Integrated Minienvironment Design Best Practices

International SEMATECH
Technology Transfer # 99033693A-ENG

Integrated Minienvironment Design Best Practices

Technology Transfer # **99033693A-ENG**
International SEMATECH
March 31, 1999

Abstract: This *Integrated Minienvironment Design Best Practices* document provides critical information that process and metrology equipment makers should consider during the design of minienvironments integrated into production equipment. The information presented here is a consolidation of best-known methods and practices drawn from a wide variety of minienvironment users in the industry through a study group of the International 300 mm Initiative (I300I).

Keywords: Integrated Minienvironments, Equipment Design, 300 mm Wafers, Suppliers

Authors: Ed Sherwood, David Hope, J. Whitmore, Craig Ottesen, Carol Davis

Approvals: Carol Davis, AMHS Program Manager
Randy Goodall, Associate Director of Productivity & Infrastructure
Ashwin Ghatalia, Director of Productivity & Infrastructure
Laurie Modrey, Technical Information Transfer Team Leader

Table of Contents

List of Figures

Acronyms and Abbreviations

AMC	Airborne Molecular Contamination
AMCA	Air Movement and Control Association International, Inc.
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
BHT	Butylated hydroxtoluene
dBA	Decibels A-scale
delta P	Delta of pressure readings
DOP	Dioctylpthalates
EMI	Electro Magnetic Interference
EMO	Emergency Machine Off
FOUP	Front Opening Unified Pod
FIMS	Front Opening Interface Machine Standard
GC/MS	Gas Chromatograph Mass Spectrometer
HPM	Hazardous Production Material
HEPA	High Efficiency Particulate Air
IC	Integrated Circuit
IEST	Institute of Environmental Sciences and Technology (formerly IES)
MPPS	Most Penetrating Particle Size
M/E	Minienvironment
MTBF	Mean Time Between Failures
MTTR	Mean Time to Repair
NC	Noise Criteria
PM	Preventive Maintenance
PSL	Polystyrene Latex Spheres
PTFE	PolyTetrafluorethylene
PWP	Particles per Wafer Pass
SAW	Surface Acoustic Wave
TEP	Triethylphosphates
TOF-SIMS	Time of Flight – Secondary Ion Mass Spectrometer
ULPA	Ultra Low Particulate Attenuation
WC	Water Column
WG	Water Gauge

1 EXECUTIVE SUMMARY

This *Integrated Minienvironment Design Best Practices* document provides critical information that process and metrology equipment makers should consider during the design of minienvironments integrated into production equipment. The information presented here is a consolidation of best-known methods and practices drawn from a wide variety of minienvironment users in the industry through a study group of the International 300 mm Initiative (I300I).

This document also provides design guidelines on issues unique to 300 mm equipment because of the use of front opening unified pods (FOUPs) and the integration of loadports, front opening interface mechanical standard (FIMS), and buffers.

Based on equipment performance requirements, portions of this document also apply to environmental chambers (which exist in some equipment and are also sometimes referred to as a minienvironment) that control and/or encapsulate the process environment from the surrounding, ambient room.

2 INTEGRATED MINIENVIRONMENT DEFINITION

Historically, minienvironments have been enclosures adapted to and built around existing process equipment designs. The vision for 300 mm equipment is that the performance requirements for a minienvironment are accommodated into the initial design of the process equipment. The minienvironment should be integrated during the earliest designs of the process equipment and should not be an afterthought later in process equipment build.

- A minienvironment (M/E) is an integrated and controlled environment in the production equipment where exposed wafers reside that separates the wafers from personnel and the general, ambient fab environment.
- The integrated M/E is a combination of components and designs that provide pre-defined conditions for this localized wafer environment. The integrated M/E is an entity that cannot be separated from the equipment and evaluated on its own. It is a combination of individual components, each having design and materials considerations. However, the quality and performance of individual components in the M/E can be measured and evaluated for the localized wafer environment.

For 300 mm manufacturing, a large majority of IC makers will operate the factory in reduced cleanroom class and, as a result, the interface between the FOUP and the equipment wafer handling components becomes very critical in the integrated M/E design. This interface maintains a clean wafer environment as wafers are transferred from the FOUP into the process equipment and vice versa.

Intermediate wafer exchange areas, in equipment such as in wet stations and vertical furnaces, may differ in some ways from M/Es (i.e., through the requirement of connections to fab exhaust systems). However, other M/E guidelines apply (i.e., those concerning filter and seal materials).

