

SEMI S18-1102

ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINE FOR SILANE FAMILY GASES HANDLING

This guideline was technically approved by the Global Environmental, Health, and Safety Committee and is the direct responsibility of the Japan Environmental, Health, and Safety Committee. Current edition approved by the Japan Regional Standards Committee on July 19, 2002. Initially available at www.semi.org September 2002; to be published November 2002.

NOTICE: Paragraphs entitled “NOTE” are not an official part of this document and are not intended to modify or supersede the official guideline. The task force has supplied them to clarify and to enhance usage of the guideline by equipment designers.

1 Purpose

1.1 This guideline is intended as a minimum set of safety and health criteria for silane family gases handling related to equipment and facilities used in semiconductor or Flat Panel Display (FPD) manufacturing.

2 Scope

2.1 Silane family gases which are described in this guideline are: monosilane (SiH_4), disilane (Si_2H_6), trisilane (Si_3H_8), dichlorosilane (SiH_2Cl_2) and trichlorosilane (SiHCl_3).

2.2 This guideline includes the following sections:

- Purpose
- Scope
- Limitations
- Referenced Standards
- Terminology
- General Principles
- Education and Training
- Leak Detection and Alarm Systems
- Fire Detection, Suppression and Alarm Systems
- Emergency Response
- Materials, Components, and Construction for Silane Family Gas Handling Equipment and Facilities.
- Pressurization and Leak Testing
- Storage
- Supply Systems
- Distribution Systems for Gas Supply

- Equipment Using Silane Family Gases
- Exhaust Systems and Plumbing
- Exhaust Treatment Systems
- Related Documents

2.3 This safety guideline does not purport to address all of the safety issues associated with its use. It is the responsibility of the users of this guideline to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Limitations

3.1 This document is not intended to impart requirements on any party.

3.2 This document is not intended to apply to gas manufacturers or distribution companies.

4 Referenced Standards

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

4.1 SEMI Standards

SEMI F1 — Specification for Leak Integrity of High Purity Gas Piping Systems and Components

SEMI F3 — Guide for Welding Stainless Steel Tubing for Semiconductor Manufacturing Applications

SEMI F4 — Specification for Pneumatically Actuated Cylinder Valves

SEMI F5 — Guide for Gaseous Effluent Handling

SEMI F6 — Guide for Secondary Containment of Hazardous Gas Piping Systems

SEMI F13 — Guide for Gas Source Control Equipment

SEMI F14 — Guide for the Design of Gas Source Equipment Enclosures

SEMI F15 — Test Method for Enclosures Using Sulfur Hexafluoride Tracer Gas and Gas Chromatography

SEMI S1 — Safety Guideline for Equipment Safety Labels

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

SEMI S4 — Safety Guideline for the Segregation/Separation of Gas Cylinders Contained in Cabinets

SEMI S5 — Safety Guideline for Flow Limiting Devices

SEMI S6 — Safety Guideline for Ventilation

SEMI S10 — Safety Guideline for Risk Assessment

SEMI S13 — Safety Guideline for Operation and Maintenance Manuals Used with Semiconductor Manufacturing Equipment

SEMI S14 — Safety Guidelines for Fire Risk Assessment and Mitigation for Semiconductor Manufacturing Equipment

4.2 NFPA¹ Standards

NFPA 13 — Installation of Sprinkler Systems

NFPA 70 — National Electrical Code

NFPA 318 — Standard for the Protection of Cleanrooms

4.3 Compressed Gas Association²

CGA P-20 — Standard for the Classification of Toxic Gas Mixtures

CGA P-23 — Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components

4.4 Other Documents

High Pressure Gas Safety Law³

The High Pressure Gas Safety Institute of Japan (KHK), Application Guide for the High Pressure Gas Safety Law⁴

Santa Clara County Toxic Gas Ordinance No. NS-517.44⁵

SSA Journal⁶, — Volume 11 No. 4, Winter 1997

1 National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101

2 Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, Virginia 22202-4102

3 KHK, Sumitomo-Tranomon Bldg., 4-3-9 Toranomon, Minatoku, Tokyo 105-8447

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5 Santa Clara County TGO

6 SSA Journal, SSA Journal Headquarters 1313 Dolly Madison Blvd. Suite402, McLean, VA22101

4.5 US Code of Federal Regulations

Uniform Fire Code (UFC)⁷—Sections 51, 79 and 80— Semiconductor Facility-Specific Sections

29CFR 1910.1200⁸, — “Hazard Communication” (OSHA)

NIOSH Pocket Guide — available online at <http://www.cdc.gov/niosh/topreq.html>

4.6 EU Directive

The Safety Sheets Directive 93/112 EEC

5 Terminology

5.1 Terminology defined in SEMI S2 should be referred to except if otherwise specified below.

5.2 Abbreviations and Acronyms

5.2.1 ACGIH[®] — American Conference of Governmental Industrial Hygienists. (ACGIH is a registered trademark of the American Conference of Governmental Industrial Hygienists.)

