

SEMI F98-0305

GUIDE FOR TREATMENT OF REUSE WATER IN SEMICONDUCTOR PROCESSING

This Standard was technically approved by the Facilities Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on December 10, 2004. Available at www.semi.org in March 2005.

1 Purpose

1.1 This Guide establishes definitional requirements for industrial water systems that reuse water in a semiconductor manufacturing facility. It is intended to establish a common basis for developing detailed specifications in subsequent documents concerning design, performance, optimization, and monitoring of such systems.

1.2 This Document may be used by users and suppliers as a basis for developing site-specific specifications and performance criteria.

2 Scope

2.1 This Guide applies to water systems designed for reuse of water including reclaim and recycle, used in semiconductor manufacturing facilities, supplying water to a variety of uses. Such uses include directing waters to the front end of a UPW system, to cooling systems, scrubbers, thermal processes, and to irrigation systems, depending on the quality of the water.

2.2 This Guide can be used to understand the design elements and functionality of water systems that support reuse of water. Although such systems can be retrofitted into existing manufacturing factories, there is a broader range of opportunities available in new facilities that can be designed with water saving applications in mind.

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 manufacturer of the reclaim or recycle system.

3.2 This Guide does not address the methodology for optimizing the reuse of spent rinse waters.

3.3 This Guide does not address the frequency or scope of ongoing maintenance for reuse water systems including change-out of resin beds and replacement of filters.

3.4 This Guide does not describe the broad range of possible reuse opportunities and the associated water quality required for each.

3.5 This Guide does not intend to cover any of the important safety considerations that relate to the proper installation, operation, or maintenance of a reuse water system.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI E49 — Guide for High Purity and Ultrahigh Purity Piping Performance, Subassemblies, and Final Assemblies

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

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

4.2 Other Documents

“Strategies for Water Reuse Reduction in Semiconductor Manufacturing”, Technology Transfer 97013232A-ENG¹

¹ SEMATECH, 257 Fuller Road, Suite 2200, Albany, NY 12203, USA; Telephone: +1.518.649.1000, <http://www.semtech.org>

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

5 Terminology

5.1 Abbreviations and Acronyms

5.1.1 UPW — ultrapure water

5.2 Definitions

5.2.1 *spent water* — any discharge water that is consumed or processed and is ready to be discharged to drain.

5.2.2 *UPW reclaim* — the reuse of spent water as feed water for a process different from the one that discharged it. For example, RO reject fed into cooling towers.

5.2.3 *UPW recycle* — the reuse of spent water as feed water for the same process that discharged it (point-of-discharge [POD] recycling), or the plant UPW system.

5.2.4 *UPW reuse* — the secondary use of spent water.

6 Design Components and Elements

6.1 *Collection of Waste Streams* — The most common collection system includes fab-wide gravity collection piping using PVC or PVDF transfer piping and associated pipe racks and tunnels to the collection tanks. Proper venting is also critical to correct operation. The system may also include a reclaim pit, pumps, tanks, and controls. Separate holding tanks are used for each grade of water or type of waste stream so that routing of waste and types of treatment can be matched to specific needs (see Figure 1).

6.1.1 A key consideration for the design of a water reuse system is the ability to separate different grades of water and collect each type of effluent. Typical types of segregation include: segregation of clean rinse water from acid waste; separation of waste streams that contain organics, (e.g., from IPA drying); and isolation of waste streams that require specific treatment such as for hydrofluoric acid, CMP processing, copper solutions, or phosphoric acid.

6.1.2 A recent initiative by semiconductor fabs encourages tool manufacturers to include multiple drain lines within the tool so that waste streams can be easily segregated. Diverter valves can be used to segregate chemicals and are also useful when organics exceed recommended levels. Tool manufacturers can also incorporate plumbing and treatment modules for returning spent water discharged from a tool as feed water for that tool (point of discharge [POD] recycling). Purchasing tools with recycle hardware already built-in eliminates the need for users to design and install customized water reuse systems unique to their site.

6.2 *Treatment of Waste Streams* — In addition to choosing the most effective and technically sound design choices, other considerations for treatment choices include easy access to all major components for operations and maintenance, availability of consumables and spare parts, and a high level of automation and reliability. There are several choices related to treatment choices:

6.2.1 Total oxidizable carbon (TOC) destruction by UV is commonly used for removal of organics found in reclaim waters and is sometimes combined with ozone or hydrogen peroxide.

6.2.2 Activated carbon or other adsorbents (e.g., GAC) are used for removal of organics and decomposed hydrogen peroxide, and is a common type of treatment in recycle water systems.

6.2.3 Electrodeionization (EDI) enables ion exchange reactions to be carried out continuously, without off-line regeneration, by introducing a dc electric field across the resin bed. This electric field is oriented transverse to the direction of water flow through the ion exchange column. Under the influence of the applied electric field, impurity ions, chemically captured by the ion exchange reactions, drift from resin bead to neighboring resin bead and ultimately through a semipermeable membrane that isolates the feed water channel from adjacent circulating water flows ('concentrate channels') that sweep away the impurities entering through the semipermeable membranes. This continuous regeneration action eliminates the need to take ion exchange columns off-line for resin regeneration and also eliminates the need for storing regeneration chemicals on site.

6.2.4 Reverse Osmosis Membrane Treatment provides extremely high rejection of dissolved ions (charged atoms and molecules), organic (carbon containing) compounds, silica (silicon containing) compounds, and virtually complete