



Rubber Coated Metal Nitrogen Sealability 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. Measure the nitrogen leak rate in standard cubic centimeters per minute (SCCM) at the measured clamp load in kiloNewtons (kN) of Rubber Coated Metal (RCM). Continue load measurements until the leak rate reaches the specified cubic centimeters per minute minimum. Nitrogen leak sensitivity is not a direct measure of fluid sealing performance. It is more sensitive to mating joint surface to gasket coating conformability and suitable for defining minimum sealing design load.

1.2 Applicability. Characterization of the load required to seal at a specified surface finish. The use of this information may be compared to the surface finish and joint load needed by production joints. Machined joint surface finishes will be different between transmission and engine at a component or part level.

1.2.1 Method A – Pressure Decay. Measure the candidate to specific application leak rate (print or bill of material designated). Test pressure and fixture finish conditions are specified by the test requester. If no information is provided the default finish is used capturing the load in kiloNewtons (kN) required to reach 0.10 SCCM at 6 bar pressure for engines. This method is used where the mating joint surface finish, internal pressure and flange pressure of production application are known. See Table 1.

1.2.2 Method B – Minimum Sealing Load Characterization. This method allows the surface finish limit bracketing of RCM for nitrogen sealing capability. It applies to new products/sources to better determine the optimum surface condition for that RCM. The surface finish performance range will vary by product and source. Using Table 1, the Rz measurement is made using the minimum sealing load starting at 3 μ m and continuing in micrometer steps through a given surface finish and coating thickness to reach the sealing target. Use the test pressure following 4.3.13 requirements. The boundary condition is found using multiple test fixture finishes in micrometers with the appropriate roughness average (Ra), and average maximum height of the profile (Rz).

1.3 Remarks.

1.3.1 The default finish method used here (Table 1) may not represent the production machining process or finish roughness variation. The information will assist for comparative purposes and general design knowledge.

1.3.2 Euclid Machine and Manufacturing Co. is a local supplier that will build and machine these test fixtures.

2 References

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

2.1 External Standards/Specifications.

ASTM A600	ASTM E4	ISO 4287	SAE J438
ASTM A681	DIN 1.2379	ISO 7500-1	
ASTM D412	DIN 1.3343	SAE J437	

2.2 GM Standards/Specifications.

9985283	GMW16676	GMW17294
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2.3 Additional References.

- American Gas & Chemical Company, Limited, Northvale, New Jersey (www.amgas.com)
- Cincinnati Test Systems (CTS), Harrison, Ohio (www.cincinnati-test.com)

- Cosmo Instruments Co. Ltd., 2974-23, Ishikawa, Hachioji, Tokyo, Japan, (<https://www.cosmo-k.co.jp/english>)
- Euclid Machine and Manufacturing Co., 29030 Northline Road, Romulus, MI 48174
- Fukuda, 2721 Pioneer Drive, Bowling Green, KY 42101, USA (<http://www.fukuda-us.com>)
- GM Global Propulsion Systems Assembly, Sealing and Fastening Bill of Material Level III Tolerances and Datums
- Mitutoyo America Corporation, 965 Corporate Boulevard Aurora, Illinois 60502
- Swagelok Company, Solon, Ohio (www.swagelok.com) with authorized service centers globally.

3 Resources

3.1 Facilities.

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 Mechanical Load Frame. See ASTM D412 apparatus description as a reference. Tests are made on a power-driven machine equipped to produce a uniform rate of applied load that allows 1% strain/s in the test specimen. The testing machine must have a suitable dynamometer and indicating or recording system for measuring the applied force. The applied force is within $\pm 1\%$ of readings throughout the entire range of testing (to normalize readings).

3.2.1.1 Load Cell. A 50 kN capacity load cell, with a load accuracy of $\pm 1\%$ or less, meeting ISO 7500-1 and ASTM E4 standards is adequate for flat specimen RCM measurements. The load cell manufacturer specified accuracy is the maximum variation, however, calibration can be made over a specified lower load range bandwidth with improved accuracy down to $\pm 0.2\%$ if needed. Select the load cell whose maximum load rating is not exceeded by the measured compression. The 50 kN range may be exceeded (to 60 kN or 70 kN) if half embossed specimens (versus flat) are used. A range of 100 kN may be required for full embossment, full hard metal substrates.

3.2.2 Pressure Decay Tester. Unit for measuring pressure flow and decay changes in the test fixture. Accuracy at 0.64 SCCM flow and 690 kPa (100 psig) pressure is ± 0.10 SCCM. Recommended unit that meets the requirements is Cincinnati Test Systems (CTS) I-28 (not available in Japan). Others including the Fukuda "FL611MC-02-01-02-02-NN-NN" (high-pressure testing Compatible type) are also capable. Units measuring in bar or pounds per square inch may have a calibrated standard converting to SCCM, or read in SCCM.

