5475 Airport Blvd., Boulder, Colorado 80301-2339
(303) 443-7100 1-800-238-1801 FAX: (303) 449-6870
Customer Response Center: 1-877-475-3317
Instrument Service & Support: 1-800-557-6363
www.pmeasuring.com

TECHNICAL DOCUMENT REVIEW

SEMASPEC: Technology Transfer 90120390B

Determination of Particle Contribution by Valves in Gas Systems

1. Introduction

Semiconductor cleanrooms are serviced by high-purity gas distribution systems. Sematech has released a standard that presents a test method that may be applied for the evaluation of one or more valves, considered for use in such systems. The test method described in the standard is expected to give comparable data among valves tested for the purposes of qualification for this installation. The procedure utilizes a condensation nucleus counter (CNC) applied to in-line gas valves typically used in semiconductor applications. It applies to automatic and manual valves of various types (such as diaphragms or bellows), 1/4 in. through 1/2 in. in size.

The test procedure addresses total particle count greater than the minimum detection limit of the CNC and does not consider classifying data into various size ranges. If classification of particles in the size range of laser particle counter is of interest (>0.07μm), an laser particle counter can be utilized for testing components. ***However flow rates, test times, sampling, and analysis outlined in the test method does not apply for use with a particle counters*** and because of these variations, data from CNCs is not comparable to data from particle counters.

2. Test Procedure

The test is to be conducted at a normal indoor temperature and must be enclosed in a Class 100 environment

2.1 Apparatus

- 2.1.1 *Test gas*—Clean, dry nitrogen or air
- 2.1.2 *Filters*—Electronics grade filters providing "particle-free" test gas.
- 2.1.3 *Pressure regulator*—A high-purity electronics grade pressure regulator
- 2.1.4 *Pressure gauge*—A high-purity electronics grade pressure gauge
- 2.1.5 *Low-flow control device*—A high-purity electronics grade 0–10 scfm flow control device
- 2.1.6 *High-flow control device*—A high-purity electronics grade 0–30 scfm flow control device
- 2.1.7 *Tubing*—High-purity electronics grade, electro polished 316L tubing is required.
- 2.1.8 *Sampler*—The sampler is to be constructed according to the drawing and design criteria. The sampler collects gas from the stream exiting the test device, where the sample is near-isokinetic in design.
- 2.1.9 *Upstream adaptor*—The upstream adaptor piece connects tubing to the test device.
- 2.1.10 *Downstream adaptor*—The downstream adaptor piece connects tubing of the sampler to the test device.
- 2.1.11 *Spool Pieces*—of the same diameter as the fittings on the test piece.
- 2.1.12 *Fittings*— face seal connectors or compression fittings
- 2.1.13 *Gaskets*— metal gaskets for attaching the test device and adapter pieces.
- 2.1.14 *Mechanical shock device*—A weight dropped on the test device to provide a mechanical shock to the test piece.
- 2.1.15 *Actuator*—A gas-operated device connected to the valve stem to open and close the valve.
- 2.1.16 *Actuator pressure*—Minimum actuator gas line pressure, required to fully open and close the valve
- 2.1.17 *CNC* — With counting efficiency characteristics for counting ultra fine particles

2.2 Procedure

There are essentially 4 phases to testing a valve to this standard, a background test, a static test, a dynamic test and an impact test.

2.2.1 Background Test

Install the test component in a fully open position by first connecting the upstream fitting and then the downstream fitting and proper adapters are in place on the test apparatus. Extreme care should be taken to minimize contamination of the test apparatus during this operation The background count is established when the counter has sampled a minimum of 3 cfm, and the arithmetic average during the last 3 cfm of gas sampled is <2 particles/cfm. At a sample flow rate of 0.05 cfm, the time required is one hour.

2.2.2 Static Test

Set the system pressure to 30 psig. Open the pneumatic valve to establish flow. Using the flow control device set the test flow rate according to the size of components to be tested. (See table below.) The volumetric flow rate required to maintain the test velocity is calculated at the outlet of the test component. Measure the static background count. Ensure that the background counts are stable or decreasing. If background cannot be achieved after 6 cfm have been sampled, there may be a problem with the counter or test apparatus.

