SEMI F101-1105 (Reapproved 1111)
TEST METHODS FOR DETERMINING PRESSURE REGULATOR PERFORMANCE IN GAS DISTRIBUTION SYSTEMS

This Standard was technically approved by the Gases Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on September 12, 2011. Available at www.semiviews.org and www.semi.org in November 2011; originally published November 2005.

NOTICE: This Document was reapproved with minor editorial changes.

SUPERSEDED

1 Purpose

1.1 The purpose of this Document is to define a method for testing pressure regulators being considered for installation into gas systems. Application of this Test Method is expected to yield comparable data among regulators tested for qualification purposes.

1.2 This Document establishes a test method for quantifying regulator performance characteristics.

2 Scope

2.1 This Test Method applies to pressure regulators. The test procedures that measure these characteristics are intended to be performed sequentially, in the order given below. This Document specifies test methods, which will allow the regulator manufacturer or user to determine regulator performance for the following characteristics:

- Particle Count
- Leakage
- Creep/Lock up
- Supply Pressure Effect
- Resolution
- Pressure vs. Flow Curve, Hysteresis Curve, and Operating Hysteresis Value
- Repeatability
- Set pressure Stability
- Step Function Transient Response
- Resonance
- Flow Coefficient
- Excess Pressure
- Endurance

2.2 This Test Method provides a common basis for communication between manufacturers and users.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 Because it is not practical to evaluate performance under all possible combinations of operating conditions, this Test Method should be applied under laboratory conditions. Its intent is to collect sufficient data to form a judgment of the field performance of the regulator being tested.

Documents Document Sharing Hub

Full document details: SEMI F101-1105-1111R

4 Reference Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI F1 — Specification for Leak Integrity of High-Purity Gas Piping Systems and Components

SEMI F32 — Test Method for Determination of Flow Coefficient in High Purity Shutoff Valves

4.2 *CGA Standard*[1]

CGA E4 — Standard for Gas Pressure Regulators

4.3 *SEMATECH Document*[2]

SEMASPEC 93021510ASTD — Test Method for Determination of Particle Contribution by Regulators in Gas Distribution Systems

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

NOTE 1: For a graphic description of the following terms, refer to Figure 1, Typical Pressure Regulator Flow Curve, Figure 2, Lockup and Creep Pressure, and Figure 3, Typical Pressure Regulator Set Pressure Stability.

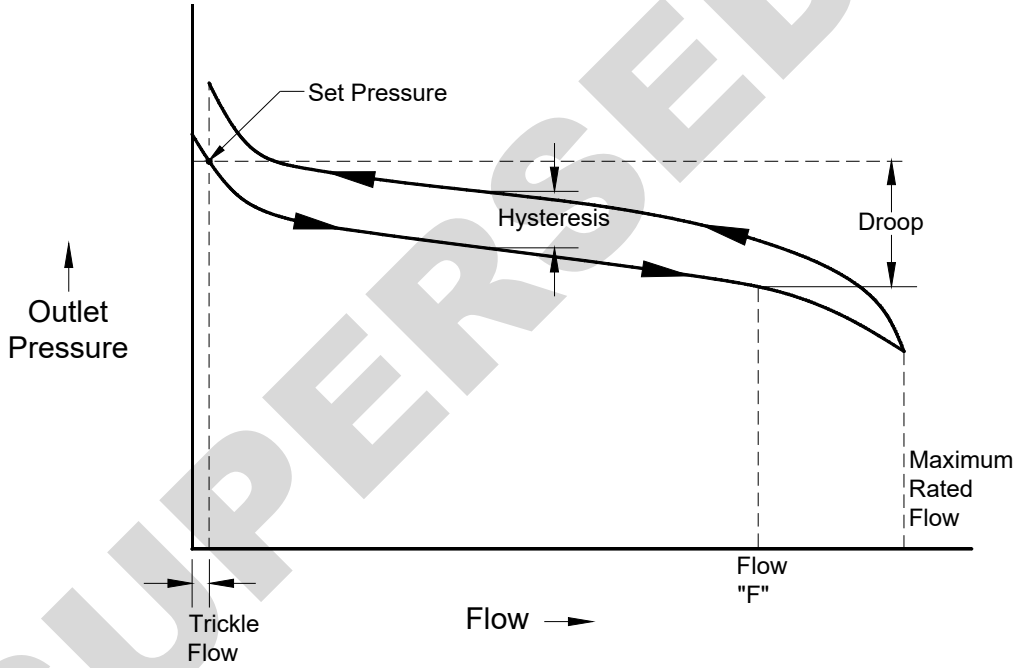

Figure 1
Typical Pressure Regulator Flow Curve

[1] Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151, USA; Telephone: +1.703.788.2700, Fax: +1.703.961.1831, http://www.cganet.com

[2] SEMATECH, 257 Fuller Road, Suite 2200, Albany, NY 12203, USA; Telephone: +1.518.649.1000, http://www.sematech.org

SUPERSEDED
Documents
Document Sharing Hub
Full document details: SEMI F101-1105-1111R

