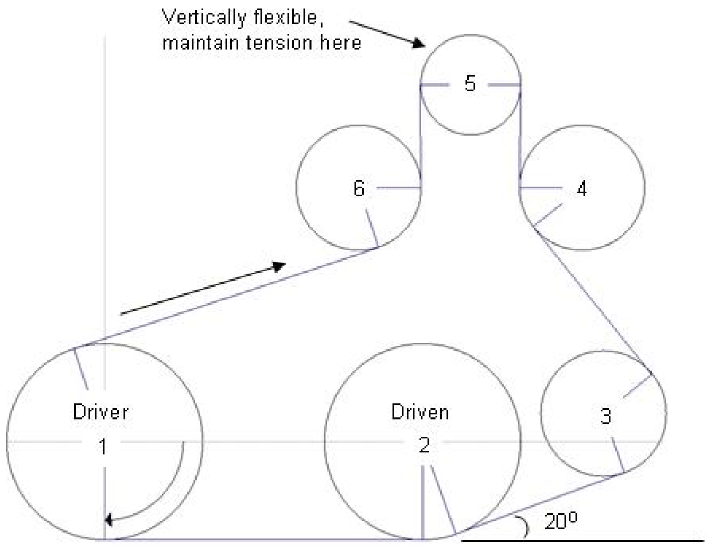
e. Pulley surface finish: 0.8 µm max.

f. Load: Variable

g. Driven Pulley Wrap: 40°

h. Profile:flat within .1 mm profile (no crown)

i. Initial belt condition:Dry



	DOB or Actual*	X (mm)	Y (mm)	Arc of Wrap (degrees)
1 Driver	121.6	0	0	
2 Driven	121.6	200.0	0	20.0
3	77.0	314.0	17.8	
4	76.2*	300.61	160.0	
5 Tensioning	61.0	230.3	225.0	180.0
6	76.2*	160.0	160.0	

Figure 7 - Dry ribbed side set up