

SEMI E49.7-0419

GUIDE FOR THE DESIGN AND MANUFACTURE OF POLYMER ASSEMBLIES USED FOR LIQUID CHEMICAL SYSTEMS IN SEMICONDUCTOR EQUIPMENT

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NOTICE: The section symbol (§) is used to reference a numbered section, paragraph, or header and all subordinate paragraphs, headers, and embedded material (i.e., EXCEPTIONs, lists) therein. The paragraph symbol (§) is used to reference a particular numbered paragraph and embedded material therein. When duplicated (i.e., §§ and §§) the symbols are used to reference more than one section or paragraph, respectively.

NOTICE: Paragraphs entitled 'NOTE:' are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

NOTICE: This Standard was completely rewritten in 2018.

1 Purpose

1.1 The objective of this Guide is to provide guidelines that will help ensure the quality of the liquid being delivered. Recommendations are for design and manufacturing of polymer liquid chemical assemblies used in Semiconductor equipment. This Guide complements SEMI F57 and E49.2.

NOTE 1: The practices outlined herein are recommendations, not specifications. Users of this Guide should recognize that alternate practices are not excluded as long as they produce results that are equivalent to those produced using the recommendations outlined here and meet the requirements of the end user.

2 Scope

2.1 The design and manufacturing methods and procedures for ensuring the quality of the liquid being delivered are presented in this Guide. This Guide represents current industry best practice(s). If a user of this Guide has a process or criteria that is more stringent than the practices in this Guide, then some of the criteria in this Guide may not be applicable.

2.2 Recommendations are provided in the following areas:

- Manufacturing Facility
- Utilities
- System Design
- Pre-Production and Inspection
- Assembly
- System Testing
- Packaging
- Traceability

2.3 For the purposes of this Guide an assembly is defined as two or more liquid delivery components provided with or within semiconductor process equipment. The scope includes all liquid delivery assemblies associated with semiconductor process equipment and ancillary support equipment. These assemblies may be as large as the entire process system associated with the manufacturing tools. Typical semiconductor process systems/equipment with liquid chemical systems may include, but are not limited to the following:

- BCD/PCD equipment

- Chemical and/or slurry filtration/mixing skids provided by OEM
- Post CMP cleaning equipment
- Metrology equipment
- Ancillary equipment provided with the process equipment

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 This Standard does not define the performance requirements of components, which may be addressed by SEMI F57. Nor does this Standard define the performance requirements of equipment systems. Bulk facility supply/distribution systems and ultra pure water (UPW) distribution systems are also outside the scope of this Standard (refer to SEMI F61 for UPW supply/distribution systems).

3.2 This Standard does not cover any type of liquid or gaseous waste discharge systems.

3.3 Flammable or other liquid chemicals requiring stainless steel or other non-polymeric wetted components are not covered in this Guide. Refer to SEMI E49.4 and SEMI E49.6 for information on stainless steel components.

3.4 System design issues outside those that directly impact liquid purity or quality are not within the scope of this Standards recommendations and are left to the individual system designers.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI C41 — Specification and Guide for 2-Propanol

SEMI C59 — Specification for Nitrogen

SEMI E49.4 — Guide for Ultrahigh Purity Solvent Distribution Systems with Metallic Fluid Paths in Semiconductor Manufacturing Equipment

SEMI E49.6 — Guide for Subsystem Assembly and Testing Procedures – Stainless Steel Systems

SEMI F34 — Guide for Liquid Chemical Pipe Labeling

SEMI F51 — Guide for Elastometric Sealing Technology

SEMI F57 — Specification for Polymer Materials and Components Used in Ultrapure Water and Liquid Chemical Distribution Systems

SEMI F61 — Guide for Ultrapure Water System Used in Semiconductor Processing

SEMI S2 — Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment

SEMI S8 — Safety Guideline for Ergonomics Engineering of Semiconductor Manufacturing Equipment

4.2 ISO® Standards¹

ISO 14644-1 — Cleanrooms and Associated Controlled Environments – Part 1 Classification of Air Cleanliness

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

5 Terminology

5.1 Refer to § 4 of SEMI E49.

¹ International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401-1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, Fax: +41.22.733.34.30, <http://www.iso.org>. ISO trademark is owned by International Organization for Standardization.

5.2 Definitions

5.2.1 *low/no-flow region* — an area or zone of static fluid retention in process tubing or piping during certain modes of operation or maintenance. This area or zone full of process fluid can facilitate unacceptable changes to the physical and/or chemical properties of the contained fluid. (Also known as dead leg, or dead zone.)

6 Manufacturing Facility Recommendations

6.1 Cleanroom Class designations as used within this Guide are defined within ISO 14644-1 classifications are listed parenthetically (Federal Standard 209E Airborne Particulate Cleanliness Classes in Clean rooms and Clean Zones are shown parenthetically).

6.2 *Materials Storage Area* — The storage area for components and assemblies should be a dedicated enclosed area, protected from the elements and separated from other materials. Only components and assemblies that have passed inspection, and are clean and packaged should be placed in the storage area.

6.3 *Gowning Area* — Gowning area should be ISO Class 7 (Class 10,000) or better. All personnel working in cleanrooms should follow appropriate gowning protocol such as: wear booties prior to entering the gowning area; and wear gowns, hood, boots, gloves, and safety glasses before entering clean areas.

6.4 *Staging Area* — Staging Area should be Class 10,000 ISO Class 7 (Class 10,000) or better. The staging area (if used) should be located immediately outside the assembly cleanroom, with appropriate access to the assembly cleanroom.

