



SEMATECH Equipment Installation Sign-off Procedure

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SEMATECH Equipment Installation Sign-off Procedure

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Abstract: The Equipment Installation Sign-off Procedure uses various checklist tools that guide SEMATECH personnel through reviews of semiconductor manufacturing equipment installation projects at pre-defined stages of the design and installation. Such reviews provide an opportunity for SEMATECH personnel to verify that required environment, safety, and health (ESH) and regulatory compliance elements are in place before starting up equipment. The Equipment Installation Checklist that corresponds to this procedure aids in proactively identifying deficiencies in the design and installation while establishing accountability for the completion of outstanding items in a timely manner. Additionally, the checklist serves as documentation of individual equipment installation projects that is archived for future reference. This document includes the checklist in Microsoft Word format, which users can modify to suit their company situation. This document also includes an application guide that describes key sections of the Equipment Installation Checklist.

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Authors: Erik Kunz

Approvals:
Mike Zimmermann, Manager, ESH Operations
Bob Duffin, Director
Laurie Modrey, Technical Information Transfer Team Leader

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Robert Sherman (Rockwell)	Michael Ware
Courtney Murdoch	C.B. Ellis
Doris Ellsworth	Tim Besaw
Gerry Moore	

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1 EXECUTIVE SUMMARY

This procedure was developed specifically for implementation at SEMATECH. As a research and development facility, SEMATECH's organizational structure, company size, and manufacturing volume may differ considerably from large manufacturing facilities. While the methodology and logic behind this procedure is sound, the procedure itself may require significant modification to be successfully implemented at other companies. The content of the Equipment Installation Checklist is not intended to address *all* safety and regulatory compliance issues related to *all* equipment installation projects. Rather it is intended to address the majority of such issues as seen fit by SEMATECH personnel and as required by the Austin Fire Department and the City of Austin Development Review and Inspection Department.

1.1 Purpose

The purpose of these guidelines is to

- Ensure that all equipment installation projects within the scope of this procedure are designed and installed in a manner consistent with applicable codes, regulations, and sound engineering practices.
- Proactively address environment, health, and safety (ESH) concerns related to the design, installation, startup, operation, and maintenance of equipment within the scope of this procedure.

The purpose of the Equipment Installation Checklist is to provide a record of single equipment installations and their review by SEMATECH personnel as required by the Austin Fire Department (AFD) and City of Austin Development Review and Inspection Department (DRID).

1.2 Scope

This procedure addresses the minimum requirements for the design and installation of new or relocated equipment within the facility. It is intended to identify the majority of ESH and regulatory compliance issues for such activities. Equipment Installation Sign-off procedures must be followed for the installation of all equipment meeting one or more of the following criteria:

- a. All equipment that uses, creates, or contains any of the following:
 1. Any Chemicals (solid, liquid, or gas)
 2. Radiation (e.g., Ionizing, Non-ionizing, Laser, RF, X-ray, etc.)
 3. Hazardous waste.
 4. > 120 Volt electrical potential (phase to ground).
 5. Hazardous energy sources in addition to electricity.
 6. Moving parts which have or need guarding to prevent injury.
- b. All equipment that requires facilities hookups such as exhaust, drain, house gases, cooling water, etc.

1.3 Definitions

The following definitions apply to this procedure and the corresponding Equipment Installation Checklist:

- a. Bulk Chemical Delivery System—A system that consists of chemical storage vessels located outside of the fabrication area from which chemicals are piped to equipment in the fabrication area.
- b. Equipment Owner—The person listed as the Requester on the Facilities Work Order. If a more appropriate party exists, the Requester must designate the person who will fulfill the responsibilities of the Equipment Owner during the installation.
- c. Equipment-specific—An item installed specifically to accommodate, either wholly or in part, the presence of the equipment being installed or installed internally on the equipment.
- d. Hazardous Energy—Electrical, mechanical (i.e., moving parts, pinch/nip points, etc.), hydraulic, pneumatic, chemical, thermal, ionizing radiation, non-ionizing radiation, and other types of energy. Lockout/tagout procedures must consider hazards associated with all types of energy related to the activity to be performed.
- e. Hazardous Production Material (HPM)—A solid, liquid, or gas associated with semiconductor manufacturing that has a Class 3 or 4 degree-of-hazard rating in health, flammability or reactivity as ranked by the National Fire Protection Association (NFPA 704 - 1997) and that is used directly in research, laboratory, or production processes whose end-product materials are not hazardous.
- f. Minimal Risk Chemical—A solid, liquid, or gas that has a Class 0 or 1 degree-of-hazard rating in health, flammability, or reactivity as ranked by the National Fire Protection Association (NFPA 704 - 1997). Minimal risk chemicals are those that pose minimal, if any, hazards to personnel who may be exposed to them. They are the only chemicals that may be introduced to the equipment upon Level 1 Sign-off.
- g. Point-of-use—That point on the external surface of the equipment that is nearest to where gas, liquid, or vacuum supply lines are connected to the equipment. Point-of-use labels are intended to identify all gas, liquid, and vacuum lines and electrical cords at the point of connection to the equipment.
- h. Wet Process Chemical—A chemical stored in and/or dispensed from a vessel that is internal to the equipment or is delivered to the equipment from storage vessel(s) in a dispensing cabinet remote from the equipment but within the fabrication area (i.e., in an adjacent service bay).
- i. Work Order System—The process currently used at SEMATECH to install equipment as specified in the Work Order and as estimated by Facilities Installations according to the design package developed by Facilities Engineering.

2 METHODOLOGY

The Equipment Installation Sign-off procedure uses various checklist tools that guide SEMATECH personnel through a review of equipment installations at pre-defined stages of the design and installation process. This procedure allows for a review of the installation design, before installation as well as at three pre-defined sign-off levels. Such reviews provide an opportunity for SEMATECH personnel to verify that required elements are in place before starting up equipment. The Equipment Installation Checklist aids in identifying deficiencies in

the design and installation while establishing accountability for the completion of outstanding items in a timely manner. Additionally, the checklist serves as documentation of individual equipment installation projects that is archived for future reference as required by the Austin Fire Department and the City Development Review and Inspection Department. The Equipment Installation Checklist contains five basic sections. The reasoning and logic underlying each section of the checklist is described in the following sections.

2.1 Equipment Installation Data Sheet

The first page of the Equipment Installation Checklist is called the Equipment Installation Data Sheet. This form is intended to provide a quick reference to the following information with regard to the particular equipment being installed:

- A brief description of the equipment
- Status of the equipment (i.e., whether it is new or being relocated within the facility)
- Location where the equipment is to be installed
- The basic safety concerns that qualify the equipment to follow this procedure.
- The important contact persons involved with the particular installation including the Equipment Owner, the Registered Industrial Plant Engineer who is responsible for the installation, and a contact person representing the equipment supplier
- The “R” Column Legend gives the abbreviations used to reference each group in the “R” column of the various checklists (see Section 3.3)

2.2 Installation Design Checklist

The Installation Design Checklist provides an opportunity to ensure certain ESH and general design requirements have been met in the design phase of the installation. This checklist is completed immediately after the installation is designed and before any actual installation activities take place.