3.2.3 Nitrogen Source. Compressed gas tank intended for nitrogen.

3.2.3.1 Nitrogen Pressure Regulator for Tank. Pressure range/scale (13.8 MPa (2000 psig)).

3.2.3.2 Pressurized Gas Line Tubing. Gauge with treaded end fittings.

3.2.3.3 Flow Meter. Verify gas flow to the levels indicated. Cosmo Instruments Digital flowmeter "DF-2820" meets the requirements.

3.2.3.4 Pressure Gauge. Pressure range (6.9 kPa to 1034 kPa (1 psig to 150 psig)) for flow control setting.

3.2.3.5 Leak Detection. Use a handheld smoke generator provided the test environment is free of interfering air currents. Liquid application using a leak detection solution to produce visible bubbles is also used.

3.2.3.5.1 Liquid Leak Detectors. Soap and water has low sensitivity and tends to obscure small leaks by foaming when applied. The following are recommended:

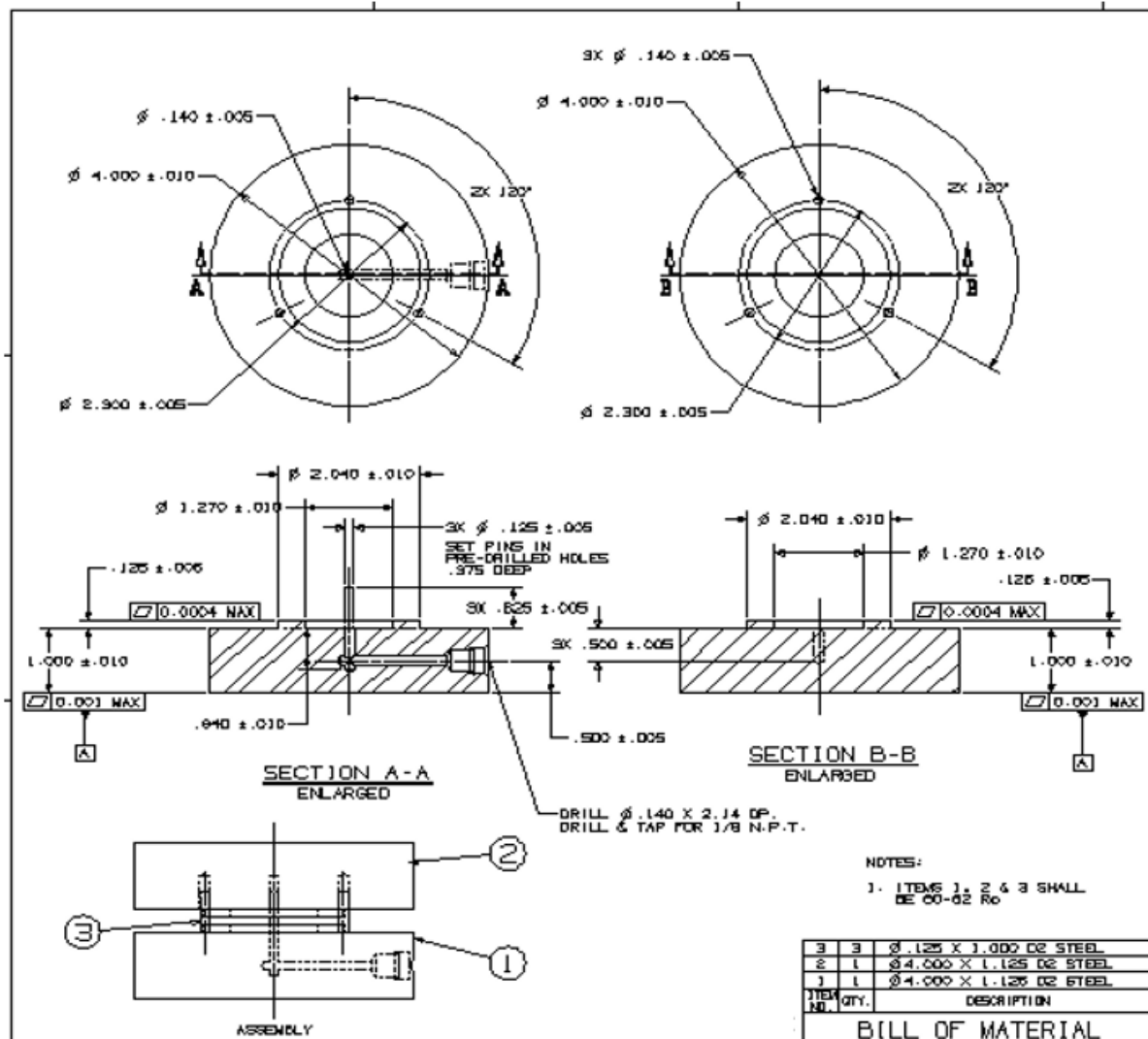
- a. Leak-Tec Thin Film Bubble Testing Solution, Source: American Gas & Chemical Company, Limited.
- b. Leak-Tec formulas consist of mixtures of stable synthetic surfactants with low surface tension and low interfacial tension on metals, whether clean, tarnished, oily or covered with oxidation products. Solutions conform to ASTM E515.
- c. Formulations:
- d. 72V for vacuum and high pressure from +2 °C to +77 °C (sensitivity: 5×10^{-4} cm³/s)

