GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification Elastomers	GMW15024

Engine Coolant Hose

1 Scope

This specification covers the material requirements of ethylene-propylene-diene (EPDM) engine coolant hose, both large diameter (radiator hose) and small diameter (heater hose). In addition, this specification covers the material requirements for engine coolant hose which is incorporated into crimped metal pipe and hose assemblies, or which is incorporated into molded branched hose assemblies. The performance requirements for engine coolant hose and assemblies incorporating engine coolant hose are defined by additional performance specifications.

These engine coolant hoses or assemblies incorporating these coolant hoses are intended to withstand the effects of circulating solutions containing corrosion inhibitors and glycols and operating under various pressure conditions at continuous operating temperatures from -40°C to maximum temperatures ranging from 120 to 150°C, dependent on type.

The tube and cover stocks of these hoses shall be made from ethylene-propylene-diene compounded and reinforced with appropriate yarn (as described in 1.1) to meet the requirements of this specification. The radial thickness of the lining shall be at least 50% of the total wall thickness. Cover may be perforated to facilitate degassing during manufacturing operations. Hose shall be black. Alternate reinforcement may be permitted with Engineering Source Approval, and this alternate reinforcement will be referenced as the approved reinforcement for that specific hose approval in MATSPC. Use of high tensile modulus, low elongation polyaramid materials (i.e., Technora, Kevlar, and Twaron) may not be suitable for heater hose part numbers which are formed with small bend radii and used for dynamic applications. For additional information or aid in selection of proper reinforcement materials for specific part numbers, contact the regional Materials Engineer. No Rubber Manufactures Association (RMA) defined colored tracer or other identifying thread shall be added to the reinforcement specified for the construction of the hose.

1.1 Material Description. Materials covered by this specification are divided into the following types:

1.1.1 Type A: EPDM coolant hose, sulphur cured utilizing rayon reinforcement, capable of operating to a maximum continuous temperature limit of +120°C.

1.1.2 Type B: EPDM coolant hose, sulphur cured utilizing rayon or aramid reinforcement, capable of operating to a maximum continuous temperature limit of +100°C and peak temperatures of +125°C. Type B hoses are not suitable for applications involving direct contact with metal fittings.

1.1.3 Type C: EPDM coolant hose, sulphur cured utilizing aramid reinforcement, capable of operating to a maximum continuous temperature limit of +130°C.

1.1.4 Type D: EPDM coolant hose, sulphur cured utilizing aramid reinforcement, capable of operating to a maximum continuous temperature limit of +130°C, and formulated to contain 0 wt% thiuram, and a maximum of 0.04 wt% thiocarbamates in the EPDM rubber stock for both hose tube and cover.

1.1.5 Type E: EPDM coolant hose, peroxide cured utilizing aramid reinforcement, capable of operating to a maximum continuous temperature limit of +150°C. A di-cumyl peroxide cure system may not be used for this hose.

1.1.6 Type F: EPDM coolant hose, peroxide cured utilizing aramid reinforcement, capable of operating to a maximum continuous temperature limit of +150°C, but having greater expansion under pressure than Type E. A di-cumyl peroxide cure system may not be used for this hose.

1.1.7 Type G: EPDM coolant hose, peroxide cured utilizing aramid reinforcement, capable of operating to a maximum continuous temperature limit of +150°C. A di-cumyl peroxide cure system may not be used for this hose.

1.1.8 Type H: EPDM coolant hose, peroxide cured utilizing Polyethylene Terephthalate (PET) reinforcement, capable of operating to a maximum continuous temperature limit of +120°C. A di-cumyl peroxide cure system may not be used for this hose.

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2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM D380	ISO 37
ASTM D395	ISO 48
ASTM D412	ISO 188
ASTM D413	ISO 815
ASTM D865	ISO 1431-1
ASTM D471	ISO 1817
ASTM D2240	ISO 7619-1
ISO 36	ISO 23529

2.2 GM Standards/Specifications.

9985809	GMW3001
B 040 1065	GMW3059
GM4486P	GMW14329
GM6277M	GMW14679
GM9902P	

3 Requirements

3.1 Resources

3.1.1 Test Samples. Unless otherwise specified, the shape and size of test pieces shall be in accordance with the relevant Test Method. Minimum six (6) test samples (hoses) are required for initial sample testing. Minimum three (3) test samples (hoses) are required for inspection testing.

