SEMI S21-1106E (Reapproved 0612)
SAFETY GUIDELINE FOR WORKER PROTECTION

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NOTICE: This Document was reapproved with minor editorial changes.

1 Purpose

1.1 This Safety Guideline identifies preferred methods for the protection of persons from safety and health hazards as they perform work on or around equipment used for semiconductor or FPD manufacturing.

2 Scope

2.1 This Safety Guideline describes methods for protection against hazards that workers may encounter in the work area, such as hazardous energies, physical hazards, or hazardous chemicals.

2.2 This Safety Guideline is intended to recommend considerations for protecting all persons that work on or around equipment used for semiconductor or FPD manufacturing.

2.3 This Safety Guideline applies to equipment suppliers and users of equipment, including activities related to semiconductor or FPD manufacturing, and equipment and process development activities.

2.4 This Safety Guideline includes the following sections:

1. Purpose
2. Scope
3. Limitations
4. Referenced Standards and Documents
5. Terminology
6. General Worker Safety
7. Chemical Hazards
8. Control of Hazardous Energy
9. EEW at Hazardous Voltage or Energy Levels
10. Radiation-Producing Equipment
11. Physical Hazards
12. Personal Protective Equipment
13. Emergency Preparation and Managing Abnormal Situations

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 Safety Guideline is intended to be used by the equipment suppliers and users in consideration of worker protection. This Safety Guideline is not intended to be all-inclusive or used to verify conformance to any regulatory requirements.

3.2 Equipment design criteria are outside the scope of this Document.

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3.3 This Safety Guideline is not intended to provide all of the criteria for worker protection in multi-employer work areas. SEMI S24 contains additional criteria for such areas.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI F34 — Guide for Liquid Chemical Pipe Labeling

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

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

SEMI S13 — Environmental, Health and Safety Guideline for Documents Provided to the Equipment User for Use with Semiconductor Manufacturing Equipment

SEMI S19 — Safety Guideline for Training of Semiconductor Manufacturing Equipment Installation, Maintenance and Service Personnel

SEMI S24 — Safety Guideline for Multi-Employer Work Areas

4.2 *ANSI Standards*[1]

ANSI B11.21 — Machine Tools – Safety Requirements for Machine Tools Using Lasers for Processing Materials

ANSI Z136.1 — Safe Use of Lasers

ANSI/NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces

4.3 *European Directives*[2]

89/686/EEC — Personal Protective Equipment Directive

4.4 *European Committee for Standardization (CEN) Standards*[3]

EN 207 — Personal Eye-Protection – Filters and Eye-Protection Against Laser Radiation

EN 208 — Personal Eye-Protection – Eye-Protectors for Adjustment Work on Lasers and Laser Systems (Laser Adjustment Eye-Protectors)

4.5 *IEC Standards*[4]

IEC 60825-1 — Safety of Laser Products – Part 1: Equipment Classification, Requirements and User Guide

4.6 *JIS Standards*[5]

JIS C 6802 — Safety of Laser Products

4.7 *OSHA Standards*[6]

29 CFR 1910.147 — The Control of Hazardous Energy (lockout/tagout)

29 CFR 1910.1200 — Hazard Communication

29 CFR 1926.502 — Fall Protection Systems Criteria and Practices

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

[1] American National Standards Institute, 25 West 43rd Street, New York, NY 10036, USA; Telephone: +1.212.642.4900, Fax: +1.212.398.0023, http://www.ansi.org

[2] European Commission, Available through the European Union On-Line at http://europa.eu.int/index_en.htm

[3] European Committee for Standardization, Avenue Marnix 17, B-1000 Brussels; Telephone: 32.2.550.08.11, Fax: 32.2.550.08.19, http://www.cen.eu

[4] International Electrotechnical Commission, 3 rue de Varembé, Case Postale 131, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.919.02.11, Fax: +41.22.919.03.00, http://www.iec.ch

[5] Japanese Standards Association, 4-1-24 Akasaka, Minato-ku, Tokyo 107-8440, Japan; Telephone: +81.3.3583.8005, Fax: +81.3.3586.2014, http://www.jsa.or.jp

[6] Occupational Safety and Health Administration, Available from U.S. Department of Labor; http://www.osha.gov

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5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *AED* — automated external defibrillator

5.1.2 *CPR* — cardiopulmonary resuscitation

5.1.3 *EEW* — energized electrical work (Also known as Working on Energized Electrical Circuitry.)

5.1.4 *EMO* — emergency off

5.1.5 *ERT* — emergency response team

5.1.6 *FPD* — flat panel display

5.1.7 *MSDS* — material safety data sheet

5.1.8 *PPE* — personal protective equipment

5.2 *Definitions*

5.2.1 *confined space* — a space that (1) is large enough and so configured that an employee can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (e.g., chambers, space in enclosures are spaces that may have limited means of entry); and (3) is not designed for continuous employee occupancy.

5.2.2 *e-diagnostic* — electronic access to equipment for the purpose of diagnosing problems from a distance (e.g., via dial-up, network connection, or wireless communication means).