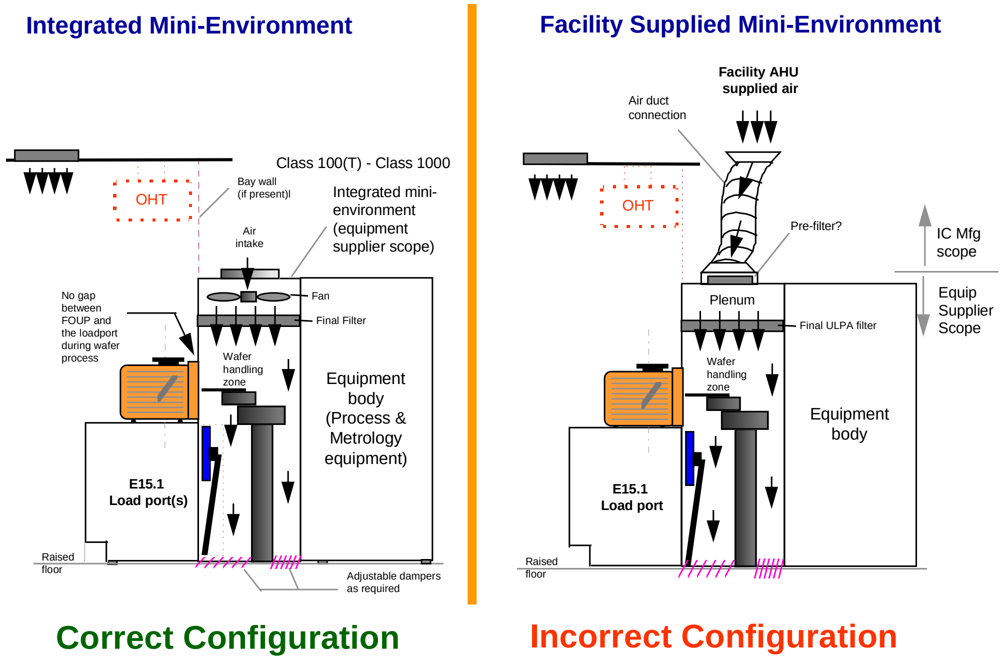

Figure 1 Integrated Minienvironment Configuration

3 RESPONSIBILITIES FOR EQUIPMENT SUPPLIER INTEGRATION

1. Integration of all M/E aspects is the responsibility of the equipment supplier. The primary equipment supplier is the integrator of all components and ultimately responsible for the performance of the M/E.
2. The selection of components should be consistent with the type of process the equipment performs.
3. Performance criteria, such as mean time between failure (MTBF), mean time to repair (MTTR), throughput, and cycle time, are integrated into the overall process equipment requirements and are not separated for M/Es.
4. The equipment supplier must include safety aspects for people, product, and equipment in overall equipment design.
5. Electrical sensors and indicators should include M/E conditions.
6. Software interfaces should include M/E conditions.
7. The M/E should be designed to meet semiconductor manufacturing process requirements while installed and operating in the specific device maker’s cleanroom environment. The equipment supplier has the responsibility to obtain the device maker’s actual and/or planned fab environmental conditions.

4 DESIGN GUIDELINES AND CONSIDERATIONS

4.1 Materials

4.1.1 Air Flow Designs

1. The M/E should isolate the air inside from contaminants in the surrounding room and should direct any potential contaminants away from the product paths.
2. M/Es that enclose equipment with exhaust systems should be fabricated such that exhaust is balanced to guarantee no leakage of hazardous production materials (HPMs) into the surrounding room.
3. Airflow outlets should be located below the working wafer plane.
4. The M/E should provide an internal air velocity in the range of 12 m/min to 27 m/min (40–90 fpm). Air velocity is a primary influence of particle control. Higher values of air velocity may be required for equipment operating at a higher temperature.
5. The air velocity uniformity across the filter should be less than ±20% of the average velocity.
6. Various techniques for adjustment of air velocity, including multi-speed fans, dampers, grilles, exhausts, will allow for compensating and tuning of laminar airflow, turbulence, and pressure.

Note: Variations in process equipment exhaust will affect the need for airflow adjustment.