2.3 Level 1 Equipment Installation Checklist

The Level 1 checklist is designed to ensure the equipment is ready to be energized. Once the equipment is set, leveled, and electrical and facilities connections are made, the installation is reviewed using the Level 1 Checklist. Once the Level 1 Checklist is completed, electrical power of 120 V or less (phase-to-ground voltage) may be supplied to the tool. Also, any minimal risk gases and liquids (waters) (see definition 3f) as well as vacuum may be supplied to the tool. Completion of the Level 1 Equipment Installation Checklist allows the supplier an opportunity to perform any equipment system checks that are necessary before introducing hazardous production materials (HPM) or other hazardous energy sources associated with the equipment. Major sections of this checklist include the following: electrical hookups, lockout/tagout procedures, maintenance and access clearances, exhaust ventilation systems, minimal risk gas and liquid hookups, vacuum line hookups, radiation sources, lasers, vacuum pumps, emergency machine off (EMO) switches, and guarding.

2.4 Level 2 Equipment Installation Checklist

The Level 2 Equipment Installation Checklist is used to verify that the equipment is ready for HPM use and that other hazards associated with the equipment are ready to be energized (i.e.,

radiation, lasers, mechanical hazards, etc). Once the Level 2 review is completed, the equipment may be approved to become fully functional, but released **ONLY** for engineering use (process qualification). Major sections of this checklist include the following: fire detection and suppression systems, wet process chemical systems, bulk chemical delivery systems, gas delivery systems, drains and chemical disposal requirements, post-process exhaust treatment systems, interlocks, gas detection, radiation, personal protective equipment, and labeling.

2.5 Level 3 Equipment Installation Checklist

The Level 3 Equipment Installation Checklist provides an opportunity to review the content of all maintenance, operations, and decommissioning procedures specific to the equipment being installed. The Level 3 review also addresses the status of any open items from previous levels to ensure their completion. Finally, the Level 3 review addresses the status of industrial hygiene baseline surveys, operator training requirements, and any specially negotiated working conditions. Once the Level 3 checklist is completed, the equipment may be approved for final release to manufacturing and full operation.

3 PROCEDURE

3.1 Integration into the Work Order System

This procedure impacts the Work Order system currently used at SEMATECH in three basic areas (see definition 3i). First, the procedure requires all necessary information to be submitted to Facilities Installations before the installation can be designed. Such information may include, but is not limited to, the following forms and documents:

- Chemical/Gas Change Request
- ATDF Tool Information
- Equipment Data
- Supplier contact information
- SEMI S2 and S8 reviews

Secondly, this procedure impacts the review of the design package by incorporating Installation Design Checklist (see Sections 2.2 and 3.4), which must be signed by the appropriate personnel before installation can begin.

Finally, this procedure divides the Work Order into three steps (Levels 1,2, &3). The three levels are described in detail in Sections 2.3 through 2.5. Completion of the checklist items is covered in Section 2.5.

3.2 Completion of the Equipment Installation Data Sheet

The Equipment Installation Data Sheet is completed by the facilities engineer responsible for the equipment installation project. Most of the information that is required in this form may be transposed directly from either the ATDF Tool Information form or the Equipment Data form that accompanies the Facilities Work Order.

3.3 The “R” Column Legend

The “R” (for Responsibility) Column Legend gives the abbreviations that are listed in the “R” column of each checklist to identify the group that is most familiar with and/or responsible for each specific checklist item. If, while completing the Equipment Installation Checklist, questions arise as to the status of any item, the group identified in the “R” column is responsible for verifying status and, if a deficiency exists, for taking action to complete the item.

3.4 Completion of the Installation Design Checklist

Once a particular installation project is designed, Facilities Engineering calls for a review of the design. The installation design review involves representatives from Facilities Engineering (FE); Environment, Safety, and Health (ESH); and Equipment Engineering and Maintenance (EM). When the Installation Design Checklist is completed and the proposed design accepted, the actual installation of the equipment can begin.

3.5 Completion of the Level 1, 2, & 3 Equipment Installation Checklists

3.5.1 Equipment Installation Sign-off Team

The completion of the Equipment Installation Checklists will be facilitated by an Equipment Installation Sign-off Team composed of representatives from each group involved in the installation. Facilities Engineering is responsible for ensuring the checklists are completed and will identify the appropriate personnel to represent each group during the installation sign-off activities. The groups to be represented in the Equipment Installation Sign-off Team are as follows:

- Facilities Engineering (FE)
- Facilities Operations (FO)
- Facilities Installations (FI)
- Equipment Engineering and Maintenance (EM)
- Environment, Safety, and Health (ESH)

3.5.2 Completion of the Level 1 & 2 Equipment Installation Checklists

The Level 1 and Level 2 Equipment Installation Checklists are completed during separate review sessions, which will be scheduled at an appropriate time by Facilities Installations. The Equipment Installation Sign-off Team meets at the installation site while the checklist items are verified under the direction of the Facilities Engineer. Each checklist item is then verified and initialed by the appropriate Sign-off Team representative as indicated in the “R” column. Each representative initials either the Yes, No, or N/A box for each checklist item that applies to his group as indicated in the “R” column. For checklist items that list more than one party in the “R” column, the party who initials the Yes, No or N/A box circles the abbreviation in the “R” column for the group he represents. Ideally, both parties will verify such items.

3.5.2.1 Punchlist Items

Any deficiencies discovered during the Level 1 and Level 2 reviews that do not directly impact the safety of the equipment or the installation should be listed in the Punchlist at the end of each Installation Checklist. The party responsible for the completion of each item must be listed in the

Punchlist as well. Punchlist items should be completed in a timely manner; they must be completed before the installation is fully approved (Level 3 review).

3.5.2.2 Deficient Checklist Items

All items for which “No” is indicated on the Level 1 or Level 2 checklists must be listed in the Deficient Checklist Items table at the end of the Level 1 or Level 2 Installation Checklist, respectively. When the deficient item is completed, the responsible party must indicate the date of completion and sign the Deficient Checklist Items table to indicate the completion.

3.5.2.3 Signature Blocks

When all checklist items are completed, whether deficient or otherwise, the installation may be approved according to the Level 1 or Level 2 Installation Checklist, whichever applies. The installation may be approved only when all deficient checklist items are completed. All parties responsible for deficient checklist items must wait to sign the signature box until those deficient checklist items are complete. All other parties may sign the appropriate signature box after all checklist items for which they are responsible are verified. The ESH representative has the final signature authority on all signature blocks and must wait to approve the installation until all checklist items (deficient or otherwise) are complete and verified.

3.6 Completion of the Level 3 Equipment Installation Checklist

The Level 3 Equipment Installation Checklist is to be completed by the appropriate representatives from the groups listed in the “R” column of that checklist. Many of the items, such as those pertaining to the review of operations, maintenance, and decommissioning procedures, may be completed at any time during the installation if the appropriate documentation is available for review. The remainder of the Level 3 items are verified in an informal review scheduled by a representative of the Equipment Engineering and Maintenance group (EM) at such time that the equipment is ready to be fully released to manufacturing.

3.7 Roles and Responsibilities

This section summarizes the roles and responsibilities of the various groups involved in equipment installations.

3.7.1 Registered Industrial Plant Engineer

The Registered Industrial Plant Engineer is

- A qualified person from the Facilities Engineering group who is responsible for the accuracy of the documented information related to each specific equipment installation. For this reason, the Registered Industrial Plant Engineer must approve, by signature, the installation as indicated on the Equipment Installation Checklists.
- Responsible for archiving, for future reference, all completed checklists and other documentation related to each specific equipment installation.