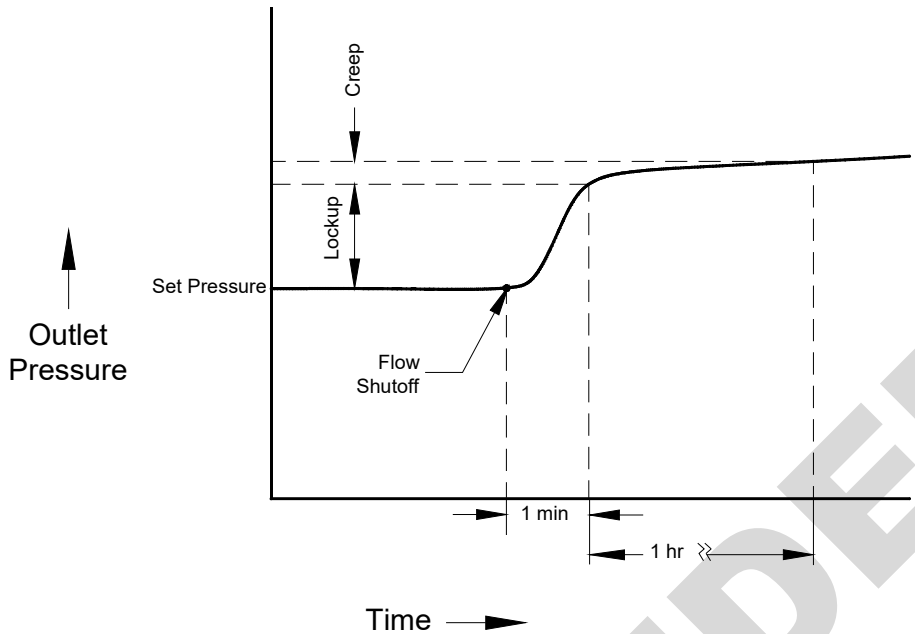

Figure 2
Lockup and Creep Pressure

5.1 *Abbreviations and Acronyms*

5.1.1 *CDA* — clean dry air

5.1.2 *DUT* — device under test

5.1.3 *kPa* — 1000 newtons per square meter

5.1.4 *MIRP* — maximum inlet rated pressure (as specified by the manufacturer)

5.1.5 *MORP* — maximum outlet rated pressure (as specified by the manufacturer)

5.1.6 *psi* — pounds per square inch

5.1.7 *psia* — pounds per square inch absolute

5.1.8 *psid* — pounds per square inch differential

5.1.9 *psig* — pounds per square inch gauge

5.1.10 *sccm* — standard cubic centimeters per minute (at 101.3 kPa, 0.0°C [14.73 psia, 32°F])

5.1.11 *scfm* — standard cubic feet per minute (at 101.3 kPa, 0.0°C [14.73 psia, 32°F])

5.1.12 *slpm* — standard liters per minute (at 101.3 kPa, 0.0°C [14.73 psia, 32°F])

5.1.13 *SPE* — supply pressure effect

5.2 *Definitions*

5.2.1 *creep* — a measurement of the seating action of the regulator.

5.2.1.1 *Discussion* — Creep is a continuing rise of pressure due to an internal leak across the seat, after downstream flow is shut off. Creep over a period of time is the increase of the outlet pressure above the lockup pressure during that time as shown in Figure 2. Typically creep is the pressure rise above lockup pressure as measured after 1 hour, minimum.

5.2.2 *droop* — the pressure drop between two flows (as shown in Figure 1).

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI F101-1105-1111R

5.2.3 *flow coefficient, Cv* — the flow capacity of an orifice or a valve or other component in a fluid handling system (as determined by SEMI F32).

5.2.3.1 *Discussion* — A maximum Cv for a component generally occurs when the component is in the full open position. Generally if a regulator is in the full open position it is then not functioning as a regulator but as a valve. One must be careful in only using the flow coefficient in sizing a regulator. It is recommended that flow curves be used as a primary source for sizing a regulator.

5.2.4 *hysteresis* — the pressure difference between readings, taken as flow is increased from a prescribed minimum to a prescribed maximum, and the pressure as the flow is decreased back to the prescribed minimum.

5.2.4.1 *Discussion* — The hysteresis value is the maximum difference observed between increasing and decreasing flow curves at a given flow, as shown in Figure 1.

5.2.5 *lockup* — the outlet pressure increase which occurs above the set pressure after flow shutoff.

5.2.5.1 *Discussion* — Typically lockup is the pressure rise above set pressure as measured 1 minute after flow shutoff, as shown in Figure 2.

5.2.6 *MRF-maximum rated flow* — a recommended flow rate specified by the manufacturer.

5.2.6.1 *Discussion* — This value is typically within the control range of the regulator (see Figure 1).

5.2.7 *repeatability* — the ability of a regulator to return to the same pressure after termination and restart of flow.

5.2.8 *resolution* — the change in the outlet pressure as the adjustment screw is adjusted at a no flow condition.

5.2.9 *resonance* — internal regulator oscillation identified as either a fluctuating outlet pressure, or an audible noise noticeably louder than typical regulator sound level.

5.2.10 *set pressure* — desired pressure level as set by user for a given flow.