Samples are finished parts or to be taken from finished parts. (Where the dimensions on the finished parts do not allow preparing of test pieces, tests are to be performed on sheet material of same production batch. The same state of cure between slabs or buttons and finished parts must be assured by appropriate tests, which must be described in the test report.)

If not otherwise stated, mechanical properties in delivery state and after heat or fluid immersion are to be tested at +23 ± 5°C and with the same test methods. Unless otherwise stated, ambient temperature test conditions shall be held to +23 ± 5°C. Unless otherwise stated, all other temperatures except +23 ± 5°C shall be held to ± 3°C.

3.1.2 Conditioning. Conditioning shall be as specified in the relevant Test Method.

3.1.3 Equipment. Conforming to the relevant Test Methods.

3.1.4 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.5 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition.

3.1.6 Facilities. Conforming to the relevant Test Methods.

3.1.7 Deviations. Deviations from the requirements of this specification shall have been agreed upon. Such deviations shall be specified on component drawings, test certificates, reports, etc.

3.2 Material and Performance Requirements.

3.2.1 Design Validation Testing. Material properties (material/compound approval) are summarized in Table 1, performance requirements (construction approval) in Table 2. For full approval of hose compliance to the requirements, Table 1 and Table 2 are needed. For Test Plan, see Appendix A.

3.2.2 Product Validation Testing. If not defined otherwise, the following testing should be done for production audit testing (see also Appendix B):

- All tests per Table 1 except Long Term Immersion, Ozone Resistance, Resistance to Electrochemical Degradation, Bloom and Paint Compatibility.
- Burst Strength, Pressure Impulse and Fatigue Test per Table 2.

3.2.3 Audit/Inspection Testing. If not defined otherwise, the following testing should be done for production audit testing (see also Appendix C):

- All tests per Table 1 except Long Term Immersion, Ozone Resistance, Resistance to Electrochemical Degradation, Bloom and Paint Compatibility.
- Burst Strength and Pressure Impulse per Table 2.

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Table 1: Material Properties

As Received Properties for Tube and Cover

Property	Test Method	Unit	Value
Hardness [Note 1]			
Types A, B; C, D, E, G, and H	ASTM D2240, 6 mm specimens, made by plying together samples of the elastomeric compound. Read scale within 1 s. or ISO 7619-1, 6 mm specimens, made by plying together samples of the elastomeric compound. Read scale within 3 s	Shore A	55 to 75
Type F	ASTM D2240, 6 mm specimens, made by plying together samples of the elastomeric compound. Read scale within 1 s. or ISO 7619-1, 6 mm specimens, made by plying together samples of the elastomeric compound. Read scale within 3 s.	Shore A	52 to 72
Elongation at Break			
All Types	ASTM D412 or ISO 37, Type 2 or 4 dumb-bell, 200 ± 20 mm/minute	%	250 minimum
Tensile Strength			
Types A, C, D, and E	ASTM D412 or ISO 37, Type 2 or 4 dumb-bell, 200 ± 20 mm/minute	MPa	7.6 minimum
Type B; G and H			7.0 minimum
Type F			6.5 minimum
Modulus at 50% Elongation			
Types A, C, D, and E	ASTM D412 or ISO 37, Type 2 or 4 dumb-bell, 200 ± 20 mm/minute	MPa,	As specified on drawing
Type B; G and H			As specified on drawing
Type F			2.1 maximum
Modulus at 100% Elongation			
Types A, C, D, and E	ASTM D412 or ISO 37, Type 2 or 4 dumb-bell, 200 ± 20 mm/minute	MPa	As specified on drawing
Type B; G and H			As specified on drawing
Type F			3.8 MPa maximum
Modulus at 200% Elongation			
Types A, C, D, E and F	ASTM D412 or ISO 37, Type 2 or 4 dumb-bell, 200 ± 20 mm/minute	MPa	3.0 minimum (tube), 4.5 minimum (cover)
Type B; G and H		MPa	As specified on drawing