3.7.2 Facilities Engineering

Being involved in virtually all aspects of equipment installations, Facilities Engineering is the owner of the Equipment Installation Checklist procedure. Specific responsibilities include

- Ensuring the completion of the Installation Sign-off Checklists in a timely manner

- Designing the installation in compliance with applicable codes, regulations, and sound engineering practices
- Upon completion of the installation design, scheduling and coordinating the Installation Design review
- Designating the representatives from each group who will be included in the Installation Sign-off Team for each review session

3.7.3 Equipment Owner

The Equipment Owner is

- Responsible for obtaining and supplying all information from the supplier pertaining to the equipment and its installation, operation, and maintenance as required during the equipment installation process (e.g., operations & maintenance procedures, lockout/tagout procedures, chemical authorization, SEMI S2/S8 review, etc.)
- A liaison between the Equipment Installation Sign-off Team and the Supplier Representative as necessary
- Responsible for assuring that the equipment operates safely and that all employees working with the equipment are adequately trained

3.7.4 Environment, Safety, and Health

ESH

- Serves as a technical resource to all parties involved in the installation process, communicating ESH requirements early in the design and installation process
- Approves the use of the equipment by reviewing the SEMI S2 and S8 documentation supplied by the equipment owner
- Authorizes the use of chemicals related to the equipment to be installed
- Verifies, by signature, final approval of the installation where indicated on Equipment Installation Checklists that are included in this procedure

3.7.5 Facilities Installations

Facilities Installations is responsible for

- Coordinating all facilities installation activities to expedite the completion of each stage of the installation in a timely manner
- Coordinating and scheduling the Level 1 & Level 2 sign-off team meetings at the appropriate time
- Verifying the completion of all outstanding Punchlist items in a timely manner to satisfy the Equipment Installation Checklists included in this procedure
- Performing certain installation activities as required to successfully complete each stage of the installation

3.7.6 Equipment Maintenance and Engineering

The Equipment Maintenance and Engineering representative

- In some instances, act as the Equipment Owner, fulfilling the responsibilities outlined in section 3.7.2
- Obtains and/or develops maintenance, lockout/tagout, and decommissioning procedures specific to the equipment
- Schedules and coordinates the Level 3 review with the appropriate parties as outlined in Section 3.6 of this procedure

3.7.7 Facilities Operations

Facilities Operations is responsible for performing certain installation activities as required to successfully complete each stage of the installation.

3.7.8 Process Engineering

Process Engineering is responsible for

- Supplying the content of all operations procedures that accompany the equipment as outlined in the Level 3 Equipment Installation Checklist
- Ensuring that all operators are properly trained to operate the equipment, including an understanding of the proper selection and use of personal protective equipment required for the equipment

3.7.9 All Groups

All groups listed in Sections 3.7.1 through 3.7.8 have the following responsibilities in common:

- Providing a delegate to represent the group on the installation sign-off team as outlined in Section 3.5.1 of this document.
- Verifying the completion of specific items on the Equipment Installation Checklists as indicated in the “R” column of the checklists.
- Communicating any and all safety concerns and/or deviations from the original installation design that may arise during the installation process.
- Verifying, by signature, approval of the installation as required on the checklists.

4 APPLICATION GUIDE

4.1 General

This section is a guide that may be referred to while completing the Equipment Installation Checklist. Each major section of the checklist is described in detail, specifically those sections where questions about the content are likely to arise. While each checklist item may not be mentioned, many of the major checklist items are described to assist the user in successfully navigating the document.

4.2 Equipment Installation Data Sheet

4.2.1 Descriptive Information

The Equipment Installation Data Sheet requires much of the same information included on SEMATECH's ATDF Tool Information form. Much of the descriptive information pertaining to the equipment can be copied from this form, which accompanies each Facilities Work Order submitted for the installation of equipment in the Advanced Tool Development Facility (ATDF). The Facilities Engineering is responsible for completing the Equipment Installation Data Sheet.

4.2.2 General Safety Concerns

The General Safety Concerns section of the checklist serves to quickly identify some of the major hazards associated with the equipment. Checking "Yes" to any of the items in this section qualifies the installation to follow the Equipment Installation Sign-off Procedure.

4.2.3 Responsible Parties

The table of Responsible Parties serves to quickly identify the Equipment Owner, the Registered Industrial Plant Engineer responsible for the particular installation, and an established supplier contact.

4.3 Installation Design Checklist

The Installation Design Checklist must be completed before any actual installation activities take place. Its purpose is to proactively address ESH concerns about the design of the installation and to ensure applicable codes, standards, regulations, and engineering "best practices" have been considered in the design phase. The items on the Installation Design Checklist are items that must be considered long before the actual installation begins. The Installation Design Checklist is intended to be expanded over time, as seen fit by the Facilities Engineering group, to become more comprehensive. It may eventually become an individual document and procedure.

4.4 Level 1 Installation Checklist

4.4.1 Electrical Data Matrix

All sources of electricity to the equipment should be listed in the matrix. After the electrical equipment is installed, the actual voltage must be verified before the equipment may be energized. While this section applies to all electrical sources to the equipment, only electrical sources of 120V or less (phase-to-ground voltage) may be supplied to the tool upon Level 1 sign-off. All other sources of electricity must remain locked/tagged out until Level 2 sign-off is complete.

4.4.2 Electrical Safety Considerations

In general, the electrical portion of the installation must be checked for correct connections, voltages, proper grounding, the presence of lockable disconnects, correct labeling, and other requirements. Suggested labeling requirements are listed in parentheses in items 9a through 9e.

4.4.3 Lockout / Tagout and Hazardous Energy Sources

Lockout/tagout procedures must be developed specific to the equipment being installed. The Equipment Engineering and Maintenance group is responsible for developing these procedures or obtaining them from the supplier. Before Level 1 sign-off, all hazardous energy sources must be completely locked/tagged out.

4.4.4 Access and Clearances

Work space clearances about electrical equipment and HPM workstations must be verified to ensure that the actual installation meets the distances specified in the design and is compliant with applicable standards. Table 1 illustrates workspace clearances, required by the National Electrical Code, about electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.

Table 1 Work Space Clearances About Electrical Equipment (NEC 1996)

Nominal Voltage to Ground	Workspace Depth*			Minimum Width of Work Space	Height of Work Space
	Condition 1	Condition 2	Condition 3		
0 – 150	3 feet	3 feet	3 feet	30" all conditions	78" all voltages, all conditions
151 – 600	3 feet	3.5 feet	4 feet	30" all conditions	
601 – 2500	3 feet	4 feet	5 feet	36" all conditions	
2501 – 9000	4 feet	5 feet	6 feet	36" all conditions	

* "Conditions," as described in NEC 110-16, are as follows (see NEC 110-16 for exact phrasing and exceptions):

Condition 1 – Exposed live parts on one side and no live or grounded parts on the other side of the working space or exposed live parts on both sides are effectively guarded by suitable insulating materials.

Condition 2 – Exposed live parts on one side and grounded parts on the other side.

Condition 3 – Exposed, non-guarded, live parts on both sides of the work space with the operator between.

4.4.5 Minimal Risk Gas/Liquid and Vacuum Facilities

All facilities lines delivering minimal risk gases or liquids (waters) or supplying vacuum to the tool should be listed in the boxes provided in this section. Generally accepted abbreviations (e.g., CDA, UPW, etc.) may be entered. See Section 4f for a definition of "minimal risk" as it applies to this procedure.

4.4.6 Vacuum Pumps

While all vacuum pumps can be checked during Level 1 sign-off, only those vacuum pumps associated with minimal risk gas or liquid, process vacuum, and exhaust ventilation may be energized upon completion of the Level 1 Installation Checklist. All pumps handling toxics, pyrophorics, or other HPMs must remain locked-out until the completion of Level 2 sign-off.

4.4.7 Emergency Machine Off (EMO)

The equipment may be powered up to test EMO functionality **only** after all other Level 1 Equipment Installation Checklist items have been verified. The tool must return to a completely locked-out state until Level 1 sign-off is approved.