5.2.3 *electrical PPE* — personal protective equipment specially designed to provide protection from electrical arc, shock or other effect that could cause injury to a person touching an electrical circuit or causing an electrical fault.

5.2.4 *emergency* — a sudden, serious event or situation, such as earthquake, explosion, fire, or release of hazardous energy or chemicals.

5.2.5 *emergency response team* — a team who is responsible for responding to emergencies.

5.2.6 *employer* — entity that directly supervises employees.

5.2.7 *energized electrical work* — work performed on energized equipment or systems containing hazardous voltages.

5.2.8 *facility operator* — entity that controls activities at the site. The facility operator may be the user itself.

5.2.9 *facility owner* — the actual owner of the property that may not be the actual operator of the facility.

5.2.10 *hazardous energy* — any energy that can potentially result in serious injury, illness, or death.

NOTE 1: Hazardous energies include electrical (e.g., capacitors, batteries), chemical, thermal/cryogenic, stored pressure (e.g., pressurized containers), suspended weight, stored mechanical (e.g., springs), generated pressure (e.g., hydraulics and pneumatics), and other sources that may lead to the risk of injury.

5.2.11 *operator* — a person who interacts with the equipment only to the degree necessary for the equipment to perform its intended function. [SEMI S2]

5.2.12 *hazardous voltage* — voltages greater than 30 volts rms, 42.4 volts peak, 60 volts DC. [SEMI S2]

NOTE 2: To avoid confusion between hazardous voltage and non-hazardous electrical energy, see definition for non-hazardous electrical energy.

5.2.13 *non-hazardous electrical energy* — electrical energy of which voltage considered to need no further protection to be safe for human contact. Includes voltages less than the value specified as 'hazardous voltage' and power less than 240 volt-amps (VA) (as used in EMO circuits and interlock circuits that must remain active during maintenance).

5.2.14 *supplier* — party who provides equipment to and communicates directly with the user. A supplier may be a manufacturer, an equipment distributor, or an equipment representative. [SEMI S2]

5.2.15 *user* — party who acquires equipment for the purpose of using it to manufacture semiconductors or FPD.

5.2.16 *work* — any activity performed on semiconductor or FPD manufacturing equipment, utilities connected to the equipment, or facilities associated with the equipment within the work area.

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5.2.17 *work area* — room or defined space where semiconductor or FPD manufacturing equipment is located and where workers are present. This can include service chases and sub-fab areas.

5.2.18 *workers* — personnel who install, operate, maintain, service, decontaminate, or disassemble equipment.

6 General Worker Safety

6.1 The hierarchy for selecting worker protection measures should be as follows:

- Hazard elimination by design
- Engineering controls
- Administrative methods
- Personal Protective Equipment

6.2 The equipment supplier should provide information in the equipment operation, maintenance, or service manual or other appropriate documents on recommended controls to reduce the risks. These documents should conform to SEMI S13.

6.3 *Equipment Engineering System (EES) Related Safety Issues*

6.3.1 Suppliers should identify all forms of e-diagnostic communications (either standard or optional) that exist or are planned and should include the preferred method (i.e., local area network (LAN), telephone line, wireless port) that is required.

6.3.2 Suppliers should describe any communications isolation feature (e.g., cut-off switches, locations for disconnecting cables) that is available to protect equipment from being controlled remotely.

NOTE 3: Isolation of communication usually will not be acceptable to local jurisdictions as a substitute for isolation of hazardous energy in a hazardous energy control procedure.

6.4 Prior to work, employers should develop safe work procedures.

6.4.1 Development of safe work procedures should use hazard analyses and risk assessments to identify the hazards and determine which hazards warrant further mitigation.

6.4.2 Risks identified by job hazard analyses and risk assessments should be reduced to an acceptable level, using the protective measure hierarchy described above.

6.5 Employers should ensure that workers are adequately trained to perform their assigned work safely.

6.5.1 Suppliers and users should agree on training involving specific equipment.

NOTE 4: See SEMI S19, which pertains to safety training and certification for personnel working in semiconductor fabrication facilities.

6.6 The supplier should provide the user with the version of equipment installation, maintenance, service, and operation manuals that matches the specific equipment configuration as installed, contains the latest information for that configuration but is appropriate to the specific equipment for both configuration and process.

NOTE 5: Installation or service manuals may not be necessary if those tasks are to be performed only by supplier personnel.

6.6.1 The user should verify that the manuals correctly reflect the equipment configuration as it was installed. If there are any discrepancies, the user and the supplier should agree on corrective actions.

6.7 The facility operator should establish site-specific safety procedures for the safety of all persons including temporary workers, visitors, and supplier representatives in the work area.

6.7.1 Site-specific hazards and appropriate protective measures including applicable safety procedures should be communicated by the facility operator to all persons.

6.8 Upon request, the facility operator should identify appropriate communication measures to ensure there is communication between workers that may be physically separated, such as between upper and lower floors or between operation and maintenance areas.

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NOTE 6: Facility operators may restrict wireless communications because of interference issues. This may include wireless phones, personal digital assistants (PDAs), two-way pagers, and other wireless devices.

