

SEMI F38-0699 (Reapproved 1104)

TEST METHOD FOR EFFICIENCY QUALIFICATION OF POINT-OF-USE GAS FILTERS

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1 Purpose

1.1 The purpose of this document is to define a comprehensive standard test sequence to qualify the particle filtration efficiency achievable using Point-of-Use (POU) gas filters.

2 Scope

2.1 This test method defines an evaluation method for Point-of-Use filters of various media (e.g., metallic, ceramic, and polymeric) typically used for filtering inert and process gases in semiconductor applications. Point-of-Use filters are designed to handle relatively low flow rates (0.5 – 50 slm.) and moderately high pressure drops. The filter housing and filtration element are combined into one sealed and inseparable unit.

2.2 This test method is intended to demonstrate the ability of a Point-of-Use gas filter to equal or exceed a specific particle filtration efficiency class when challenged with a monodispersed aerosol in the size range described in Section 6.6.

2.2.1 The efficiency class of the test method is defined as the log reduction value (LRV), where LRV is the Log [Input Concentration/System Background Level].

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 These test methods do not apply to gas filter cartridges.

3.2 These test methods do not apply to bulk gas filters.

3.3 The various media (e.g., metallic, ceramic, and polymeric) may have slightly different critical particle sizes (most penetrating particle sizes). Therefore, many challenge tests have to be performed over a range of particle sizes to assure that the “worst case” challenge has been performed.

3.4 The efficiency test is for steady state flow and room temperature only. Comparison to efficiency in pulsed flow, elevated temperature etc., will have to be developed separately.

3.5 Statistical evaluation on the variability in efficiency of a media type should be done with a valid sample size. This evaluation is not within the scope of this test method.

3.6 The upper concentration limit of the CNC as specified by the manufacturer should not be exceeded. Exceeding the CNC concentration will understate the challenge concentration due to coincidence counting, thus affecting filter efficiency calculations.

3.7 This is not intended as a method for precise determination of filter efficiency. It is intended as a means for determining if a filter has an efficiency equal to or better than an approximate nominal value.

3.8 Commercially available radioactive neutralizers have pressure limitations. Users should be aware of these limits.

4 Referenced Standards

4.1 None.

5 Summary of Method

5.1 The test sequence consists of three steps:

5.1.1 Static background with filter.

5.1.2 Filter challenge with first monodispersed particle size (see Section 6.6 for particle size test sequence).

5.1.3 Filter challenge with subsequent monodispersed particle sizes.

6 Apparatus and Facility

6.1 *Gas Source* — Clean, dry gas (nitrogen or air) with less than 0.5 ppm moisture and less than 0.5 ppm total hydrocarbons.

6.2 *Particle Detector* — A condensation nucleus counter (CNC) with a counting efficiency of 50% at 0.01 micron, as reported by the manufacturer, is recommended to measure total particle concentration of particles greater than 0.01 micron. The CNC must meet

a background level as specified in Section 7.1.2.

6.3 Test Environment — Particle challenge testing does not require a clean area. Testing in a Class 100 area is recommended but not required. Refer to Section 6.7 for installation precautions.

6.4 Configuration for Efficiency Test — One example of the configuration is shown in Figure 1. The setup shown in Figure 1 is intended only as a guideline. This system consists of:

- an aerosol generation system,
- aerosol concentration detectors,
- an air flow measuring system,
- a filter pressure drop sensor, and
- the test filters.

6.5 Test Flow Rate — Maximum manufacturer's rated flow rate.

6.6 Challenge Particle Sizes — Experimentation of various media (e.g., metallic, ceramic, and polymeric) have resulted in most penetrating particle sizes ranging from 0.05–0.11 micron.^{1 2 3 4}

6.6.1 Several monodispersed particle challenge tests shall be done over a range of particle sizes so that testing at the most penetrating particle size is performed. An electrostatic classifier must be used to produce a monodispersed challenge.

6.6.2 Due to the effects of particle loading in relation to filtration efficiency, a clean filter should be used for each particle size challenge. The differential pressure across the test filter should be continuously monitored to eliminate the possibility of particle loading. The following particle increments are a guideline. Smaller increments are achievable and are desirable.

6.6.2.1 Challenge Particle Size In Microns:

1 Rubow, K.L., C.B. Davis (1991) "Particle Penetration Characteristics of Porous Metal Filter Media for High Purity Gas Filtration", Proceedings of Institute of Environmental Sciences Annual Technical Meeting

2 Rubow, K.L., and Liu, B.Y.H., Evaluation of Ultra-High Efficiency Membrane Filters, Proceedings of the 30th Annual Technical Meeting, Institute of Environmental Sciences, 1984.

3 Rubow, K.L., Liu, B.Y.H., and Grant, D.C., Characteristics of Ultra-High Efficiency Membrane Filters in Gas Applications; Journal of Environmental Sciences, May/June, 1988.

4 B. Gotlinsky, P. Conner, D. Capitanio, L. Johnson, and S. Tousi, Testing of All-Metal Filters for High Purity Semiconductor Process Gases, Proceedings of the 37th Annual Technical Meeting, Institute of Environmental Sciences, 1991.

- 0.05
- 0.07
- 0.10

6.7 Sample Installation — Reasonable precautions shall be taken when installing the test filter to avoid particle contamination of the system from ambient. These precautions may include, but are not limited to: installation in a Class 100 laminar flow area, installation in a purged glove bag or other controlled ambient enclosure, use of a purge flow downstream of the sample point so that all parts of the system are under purge, isolation, or termination of the CNC sample flow, and isolation of the isokinetic sampler exhaust from ambient.

6.8 Customary practices shall be employed for the design of the sampling system. This includes any specialized equipment or procedures recommended by the CNC manufacturer. Every effort should be taken to minimize differences in the particle concentrations of the sampling volume relative to the actual test volume. Care should be taken to provide an adequate exhaust length so that back diffusion of particles does not affect background at 2 times the sampling flow rate. This length will depend upon the particle concentration in the ambient environment and on other factors.

6.9 Test Particle — Solid non-volatile particles. Sodium chloride is recommended, but other particles could be used such as polystyrene latex beads (PSL) if sufficiently high concentrations can be generated.

7 Procedure

7.1 Static Background Test

7.1.1 Purge the system at a high velocity flush of 100 slm or the maximum flow rate that the system components will allow.

7.1.2 Purge the system at test flow rate (Section 6.5). Measure the particle concentration with clean gas to determine the background concentration. The background count is established when the counter has sampled a minimum of 3 scf (85 sl), and the arithmetic average during the last 3 scf (85 sl) of gas sampled is <2 particles/scf (<0.07 particles/sl). The sample interval shall be 1 minute in duration. Ensure that the background counts are stable or decreasing. If background cannot be achieved after 6 scf (170 sl) have been sampled, there may be a problem with the counter or test apparatus. Past experience has shown this to be an adequate volume of gas to give a satisfactory low level background particle counts.

7.2 Penetration Test