PT 112
Product validation testing
June 16, 2026

Overview

Product testing to determine whether a newly designed product meets specifications is termed validation testing. It is a rigorous battery of tests to which, as the name implies, validates that the product meets design goals and industry requirements in addition to performance. Testing standards are per CGA, SEMI, ASME and ASTM guidelines. Products meet all applicable regulations from said agencies and specific references are only made for clarification. Test procedures document test protocols. Validation testing is differentiated from production testing, which is testing to have confidence that the product meets the specifications derived from validation testing.

Validation testing varies by product type, as the requirements are generally different for example between a pressure regulator (regulator) and shut off valve (valve). The testing within a product group is consistent.

Rather than create a test document per product, this document outlines the testing performed and the data sheet presents the guaranteed specifications derived from testing. It must be noted that not all testing results in a published specification in a data sheet. The tests are not necessarily listed in the sequence performed to validate a product.

Please refer to Pure T product testing specifications for further details in addition to SEMI and CGA referenced testing guidelines.

Testing general comments

The typical number of devices tested is a minimum of six (6) units for any given test. Testing is generally to a goal meaning not tested beyond test specification or until failure. However, testing to a safety factor above specification, such as in the case of a leak rate, is done when appropriate.

Pressure testing

Static pressure testing to rated operating pressures is performed to verify gross leak integrity and basic function, such as pressure regulation or shut off.

Proof pressure testing is testing to 150% (1 ½ times) operating pressure. The

product must contain the pressure without leaks and function after testing, though not necessarily as new. A pressure regulator has two operating pressures, an inlet and outlet, which means that two different pressures are applied. Pure T test procedure PTTP 0019

Burst pressure testing is to 300% (3 times) operating pressure. The product must contain the pressure without deformation or throwing parts, though a leak is acceptable. The product does not need to function after burst testing. A pressure regulator has two operating pressures, inlet and outlet, which means that two different pressures are applied. Pure T test procedure PTTP 0019

Regulator reverse pressure test is a safety test for the possibility of connecting a regulator backwards. Maximum rated inlet pressure is applied to the outlet of a regulator. As with burst testing, the regulator must not deform or throw parts, though it may leak and does not need to function after the test. Pure T test procedure PTTP 0019

Regulator supply pressure effect (SPE) is the change in outlet pressure as a function of the change in inlet pressure. It is tested by monitoring the outlet pressure change as the inlet pressure is varied. Pure T test procedure PTTP 0004

Valve pneumatic actuator pressure rating is tested to confirm that the valve is fully open at the minimum rated actuator operating pressure. The maximum rating is determined by design and verified by testing. The actuator seals must be bubble tight within rated operating pressures.

Flow testing

Cv testing is performed per SEMI standards for gases. The numerical value correlates to flow capacity as defined. Pure T test procedure PTTP 0002

Flow curves for regulators are generated with appropriate inlet and outlet pressures for the device. Select flow curves are published in the data sheets. Pure T test procedure PTTP 0003

Hysteresis for regulators is tested by plotting two curves with increasing and then decreasing flows and the same pressures. The difference between the curves is the hysteresis value. Pure T test procedure PTTP 0010

Stability for regulators is tested by monitoring outlet pressure with a steady state flow for a specified period of time. Pure T test procedure PTTP 0006

Resonance for regulators is tested throughout the usable flow range of the device. The regulator is tested a various pressures varying the minimum to maximum flow of the device to verify that the regulator does not become unstable or make noise throughout the range. Pure T test procedure PTTP 0009

He leak testing

Inboard He leak testing is performed per SEMI standards. The leak detector pulls vacuum on the device which is capped and wide open while He is sprayed to the exterior. Pure T test procedure PTTP 0014

Outboard He leak testing is performed with a bell jar per SEMI standards. The device is wide open with outlets capped and pressurized to an appropriate pressure with He while in a vacuum chamber (bell jar) with vacuum pulled by the leak detector. Pure T test procedure PTTP 0017

Across the seat He leak test is performed in a bell jar to SEMI standards. The device is fully closed with outlet not capped in a vacuum chamber (bell jar). The leak detector pulls vacuum and the device is pressurized with an appropriate pressure of He. Pure T test procedure PTTP 0017

It must be noted that He leak testing a pressure regulator across the seat can only be performed via outboard method, either in a bell jar or with a sniffer probe. He leak testing results from an inboard method to testing are inconclusive whether vacuum is pulled from the outlet or inlet of the regulator.

