



SEMI F61-0521

GUIDE FOR DESIGN AND OPERATION OF A SEMICONDUCTOR ULTRAPURE WATER SYSTEM

This Standard was technically approved by the Liquid Chemicals Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on March 9, 2021. Available at www.semiviews.org and www.semi.org in May 2021; originally published March 2001; previously published June 2017.

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: 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.

1 Purpose

1.1 This Guide should be used in conjunction with SEMI F63 and SEMI F75. Together these Guides provide recommendations for facility engineers and other manufacturing professionals who are responsible for establishing programs to monitor and control the quality of their ultrapure water (UPW) systems through to point-of-use (POU).

1.2 This Guide describes the engineering and component requirements for a UPW system used in semiconductor manufacturing. It is intended to establish a common basis for developing detailed specifications for design, operations, certification, and monitoring of UPW and hot ultrapure water (HUPW) systems.

2 Scope

2.1 This Guide applies to advanced UPW systems used in semiconductor manufacturing facilities for supplying high purity water for wafer processing, chemical dilutions, and other facility applications. This Guide provides definitions used for identification of UPW system components and other commonly used terms associated with the semiconductor facility water systems.

2.2 This Guide provides reference to other relevant SEMI Standards that ensure quality and reliability of UPW systems. This Guide logically follows the series of SEMI Standards developed for UPW; which includes SEMI F63, a Standard defining the quality of UPW, and SEMI F75, a Standard for monitoring UPW.

2.3 This Guide provides recommendations for design and operation of the UPW system including treatment plant, distribution system, and the semiconductor manufacturing tool hook up.

2.4 This Guide addresses the testing and prequalification of high purity polymer materials used in UPW system equipment and distribution.

2.5 This Guide provides minimum definitions for site utilities needed to support the UPW system.

2.6 This Standard provides guidance for construction, qualification, and commissioning of new or recently upgraded UPW systems.

2.7 This Standard provides guidance on maintenance, operations, safety, and redundancy of the UPW systems. This Guide provides further quality information on critical components such as ion exchange resin and filter media.

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 Guide does not define the actual specifications generally negotiated between the user and the suppliers of the UPW system, against which water quality is tested and qualification is passed.



3.2 This Guide does not address the protocols and requirements defined by the suppliers concerning the installation of the UPW system.

3.3 The recommendations provided in this Guide are based upon information available at the time the Standard was prepared and on the experience of the group involved in the Standard development.

3.4 This Guide is limited to the scope of UPW treatment and distribution system; it does not address the considerations of the UPW materials and components within manufacturing tools.

3.5 This Guide focuses on the parameters and conditions which mitigate risks to manufacturing yield and UPW system performance; it does not deal with definitions that present opportunities for competitive intellectual properties of the technology providers.

3.6 In order to maintain the relevance of SEMI Standards, it is important that Standards be updated on a regular basis. In particular this Standard, and SEMI F63 and SEMI F75, will be updated at the same time to ensure continuity for the users of all three Standards. All three Standards will be reviewed and updated (if necessary) on a two-year cycle.

3.7 This Guide does not provide recommendations for the design or operation of POU specialty systems, such as carbonated UPW water, ozonated UPW water, low TOC UPW water, and low particle UPW Water.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI F19 — Specification for the Surface Condition of the Wetted Surfaces of Stainless Steel Components

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

SEMI F63 — Guide for Ultrapure Water System Used in Semiconductor Processing

SEMI F75 — Guide for Quality Monitoring of Ultrapure Water Used in Semiconductor Manufacturing

4.2 ASTM Standards¹

ASTM D5127 — Ultra-Pure Water Used in the Electronics and Semiconductor Industries

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

5 Terminology

NOTE 1: This section focuses on definitions related to UPW system used in microelectronic industry and does not include common water treatment process technology definitions used elsewhere. UPW quality related definitions are included in SEMI F63.

5.1 Definitions

5.1.1 *deionized water (DI)* — any purified water that has level of ions reduced down to the resistivity of minimum 1 MΩ·cm. Although a commonly used term, this quality of water is not applicable for advanced semiconductor manufacturing.