2.2.3 Dynamic Test

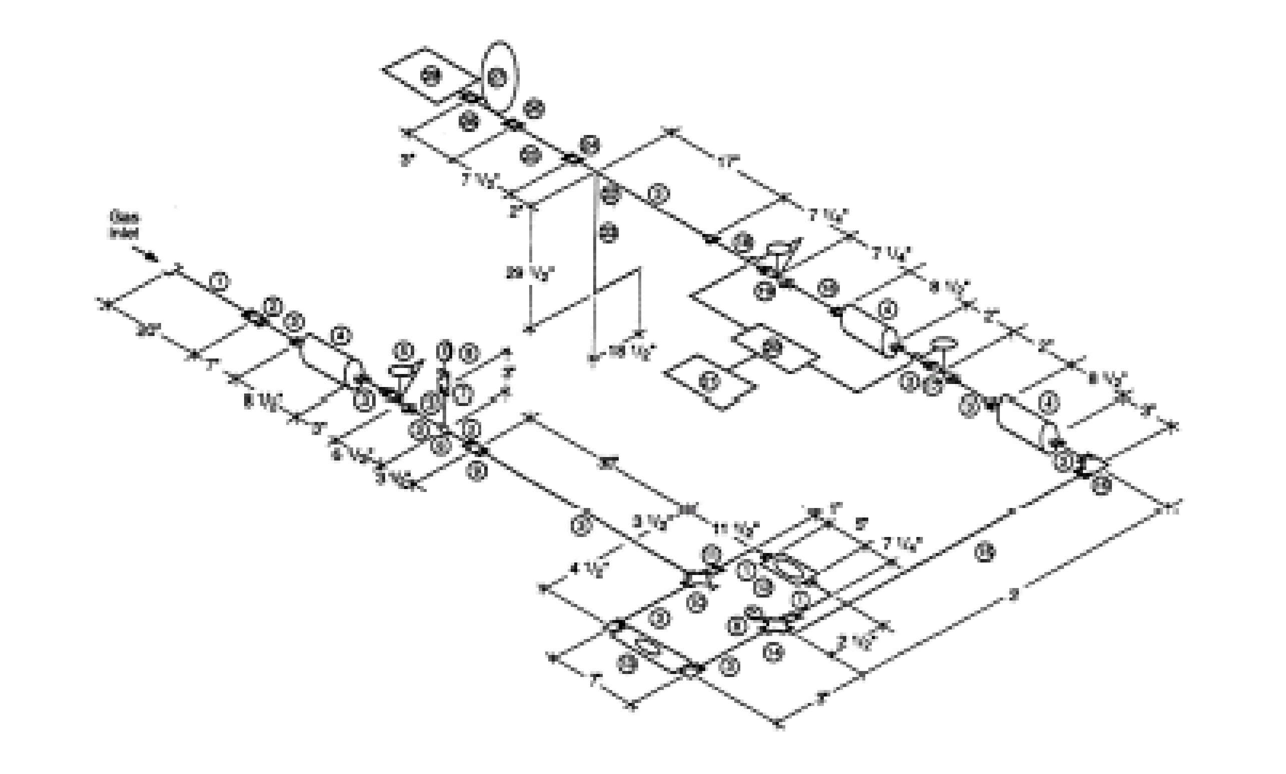
This test is to immediately follow the static test, set the system pressure to the minimum pressure recommended by the manufacturer to fully open the valve. Actuate the pneumatic valve at 30 cycles per minute for 60 minutes to measure the background counts under dynamic test conditions. For the testing of manually operated valves, actuate the pneumatic valve at 4 cycles per minute for 60 minutes. A cycle consists of off *and* on actuation of the valve.