6.5 *Assembly Areas* — All production operations such as cutting, welding, cleaning, assembly, final integration, final test, and packaging (if applicable) should be performed in a ISO Class 7 (Class 10,000) cleanroom or better.

7 Utility Recommendations

7.1 *Nitrogen* — Uses include leak testing of non-brittle materials, drying, and purging.

- Nitrogen quality should meet requirements of SEMI C59.
- Particle filtration should be 99.99999% removal of 0.003 micron particles.

NOTE 2: Use 316L electropolished tubing or PFA tubing for purge piping. (Use tubing that does not degrade N₂.)

7.2 *UPW* — Uses include cleaning and rinsing.

- *Resistivity* — ≥ 18 mega ohm-cm at 25°C (77°F).
- *TOC* — < 20 ppb.
- *Silica* — < 5 ppb.
- *Particles* — < 1 particle/milliliter at ≥ 0.1 μm size.
- *Bacteria* — < 10 colonies/100 milliliter.

NOTE 3: If testing requirements dictate, access to higher quality UPW may be appropriate in portions of the facility. Additional information related to UPW facility design and terminology may be obtained in SEMI F61.

7.3 *Hot UPW* — Uses in cleaning, rinsing, testing.

- *Resistivity* — ≥ 18 mega ohm-cm at 25°C (77°F).
- *TOC* — < 20 ppb.
- *Particles* — < 10 particle/milliliter at ≥ 0.1 μm size.

7.3.1 Many manufacturing processes for assemblies utilize hot UPW as part of cleaning/drying process. Hot UPW should be used in conjunction with nitrogen or hot nitrogen to accomplish this.

7.3.2 Hot UPW is used to elevate assembly temperature to operational temperature when it is tests. This is to ensure that at operational temperature the assembly maintains its physical design characteristics.

7.3.3 The temperature range recommended for hot UPW used in manufacturing processes is in the range of 60°C to 90°C.

7.4 *Propanol/IPA* — Uses include cleaning.

- Requires SEMI C41, Grade 1, or better.

7.5 *Clean Dry Air (CDA) or Oil Free Air* — Uses include pneumatic control and air actuation.

7.5.1 CDA is not recommended for use on cleaned wetted surfaces. Nitrogen is recommended for drying cleaned wetted surfaces because the purity level is clearly defined and controlled.

8 System Design Recommendations

8.1 *General Recommendations* — The intent of this section is to recommend design practices that ensure the quality of the liquid being delivered. These recommendations should be considered along with design constraints such as minimizing liquid consumption, cost, and ensuring maintainability. In addition, the appropriateness and simplicity of the facility interface should be considered. Refer to SEMI S2 and SEMI S8 for safety and ergonomic considerations of design.

8.1.1 Low flow regions can occur in many different ways. The designer should be aware of different physical situations that can result in low/no flow situation. Examples of this are flow through a tee, flow into a region of large volumetric increase that results in a significant loss of flow rate or velocity, and regions immediately downstream of a pressure restriction.

8.1.2 *Low/No Flow Region Time Considerations* — For UPW system designs the criteria should address the potential for microbiological growth within the volume, as such, the time to account for potential low/no-flow volume should not exceed 3 hours. For slurry system designs the criteria should address the potential settling of solids in the volume. Due to the variety of slurry formulations, refer to the slurry supplier for specific information on the settling and dispersion characteristics of the material to be used for design criteria. For liquid chemical systems designs the criteria should address degassing, shear, thermal effects, retained particle entrainment, and/or reactions caused by internal or external influences.

8.2 *Component Recommendations* — Components should limit system exposure to ionic, metallic, total organic carbon, and particle contamination.

8.2.1 All applicable components should comply with SEMI F57 where possible.

8.2.2 For components not addressed in SEMI F57, a discussion of recommended materials (similar to that found in SEMI F57) may benefit the reader and is therefore provided.

8.2.2.1 Care should be taken to ensure that the materials are compatible with the liquid streams for long term applications. Additionally, it is important that the materials used be compatible with the application temperature and/or sanitization methods such as ozone, UV light and/or hydrogen peroxide, hydrofluoric acid, potassium hydroxide.

8.2.2.2 These recommendations often imply the use of existing materials of choice, such as high purity grades of perfluoroalkoxy (PFA), polytetrafluoroethylene (PTFE), and polyvinylidene fluoride (PVDF), ethylenechlorotrifluoroethylene (ECTFE), polyether-etherketone (PEEK), polypropylene (PP), acetal resin, polyvinyl chloride (PVC), perfluoromethylether-based perfluoroalkoxy (MFA), etc.

8.2.2.3 Material selection should consider the presence of extractables that may contaminate the chemistry.

8.2.2.4 Due to purity and traceability issues, reprocessed or regrind material is not allowed.

8.3 *Joining Recommendations* — Joining technology that is free of no-flow and entrapment areas is recommended to reduce negative effects such as microbial proliferation, microbubble generation and impacts to slurry particle size distribution. For this reason pipe thread connections can be used if there is no other viable option.

8.3.1 Care should be taken to minimize the use of dissimilar fitting designs within the system. Ensure that components of dissimilar fitting design are not joined directly together. Manufacturers should be consulted prior to using similar style fittings from different manufacturers interchangeably.

8.3.2 Pipe should be joined with welds that minimize dead space and entrapment areas. Preparation and welding should be performed in accordance with component manufacturer's recommendations.