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Requirements to the Cover

Property	Test Method	Unit	Value
Age Resistance (Heat Aging)			
Types A, C, and D	ASTM D865, 168 h at 150°C Change of hardness Change of elongation at break or Elongation at break Change of tensile strength	 Shore A % % %	 0 to +18 -65 maximum 120 minimum -35 maximum
Type B	ISO 188 Method B, 72 -2 h at +125 ± 3°C Change of hardness Change of elongation at break Change of tensile strength	 Shore A % %	 0 to +15 -50 maximum -20 maximum
Type E	ASTM D865, 168 h at 165°C Change of hardness Change of elongation at break Change of tensile strength	 Shore A % %	 0 to +15 -55 maximum -30 maximum
Type F	ASTM D865, 168 h @ 165°C Change of hardness Change of elongation at break Change of tensile strength	 Shore A % %	 0 to +20 -55 maximum -35 maximum
Type G and H	ISO 188 Method B, 168 -2 h at +150 ± 3°C Change of hardness Change of elongation at break Change of tensile strength	 Shore A % %	 0 to +15 -65 maximum -35 maximum
Ozone Resistance			
Types A, C, D, E and F	GM4486P 100 pphm, 13 mm straight sample, elongated 20% for test, 40 ± 2°C 336 - 2°h. Visual Examination, 2X magnification		No cracks
Type B; G and H	ISO 1431-1, 50 pphm, straight sample 20% strain, 40 ± 2°C, 72 - 2°h Visual Examination, 7X magnification		No cracks

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Requirements to the Lining

Property	Test Method	Unit	Value
Immersion in Coolant			
Types A, C, and D	ASTM D471 in mixture of 55% ethylene glycol type coolant to GM6277M (9985809) and 45% water 168 h at boiling temperature		
	Change of hardness	Shore A	-15 to +15
	Change of elongation at break or	%	-30 maximum
	Elongation at break	%	250 minimum
	Change of tensile strength	%	-15 maximum
	Change in volume	%	+20 maximum
Type B; G and H	ISO 1817, in mixture of 50% ethylene glycol (B 040 1065), and 50 % water boiling under reflux, 168 – 2 h.		
	Change of hardness	Shore A	±10
	Change of elongation at break	%	-30 maximum
	Change of tensile strength	%	-5 maximum
	Change in volume	%	-5 to +15
Type E	ASTM D471 in mixture of 55% ethylene glycol type coolant to GM6277M (9985809) and 45 % water 168 h at boiling temperature		
	Change of hardness	Shore A	-15 to +15
	Change of elongation at break	%	-15 maximum
	Change of tensile strength	%	-15 maximum
	Change in volume		+20 maximum
Type F	ASTM D471 in mixture of 55% ethylene glycol type coolant to GM6277M (9985809) and 45% water 168 h at boiling temperature		
	Change of hardness	Shore A	-15 to +15
	Change of elongation at break	%	-20 maximum
	Change of tensile strength	%	-15 maximum
	Change in volume		+20 maximum
Long Time Immersion in Coolant			
Types A, C, and D	ASTM D471 in mixture of 55% ethylene glycol type coolant to GM6277M (9985809) and 45% water 1000 h at boiling temperature.		
	Change of elongation at break or	%	-40 maximum
	Elongation at break	%	225 minimum
Type E and F	ASTM D471 in mixture of 55% ethylene glycol type coolant to GM6277M (9985809) and 45 % water 1000 h at boiling temperature.		
	Change of elongation at break	%	-40 maximum

