



Engine Ventilation System – Valve Durability Test

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This procedure describes the tests to determine the durability of ventilation valves (pressure regulator, check valve, bypass valve, etc.) in an engine ventilation system.

1.2 Applicability. The engine ventilation system valve durability test is typically used when an engine blowby system has a pressure regulator, check valve, bypass valve, etc., in the oil separator, Positive Crankcase Ventilation (PCV) tubes, PCV passages, and/or oil drain tubes.

2 References

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

2.1 External Standards/Specifications.

ASTM D1094

2.2 GM Standards/Specifications.

B 040 0050

GMW3059

GMW14729

GMW14914

2.3 Additional References.

- Bayerische Motoren Werke AG (BMW), Munich, Germany (www.bmw.com)
- GM Part Number 9274002
- ISP The Testing Institute, ISP Salzbergen GmbH & Company, KG, (www.isp-testing.com)

3 Resources

3.1 Facilities. A suitable area or room for conducting testing with a stable and conditioned environment.

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

3.1.2 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 their physical definition.

3.2 Equipment.

3.2.1 Testing devices according to the respective test methods.

3.2.2 Drawings, measuring devices and gauges for the dimensional test.

3.2.3 Vacuum generator, range -0.5 kPa to 95 kPa.

3.2.4 Pressure reducing valve, range 0 kPa to 200 kPa.

3.2.5 Pressure gauge, indicating range 0 kPa to 500 kPa.

3.2.6 Vacuum gauge with a range 0 kPa to 100 kPa and resolution of 0.1 kPa.

3.2.7 Timing device capable of 600 s minimum.

3.2.8 Thermal chamber with recirculating air and a temperature range from -40 °C to +170 °C. The design of the thermal chamber shall ensure that temperatures remain within the tolerances stated in this test procedure.

3.2.9 White oil. GM Part Number 9274002; B 040 0050.

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3.2.10 Fuel exposure. Exposure to all expected regional fuel blends per GMW14914.

3.2.11 Bayerische Motoren Werke AG (BMW) worst case used oil exposure. This test oil developed by BMW and is available from ISP The Testing Institute (www.isp-testing.com). Other suppliers may become available. Because it is a mixture, long term storage will likely result in phase separation (see ASTM D1094 to evaluate phase separation). It must be shaken or stirred to a homogenous mix before entering the pressure vessel. During testing the solution must be constantly stirred. The mixing controls, stability and batch to batch consistency are unknown, therefore, order only the amount required for completing testing. Record the fluid batch number in all test reports.

3.3 Test Vehicle/Test Piece.

3.3.1 Unless otherwise specified, at least 23 valves shall be required for initial sample approval and release testing to this procedure.

3.3.2 The submitted test samples are expected to represent the entire scale of parameters found within the tolerance range of production.

3.3.3 Test selection and number of test pieces for inspection testing shall be agreed upon between responsible engineering and supplier. In arbitrary cases, it is up to the decision of the GM engineer to require complete comprehensive release testing.

3.4 Test Time. Test time dependent on sample size and testing requested. Estimated times below:

	Check Valves	Pressure Regulator Valve (PRV) Membranes
Calendar time:	240 days	60 days
Test hours:	1500 hours	300 hours
Coordination hours:	40 hours	40 hours

3.5 Test Required Information. The tests shall be carried out in accordance with the test schedule in Tables A1 and A2, Appendix A. Tests shall be performed in the prescribed order.

3.6 Personnel/Skills. Lab measurement personnel must have experience using this technique, an acquired skill through application. Experienced personnel is recommended.

4 Procedure

4.1 Preparation. Inspect the sample valves according to 4.1.1 through 4.1.3. Record findings in the test record. Samples not conforming should be tested only after approval by the Design Engineer.

4.1.1 Materials. All materials used for the valves shall comply with the drawing specifications and release data. If single parts of the valve consist of material which is prone to stress cracks, such as polyamide, these shall be protected against contact with zinc ions. Materials used must meet the requirements of GMW3059 Restricted and Reportable Substances for Parts.

4.1.2 Coding. The date of manufacture, the manufacturer's symbol, and an indication of the direction of air flow shall be shown at a suitable position on the valve. All markings shall be readily legible and permanent.

4.1.3 Visual Inspection and Dimensional Test. In the as-received condition, the valves shall not have any visible damage or defects which would adversely affect the function or appearance. The body interior shall not contain contamination, such as material residues, dirt, etc., which could lead to malfunction. The valves shall comply with the dimensions and tolerances specified in the drawings or releases. Non-conforming parts shall be removed from the test matrix and replaced with conforming parts to complete the minimum part quantity requirement.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless otherwise specified, testing shall be performed at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

4.2.1.1 Unless otherwise specified in the instructions for individual tests, testing shall be performed in the as-received condition at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ without conditioning.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

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4.3 Instructions. Follow the sequence of testing for each of the test valves as shown in Tables A1 and A2, Appendix A. This section describes the individual tests that are specified. As shown in Tables A1 and A2, Appendix A, each valve sample is subjected to only some of the tests. Refer to the test work order which should specify the number of valves to be tested and which test sequence to use for each valve.