4.5 Level 2 Installation Checklist

4.5.1 Fire Protection Requirements

This section applies to all equipment-specific fire detection, monitoring, suppression, and alarm systems. This includes systems internal to the equipment itself and systems installed specifically to accommodate, either wholly or in part the presence of the equipment (e.g., sprinklers in the bay ceiling that service the area occupied by the equipment).

4.5.2 Wet Process and Bulk Chemical Inventory

All chemicals (other than gases) supplied to the equipment must be listed on this form. The form asks for an indication of the type of container in which the chemical is stored before or during use by the equipment. For this procedure, the following definitions apply:

- A **bath** is a container that is normally open on top during normal operation of the equipment.
- A **tank** is any other type of container that is normally completely enclosed during normal operation of the equipment. All bulk chemicals are assumed to originate from a tank.

4.5.3 Bulk Chemical Delivery System Requirements

See Section 1.3 for a definition of “Bulk Chemical Delivery System” as it applies to this procedure.

4.5.4 Wet Process Chemical Considerations

See Section 1.3 for a definition of “Wet Process Chemical” as it applies to this procedure.

4.5.5 Gas Delivery Systems

All gases (HPM or otherwise) supplied to the tool must be listed in this section.

4.5.6 Gas Detection Requirements

All gases for which monitoring is required must be listed in the Gas Detection Matrix along with the detection system used, all sampling point locations, the high and low set points, and the date each sampling point is tested and verified to be functional.

4.5.7 Chemical Disposal Requirements

List all chemical drain lines that carry effluent from the equipment. HPM drain lines must be leak-checked before use according to the Uniform Plumbing Code.

4.5.8 Post-Process Exhaust Treatment Systems

Multiple parties are listed in the “R” column for most items in this section. The responsibility for each checklist item depends upon the location of the post-process exhaust treatment systems within the facility. The representatives verifying each item should circle the group they represent (in the “R” column). If both parties listed in the “R” column have responsibilities pertaining to a specific item, both parties must verify the item by initialing the Yes, No, or N/A box, whichever applies.

4.5.9 Interlocks

The supplier of the equipment must provide an interlock matrix, listing all interlocks that are specific to the equipment. This matrix should be attached to the Equipment Installation Checklist. All interlocks listed on the matrix must be verified to be functional. Interlocks present on peripheral equipment (i.e., vacuum pumps, exhaust treatment systems, gas detection systems, etc.) are addressed in those respective sections of the Equipment Installation Checklist. Section L of the Level 2 Equipment Installation Checklist applies only to interlocks that are internal to the equipment as it is provided by the supplier. It is important to ensure that any changes to the equipment or the operating system do not affect the functionality of any interlock(s). Interlocks must be re-tested and verified to be functional after every such change.

4.5.10 Radiation

Radiation baseline surveys may need to be postponed until the equipment is fully functional. If this is the case, all necessary radiation surveys must be scheduled to be performed in a timely manner, preferably before Level 3 approval.

4.5.11 Personal Protective Equipment

ESH will assist the Equipment Owner in selecting the necessary Personal Protective Equipment for all operation and maintenance tasks associated with the equipment.

4.6 Level 3 Installation Checklist

4.6.1 General

All Punchlist items from Levels 1 and 2 must be satisfactorily completed before the equipment can be approved for release to manufacturing and full operation.

4.6.2 Operations and Maintenance Procedures

Equipment Maintenance is responsible for the content of the maintenance procedures that accompany the equipment. Process Engineering is responsible for the content of all operations procedures that accompany the equipment. These responsibilities are implied by the “R” column in this section.

All flow monitoring devices, such as photohelics, must be periodically calibrated according to the manufacturer’s recommendations, and the alarm set points must be set and periodically verified.

4.6.3 Decommissioning Procedures:

Equipment-specific decommissioning procedures must be developed or received from the supplier and reviewed by ESH before the equipment is approved for release to manufacturing and full operation.

5 RELATED PUBLICATIONS

The following is a list of publications that may be useful resources to those involved in equipment installations. While the contents of every publication listed are not enforceable by law, many are either referenced in regulations or may be considered “best practices.”

- **American National Standards Institute (ANSI)** –
1430 Broadway, New York, NY 10036
 - ANSI Standards** –
 - ANSI A 13.1–1981 – Scheme for the Identification of Piping Systems
 - ANSI Z 35.1–68 – Specifications for Accident Prevention Signs
 - ANSI Z 53.1–1979 – Safety Color Code for Marking Physical Hazards
 - ANSI Z 136.1–1993 – *American National Standard for the Safe Use of Lasers*
 - ANSI Z 358.1–1990 – American National Standard for Emergency Eyewash and Shower Equipment
 - ANSI Z 535.1–1991 – *Safety Color Code*
 - ANSI Z535.2–1991 – Environmental and Facility Safety Signs
- **American Society of Mechanical Engineers (ASME)**
345 East 47th St., New York, NY 10017
 - ASME Boiler and Pressure Vessel Code
- **City of Austin, Texas – Hazardous Materials Ordinance** –
 - Ordinance No. 960912-H
- **Compressed Gas Association, Inc.** –
1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4100
 - CGA Pamphlets** –
 - C-7 Guide to the Precautionary Labeling and Marking of Compressed Gas Containers
 - P-1 Safe Handling of Compressed Gases
- **International Fire Code Institute** –
9300 Jollyville Road, Suite 105, Austin, TX 78759-7455
 - Uniform Fire Code (UFC) – 1997 edition**
 - UFC Article 10 – Fire Protection Systems
 - UFC Article 51 – Semiconductor Fabrication Facilities
 - UFC Article 74 – Compressed Gases
 - UFC 7401.5.3 – Marking of Piping Systems
 - UFC Article 79 – Flammable and Combustible Liquids
 - UFC 7901.11.10 – Testing of Piping, Valves, and Fittings
 - UFC Article 80 – Hazardous Materials
 - UFC 8001.4.3 – Design and Construction of Piping, Tubing, Valves and Fittings

- **National Fire Protection Association (NFPA) –**
P.O. Box 9101, Batterymarch Park, Quincy, MA 02269
 - NFPA Standards –**
 - NFPA 70 – National Electrical Code (NEC)
 - NEC Article 110 – Requirements for Electrical Installations
 - NEC 110-16 – Working Space About Electric Equipment (600 Volts Nominal or Less)
 - NEC 110-32 – Working Space About Electric Equipment (Over 600 Volts Nominal)
 - NFPA 79– Electrical Standard for Industrial Machinery
 - NFPA 318 – Standard for the Protection of Cleanrooms
 - NFPA 704 – Standard System for the Identification of the Hazards of Materials for Emergency Response
- **SEMI S2-93A** – Safety Guidelines for Semiconductor Manufacturing Equipment
- **SEMI S8** – Safety Guidelines for Ergonomics/Human Factors Engineering of Semiconductor Manufacturing Equipment
- **Supplier Ergonomic Success Criteria (SESC) checklist** – Design Supplement for SEMI-S8
- **United States of America Regulations –**
Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
 - Code of Federal Regulations (CFR)**
 - 21 CFR 1000 to 1050 – Food & Drug Administration
 - 21 CFR 1010 – Performance Standards for Electronic Products: General
 - 21 CFR 1040 – Performance Standards for Light – Emitting Products
 - 29 CFR Parts 1900 to 1910.999 – Federal Occupational Safety and Health Standards
 - 29 CFR 1910.147 – The Control of Hazardous Energy (lockout/tagout)

APPENDIX A EQUIPMENT INSTALLATION DATA SHEET

Equipment Installation Data Sheet

Much of the information on this form can be found on the ATDF Tool Information form that is submitted with the Facilities Work Order.