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Property	Test Method	Unit	Value
Long Time Immersion in Coolant (test in pressure vessel) Note 2			
Type B	ISO 1817, in mixture of 50% ethylene glycol (B 040 1065), and 50 % water test in pressure vessel, 504 – 2 h, at +125 ± 3°C. Change of hardness Change of elongation at break Change of tensile strength Change in volume	 Shore A % % %	 ±10 -30 maximum -20 maximum -5 to +15
Type G and H	ISO 1817, in mixture of 50% ethylene glycol (B 040 1065), and 50 % water test in pressure vessel, 504 – 2 h, at +150 ± 3°C. Change of hardness Change of elongation at break Change of tensile strength Change in volume	 Shore A % % %	 ±10 -30 maximum -20 maximum -5 to +15

Requirements for the Construction/Constructional Properties

Property	Test Method	Unit	Value
Compression Set			
Types A, C, and D	ASTM D395, Method B, 125°, 70 h. Molded buttons with equivalent cure state to production hose.	%	85 maximum
Type B	ISO 815 test piece Type B samples to be taken from calibrated ends, if existing +125°C, 24 h, 25% compressed	%	45 maximum
Type E	ASTM D395, Method B, 150°, 70 h. Molded buttons with equivalent cure state to production hose.	%	60 maximum
Type F	ASTM D395, Method B, 150°, 70 h. Molded buttons with equivalent cure state to production hose.	%	80 maximum
Type G and H	ISO 815 test piece Type B samples to be taken from calibrated ends, if existing +150°C, 24 h, 25% compressed	%	45 maximum
Adhesion			
Types A, C, D, E and F	ASTM D413, Machine Method. Adhesion of Cover to Tube and Cover/Tube to Reinforcement	N/mm	1.4 minimum
Type B; G and H	ISO 36 strip test pieces (for hoses above ID 28 mm) or ring shaped test pieces (for hoses up to ID 28 mm)	N/mm	2.5 minimum
Cold Flexibility			
All Types	ASTM D380, specimens from straight length hose. Condition -40 ± 3°C; 22 +1 h prior to flexing Visual Examination		No cracks
All Types	ISO 23529, -40 ± 3°C; 22 +1 h, strip cut through hose, (5 to 10) mm wide, 100 mm long, bent 180° around radius of 12.5 mm. Visual Examination		No cracks

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Property	Test Method	Unit	Value
Resistance to Electrochemical Degradation			
Types A, B, and C	GMW14679 Method A 12 V imposed voltage, 504 -4 h test duration, +100 ± 3°C Visual Examination		No Striations
Type D, E, F, G and H	GMW14679 Method B 12 V imposed voltage, 504 -4 h test duration, +115 ± 3°C Visual Examination		No Striations
Bloom			
All Types	Place a sample of the hose into a suitable, clean, non-contaminating container and run the following test schedule: 48 -2 h at -30 ± 3°C 48 -2 h at +100 ± 3°C 72 -2 h at -30 ± 3°C 168 -2 h at +100 ± 3°C Check surface daily, when possible, and at the end of exposure, Visual Examination		No deposit of solid on the surface
Paint Compatibility			
Types A, B,C, D, E, F, G, H	GM9902P	Delta b	≤ 4.0

Note 1: If thickness of cover will not be sufficient to measure hardness in Shore A, measurement in IRHD to ISO 48 Method M is possible, deviation must be stated in the report.
Note 2: Values under consideration.

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Table 2: Performance Properties