4.3.1 PCV Drain Valve and Check Valve Tests (Table A1, Appendix A, for Test Matrix).

4.3.1.1 Opening Pressure Test. Reference Figure A2, Appendix A for test setup. The valve must open, and in its opening direction, per the flow characteristic defined in the Table 1, within 0.5 s after applying a vacuum of 0.3 kPa.

Table 1: Valve Flow Characteristics

Check Valve	Primary	Secondary	Fresh Air	Oil Drain
Opening Pressure Test Minimum Flow Rate	> 10 L/minute	> 10 L/minute	> 10 L/minute	> 1 L/minute
Pressure	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa

4.3.1.2 Closing Test. After opening, the valve must re-close within 0.5 s after applying a vacuum of 0.3 kPa without exceeding 30 L/minute flow (see Figure A5, Appendix A). Reference Table 1 for leak rate criteria. Reference Table 2 for maximum allowable leakage rates.

Table 2: Maximum Allowable Leakage Rates

Check Valve	Primary	Secondary	Fresh Air	Oil Drain
Leak rate in Check Direction	< 1 L/minute	< 1 L/minute	< 1 L/minute	< 1 L/minute
Pressure	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa	0.3 kPa ± 0.05 kPa

4.3.1.3 Leakage of the Check Valve Under Vacuum Test. With the aid of a vacuum generator, the pressure in the vessel shall be set to the values in Table 3 and held for 5 minutes (see Figure A5, Appendix A). The test shall be performed at +23 °C ± 5 °C. Measure the initial pressure at time zero (0) and the final pressure at time 5 minutes and the respective leak rates.

Table 3: Check Valve Leakage Under Vacuum

Check Valve	Primary						Secondary		Fresh Air		Oil Drain	
Leak rate in Check Direction (L/minute)	≤ 3.0	≤ 1.2	≤ 0.9	≤ 0.5	≤ 0.25	≤ 0.2	≤ 0.3	≤ 0.2	≤ 0.2	≤ 0.1	≤ 0.2	≤ 0.1
Δp ± 10% (kPa)	275	100	70	30	5	0.1	10	0.1	10	0.1	10	0.1

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4.3.1.4 Check Valve Flow Rate. Reference Table 4. Also reference Figure A1, Appendix A for Oil Drain.

Table 4: Check Valve Flow Rate

Check Valve	Primary	Secondary	Fresh Air		Oil Drain
Flow (L/minute)	> 100	> 100	> 100	> 50	> 1
At Δp (kPa)	1.1	0.9	3.0	1.0	0.05

4.3.1.5 Check Valve Cyclic Durability Test (Primary, Secondary, Fresh Air, Oil Drain).

4.3.1.5.1 Temperature profile: 12 h cycle (see Figure A4, Appendix A).

- $-40\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$, 2.5 h.
- $100\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$, 3.5 h.
- $150\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$, 4 h.
- Remainder is temperature transition time.

4.3.1.5.2 Humidity: Humidity of the air flow applied internally to the test piece, minimum 95% at $100\text{ }^{\circ}\text{C}$.

4.3.1.5.3 Frequency: 10 Hz for flow/check cycle. It is mandatory that the valve opens and closes completely in one (1) cycle. Frequency may be modified providing supplier demonstrates that the frequency allows complete opening and closing of the valve in one (1) cycle.

4.3.1.5.4 Closing and opening pressures as measured in the membrane housing and monitored during the complete test duration.

- Primary check valve: Flow with a Δp , 90 kPa; check with a Δp , 210 kPa.
- Secondary check valve: Flow and check with a Δp , 25 kPa.
- Fresh air: Flow and check with a Δp , ± 10 kPa.
- Oil drain: Flow and check (typical opening Δp , 5 kPa; closing Δp , 15 kPa).

4.3.1.5.5 Each check valve is wetted once daily with BMW Worst Case Used Oil (WCUO) for 1 h on surfaces that are exposed to the blowby gases.

4.3.1.5.6 Number of cycles: 200×10^6 (240 days at 10 Hz).

During the durability test, base valve performance checks (4.3.1.1, 4.3.1.2, 4.3.1.3, and 4.3.1.4) shall be performed at 50 000 000, 100 000 000, and 150 000 000 cycle test points.

The check valves shall not produce any abnormal noises such as whistling, rattling, etc.

4.3.1.6 Excess Pressure Test. The check valves shall be subjected to excess pressure using the test arrangement in Figure A5, Appendix A. The check valve body is exposed to 1000 kPa for a duration of 10 s. If actual backfire pressure data is available, a measured value may be substituted for the 1000 kPa value. Upon completion, continue the test sequence.

4.3.1.7 Temperature Exposure Test. Check valves shall twice undergo the cycle:

- Four (4) h at $+170\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$ followed by 20 h at $-40\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.
- After being warmed to $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, continue the test sequence.

4.3.1.8 Storage in Fuel Test. Check valves shall be stored in fuel as follows:

- Seventy-two (72) h at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ storage in regional use fuel per GMW14914.
- After, the valve is allowed to drip dry through both openings for 10 minutes and then dried for 2 h at $+90\text{ }^{\circ}\text{C} \pm 2.5\text{ }^{\circ}\text{C}$.
- Upon completion, continue the test sequence.

4.3.1.9 Exposure To Worst Case Used Oil. Check valves shall be exposed as follows:

- Seventy-two (72) h at $+23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ exposure to BMW WCUO on surfaces that are exposed to the blowby gases.

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