Equipment Description	
Tool ID Code	
Tool Name	
Supplier	
Model	

Equipment Status			
New	<input type="checkbox"/>	If New, date equipment arrived on site.	___ / ___ / ___.
Relocated	<input type="checkbox"/>	If Relocated, date equipment was decommissioned.	___ / ___ / ___.
For new equipment, has SEMI S2 / S8 review been ordered?			Yes No NA
If relocated, has the equipment been decontaminated & approved by IH?			Yes No NA

Equipment Location	
Process	
Fab Bay	

General Safety Concerns			
<i>If yes to any of the following questions, the installation must follow the SEMATECH Equipment Installation Sign-off Procedure.</i>		Yes	No
1. Does this equipment use, create, or contain any of the following:			
Any chemicals? (Solids, Liquids, or Gases)			
Radiation? (Ionizing, laser, RF, X-ray)			
Hazardous waste? (e.g. Acid / Solvent waste / contaminated rags)			
> 120 Volt potential electrical service (phase to ground)?			
Hazardous energy sources in addition to electricity? (e.g. hydraulic, pneumatic, etc.)			
Moving parts which have or need guarding to prevent employee injury?			
2. Will this equipment require facilities hookups? (exhaust/ drain/ non-HPM gas/ cooling water)			

Responsible Parties	Name	Phone #	Department
Equipment Owner *			
Registered Industrial Plant Engineer			
Supplier Representative **			

* As indicated on the Facilities Work Order **If Applicable

"R" Column Legend			
<i>The "R" column indicates the group responsible for verifying the status of each line item on the Installation Checklists. The group identified in the "R" column is responsible for completing the line item should a deficiency exist.</i>			
Code	Description	Code	Description
<i>FE</i>	<i>Facilities Engineering</i>	<i>ESH</i>	<i>Environmental Safety and Health</i>
<i>FI</i>	<i>Facilities Installations</i>	<i>EM</i>	<i>Equipment Engineering and Maintenance</i>
<i>FO</i>	<i>Facilities Operations</i>	<i>PE</i>	<i>Process Engineer</i>

Note: Shaded checklist items are those which are listed on the checklist developed by the Austin Fire Dept. and City of Austin Development Review and Inspection Dept.

Installation Design Checklist

*This checklist **must** be completed before installation of the equipment begins.*

Installation Design Requirements				
General				
	R	Yes	No	NA
1. Is the equipment approved for use by the Environmental Engineer?	ESH			
2. Has the tool undergone a SEMI S2 / S8 review and has a copy been supplied to ESH?	ESH			
3. Has the supplier completed and provided the Supplier Ergonomics Success Criteria checklist?	EM			
Radiation				
	R	Yes	No	NA
4. Has the radiation device inventory been completed and provided to the site Industrial Hygienist or Radiation Safety Officer (RSO) prior to installation?	ESH			
5. Have all lasers been approved by the Laser Safety Officer (LSO)?	ESH			
6. Are there radioactive sources (isotopes)? If so, contact the RSO for further requirements.	EM			
Installation Materials Compatibility				
	R	Yes	No	NA
7. Are all materials of construction for Bulk Chemical Delivery systems compatible with the chemicals being used?	FE			
8. Are all ducts constructed of materials that are appropriate for the materials they convey (UMC 1107)?	FE			
9. If two or more operations are connected to the same exhaust system, are the products they convey compatible so as to avoid fire, explosion, or chemical reaction hazards within the duct?	FE			
10. Are all gas system materials of construction compatible with the gases they convey?	FE			
Electrical Installations				
	R	Yes	No	NA
11. Are all electrical components rated for the environment in which they will be installed? (i.e. hazardous classified locations, areas where flammable vapors are present, etc.)	FE			
12. Is all electrical wiring and equipment within 5 feet of workstations using flammable gases or liquids installed in accordance with the National Electrical Code for Class 1, Division 2 hazardous locations? (UFC 5104.5)	FE			
Access and Clearances				
	R	Yes	No	NA
13. Do vertical & horizontal workspace clearances about electrical equipment meet NEC requirements?	FE			
14. Do servicing clearances about HPM workstations meet UFC requirements (UFC 5104.6.5)?	FE			
HPM chemical systems				
	R	Yes	No	NA
15. Has chemical use been approved for all chemicals associated with this equipment?	ESH			
16. Has it been verified that the quantity of chemical associated with the equipment will not exceed the maximum workstation chemical quantities specified in UFC Table No. 5104-A?	ESH			
17. Have chemical storage densities in the fabrication area been recalculated to ensure the density limits specified in UFC Table 5103-A will not be exceeded?	ESH			
18. Are readily accessible shutoff valves provided for all HPM supply piping at the workstation?	FE			
19. Will all valves & fittings for HPM gas & liquid systems be contained within a ventilated enclosure?(UFC 5103.5.2)	FE			
Exhaust Treatment Systems				
	R	Yes	No	NA
20. Will post-process exhaust treatment systems have sufficient capacity to handle the maximum possible output from the process tool under a worst case release? (i.e. maximum process flow from an open/defective MFC)	FE			
Waste Drain System				
	R	Yes	No	NA
21. Have all specialty waste drains been approved by the Environmental Engineer?	ESH			
22. Will HPM waste lines be double contained where required?	FE			
23. Will waste lines be installed with p-traps and vent lines or equivalent as required?	FE			
Vacuum Pumps				
	R	Yes	No	NA
24. Are sections of vacuum pump exhaust lines designed to be removable for cleaning/inspection where required?	FE			
25. Will all vacuum pumps that convey toxic gases be contained within an exhausted enclosure?	FE			
Fire Prevention				
	R	Yes	No	NA
26. Will all workstations of combustible construction have a sprinkler head installed <u>in the exhaust duct / plenum</u> within 2 feet from the point of the duct connection or the connection to the plenum? (UFC 5104.4)	FE			
27. Will sprinklers be installed in all combustible ducts & non-combustible ducts conveying vapors or gases in the flammable range (>10% LEL), that are $\geq 10"$ in diameter? (UFC 5104.3.2.4)	FE			

Installation Design Review Signatures			
<i>I have reviewed the Installation Design package and approve the commencement of installation activities per design.</i>			
Title	Signature	Print Name	Date
Equipment Owner			
Facilities Engineer (FE)			
Environmental, Safety & Health			
Registered Industrial Plant Engineer			

Level 1 Equipment Installation Checklist Electrical Activation, Non-HPM Chemicals and Facilities Release

Upon completion of the Level 1 checklist, electrical power ≤ 120 V (phase to ground) may be supplied to the equipment along with vacuum, minimal risk gas and liquid (water) facilities. **All other systems associated with the tool (i.e. any physical, chemical, radiation, or other hazards) must remain completely locked-out and inactive until installation is complete and Level 2 Sign-off is approved.**

Note: Electrical power > 120 V (phase to ground) must remain locked/tagged out until level 2 Sign-off is complete.