- e. 372E general purpose use from +2 °C to +71 °C (sensitivity: $1 \times 10^{-5} \text{ cm}^3/\text{s}$)
 f. Real Cool Snoop Liquid Leak Detector, Source: Swagelok, -54 °C to +93 °C

3.2.4 Test Fixture. Use American Iron and Steel Institute (AISI) M-2 high strength (ASTM A600, DIN 1.3343 or SAE J437) or hardened AISI D-2 (ASTM A681, DIN 1.2379, or SAE J437, SAE J438) steel, Rockwell C (Rc) 60 hardness to 62 hardness. The test fixture material was selected for maximum durability between mating surface refinishing given the majority of test specimens are full hard 301 stainless steel. Aluminum and cast iron fixtures give similar test results when new but wear out faster. See Figure A1, item J in Appendix A.

3.2.4.1 Fixture Dimensions. All dimension tolerances are $\pm 0.2 \text{ mm}$. See Figure 1.

Figure 1: Top and Side View of Leak Test Fixture Base with Specimen Platform



✓ Ra 1.4
Rz1max 14 / Rz 11
Wt 14

Horizontal milled surfaces

3.2.4.2 Base Modifications.

3.2.4.2.1 The upper and lower halves are machined so a 51.8 mm Outer Diameter (OD) × 32.3 mm Inner Diameter (ID) × 3.0 mm high shelf protrudes up from the surface. The test specimen lays on this shelf protrusion.

3.2.4.2.2 A 3.2 mm diameter gas entry port is drilled in the center ID of the protrusion. It is jointed with a side channel of identical size. The hole is drilled, tap threaded to permit a quick connect fitting. The CTS I-28 unit line uses a 3.175 mm ($\frac{1}{8}$ in) National Pipe Taper (NPT) connect fitting. Other sizes may be accommodated depending on the gas tubing line size.

3.2.4.2.3 Fixture Alignment Pins. Three (3) solid pins, 3.1 mm to 3.2 mm diameter, and 8 mm to 14 mm in length, spaced 120 degrees apart, at a 29.2 mm radial distance from the lower fixture center point. The upper fixture has three (3) holes matched to fit over these pins at closure. The pin may be AISI 1022 low carbon steel, work hardened to 480 MPa tensile strength, or AISI 6150 heat treated to a hardness of Rc, 43 to 49, with a corresponding tensile strength of 1620 MPa.

3.2.4.3 Upper and Lower Test Fixture Surface Finish. Horizontal mill machine the test surface with a precision surface grinder. A Computer Numerical Control (CNC) precision surface grinder with repeatability and positioning accuracy of 0.0025 mm capable of achieving the surface finish parameters in Table 1 can be used.

Table 1: Fixture Surface Finish Parameters by Test Method

Method	Ra (micrometers)	Allowable Range to maintain Ra/Rz Ratio (0.10 to 0.17) micrometers	Rz (micrometers) Controlling Machining Measurement	Allowable Range to maintain Ra/Rz Ratio (0.10 to 0.17) micrometers
A	As specified		As specified	As specified
Default	1.4	1.3 to 1.5	11	8 to 15
Method	Ref. Ra (micrometers)	Reference Range (micrometers)	Target Rz (micrometers)	Target (micrometers)
B	0.5	0.4 to 0.6	3	2.5 to 3.5
	0.9	0.8 to 1.0	6	5 to 9
	1.4	1.3 to 1.5	11	8 to 15
	1.9	1.8 to 2.0	17	11 to 20
	3.0	2.9 to 3.1	22	17 to 31

The default condition is used for Method A if none is provided for the end use application. Measurements are recorded per GMW16676. Machine a horizontal mill across the circular fixture halves. Unless otherwise specified, all Table 1 numbers are maximums. The as specified values may be a range (upper to lower).

3.2.4.4 Test Fixture Surface Finish Life. Surface finish shall be rechecked every 50 tests to Table 1 requirements. Non-compliant dimensions, or any damage to the fixture, creating potential surface leak paths or adversely affecting test results, shall be reworked or discarded.

3.2.4.5 Surface Measurement Equipment. The Mitutoyo Surftest SJ410 (Series 178) portable surface roughness tester is a suitable device for verifying test fixture machined surface measurements.

3.3 Test Vehicle/Test Piece. Dual sided rubber coated metal washer, 29 mm ID and 54 mm OD. Dimension tolerances are ± 0.1 mm. The thickness varies with the supplied product. The specimen is slightly oversized for the machined platform shelf to eliminate edge cutting or distortion influencing the readings.

3.4 Test Time. Times are based on a single run of specimens prepared from sheet or roll form, including procurement, preparation and reporting of results.

Calendar time: 2 to 4 days

Test time: 1 h

Coordination time: 6 h to 48 h

3.5 Test Required Information.

3.5.1 Method A – Leak Decay. The test requester is responsible for supplying the mating joint surface finish, internal pressure and flange pressure of the production intent application. If no information is provided use the