



High Temperature Tubes for PCV and Exhaust Condensate Exposure

1 Scope

This standard covers the material requirements of engine tubes that are exposed to exhaust gas condensate and positive crankcase and ventilation, also known as vent and blow-by hoses, for use in automotive systems. Material properties are suitable for low vacuum and pressure tubes not requiring reinforcement, but reinforced hoses can as well be used and are part of this specification. Material properties are also suitable for vacuum hoses. No resistance tests to crank-case ventilation gases per GMW17227 are required for vacuum hoses.

1.1 Material Description. Materials covered by this specification are divided into several Types and Classes, depending on construction and temperature capability. See Table 1. Hoses are defined by the Construction and Temperature capability.

1.1.1 Hoses are either suitable for applications subjected to maximum continuous operation temperatures of +150 °C with intermittent operation at temperatures up to +175 °C maximum, to maximum continuous operation temperatures of +175 °C with intermittent operation at temperatures up to +200 °C maximum, or for applications subjected to maximum continuous operation temperatures of +200 °C with intermittent operation at temperatures up to +225 °C, dependent on the Temperature Rating of the hose. The designation for the blow-by hose is defined as GMW17391 Type VWYZ, where V defines the construction of the hose, W defines the temperature capability of the hose, Y defines reinforcement, and Z defines the requirements for GMW17227 qualifications.

- Suffix Code Z for requiring GMW17227 is xxxx1; if no resistance is needed, xxx2.
- If no suffix is given, suffix A shall apply.
- Detailed overview of all types are shown in Table 1.

Note: Continuous and Excursion temperature limits are defined in the Vehicle Technical Specifications (VTS). The cold resistance test for all types of hoses is defined at -30 °C, however, hoses will be able to operate at -40 °C as soon as they are immersed with oil and blow-by in the engine.

1.2 Symbols. Not applicable.

1.3 Applicability. For all elastomeric tubes and hoses exposed to Positive Crankcase Ventilation (PCV), Exhaust Gas Recirculation (EGR) gases, and vacuum tubes/hoses.

2 References

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

2.1 External Standards/Specifications.

ASTM D413	ISO 37	ISO 815	ISO 7619-1
ISO 34-1	ISO 48	ISO 1431-1	ISO 23529
ISO 36	ISO 188	ISO 1817	

2.2 GM Standards/Specifications.

GMW3059	GMW15423	GMW16955	GMW17245
GMW14914	GMW16153	GMW17227	

2.3 Additional References.

- Vehicle Technical Specifications (VTS).

3 Requirements

3.1 Resources.

Table 1: Construction, Temperature Limit, and Coding

Lining	Intermediate Layer	Reinforcement	Cover	Coding	Comment
	Temperature Limit 1: +150 °C ± 3 °C to +175 °C ± 3 °C				
Ethylene Acrylate Elastomer (AEM)	--	--	--	A1Ax	
AEM		Textile Fibers ^{Note 1}	AEM	A1Bx	Improved resistance to crank case ventilation gases compared to Types A1A1 and A1B1 (see 3.2.1)
Fluoroelastomer (FKM)	--	--	AEM	B1Ax	
FKM		Textile fibers ^{Note 1}	AEM	B1Bx	
FKM	AEM	Textile fibers ^{Note 1}	AEM	C1Bx	
	Temperature Limit 2: +175 °C ± 3 °C to +200 °C ± 3 °C				
FKM	--	--	--	D2Ax	
FKM	--	--	VMQ	E2Ax	
FKM	Silicone Elastomer (VMQ)	Aramid	VMQ	F2Bx	
	Temperature Limit 3: +200 °C ± 3 °C to +225 °C ± 3 °C				
FKM	--	--	---	D3Ax	
FKM	--	--	VMQ	E3Ax	
FKM	VMQ	Aramid	VMQ	F3Bx	

Note 1: Hoses with textile reinforcement must fulfill the requirements of the material and durability tests, if specified on respective drawing.

3.1.1 Test Samples. Unless otherwise specified, the shape, size, and number of test pieces shall be in accordance with the relevant test methods. Minimum three (3) test samples (hoses) are required for inspection testing. Report both individual and averaged values. Unless otherwise specified, samples are finished parts or to be taken from finished parts. Where the dimensions of the finished parts do not allow preparing of test pieces, tests are to be performed on sheet material of the same production batch. Tests must be carried out to confirm same state of cure between sheet material and finished parts. If not otherwise stated, mechanical properties in delivery state and after heat or fluid immersion, are to be tested at 23 °C ± 3 °C, and with the same test methods.

3.1.2 Conditioning. Conditioning shall be as specified in the relevant test methods.

3.1.2.1 Environmental Conditions. The minimum time between vulcanization and testing of elastomers shall be 72 h. The test pieces shall be maintained at a temperature of 23 °C ± 5 °C for at least 8 h prior to test and shall be free from strain during this period.