A. Electrical Data Matrix <i>List all sources of electricity to the tool</i>						
Name of Panel / Feeder	Voltage (V)		Phase	Current (A)	Breaker Size (A)	Lockable Disconnect?
	List voltage	Tested & Verified?				
						Yes No
						Yes No
						Yes No
						Yes No
						Yes No
						Yes No
						Yes No
						Yes No

B. Electrical Safety Requirements					R	Yes	No	NA
1. Has ground continuity been verified? (Ground/bond straps installed & verified where applicable)	FI							
2. Has the facility power network from the distribution or branch panel to the tool main disconnect been verified for correct connections and labeling?	FI							
3. Is there a lockable main power disconnect that is readily accessible, properly labeled, and capable of disconnecting all electrical power sources to the machine?	FI							
4. Is electrical wiring / equipment protected from probable liquid leak sources?	FI							
5. Is a ground fault circuit interrupt (GFCI) system installed & operating per design, where applicable?	FI							
6. If installed in hazardous classified locations or exposed to flammable vapors, are all electrical components rated for hazardous locations in accordance with NEC class, group & division per design?	FI FE							
7. Is the tool connected to an Uninterruptible Power Supply (UPS unit & tool labeled accordingly)?	FI							
8. Are all support systems (i.e. vacuum pumps, chillers, etc) fed from the tool or sub-panel properly connected and labeled?	FI							
9. Are the following items labeled correctly and clearly ? (labeling requirements in parentheses)	FI							
a. Main power disconnect (On/Off, tool ID(s) that it supplies, voltage, phase, current, supply circuit #, location / ID of supply sub-panel).	FI							
b. Supply electrical sub-panel (tool identification that it supplies).	FI							
c. All tool disconnects (On/Off, tool ID(s) that it supplies, voltage, phase, current, supply circuit #, location / ID of supply sub-panel, type of power (e.g. Normal, UPS)).	FI							
d. Convenience outlets (circuit breaker #, panel #).	FI							

C. Lockout / Tagout and Hazardous Energy Sources					R	Yes	No	NA
1. Have lockout / tagout procedures been developed specific to this equipment?	EM							
2. Are means provided for isolation (LO/TO) of all hazardous energy sources (mechanical, pneumatic, hydraulic, chemical, radiation, etc.) & are all isolation points identified & documented?	EM							
3. Prior to level 1 sign-off, are all hazardous energies completely locked and tagged out?	FI							
4. Will the functionality of any level 1-cleared items (e.g. electrical activation) present hazardous situations to installation personnel while preparing the equipment for level 2 sign-off? (describe)	EM							
Notes / Comments:								

E. Access and Clearance Requirements		R	Yes	No	NA
1. Is the minimum work space clearance in front of electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized compliant with NEC 110-16a or NEC 110-34a ? (36" for <150 V or 42-48" for 151-600 V, depending on NEC conditions)	FI				
2. Is the width of clear workspace about electrical equipment that may require examination, adjustment or servicing while energized, 30 inches minimum (NEC 110-16a)?	FI FE				
3. Is there a minimum of 78" clear headroom in electrical workspaces per NEC 110-16e ?	FI, FE				
4. Is there a 36" horizontal servicing clearance for HPM workstations (per UFC Section 5104.6.5)?	FI, FE				
5. Do all exterior doors and access panels warn of the hazards located behind them?	ESH				

NA		F. Exhaust Ventilation			
Location <i>List all exhaust outlets</i>	Type: scrubbed, heat, solvent, etc.	Flow Monitoring Devices <i>Type and location</i>	Set points labeled?		Recommended CFM
			Yes	No	
			Yes	No	
			Yes	No	
			Yes	No	
			Yes	No	
			Yes	No	
			Yes	No	
			Yes	No	

NA		G. Exhaust Ventilation Requirements			
		R	Yes	No	NA
1. Are all exhaust ducts labeled with contents and direction of flow at every change of direction, before & after every structural penetration and at regular intervals according to SEMATECH labeling guidelines?		FI			
2. Has a ventilation test and balance been completed and are all dampers marked and secured ?		FO			
3. Do all ventilation systems which handle HPMS have continuous monitoring devices (i.e. photohelic, magnehelic, etc.) installed?		FE			
a. Are all monitoring devices in the <u>plenum</u> functional, tamperproof, properly set & labeled with set points?		FO			
b. Are all monitoring devices at the <u>tool</u> functional, tamperproof, properly set & labeled with set points?		EM			
4. Has a loss of exhaust test been performed to verify that the tool is placed in a safe condition upon loss of exhaust ventilation flow?		EM			
5. Are Industrial Hygiene Ventilation Assessments (capture velocity) <u>complete</u> for all areas where Hazardous chemicals may be exposed to the open environment (i.e. wet stations, lab hoods, wet chemical dispense cabinets, etc)? (Note: requires scheduling with ESH prior to the Level 1 review.)		ESH			
6. Are local exhaust systems provided for maintenance activities?		FE			
Notes/Comments:					

NA		H. Lasers			
		R	Yes	No	NA
1. Is a label visibly present on the outside of the tool, certifying compliance with FDA-CDRH requirements? (21 CFR 1010.2)		ESH			
2. Is equipment containing lasers labeled per ANSI Z136.1 & per 21CFR 1010 and 21CFR 1040.10?		ESH			
3. Are all lasers interlocked (including power supply), are all interlocks functional, & is the Activation Warning System operational as required?		EM			
4. Is there a protective housing around the laser?		EM			
5. Are all removable service access panels either interlocked or require a tool for removal?		EM			
6. Do all viewing portals attenuate to class 1 or less?		EM			
7. Is there open beam exposure potential to class 3b or 4 lasers? (if so complete the following)		EM			
a. Is the area posted as a controlled area for class 3b or 4 lasers?		EM			
b. Is eye protection with the proper optical density (OD) designated and available?		ESH			
c. Has medical monitoring been initiated for personnel using / maintaining open beam systems?		ESH			

<input type="checkbox"/> NA	Radiation			
Check all that apply	Frequency &/or Wavelength	Maximum Power	Properly Labeled?	
RF/Microwave	<input type="checkbox"/>		Yes	No
Ultraviolet	<input type="checkbox"/>		Yes	No
Infrared	<input type="checkbox"/>		Yes	No
X-Ray	<input type="checkbox"/>		Yes	No

<input type="checkbox"/> NA	I. Radiation Requirements	R	Yes	No	NA
	1. If hazardous UV light sources are present, are the sources enclosed or interlocked?	EM			
	2. Are sources of strong magnetic fields (>5 gauss) properly labeled with pacemaker hazard, field strength and hazard distance?	EM			
	3. Have all RF & microwave sources been identified & properly labeled?	ESH			
	4. Is the power supply to all radiation sources (ionizing and non-ionizing) locked / tagged out and is all shielding in place? (Note: radiation sources shall not be energized prior to level 2 sign-off)	EM			

<input type="checkbox"/> NA	J. List all Minimal Risk Gas/Liquid & Vacuum facilities lines needed for Level 1 sign-off	R	Yes	No	NA
	1. Are all minimal risk gas, liquid and vacuum lines clearly labeled (contents & direction of flow) at every change of direction, before & after every structural penetration, and at regular intervals according to SEMATECH labeling guidelines?	F			
	2. Have all lines conveying minimal risk materials been pressure & leak checked & documented?	F			

<input type="checkbox"/> NA	K. Vacuum Pumps	R	Yes	No	NA
	1. Are all inputs and outputs labeled with contents and direction of flow and are all lines adequately secured?	FI			
	2. Has the vacuum pump rotation been verified?	FI,EM			
	3. Are all vacuum pump EMOs and interlocks functional (e.g. nitrogen purge, back-pressure, temperature, cooling water flow)?	EM			
	4. Are all vacuum pumps that convey toxic gases contained within an exhausted enclosure?	FE			
	5. Are all nitrogen and water flow indication devices functional?	FI			
	6. Where applicable, are the shaft seal nitrogen purges operational?	FI			
	7. Is exhaust piping routed to prevent pooling of liquids? (no visible low spots or sagging)	FI			
	8. Have appropriate measures been taken to prevent back streaming into the house nitrogen system?	FI,FE			
	9. For oil sealed pumps, list oil type: _____	FI,EM			
	a. Is the pump oil compatible with the process materials?	EM			
	b. Has an oil drip pan been installed under the entire pump package?	FI			
	c. Is an oil demister or separator installed if required?	FE			
	d. Is the pump case purged and pump ballast purged / interlocked? (oil sealed pumps)	FE			