Property	Test Method	Unit	Value
Kink Note 1			
All Types (Hose of ID ≤ 20 mm only)	GMW14329, Section 4.1	mm	≤ 7.1 mm
Burst Strength			
All Types (Hose of ID ≤ 20 mm only, hoses in heating system)	GMW14329, Section 4.2 As-Received Burst, Ambient Temperature.	Mpa	1.9 minimum
All Types (Hose of ID > 20 mm only, hoses in radiator system)	GMW14329, Section 4.2 As-Received Burst, Ambient Temperature.	MPa	1.2 minimum
All Types (Hose of ID ≤ 20 mm only, hoses in heating system)	GMW14329, Section 4.2 As-Received Burst, 110°C	MPa	1.3 minimum
All Types (Hose of ID > 20 mm only, hoses in radiator system)	GMW14329, Section 4.2 As-Received Burst, 110°C	MPa	1.1 minimum
Types A, B, C, D, (Hose of ID ≤ 20 mm only , hoses in heating system)	GMW14329, Section 4.2 Burst at ambient temperature after Oven Aging: 168 h at 125°C.	MPa	1.9 minimum
Types A, B, C, D (Hose of ID > 20 mm only, hoses in radiator system)	GMW14329, Section 4.2 Burst at ambient temperature after Oven Aging: 168 h at 125°C.	MPa	1.2 minimum
Types E, F, G, H (Hose of ID ≤ 20 mm only, hoses in heating system)	GMW14329, Section 4.2 Burst at ambient temperature after Oven Aging: 168 h at 165°C.	MPa	1.9 minimum
Types E, F, G, H (Hose of ID > 20 mm only, hoses in radiator system)	GMW14329, Section 4.2 Burst at ambient temperature after Oven Aging: 168 h at 165°C.	MPa	1.2 minimum
Coolant Circulation			
All Types (Hose of ID ≤ 20 mm only hoses in heating system)	GMW14329, Section 4.3. Change of outer diameter Cover and tube cracking or disintegration, Visual Examination Burst strength at 110°C.	 %; MPa	 0 to +12; no cracking, discoloration, or disintegration; 1.1 minimum.
All Types (Hose of ID > 20 mm only hoses in radiator system)	GMW14329, Section 4.3. Change of outer diameter Cover and tube cracking or disintegration, Visual Examination Burst strength at 110°C.	 %; MPa	 0 to +12 no cracking, discoloration, or disintegration; 0.8 minimum
Vacuum Collapse			
All Types	GMW14329, Section 4.4 - As-Received. Visual Examination		No Collapse
Pressure Impulse Note 2			
All Types	GMW14329, Section 4.5. Visual Examination Burst strength at ambient temperature	 MPa	No Burst or Cracks; Report measured value

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Property	Test Method	Unit	Value
Fatigue Test (incl. simulation of engine movement) [Note 2]			
Types A, B, C, D	GMW14329, Section 4.6 - 5 cycles (100 h) Visual Examination Circumferential Expansion at 0.2 MPa for Hose of ID > 20 mm only hoses in radiator system 0.35 MPa for Hose of ID ≤ 20 mm only hoses in heater system Permanent Deformation Vacuum Collapse Burst strength at ambient temperature	 % % % MPa	 No Burst or Cracks; 12 maximum 12 maximum 6 maximum No Collapse Report measured value
Types E, F, G, H	GMW14329, Section 4.6 - 10 cycles (200 h) Visual Examination Circumferential Expansion 0.2 MPa for Hose of ID > 20 mm only hoses in radiator system 0.35 MPa for Hose of ID ≤ 20 mm only hoses in heater system Permanent Deformation Vacuum Collapse Burst strength at ambient temperature	 % % % MPa	 No Burst or Cracks; 12 maximum 12 maximum 6 maximum No Collapse Report measured value

Note 1: Test only performed on straight (not formed) hoses
Note 2: Hoses for Type H must be preconditioned: Fill hose to 80 % of its volume with mixture of 50% ethylene glycol (B 040 1065), and 50% water, plug and store for 168 h at +80 °C. Start test within 4 h after conditioning.

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4 Manufacturing Process

The inner surface of the hose shall be free of excess soap, talc or other material which could affect serviceability and usage. The hoses must have properly manufactured ends; free threads of textile reinforcement may not exceed 1.5 mm maximum.

5 Rules and Regulations

5.1 All materials supplied to this standard must comply with the requirements of GMW3001, **Rules and Regulations for Material Specifications.**

5.2 All materials supplied to this standard must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts.**

6 Approved Sources

Engineering qualifications of an approved source are required for this standard. Only sources listed in the GM Materials File (i.e., GM Supply Power) under this standard number have been qualified by engineering as meeting the requirements of this standard.

For other GM locations, the responsible engineering group should be contacted to obtain the approved source in that individual country.