5.2.2 ESOV — Emergency Shut Off Valve.

5.2.3 IDLH — Immediately Dangerous to Life and Health, concentration of airborne contaminants, normally expressed in parts per million or milligrams per cubic meter, which represents the maximum level from which one could escape within thirty minutes without any escape-impairing symptoms or irreversible health effects. This level is established by the National Institute of Occupational Safety and Health (NIOSH). [SEMI F6]

5.2.4 MSDS — Material Safety Data Sheet, a document that provides information on the properties of a chemical material in a format specified by a regulation such as OSHA 29 CFR 1910.1200, “Hazard Communication”.

5.2.5 PTFE — Poly Tetra Fluoro Ethylene.

5.2.6 SSCS — silane safety control system. SSCSs are integrated systems of detection devices that, when monitored as a group, provide for an overall status of the safety of the hazardous gas handling system (e.g., pressure transducers linked to valve status monitors and valve cycle counting programs or excess-flow monitoring interlocked to shutdown the source).

5.2.7 TLVs[®] — Threshold Limit Values for chemical substances in the work environment adopted by ACGIH[®] (TLV[®] is a registered trademark of the

7 Uniform Fire Code, 5360 South Workman Mill Road, Whittier, CA 90601

8 Occupational Safety and Health Administration U.S. Department of Labor, <http://www.osha.gov>

American Conference of Governmental Industrial Hygienists.) [SEMI F6].

5.2.8 *TWA* — Time Weighted Average — As defined by the American Conference of Governmental Industrial Hygienists (ACGIH®) [SEMI F6].

5.2.9 *VMB* — Valve Manifold Box.

5.3 Definitions

5.3.1 *abatement system* — a system used to modify the effluent from a process in order to make it safe to emit from the facility or to reduce emissions of hazardous materials to safe levels.

5.3.2 *authorized personnel* — those persons trained and capable of performing activities involving the risks associated with the defined tasks.

5.3.3 *carriage* — a hand cart for carrying one or two gas cylinders.

5.3.4 *chlorosilane* — dichlorosilane or trichlorosilane.

5.3.5 *controlled condition* — when related to silane family gases, a condition in which the gas is controlled within the confines of an approved piping system with controls that can determine if the safe parameters of the piping system have failed.

5.3.6 *exhaust treatment system* — a system similar to an abatement system, except it handles only the airborne emissions from a process in order to make them safe to emit or to reduce the levels of hazardous materials to safe emission levels.

5.3.7 *fail-safe* — designed so that a failure does not result in an increased risk [SEMI S2].

5.3.8 *flammable gas* — any gas that forms an ignitable mixture in air at 20 degrees C (68°F) and 101.3 kPa (14.7 psia) [SEMI S2].

5.3.9 *Flow Limiting Device* — a device installed in a valve that is designed to reduce the maximum flow from the valve under full flow conditions [SEMI F5] [One such device is a Restricted Flow Orifice (RFO)].

5.3.10 *foolproof* — designed so that any single human error or misuse does not result in unacceptable risk.

5.3.11 *occupational exposure limits (OELs)* — Various terms are used to refer to OELs, such as permissible exposure levels, Threshold Limit Values®, maximum acceptable concentrations, maximum exposure limits, and occupational exposure standards. When OELs are used to specify work-area criteria in this document, OELs are generally established on the basis of an eight hour workday. When OELs are used to specify criteria in this document for alarm or warning in non-occupational area, OELs established on shorter

exposure basis may be used. However, the criteria used in determining OELs can differ among the various countries that have established values. Refer to the national bodies responsible for the establishment of OELs. (Threshold Limit Value is a registered trademark of the American Conference of Governmental Industrial Hygienists.)

5.3.12 *oxidizer gas* — a gas which will support combustion or increase the burning rate of a combustible material with which it may come in contact [SEMI S4].

5.3.13 *pyrophoric gas* — “a gas which upon contact with air will ignite spontaneously at or below a temperature of 54°C (130°F) [SEMI S4]” at a pressure of 101.3kPa (14.7psia).

5.3.14 *safe shutdown condition* — a condition in which all hazardous energy sources are removed or suitably contained and hazardous production materials are removed or contained, unless this results in additional hazardous conditions.

5.3.15 *safe state* — a condition in which the equipment does not present any uncontrolled hazards to itself or to personnel. It does not allow hazardous production chemicals to flow. An acceptable safe state is determined by the designer of the equipment and is based on the hazards in the design.

5.3.16 *silane* — any of monosilane, disilane, or trisilane.

5.3.17 *unacceptable risks* — risks of a degree or type which are not acceptable to the person who approves a design or procedure.

5.3.18 *unsafe gas condition* — a condition in which the gas is not safely contained within the designed parameters of the equipment process, or which could lead to a gas emission or gas hazard.

6 General Principles

6.1 Since silane family gases have several hazardous properties, personnel should wear appropriate protective equipment when working with silane family gas sources.

6.1.1 Monosilane (SiH₄), disilane (Si₂H₆) and trisilane (Si₃H₈) are pyrophoric. If these gases are mixed with stronger oxidizing gases than air, combustion and explosion energies can radically increase.

6.1.2 Dichlorosilane (SiH₂Cl₂) is pyrophoric and trichlorosilane (SiHCl₃) is flammable. Dichlorosilane (SiH₂Cl₂) and trichlorosilane (SiHCl₃) are also corrosive gases. If these gases are mixed with