L. Emergency Machine Off (EMO)		R	Yes	No	NA
<i>The tool may be powered up to test EMO functionality ONLY after all other level 1 checklist items have been verified. The tool must return to a locked-out state until Level 1 sign-off is complete.</i>					
1.	Does the EMO cut off all electrical power to the system including the UPS (except non-hazardous control voltage and power sources to safety related devices)?	EM			
2.	Upon resetting of the EMO, does the equipment remain shutdown and require a manual re-start?	EM			
3.	Are EMO buttons located within 10 feet of all operating & regularly scheduled maintenance locations or where a physical barrier (wall, floor, panel, etc) is between work locations & a button?	EM			

<input type="checkbox"/> NA	M. Guarding	R	Yes	No	NA
	1. Are all electrical, thermal, & mechanical hazards (i.e. pinch/nip points, moving parts, etc.) properly guarded & labeled?	EM			
	2. Are all robotics envelopes adequately defined and guarded?	EM			

NA	C. Wet Process Chemical Requirements	R	Yes	No	NA
	1. Are all chemical supply lines and containment piping clearly labeled (contents & direction of flow) at every change of direction, before & after every structural penetration, and at regular intervals according to SEMATECH labeling guidelines?	FI			
	2. Are all chemical enclosures properly labeled with approved Hazcom labels?	FI			
	3. Have all HPM supply lines been pressure tested and are they double contained where required?	FO			
	4. Are all valves and fittings for HPM liquid delivery systems contained within a ventilated enclosure?	FI			
	5. Is leak detection (liquid &/or vapor) adequately installed internally and externally to the equipment and in all wet chemical valve boxes?	EM			
	a. Have all leak detection systems been tested and verified to be operational?	EM			
	7. Are all pressurized chemical containers equipped with the following:				
	a. If pressurized to >15 psig, are they ASME rated and provided with adequate over-pressure protection?	EM			
	b. If non-rated, are containers equipped with pressure relief devices set to a maximum of 15 psig?	EM			
	c. Vented to the system exhaust?	EM			
	d. Equipped with functional liquid level detection and overflow protection?	EM			
	e. Bonding / grounding & provided with an inert pressurizing agent (flammable chemical containers)?	EM			
	8. Are all access areas to pressurized lines shielded or interlocked to prevent potential exposure to chemistries?	EM			
	9. Are safety showers and eye washes located within 10 seconds travel or 100 feet of chemical use or closer depending on the degree of hazard associated with the chemical(s) used? (ANSI Z358.1-1990)	FE			
NA	D. Bulk Chemical Delivery System Requirements	R	Yes	No	NA
	1. Are all chemical supply lines and containment piping clearly labeled (contents & direction of flow) at every change of direction, before & after every structural penetration, and at regular intervals according to SEMATECH labeling guidelines?				
	2. Is the tool & all support equipment labeled with point-of-use chemical labels?	FI FO			
	3. Are all chemical enclosures labeled with approved hazcom labels	FI FO			
	4. Are all bulk chemical delivery lines and containment piping, attached to the correct point of use, and terminated at the tool? (no fittings within the double contained piping)	FI			
	5. Are all valves and fittings for HPM liquid delivery systems contained within a ventilated enclosure?	FO			
	6. Have all HPM delivery lines been pressure-tested & are they double contained where required?	FI			
	7. Have the following items been leak-tested and has the leak test documentation been reviewed and accepted?				
	a. All containment lines?	FI			
	b. All chemical valve boxes?	FI			
	8. Does the chemical valve box supply to the tool close upon EMO activation from the tool?	FO			
	9. Are all emergency shutoff valves for HPMs clearly visible and indicated by means of a sign? (UFC 8001.4.3.2)	FI			
	10. Are all flammable and combustible materials sealed from electrical equipment or ignition sources?	FE			
	11. Have PLC communications systems been properly wired and connected to the tool?	FO			
	12. Have PLC communications systems been properly programmed and verified to send the correct signals to the correct valves per design?	FO			
NA	E. Gas Delivery Systems	<i>List all process gases supplied to the equipment</i>			
	1. Have all lines been traced to origin/contents verified?				
	2. Process flow rate:				
	3. MFC maximum flow rate:				
	4. Is MFC bypass possible?				
	5. Are double contained lines in place as required?				
NA	F. Gas Delivery System Requirements	R	Yes	No	NA
	1. Are all gas lines clearly labeled (contents & direction of flow) at every change of direction, before & after every structural penetration, and at regular intervals according to SEMATECH labeling guidelines?	FI			
	2. Are all enclosures (where gases are present) properly labeled with approved hazcom labels for gases?	FI			
	3. Are all gas cabinets properly labeled ("Tool Destination Labels")?	FE			
	4. Are all leak points for HPMs exhausted?	FI			
	5. Have all gas delivery systems internal & external to the tool been leak checked?	FI			
	6. Are all valves and fittings on HPM gas systems contained within a ventilated enclosure per design?	FI FE			

<input type="checkbox"/>	NA	Gas Detection Matrix (to be completed by FE)			
Gas	Detection System	Sample point locations	WARN set point	ALARM set point	Functional Test Date

<input type="checkbox"/>	NA	G. Gas Detection Requirements	R	Yes	No	NA
		1. Has <u>continuous</u> gas detection been installed at appropriate monitoring points per design? (UFC 5103.5.3)	FI			
		2. Has each gas monitoring point been checked to verify that upon activation, an automatic, fail-safe gas source shutdown occurs and a visible/audible area alarm is initiated?	FE			

<input type="checkbox"/>	NA	H. Drain Matrix				
Drain System (FE)	Material of Construction (FE)	Leak Checked (if required) (FI)			Piping Labeled Properly (FI)	
		Yes	No	N/A	Yes	No
		Yes	No	N/A	Yes	No
		Yes	No	N/A	Yes	No
		Yes	No	N/A	Yes	No
		Yes	No	N/A	Yes	No
		Yes	No	N/A	Yes	No

<input type="checkbox"/>	NA	I. Chemical Disposal Requirements	R	Yes	No	NA
		1. Is all drain piping clearly labeled (contents & direction of flow) at every change of direction, before & after every structural penetration and at regular intervals according to SEMATECH labeling guidelines?	FI			
		2. Is all workstation drainage piping connected to a compatible system so as to avoid chemical reactions generating heat, gases, or dangerous by-products?	FI FE			
		3. Are waste lines installed with p-traps and vent lines or equivalent per design?	FI FE			
		4. Are appropriate trash receptacles available in the work area and properly labeled?	ESH			
		5. Are segregated satellite collection locations present as needed? (e.g. arsenic or lead waste)	FE			
		6. Are HPM drain lines double contained where required?	FE			
		7. Is the workstation provided with an approved means of containing or directing spills to a drainage system per design (i.e. slope or other approved means of spill containment)? (UFC 5104.6.1)	FI FE			