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 standard 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. Material and Performance Requirements are summarized in Table 2 through Table 8. Tables use International Rubber Hardness Degrees (IRHD) as a unit of measure.

3.2.1 Properties for single layer hose in AEM Types A1Ax, intermediate layer of multi-layer hose FKM/AEM/AEM to Type C1Bx and cover of multilayer hoses AEM/AEM to Type A1Bx and FKM/AEM to Type B1Ax, Type B1Bx, and Type C1Bx, per Table 2.

Table 2: Material Properties Requirements for Hoses to Temperature Limit 1

Property	Test Procedure	Unit	Value
Hardness			
Type A1Ax to Type C1Bx	ISO 48, Method M	IRHD	60 to 70
Type A1Ax to Type C1Bx	ISO 7619-1	Shore A	65 to 75
Elongation at Break			
Type A1Ax to Type C1Bx	ISO 37, Type 2 dumbbell or Type 4 dumbbell, 200 mm/minute $\pm$ 20 mm/minute	%	150 Minimum
Tensile Strength			
Type A1Ax to Type C1Bx	ISO 37, Type 2 dumbbell or Type 4 dumbbell, 200 mm/minute $\pm$ 20 mm/minute	MPa	9 Minimum
Tear Strength			
Type A1Ax to Type C1Bx	ISO 34-1 Method A (trouser test piece)	N/mm	2.0 Minimum
Age Resistance (Heat Aging)			
Type A1Ax to Type C1Bx	ISO 188 Method B +150 °C $\pm$ 3 °C, 168 h -2 h Change in Hardness Change in Elongation at break Tensile strength	IRHD/Shore A % MPa	0 to +15 -20 Maximum 10 Minimum
Type A1Ax to Type C1Bx	ISO 188 Method B +175 °C $\pm$ 3 °C, 72 h -2 h Change in Hardness Change in Elongation at break Tensile strength	IRHD/Shore A % MPa	0 to +15 -40 Maximum 10 Minimum
Ozone Resistance			
Type A1Ax to Type C1Bx	ISO 1431-1, 50 pphm, 20% strain, 40 °C $\pm$ 2 °C, 72 h Visual Examination		No cracks

Property	Test Procedure	Unit	Value
Compression Set			
Type A1Ax	ISO 815 test piece Type B ^{Note 2} , wall thickness is test piece thickness, samples to be taken from calibrated ends, (if existing) +150 °C, 24 h, 25% compressed	%	40 Maximum
Cold Flexibility			
Type A1Ax	Condition per ISO 23529, -30 °C ± 3 °C; 22 h +1 h Change in Hardness test piece is section cut from hose, 100 mm long, bent 180 degrees around radius of 2.5 mm. Visual Examination	Shore A	+25 Maximum No cracks
Oil Resistance			
Type A1Ax, Type A1Bx lining	to ISO 1817 in heat aged engine oil GMW17245 168 h -2 h at 150 °C ± 3 °C Change in Hardness Elongation at Break Change in Elongation at Break Change in Tensile Strength Change in Volume	IRHD/Shore A % % MPa %	-20 to +10 100 Minimum -50 Maximum 9 Minimum ± 15 Maximum
Fuel Resistance Gasoline Compatibility			
Type A1Ax, Type A1Bx lining	ISO 1817 to Gasoline test fuel per GMW14914 168 h -2 h, at 23 °C ± 5 °C test piece thickness 1 mm ± 0.1 mm All tests performed 1 minute after removal from test liquid Elongation at break Tensile strength Change in Mass Drying of test pieces for 48 h at room temperature (RT) Elongation at break Tensile strength	% MPa % % MPa	80 Minimum ^{Note 1} 3.5 Minimum ^{Note 1} 0 to +90 ^{Note 1} 150 Minimum 9 Minimum
Resistance to Crankcase Ventilation Gases			
Type A1A1, Type A1B1 lining	GMW17227 Cycle G or Cycle D ^{Note 3} after four (4) cycles Change in Hardness Elongation at break Change in Elongation at Break Tensile strength Change in Tensile Strength Change in Volume	IRHD/Shore A % % MPa % %	-25 to +2 80 Minimum -60 Maximum 6 Minimum -60 Maximum 0 to +80 Maximum

Note 1: Values under consideration.

Note 2: The reference to ISO 815 indicates the test piece diameter and refers to the calculation of the results. But test pieces must be taken from finished hose in product thickness.

Note 3: Select kind of cycle depending on the usage, for a general release (diesel and gasoline engines), requirements to Cycle G and Cycle D must be met.

pphm = Parts per Hundred Million

3.2.2 Properties for the single layer hose FKM - Type D2Ax and Type D3Ax and FKM liner of hoses Type B1Ax to Type C1Bx, Type E2Ax, Type F2Bx, Type E3Ax and Type F3Ax per Table 3.