

SEMI E49.7-0702

PURITY GUIDE FOR THE DESIGN AND MANUFACTURE OF ULTRAPURE WATER AND LIQUID CHEMICAL SYSTEMS IN SEMICONDUCTOR PROCESS EQUIPMENT

This guide was technically approved by the Global Liquid Chemicals Committee and is the direct responsibility of the North American Liquid Chemicals Committee. Current edition approved by the North American Regional Standards Committee on April 30, 2002. Initially available at www.semi.org June 2002; to be published July 2002. Originally published 1995.

This document as balloted replaces SEMI E49.7 in its entirety. The title for the previous revision of E49.7 was, "GUIDE FOR SUBSYSTEM ASSEMBLY AND TESTING PROCEDURES - POLYMER SYSTEMS."

1 Purpose

1.1 The objective of this document is to provide recommendations that will help maintain the quality of the liquid being delivered. Recommendations are given for activities specific to polymer ultrapure water and liquid chemical systems used in Semiconductor process equipment.

NOTE 1: As with any SEMI guide, the practices outlined herein are recommendations, not specifications. Users of this document 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 It is within the scope of this standard to recommend procedures that complement the requirements in SEMI F57 with the goal of ensuring the quality of the liquid being delivered. Recommendations are provided in the following areas:

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

2.2 For the purposes of this document, systems include all liquid delivery components inside semiconductor process equipment and ancillary support equipment, as well as additional plumbing provided by the OEM with the processing equipment. This includes any assembly of two or more liquid delivery components provided with or within semiconductor process equipment.

2.3 Typical semiconductor process equipment with ultrapure water and liquid chemical delivery systems includes, but is not limited to the following:

- Wafer Handling Equip.
- Wafer Cleaning Systems
- Chemical Filtration/Mixing Skids provided by OEM
- Wet Clean Stations
- Wafer Scrubbers
- CMP
- Photolithography coaters and developers
- Ion Implanters
- Metrology equipment

2.4 This standard does not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory 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. Facility distribution systems are also outside the scope of this standard.

3.2 Organic liquids, such as isopropyl alcohol and methyl alcohol, are typically in contact with stainless steel or other non-polymeric components. The polymer systems described within this document are NOT intended for use with such organic liquids. Refer to SEMI E49.4, SEMI E49.5, and SEMI E49.6 for information on stainless steel components.

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

3.4 Polymer systems described within this document are intended for use in ultrapure water and liquid chemical delivery only. Their performance requirements may exceed the needs of systems used in drainage and other lesser quality liquids.

4 Referenced Standards

4.1 SEMI Standards

SEMI C3.28 — Standard for Nitrogen (N₂), VLSI Grade in Cylinders, 99.9996% Quality

SEMI C41 — Specifications and Guidelines for 2-Propanol

SEMI E49 — Guide for Standard Performance, Practices, and Sub-Assembly for High Purity Piping Systems and Final Assembly for Semiconductor Manufacturing Equipment

SEMI E49.4 — Guide for High Purity Solvent Distribution Systems in Semiconductor Manufacturing Equipment

SEMI E49.5 — Guide for Ultrahigh Purity Solvent Distribution Systems 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 F57 — Provisional Specification for Polymer Components Used in Ultrapure Water and Liquid Chemical Distribution Systems

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

4.2 Federal Standard (FED-STD)¹

Fed Stand 209E — Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

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

4.3 ISO Document²

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

NOTE 2: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 See Section 4 of SEMI E49.

6 Manufacturing Facility Recommendations

6.1 Cleanroom Class designations as used within this document are defined within Federal Standard 209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones. (ISO standard 14644-1 classifications are listed 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 Class 10,000 (ISO Class 7) 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) 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 class 10,000 (ISO Class 7) 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 C3.28.
- Particle filtration should be 99.99999% removal of 0.003 micron particles.

² International Organization for Standardization, ISO Central Secretariat, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30
Website: www.iso.ch

NOTE 3: Use 316L electropolished tubing or PFA tubing for purge piping. (Use tubing that does not degrade N₂.)

7.2 *Ultrapure Water* (Uses include cleaning and rinsing.)

- Resistivity $\geq$ 18 mega ohm-cm @ 25°C (77°F)
- TOC — < 20 ppb
- Silica — < 5 ppb
- Particles — < 1 particle/milliliter @ 0.1 μ m size
- Bacteria — < 10 colonies/100 milliliter
- Hot Ultrapure Water Temperature — 80°C (176°F), minimum

NOTE 4: If testing requirements dictate, access to higher quality ultrapure water may be appropriate in portions of the facility. Additional information related to ultrapure water facility design and terminology may be obtained in SEMI F61.

7.3 *2-Propanol/IPA* (Uses include cleaning.)

- 2-Propanol/IPA quality should meet requirements of SEMI C41, Grade 1

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

7.4.1 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, ensuring maintainability, and limiting complexity. In addition, the appropriateness and simplicity of the facility interface should be considered.

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.

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.

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). However, unique design specifications or new materials may result in instances where significant efficiencies may be achieved while maintaining substantially equivalent performance. These scenarios could result in the use of new or existing materials such as ethylenechlorotrifluoroethylene (ECTFE), polyether-etherketone (PEEK), polypropylene (PP), acetal resin (such as Delrin[®]™³, Celcon[®]™¹ and others), polyvinyl chloride (PVC), perfluoromethylether-based perfluoroalkoxy (MFA), etc.

8.2.2.3 Due to purity and traceability issues, reprocessed or regrind material is not recommended.

8.3 *Joining Recommendations* — Joining technology that is free of dead space and entrapment areas is recommended to reduce negative effects such as microbial proliferation and impacts to slurry particle size distribution. For this reason pipe thread connections are not recommended.

8.3.1 Tubing should be joined with flare fittings, or similar dead space free technology. Preparation and joining of fittings should be performed in accordance with component manufacturer recommendations.

8.3.1.1 Care should be taken to ensure that dissimilar flare fittings are not joined together. When possible, one style of fitting should be used throughout the system. 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.

NOTE 5: Users of this guideline are cautioned that suitable welding methods, such as thermal butt welding, may be covered by patents or other intellectual property.

8.3.2.1 Glue, solvent, or thermal socket welding of pipe is not recommended.

8.4 *System Volume Recommendations* — When possible, dead volumes should be eliminated and overall system volume should be minimized to reduce negative effects on purity as well as flush times.

³ Delrin is a trademark of DuPont; Celcon is a trademark of Hoechst Celanese.