6.9 The facility operator should ensure conformance to all applicable regulatory requirements and control of hazards in the work area. The use of industry practices should be considered in the absence of regulatory requirements.

NOTE 7: Multi-employer work site issues may be involved in some jurisdictions. Check with local site personnel for information before finalizing practices.

6.10 Hazards should be controlled based on each job category: installation, operation, maintenance and service.

6.10.1 *Installation*

6.10.1.1 Prior to equipment installation, the installation manual or other available documents should be checked to ensure that the appropriate information is available, including:

- Utilities connection diagram
- Electrical cabling information
- Hazardous energy isolation procedures
- Instructions for use of installation support tool, such as a lifting device
- Test procedures for safety features and performance
- Chemical information
- Safety related detector types and locations

6.10.1.2 Prior to equipment installation, worker protection measures that are necessary but are not provided with the equipment should be identified and prepared.

NOTE 8: Anchorage point for the safety harness may be necessary during installation for work at elevated positions but may not be supplied with the equipment. Availability of anchorage point at the site needs to be checked in advance.

6.10.2 *Operation*

6.10.2.1 EMO and safety interlock features should not be removed, bypassed or overridden during normal operating periods.

6.10.2.2 The location and functionality of each safety interlock feature and EMO feature should be verified before initial start-up of any system.

6.10.2.3 Periodic testing and validation of EMO and safety interlock features should be performed in accordance with the supplier's recommendations.

6.10.2.4 EMO and safety interlock systems should be tested and validated following extended shutdown for maintenance and service.

6.10.3 *Maintenance and Service*

6.10.3.1 Prior to maintenance or service, the worker should check for the following:

- Effects of the tasks on any safety systems
- Presence of active hazardous energy sources
- Hazardous energy source isolation (lockout/tagout) requirements
- Verification of remaining hazardous energies after energy isolation
- Procedure for removal or isolation of remaining hazardous energies
- Necessity and procedures to override safety interlocks
- Proper restoration of overridden safety interlocks after completion of the work

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- Personal protective measures required for the work including the use of personal protective equipment and training requirements
- Requirements to document the work

6.10.3.2 Workers should perform their tasks in accordance with identified procedures and requirements.

NOTE 9: Personal protective measures may be necessary to control risks associated with ergonomic hazards when handling heavy or bulky items (e.g., large motors, chamber lids, flat panel substrates). Special fixtures and instructions for use may be necessary.

7 Chemical Hazards

7.1 The hazards of all work-related chemicals should be identified. Hazard communication should be provided for all known hazards of those chemicals.

7.2 *Hazard Communication (HAZCOM)*

7.2.1 The user should provide chemical safety data to a designated supplier representative and all potentially exposed persons. The supplier representative should be the manager responsible for field service personnel.

7.2.2 Only personnel who have been trained in safe handling techniques and the hazards associated with exposure should perform work associated with hazardous chemicals.

7.2.3 When performing work at the user's site, the supplier should provide the user information in advance on any chemicals that the supplier brings onto the user's site. It is the responsibility of the supplier to provide information in advance on supplier-specified hazardous chemicals and the appropriate handling procedures. It is the responsibility of the user to train workers on user-specified hazardous chemicals.

7.2.4 Chemicals and gases should be handled with special care based on specific handling instructions that are described in material safety data sheets (MSDSs) and equipment manuals.

7.2.5 MSDSs for the chemicals in use should be readily accessible while work associated with the chemicals is being performed.

7.2.6 All chemical containers and pipes should be labeled with contents and hazards according to applicable codes or standards.

NOTE 10: Process piping that may carry varying contents depending upon the timing or recipe may be labeled with the generic contents of the piping provided the hazards and protective measures can be easily identified from the label.

NOTE 11: Information about chemical labeling methods is provided in SEMI F34 and OSHA 29 CFR 1910.1200.

7.2.7 A written program for controlling hazardous chemicals should be developed by each employer.

7.2.7.1 This program should be periodically reviewed, for adequacy, by employers.

7.2.7.2 Employers should train their workers on proper implementation of the program.

7.3 *Chemical Handling and Storage*

NOTE 12: Information on chemicals used in the area and the facility-operator-required personal protective equipment (PPE) is the responsibility of the facility operator and should be available in the work area according to regulations for the location.

7.3.1 All workers should be trained on the chemical hazards, the proper use of the PPE, and the limitations of the PPE.

7.3.2 Chemical information should be presented to workers during training in a clearly understandable format (such as a table) and should include chemical names, chemical formulas, hazardous properties (flammable, corrosive), chemical states (solid, liquid, or gas), and other hazard information.

NOTE 13: It is recommended that users of this Document refer to § 12, Personal Protective Equipment for additional information on protection from chemical exposure.

7.3.3 Further information on typical chemical categories and their related hazards is provided in Table A1-1 of Appendix 1.

7.3.4 When operation, maintenance, or service tasks may include exposure to chemical mists, fumes, or vapors, the tasks should be conducted with adequate ventilation.

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