2.2.3 Impact Test

This test is to immediately follow the dynamic test. Maintain the test flow rate for 30 minutes, with the valve in the fully open position. Impact the valve once a minute for 10 minutes, using the mechanical shock device. Purge the test component by maintaining the test flow rate for 30 minutes.

At the close of testing the system should be flushed for 30 minutes at the test flow rate and the CNC pump turned off while leaving the CNC power on and then decrease the test gas flow rate to approximately 0.5 scfm, the system airflow should be left running in this reduced state during idle periods.

Figure 1 – Valve test Schematic

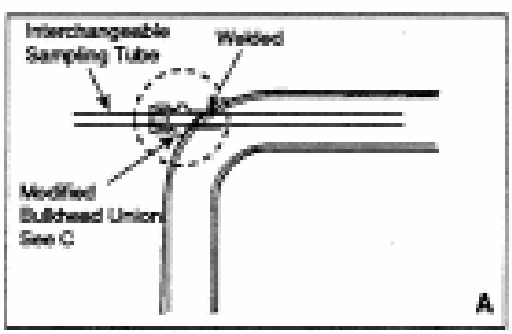


Item number	Description
1	1/4 in. dia. electro polished (EP) SS tube
2	1/4 in. to 1/2 in. tube reducing union
3	1/2 in. dia. EP SS tube
4	PTFE membrane filter with 3/8 in. VCR gasket seal
5	Pressure regulator, 0-300 inlet pressure, and 0-100-outlet pressure
6	1/2 in. butt weld tee
7	1/2 in. tube to 3/8 in. NPT female connector
8	0-60 psig electronics grade pressure gauge
9	1/2 in. to 1/2 in. union
10	1/2 in. 3-way SS ball valve
11	1/4 in. tube to 1/2 in. port reducer
12	0.2-2 STD ft^3 flow meter
13	1-15 STD ft^3 flow meter
14	1/2 in. SS union cross
15	1/2 in. dia, 3-ft flexible SS tube
16	1/2 in. union elbow
17	1/2 in. pneumatic valve
18	1/2 in. to 1/4 in. SS reducer gland
19	Test component
20	3-way normally closed solenoid air valve
21	Solenoid valve cycle controller
22	1/2 in. welded tee
23	1 1/2 in. dia., 4-ft long exhaust tube
24	1/2 in. tube to 1/4 in. NPT adapter
25	1/8 in. dia., 17 in. long SS sample tube
26	1/4 in. to 1/8 in. reducer union
27	1/4 in. dia., 30 in. long SS sample loop
28	1/4 in. to 3/8 in. reducer union
29	CNC

Table 1 – Matrix of Test Flow Rates and Sample Tube Nominal Outside Diameters

TEST COMPONENT NOMINAL DIAMETER	TEST COMPONENT INSIDE DIAMETER (inches)	OUTLET REYNOLDS NUMBER	AVERAGE TEST VELOCITY (ft/sec)	TEST FLOW RATE (scfm)
1 1/4"	0.180	20,600	224	2.4
2 3/8"	0.305	20,600	132	4.0
3 1/2"	0.402	20,600	100	5.3
4 3/4"	0.652	20,600	62	8.6
5 1"	0.870	20,600	46	11.4
6 2"	1.870	20,600	22	25.2

TEST COMPONENT NOMINAL DIAMETER	EXPANSION CONE INSIDE DIAMETER (inches)	SAMPLE TUBE ID @0.10 cfm FLOWRATE (inches)	SAMPLE TUBE OD NOMINAL (inches)
1 1/4"	0.43	0.09	1/8"
2 3/8"	0.43	0.07	1/8"
3 1/2"	0.43	0.06	1/8"
4 3/4"	1.87	0.20	1/4"
5 1"	1.87	0.18	1/4"
6 2"	1.87	0.12	1/4"



For full details of the Test specification please refer to the document:

SEMASPEC Test Method for Determination of Particle Contribution by Valves in Gas Distribution Systems
Technology Transfer # 90120390B-STD
SEMATECH
February 22, 1993

Author: Jeff Riddle