

SEMI E49.6-95

GUIDE FOR SUBSYSTEM ASSEMBLY AND TESTING PROCEDURES - STAINLESS STEEL SYSTEMS

1 Purpose

The objective of this document is to establish standard guidelines for cleanroom activities specific to the manufacturing, assembly, testing, and integration of materials and components used in stainless steel semiconductor process equipment.

2 Scope

This standard has been developed as a guide for the assembly and testing of high purity and ultrahigh purity gas and solvent subsystems.

3 Referenced Documents

Note: Refer to the latest version of the following documents for general cleanroom protocol.

3.1 Federal Standard (FED-STD)¹

Federal Standard Cleanroom and Work Station Requirements, Controlled Environment

3.2 Institute of Environmental Sciences (IES)²

IES-RP-CC-001 — Recommended Practices for HEPA Filters

IES-RP-CC-002 — Recommended Practices for Laminar Flow Clean Air Devices

IES-RP-CC-003 — Recommended Practices for Garments Required in Cleanrooms and Controlled Environmental Areas

IES-RP-CC-006 — Recommended Practices for Testing Cleanrooms

4 Terminology

See Section 4 of SEMI E49.

5 Facility Guidelines

5.1 Gowning Area Class 10,000/1,000 (HP/UHP) — All personnel working in cleanrooms should wear paper booties prior to entering the gowning area. Personnel should wear polyester gowns, hood, and boots, pure

latex gloves (no talc), and safety glasses before entering clean areas.

5.2 Materials Staging Area Class 10,000/1,000 (HP/UHP) — Materials used in the cleanroom should have the outer bag removed and the inner bag wiped down with cleanroom wipes saturated with a 50/50 IPA/DI mix in the materials staging area prior to entry into the cleanroom.

5.3 Cutting Area Class 10,000 or Better — Cutting area should be a Class 1,000 area while in normal (at rest) operation. Work areas should maintain a Class 1,000 average at all times.

5.4 Welding and Cleaning Area Class 1,000/100 (HP/UHP) — Welding and cleaning area — ultrasonic tanks, DI rinse stations, and dry-down stations — should be Class 1,000 or 100, depending on purity classification. After final cleaning operation, there should be a Class 100 station for final bagging of cleaned parts prior to their entry into the cleanroom.

5.5 Assembly, Final Integration, and Final Test Class 100/10 (HP/UHP) — All areas used for gas/liquid system assembly, integration, and test should be Class 100/10 under all working conditions. This area should be segregated by hard or soft walls from all other fabrication areas.

5.6 Common Plenums — Adjoining clean areas of varying classifications should be separated with floor-to-ceiling hard or soft walls, have separate return air grilles, and be positively pressurized to a minimum of 1.3 mm (0.05 in.) H₂O (W.C.) over the lower adjacent class clean area when otherwise common by access or pass-through.

6 Utility System Guidelines

6.1 Nitrogen for Drying after Cleaning (Both HP and UHP Classes)

- Filtration — 0.01 µm rated
- Oxygen Content — < 1.5 ppm
- Moisture Content — < 1.0 ppm
- Hydrocarbon Content — < 2.0 ppm

6.2 Purge Gases — Argon or nitrogen for purging gas systems during assembly and for testing, using cryogenic source and 0.01 µm filtered. The following purity levels should be as certified by the gas supplier.

1 Available from General Service Administration, Federal Supply Service Bureau, Specification Section, Suite 8167, 470 East L'Enfant Place SW, Washington, D.C. 20407.

2 Available from Institute of Environmental Sciences, 940 E. Northwest Hwy., Mount Prospect, IL 60056.

	HP	UHP
Oxygen Content	< 40 ppb	< 10 ppb
Moisture Content	< 20 ppb	< 10 ppb
Total Hydrocarbon Content	< 40 ppb	< 20 ppb
Particles	< 0.1 particles per ft ³ ≥ 0.1 μm and 0 > 0.2 μm (both classes)	
Purified at POC	Optional	Required

6.3 *Weld Gases* — Welding argon (minimum specification, purifiers and 0.01 μm rated filter), recommended for ID/OD purge for both HP and UHP systems):

- Oxygen Content — < 50 ppb
- CO Content — < 50 ppb
- CO₂ Content — < 50 ppb
- THC as Content — < 50 ppb
- Moisture Content — < 50 ppb
- These contaminant levels should be as measured at the POC to the parts to be welded.

6.4 *DI Water - HP/UHP Classes*

- Resistivity — ≥ 18 mega ohm-cm @ 25°C (77°F)
- TOC — < 20 ppb
- Silica — < 5 ppb
- Particles — < 1 particle/millimeter @ ≥ 0.1 μm
- Bacteria — < 10 colonies/100 millimeter
- Hot DI Temperature — 80°C (176°F), minimum

7 Materials Procedures

7.1 *Procedures for Incoming Materials and Components (Component Suppliers)*

7.1.1 *Identification Guidelines*

7.1.1.1 Every deliverable item should have some scheme of positive and permanent identification, so that traceability is provided from the steel melt source to the final metal finishing and packaging through site installation.

7.1.1.2 This identification should provide nondestructive post installation traceability.

7.1.1.3 Clearly visible labeling (without the need to open the package) should be provided at each level of packaging.

7.1.2 *Packaging and Shipping Guidelines*

7.1.2.1 Double bagging should be required.

7.1.2.2 The inner bag should be nonpermeable (minimum six mil polyethylene or Nylon 6) and should prevent damage from normal handling.