6.1 Suppliers are permitted to qualify cured hoses to Type B, C and D.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

EPDM	Ethylene-propylene-diene
PET	Polyethylene Terephthalate
RMA	Rubber Manufacturers Association

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Material per GMW15024 Type "X", where X = material type as defined in Section 1.1

9 Release and Revisions

9.1 Release. This standard originated in January 2006. It was first approved by Global Elastomers Team in July 2006. It was first published in January 2008

It supersedes all regional material specifications for coolant hoses for use on Global Engineered materials including but not limited to: GME13001, GM224M, GM6250M, and GM6278M.

Specification will be reworked, when missing information is available.

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Appendix A

Tests are done on a hose for construction approval (Design Validation). For all material tests to Table 1 except test "Resistance to Electrochemical Degradation", it is assumed that the hose length is a minimum of 40 cm. If the part number selected for test is shorter than 40 cm, it may be necessary to deliver additional parts to complete the test requirements detailed in the table. For the "Resistance to Electrochemical Degradation" a special sample of 1 m length and ID = 34 mm is required.

Total number of test samples is a minimum 48 samples plus the additional special sample.

Table A1: Test Plan for Design Validation

Test Sample Numbers:	1-6	7-12	13-18	19-24	25-30	31-36	43-48	37-42	Special Sample
Test per Table 1:									
Hardness	x								
Elongation at Break	x								
Tensile Strength	x								
Modulus at 50% Elongation	x								
Modulus at 100% Elongation	x								
Modulus at 200% Elongation	x								
Age Resistance (Heat Aging)	x								
Ozone Resistance	x								
Immersion in Coolant	x								
Long Time Immersion in Coolant	x								
Long Time Immersion in Coolant (test in pressure vessel)	x								
Compression Set	x								
Adhesion	x								
Cold Flexibility	x								
Resistance to Electrochemical Degradation									x
Bloom Compound Approval or on request	x								
Paint Compatibility Compound Approval or on request	x								
Test per Table 2:									
Kink		x							
Burst Strength									
As-Received Burst, Ambient Temperature.			x						
As-Received Burst, 110 C				x					
Burst at ambient temperature after Oven Aging					x				
Coolant Circulation						x			
Vacuum Collapse								x	
Fatigue Test							x		

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Appendix B

Tests are done on a hose for Initial Sample Approval (PPAP, Process Validation). For all material tests to Table 1, it is assumed that the hose length is a minimum of 40 cm. If the part number selected for test is shorter than 40 cm, it may be necessary to deliver additional parts to complete the test requirements detailed in the table.

Total number of test samples is 24 samples.

Table B1: Test Plan for Product Validation

Test Sample Numbers:	1-6	7-12	13-18	19-24
Test per Table 1:				
Hardness	x			
Elongation at Break	x			
Tensile Strength	x			
Modulus at 50% Elongation	x			
Modulus at 100% Elongation	x			
Modulus at 200% Elongation	x			
Age Resistance (Heat Aging)	x			
Immersion in Coolant	x			
Compression Set	x			
Adhesion	x			
Cold Flexibility	x			
Test per Table 2:				
Burst Strength As-Received Burst, 110 °C		x		
Pressure Impulse			x	
Fatigue Test				x

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Appendix C

Tests are done on a hose for Inspection (In Process). For all material tests to Table 1, it is assumed that the hose length is a minimum of 40 cm. If the part number selected for test is shorter than 40 cm, it may be necessary to deliver additional parts to complete the test requirements detailed in the table.

Total number of test samples is 9 samples.

Table C1: Test Plan for Audit / Inspection

Test Sample Numbers:	1-3	4-6	7-9
Test per Table 1:			
Hardness	X		
Elongation at Break	X		
Tensile Strength	X		
Modulus at 50% Elongation	X		
Modulus at 100% Elongation	X		
Modulus at 200% Elongation	X		
Age Resistance (Heat Aging)	X		
Immersion in Coolant	X		
Compression Set	X		
Adhesion	X		
Cold Flexibility	X		
Test per Table 2:			
Burst Strength As-Received Burst, 110 °C		X	
Pressure Impulse			X

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