5.1.2 *DI system* — a system that comprises one or multiple deionization steps to produce DI water. DI system treatment is typically based on one or combination of the following technologies: ion exchange, reverse osmosis, and EDI technologies.

5.1.2.1 *Discussion* — UPW Plant is a complex automated system. In order to provide effective communication when dealing with specific treatment steps and components additional definitions are required. The following definitions of the UPW system sections are based on treatment steps located in between major tanks typically used: raw water tank, permeate tank, and UPW Tank (see § 8.1, Figure 1).

5.1.2.2 Although typical design is based on the goal of producing and distributing single quality spec UPW, some fab or sub-fab users receive lower grade water, such as RO permeate or primary product. Such decisions are project specific.

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5.1.3 *high volume manufacturing (HVM)* — refers to full size production facilities as opposed to a pilot or technology development production line.

5.1.4 *final filter* — usually it is the final treatment step in a UPW system; used to remove particulates.

5.1.5 *make-up plant* — portion of the UPW system upstream of the UPW tank that supplies water in the polishing loop to replace UPW consumed by the fab.

5.1.6 *raw water* — any water available to the site for the production of UPW (from river, lake, ground, or ocean). Such water may or may not be treated and can also include reclaim water.

5.1.7 *permeate water tank* — tank containing water treated by reverse osmosis in pre-treatment and other streams consistent with permeate quality.

5.1.8 *ultrapure water (UPW)* — purified water meeting microelectronic industry requirements documented in SEMI F63 and ASTM D5127 for the line width of one micrometer and smaller.

5.1.9 *UPW distribution loop* — the piping from the final filter of the polish system that distributes UPW to the end users and conveys the remainder to the inlet of the polish tank via UPW return.

5.1.10 *UPW return* — UPW sent to but not used by end users (returns to the UPW storage tank).

5.1.10.1 Points of measurement of the water quality in the polish loop:

5.1.10.1.1 *point of connection (POC)* — sample port near a take-off valve on the lateral used to connect to the manufacturing tool.

5.1.10.1.2 *point of distribution (POD)* — sample port near the outlet of the final filter.

5.1.10.1.3 *point of entry (POE)* — sample port near the feed connection to the manufacturing tool.

5.1.10.1.4 *point of process (POP)* — water in production chamber.

5.1.10.1.5 *point of use (POU)* — sample port within the tool near the entry to the process chamber.

5.1.11 *UPW supply* — UPW sent to end users.

5.1.12 *UPW system* — a production and distribution facility comprising of unit operations including deionization, reverse osmosis, dissolved gas control, organics treatment, and particles removal to meet requirements of UPW quality. UPW system equipment boundaries start at the feed to the raw water tank (if exists) or otherwise at the feed to the raw water pump. The system boundaries end at the point of connection valves supplying UPW to the manufacturing tool or any other fab or facility user utilizing UPW to support production.

5.1.13 *UPW tank* — tank that receives water from make-up plant and UPW return and then supplies water to the polish plant.

6 General Recommendations

6.1 *Materials* — Components of the UPW system should be comprised of materials appropriate to the application and conform to electrical, mechanical, and purity requirements of the UPW. Materials should also comply with the purity as defined by applicable SEMI Standards. See Appendix 1 for details on the material quality requirements.

6.2 *System Installation* — A UPW system is installed according to a protocol that ensures mechanical integrity, leak proof operation, and none (or minimal) contamination during installation. See Appendix 1 for details on the piping supports, welding, and other requirements for system installation.

6.3 *Acceptance Tests* — Acceptance tests are conducted on each subsystem. Such tests may include performance demonstrations, demonstrations of reliability criteria, and achievement of purity standards and are the basis for acceptance or rejection by the purchaser against a pre-negotiated set of criteria for system performance. See Appendix 2 for details on the UPW system qualification methodology.

6.4 *Monitoring* — UPW systems are monitored for continuing performance against desired and achievable levels of quality. Action limits are set to determine when system performance suggests that corrective action is required.

6.5 *UPW Specifications* — UPW systems should deliver a specified water quality on an ongoing basis. The guaranteed performance is established in advance between the UPW equipment supplier and the system owner. Both