7.1.2.3 Vacuum sealing or dry inert gas purging should be used on the inner bag.

7.1.2.4 The ends of the component should be protected using some noncontaminating method.

7.1.2.5 The outer bag may be any suitable material but should be purged with a dry inert gas prior to sealing.

7.1.3 *Documentation*

7.1.3.1 Test results should be provided for each shipment.

7.1.3.2 Shipment should be in complete lot sizes.

7.1.3.3 The performance tests should be considered production qualification tests. It is the responsibility of the component manufacturer to provide statistically valid data which correlates their production tests to these qualification tests (e.g., Statistical Process Control, MIL-STD-105D).

7.1.3.4 The equipment supplier should be responsible for maintaining and supplying, upon request, documentation that proves their components meet the user's materials performance requirements.

7.2 *Receiving*

7.2.1 All incoming material should be segregated from "acceptable material" until it has been formally accepted through documented procedure.

7.2.2 All cartons should be opened (100%); all goods should be checked visually for damage (e.g., torn bags, inadequate padding causing damage).

7.2.3 Material should be stored in original packaging. Do not open until ready to use or inspect. Inspection involving opening sealed plastic bags should be conducted within the materials staging prefab cleanroom. After inspection, purge and heat-seal the material into a clean polyethylene bag.

7.2.4 Any material failing initial inspection should be immediately "red tagged" and set aside in a "quarantine" area until the supplier of the material is notified and disposition is determined.

7.3 *Acceptance and Rejection*

7.3.1 All material should be uniquely identified with a heat number, lot number, and serial number, allowing traceability back to source and documentation. Only material so marked should be accepted.

7.3.2 All material should meet a purchasing specification and be provided with documentation

demonstrating compliance. Only material so documented should be accepted.

7.3.3 A certain percentage of material should undergo incoming QA checks for parameters such as: surface contamination (e.g., hydrocarbon, particulate), tubing quality, wall thickness, nicks, scratches; surface roughness, pits, stringers, particle count, weldability, helium leak rate (inboard/outboard/across seat), and dimensions.

The material should be accepted only after these incoming QA checks are completed. A statistically valid sample size should be determined. This means that sufficient pieces must be checked to guarantee that no defective parts arrive at the buyer's location.

7.3.4 Any material that does not pass the basic incoming QA requirements should be "red tagged" and placed in "quarantine" pending final disposition.

7.3.5 Material that passes incoming QA should be uniquely tagged.

8 Construction Procedures

8.1 Tube Cutting and Preparation

8.1.1 Stainless steel tubing should be opened, cut, faced, and deburred in a required cleanroom environment, leaving no visible particulates inside the cut end.

8.1.2 For tube cutting, use a wheel cutter with lathe-type facing tool or a special designed power saw with alignment guide. Do not use lubricant. If any "nicks" are found, reface or discard the tube.

8.1.3 When practical during cutting and during all facing operations, use an argon or nitrogen purge (50-100 f/s) to preclude particles from entering tubing.

8.1.4 The prepared end should conform to ASTM A 632 (or ASTM A 269 $\geq 1/2$ " O.D.) tubing specification with regard to ovality and wall thickness.

8.1.5 The prepared end should be square to tube run within 1/4 deg. (angle).

8.1.6 After preparing, debur the inside diameter carefully and lightly. Do not scratch the inside diameter. Any scratched tubes should be repped or scrapped. Chamfering is not required.

8.1.7 Avoid cross-contamination from dissimilar materials.

8.2 Tube Cleaning

8.2.1 After cut and prep, tubing should be cleaned using a process which removes all debris and assures that the surface is totally free of hydrocarbons. This process should be custom-tailored to the supplier's need

based on tubing supplier quality control (QC) and on purity grade requirement (HP/UHP).

8.2.2 If using tubing certified "hydrocarbon-free" from a tubing supplier, a cleaning procedure as follows is recommended:

- Primary rinse in cold running DI water.
- Secondary rinse in hot [80°C (176°F)] DI water.
- Final rinse in cold DI water with "pressure flush."
- Blow dry with high velocity > 305 meters/min. (> 1,000 feet/min.) hot (150°C (318°F)) N₂. Ensure that drying occurs immediately after final rinse to prevent evaporation of DI from the tubing ID surface.
- Use immediately or seal in plastic sleeves.
- Document the process through ESCA elemental chemical composition analysis and SEM photographs that procedure does remove all contaminants. Once process is documented, audit periodically to assure process continues to produce noncontaminated goods.

8.3 *Orbital Welding* — All orbital welding should be performed only by certified welders. Certification procedures should include, at the minimum, producing three acceptable welds in a row of all types of typical orbital weld joints of all sizes of tubing to be welded. Welding parameters should be set by the welder without the use of any written aids. Certification process should be performed every six months.

8.3.1 Weld Equipment Setup

8.3.1.1 All welding fixtures should be clean and free of any particulates and excessive discoloration. Weld head should rotate freely and smoothly at all speeds. All clamping and holding fixtures should fit tightly around applicable fittings/tubing, allowing no fitting movement after clamping in excess of 0.008 cm (0.003 in.).

8.3.1.2 Electrodes should be precision ground. Electrode gap should be set using tooling and procedures which provide accurate and repeatable gaps to be set to within 0.005 cm (0.002 in.).

8.3.1.3 Documented procedures should exist for each weld configuration including all parameters (including purge times, orifice sizes, purge rates, and internal pressure).

8.3.1.4 Purge gas apparatus should be stainless steel tubing and components with face seal fittings. Plastic tubing is acceptable as the final run to allow flexibility for hook-up. Lengths should be restricted to less than ten feet. All components which come into contact with the weldment should be stainless steel.