<input type="checkbox"/>	NA	J. Post-Process Exhaust Treatment Systems <i>(Facilities Engineering) Check all that apply</i>				
<input type="checkbox"/>	Passive Dilution/Reaction Chamber	<input type="checkbox"/>	Dynamic Neutralization Chamber (DNC)			
<input type="checkbox"/>	Thermal Decomposition Unit (TDU)	<input type="checkbox"/>	Wet Chemical Reactors			
<input type="checkbox"/>	Dry Chemical Reactors	<input type="checkbox"/>	Other:			
Post Process Exhaust Treatment Systems			R	Yes	No	NA
		1. Is the post-process exhaust treatment system operational, and are all interlocks functioning?	EM FO			
		2. Does the process gas flow shut down in the event of exhaust treatment system failure?	EM FO			
		3. Upon activation of a trouble alarm, does the system place the tool into a safe condition?	EM FO			
		4. Does the exhaust treatment system configuration allow access for inspection and cleaning?	EM			
		5. Is a fire sprinkler (wax coated, plastic bag, quick response) installed downstream of the reaction chamber, at the transition to the main exhaust lateral per design ? (Is water drainage adequate?)	FE FI			

<input type="checkbox"/>	NA	Fire Detection
		<i>Check all that apply specifically to this equipment and list locations</i>
<input type="checkbox"/>		High sensitivity detection (Optical Air Sampling Smoke Detection, e.g., VESDA, HSSD) Location(s):
<input type="checkbox"/>		Smoke Detection:
<input type="checkbox"/>		UV / IR detection:
<input type="checkbox"/>		Other:


<input type="checkbox"/>	NA	K. Fire Protection Requirements	R	Yes	No	NA
		1. Has annunciation been verified for all equipment-specific fire detection devices?	EM			
		2. Has equipment-specific fire alarm annunciation been verified?	EM			
		3. Are lab hoods that use flammable/combustible liquids, serviced internally by a fire sprinkler head?	EM			
		4. For Wet Stations (all wet chemical processes) are sprinklers installed on the bay ceiling in front and behind the tool, providing coverage to all areas of the tool?	FE			
		5. Do all workstations of combustible construction have a sprinkler head installed in the exhaust duct / plenum within 2 feet from the point of the duct connection or the connection to the plenum? (UFC 5104.4)	FE			
		6. Are sprinklers installed in all combustible ducts & non-combustible ducts conveying vapors or gases in the flammable range (>10% LEL), that are ≥ 10 " in diameter. (UFC Section 5104.3.2.4)	FE			
		7. Has all fire suppression agent (i.e. sprinkler, CO ₂ , etc.) delivery piping leading into enclosed equipment been pressure tested?	FI			
		8. Has it been verified that fire sprinkler flow patterns within enclosed equipment are unobstructed?	EM			
		9. Are fire suppression systems installed within enclosed equipment where necessary (including CO ₂ /Halon systems) and have they been tested and verified functional, providing the required discharge density?	EM			
		10. Are all sprinklers that service the area occupied by this equipment, accessible for periodic inspections?	FE			

<input type="checkbox"/>	NA	L. Interlocks	R	Yes	No	NA
		Note: This section applies to all interlocks internal to the equipment.				
		1. Has an interlock matrix (indicating what is activated or shutdown when each interlock is activated) been provided for each of the following interlocks? (Attach matrix)	EM			
		a. Exhaust flow (e.g. photohelic)?	EM			
		b. Temperature / Fire Detection (e.g. overtemp, UV Sensor)?	EM			
		c. Mechanical (e.g. pinch points)?	EM			
		d. Automation (e.g. light curtains)?	EM			
		e. Pneumatic / Hydraulic?	EM			
		f. Robotics (e.g. IR Sensors)?	EM			
		g. Electrical (e.g. High voltage, door panels)?	EM			
		h. Other ?	EM			
		2. Have all interlocks been tested and verified to be operational as indicated on the interlock matrix?	EM			
		3. Have any changes been made to the tool or the operating system that may have affected the functioning of any interlocks?	EM			
		a. If so, have all interlocks been re-tested after every such change & verified to be operational?	EM			

<input type="checkbox"/>	NA	M. Radiation	R	Yes	No	NA
		1. Have the appropriate radiation warning labels been placed on the tool? (e.g., RF, UV, IR, X-Ray.)	ESH			
		2. Have the appropriate ionizing/non-ionizing radiation surveys been scheduled for this installation?	ESH			
		3. Are all radiation-related interlocks functioning properly?	EM			

<input type="checkbox"/>	NA	N. Personal Protective Equipment	R	Yes	No	NA
		1. Is the proper PPE available for all operation & maintenance tasks associated with this equipment?	EM			
		2. Is proper PPE storage available?	EM			

Level 3 Equipment Installation Checklist *Full Release to Manufacturing*

General		R	Yes	No	NA
1. Have all outstanding Punchlist items from Levels 1 & 2 been satisfactorily completed?		FE			
2. Have all operators been trained in regard to the proper selection & use of PPE required for this equipment?		PE			
3. Are the following baseline Industrial Hygiene surveys / assessments complete or scheduled if applicable?					
a. Non-ionizing Radiation.		ESH			
i. If so is RF / EMI grounding adequate?		ESH			
b. Ionizing radiation?		ESH			
c. Ventilation?		ESH			
d. Air Sampling (HPM's, process chemicals, etc)?		ESH			
e. Other:		ESH			
4. Are all unresolved Ergonomics issues listed on an action plan and documented?		EM			
5. Are there any specially negotiated working conditions? Describe		ESH			
Notes / Comments: 					

Operations and Maintenance Procedures		R	Yes	No	NA
1. Have operation and maintenance procedures been developed specifically for this equipment?		EM			
2. Are provisions incorporated to ensure that all flow monitoring devices (i.e. photohelics) for exhaust ventilation systems are periodically calibrated according to the manufacturers recommendations & the alarm set points are tested & verified on a periodic basis?		EM			

Do operation and/or maintenance procedures include the following items?		R	Yes	No	NA
<i>PE is responsible for the content of Operation Procedures. EM is responsible for the content of Maintenance procedures.</i>					
a. Specific lockout/tagout procedures? (per 29 CFR 1910.147) (maintenance spec)		EM			
b. Personal Protective Equipment requirements? (operations and maintenance spec's)	PE	EM			
c. Testing of EMOs & interlocks annually or whenever the EMO or interlock has been deactivated for a maintenance procedure? (maintenance spec)		EM			
d. Testing procedures for all equipment specific fire protection systems? (maintenance spec)		EM			
e. Procedures for collection of waste generated during PM's and non-routine operations?	PE	EM			
f. MSDS location(s)? (operations and maintenance spec's)	PE	EM			
g. Written and approved procedures for changing out spent canisters in dry scrubbers?		EM			
h. Radiation leak check at least annually or whenever shielding or interlocks have been removed or defeated? (and after major PM's on Ion Implanters)		EM			

Decommissioning Procedures		B	Yes	No	NA
1. Have decommissioning procedures been developed specifically for this equipment?		EM			
2. Do the decommissioning procedures for this equipment include the following items:		EM			
a. Instructions for purging gas lines and panels?		EM			
b. Instructions for removing chemicals and flushing reservoirs, dispense and drain lines?		EM			
c. Instructions for cleaning all surfaces of residual chemicals?		EM			
d. Requirements for respiratory protection, protective clothing, and PPE for each task involved in the decommissioning process?		EM			

Level 3 Signatures			
<i>I confirm that the installation is complete and the equipment is ready for full operation.</i>			
Title	Signature	Print Name	Date
Facilities Engineer			
Process Engineer			
Equipment Engineer			
ESH			

Upon completion of Sign-off Level 3, the equipment may be approved for release to manufacturing and full operation.

**SEMATECH Technology Transfer
2706 Montopolis Drive
Austin, TX 78741**

**<http://www.sematech.org>
e-mail: info@sematech.org**