5.2.11 *set pressure sensitivity* — the minimum pressure increment that can be repeatedly set on a regulator.

5.2.12 *set pressure stability* — the variation in the outlet pressure that occurs under steady state conditions, within the control range of a regulator. See Figure 3.

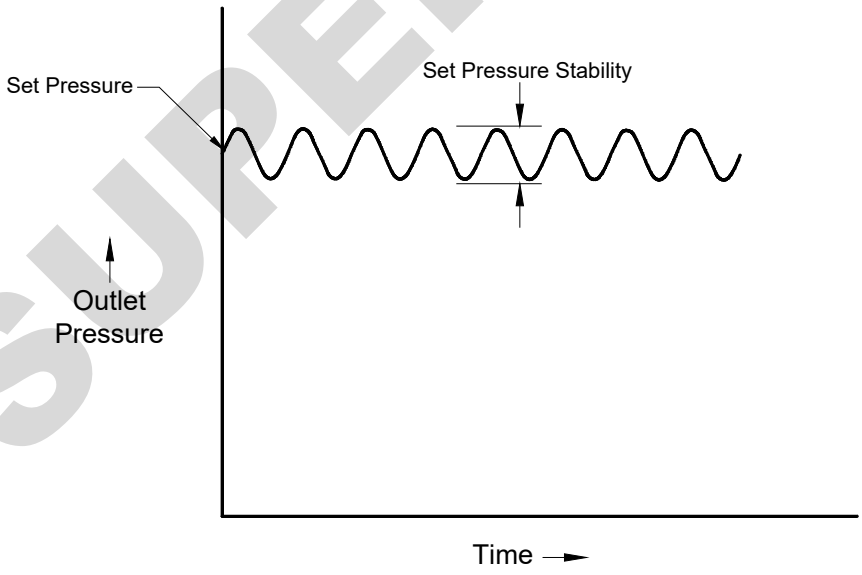

Figure 3
Typical Pressure Regulator Set Pressure Stability

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI F101-1105-1111R

5.2.13 *step function transient response* — outlet pressure vs. time when rapidly switching between two different flow rates.

5.2.14 *supply pressure effect (SPE)* — the effect of an inlet pressure change on the outlet pressure of a regulator.

5.2.14.1 *Discussion* — Typically, supply pressure effect is reported as the change of outlet pressure per 100 psi change of inlet pressure.

5.2.15 *trickle flow* — a small amount of gas flow used to set test regulator outlet pressure (approx. 200 sccm).

6 Test Apparatus and Conditions

6.1 *Test Conditions*

6.1.1 Test pressure is incremental up to the maximum inlet rated pressure (MIRP) of the regulator.

6.1.2 Tests are to be conducted at a room temperature maintained between 18°C (64°F) and 26°C (78°F). Environmental temperature fluctuations within this range are not expected to have any measurable effect on the test results.

6.1.3 *Test Gas* — Nitrogen or CDA, filtered with a 0.05 micrometer rated pore size filter, minimum.

6.1.4 All flow settings shall be within ±5% of specified value unless otherwise specified in the procedure.

6.1.5 All flows should be compensated for pressure and temperature into standard conditions.

6.1.6 Data acquisition must be able to sample and record pressure (P) and time (t) at a rate of 50 milliseconds, or faster.

6.1.7 Pressure measurement devices shall have an accuracy of 2% of reading or better.

6.2 *Test Setup*

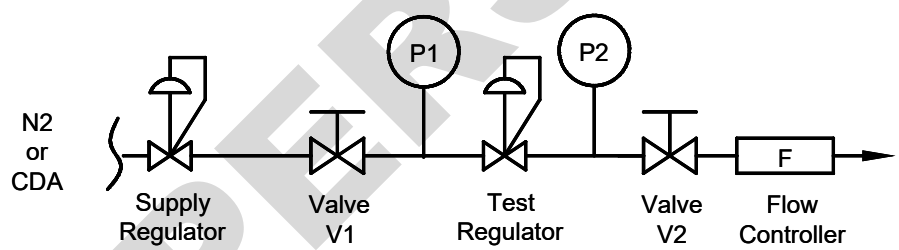

Figure 4
Test Setup, Standard Functional Tests

6.2.1 For each of the standard functional tests specified by this Document, use the schematic shown in Figure 4 to assemble the test apparatus. For the sub-atmospheric test and step function transient response test use the test apparatus specified in the appropriate section.

6.2.2 The standard test set up should consist of (connected in series): a supply regulator, supply shutoff valve V1 (is recommended), pressure monitoring device, test regulator, pressure monitoring device, shutoff (or throttling) valve V2, and flow controller (or flow measuring device). Note all flows should be compensated for pressure into standard conditions.

6.2.3 The total volume between the outlet of the device under test (DUT) and the inlet of the downstream isolation valve (valve nomenclature varies per test setup), (including gauges and fittings) shall be less than 25 cc for ¼ inch (or smaller) components. For components greater than ¼ inch, the equivalent maximum volume can be determined by multiplying the cross sectional area of the components by the volume 25 cc and dividing by the ¼ inch cross sectional area.

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI F101-1105-1111R