Regulator N2 across the seat testing

Regulators are tested across the seat with N2 in addition to a He leak test. The regulator is adjusted to a mid-range outlet pressure and has a low flow for the test. A valve is closely coupled downstream for flow shut off. Two pressure values are monitored, lock up and creep.

Lock up is the pressure rise in the initial one minute from flow stopping. It measures in essence the ability of the regulator internal valve mechanism to close. The acceptable lock varies by regulator size and type. Pure T test procedure PTTP 0008

Creep is the amount of pressure rise after lock up, tested for next two minutes (total test time for lock and creep is three minutes). The acceptable creep varies by regulator size and type. Pure T test procedure PTTP 0008

Cycle testing

Products are subjected to cycle testing with N2. The test parameters vary by product type. Products must function properly and be leak tight, both outboard and across the seat, after testing is completed.

Regulators must pass an enhanced CGA test, cycling from vacuum to rated outlet pressure to a target goal of 10,000 cycles. This is a rigorous test as vacuum increases the stroke of the diaphragm, flexing it in the opposite way of

pressurization. Successfully passing this test indicates that the regulator will last the typical life of an installation, i.e. wafer fab, when operated properly. Pure T test procedure PTTP 0011

Valves are cycled dead ended, pressure trapped, to rated pressure. The number of cycles varies by valve type, with a manual valve being in the range of 10,000 cycles whereas low pressure pneumatic valve will be in the millions of cycles and high-pressure pneumatic valves 30,000 cycles. Pure T test procedures PTTP 0022, 0024

Other devices are cycled based upon the product type. Flow switches, for example, are cycled to trip 100,000 times. Pure T test procedure PTTP 0045

Temperature testing

Operating temperatures, minimum and maximum, are determined by a product's design and materials of construction. For example, a given seat material or O ring seal will have a temperature rating based upon the application. Products are tested to both minimum and maximum temperatures for function. Leak integrity and final function are verified at ambient temperature after the device has been subjected to minimum and maximum temperatures. Pure T test procedure PTTP 0016

Particle testing

Regulators are tested for particle generation using a laser particle measurement tool with 0.1 µm sensitivity per SEMI guidelines using N2. Pure T test procedure PTTP 0044

Moisture testing

Devices are tested for moisture dry down time using SEMI guidelines. The device is exposed to atmosphere for a period of time prior to being connected to the test system for dry down. N2 flows through the device to remove moisture and the moisture level is monitored. The test verifies that the device is able to dry down in a given amount of time. Pure T test procedure PTTP 0046

Internal volume

The internal volume of a device is determined using 3D modeling. The volume includes typical connections. The volume can also be determined by filling the device with water and then measuring the volume of water.

Operating characteristics

A variety of other tests are also performed to ensure that products will operate properly. The following are a few examples:

Pressure regulator adjustment is tested for knob torque and number of turns from initial pressure to maximum. The required torque to adjust pressure must be comfortable to turn by hand without tools. The number of full turns from starting to deliver pressure to the maximum must be at least five (5) for ease of fine adjustment.

The pressure change must also be smooth, free of incremental jumps, as the knob is adjusted to either increase or decrease the pressure. Pure T test procedure PTTP 0005

Manual valve operation the required torque to close the valve at full rated pressure must be comfortable for the hand and without tools.

Pneumatic valve operation verified that the valve is fully open at the minimum actuation pressure (as previously noted) and in some cases response time to open and close is measured.

Standards and regulatory compliance

Various regions of the world have specific product requirements and regulations from governmental agencies. In addition to meeting industry requirements of SEMI, CGA, ASME and ASTM, the validation process also ensures compliance with regulations for all the regions the product being tested is intended to be sold. The following is a list[1] of standards and regulatory requirements Pure T products conform and comply with:

ATEX (Explosive atmospheres) 2014/34/EU
PED (Pressure Equipment Directive) 2014/68/EU
CGA-E-4-2010
Semi Standards: F1, F19, F20, F32, F70, F73, F81, F86, F87, F101
China RoHS
European RoHS2

1: The list is not all inclusive as there are other standards, such as ASTM and ASME, that products also are in compliance