4.1.2 Filter Materials and Testing

1. HEPA/ULPA filters contain polyurethane compounds that may outgas undesirable amounts of chemicals if not formulated and/or mixed correctly. HEPA/ULPA filters may shed particles and can easily be damaged by handling and equipment PMs. Studies [1, 2] have shown some HEPA/ULPA filters to be sources of boron and phosphorus. Many filters suppliers factory leak test their filters with chemicals that are known AMC compounds.
2. The choice of filter medium to be used, PTFE or "low boron" (0.5% or less) micro fiberglass, will depend on the particular process being performed in the M/E. Where there may be exposure to liquid process chemicals or vapors, polytetrafluorethylene (PTFE) should be the material of choice. Other low boron filter medias may be considered by device manufacturers. A micro fiberglass media filter should employ a non-particle generating face screen to protect against handling or other accidental damage. No other materials should be installed down stream of the HEPA/ULPA filters as to impact airflow and or cleanliness levels (i.e., egg crate covers, diffusers, etc.).

---

[1] HEPA Filters as a contamination Source, Carol M. Davis et al, Journal of the Institute of Environmental Sciences, March/April 1981.

[2] Mori, E.J., Dowdy, J.D., and Shive, L.W., "Correlating Organophosphorus Contamination on Wafer Surfaces with HEPA Installation", presented at the Microcontamination Conference, 1992.

3. Filters and associated components should meet or exceed UL-900 Class 1 requirements or the applicable local codes, whichever is more stringent, with regard to flammability ratings. Each filter should be labeled to reflect compliance with UL-900 Class 1 rating or the applicable local code in effect.
4. Many filter suppliers use dioctylpthalates (DOP) as a challenge for final leak testing, which is a known airborne molecular contamination (AMC) source and should be avoided. Some others use a variety of oil-based challenges or silica, which are also not acceptable. The approved challenge material is limited to PSL spheres carried by a deionized water mist.
5. The preferred material for the filter frame is anodized aluminum. Many filters still employ a particleboard or type of wood frame and these should not be considered, along with any other material that will shed or particulate. The depth and number of pleats per inch of the media pack, which should be separator-less, will determine the delta pressure across the filter. Ideally the delta-pressure should be as low as possible to reduce fan energy requirements but physical space availability for the filter may be a higher priority. When operating at 40 feet per minute face velocity, the filter pressure drop should not exceed 0.76 cm (0.3 inch) WG. The filter may be a knife-edge design, an integrated “liquid” seal or other more solid, flexible seal. All filters should be properly sealed to their supporting structure with a continuous potting compound. The filter media should be a minimum of 99.99995% efficient at 0.07 µm and the MPPS micron particle sizes when tested at 100 fpm in accordance with the IEST recommended practice IES-RP-CC007.
6. There should be no intentional designed penetration through the filter media or frame.

4.1.3 Fan/Motors

1. The fans should be an internally isolated unit. The fan should be rated and tested in accordance with applicable American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and Air Movement and Control Association International, Inc. (AMCA) standards and should be tested within the unit housing. The preferred type is a direct drive design.
2. The fan should be statically and dynamically balanced before assembly. After assembly of the fan to the motor, the unit should be balanced, and fan transmission to attached structure should not exceed 2.5 µm (0.1 MIL) peak-to-peak displacement, 3–100 Hz.
3. The fan/motor unit should be furnished with a vibration switch or flow sensor. These devices should have extra contacts for remote monitoring visible near the user interface.
4. An indication light located on the fan housing should indicate the operating condition of the fan.
5. The fan system should be vibration isolated from the structure of the housing. Isolation system should be sufficient to ensure equipment specifications.
6. Fan motor sound level should meet acoustical performance requirements as specified in SEMI S2.

7. Fan mounting and access should be such that replacement of the fan/motor assembly can be accomplished easily and in a timely fashion. Fan/motor service should not require opening the M/E enclosure to surrounding air or disturbing the filter.
8. Fan motors should be totally enclosed and powered from a single source. All voltage and phase requirements for the motor should be included in the specifications for the equipment.
9. The mounted motor diameter should not exceed the fan hub diameter. Motor bearing should be sealed and require no maintenance to reach specified MTBF requirements. No motor wiring should be exposed in the air stream.

4.1.4 Pressure Control

1. A positive pressure differential should be maintained between the M/E and the bay to prevent contamination of the clean wafer-processing zone with particles from the bay. At least 0.127 mm (0.005”) of water overpressure relative to the fab ambient should be provided. While there is no maximum overpressure requirement, it is not believed that there should be any reason to go above 0.1 cm (0.04 inch) water gauge.
2. Automated closed-loop differential pressure control is not required. IC manufacturers only require the use of manually adjustable louvers, which are expected to need adjustment on an infrequent basis. Louvers may not be sufficient in providing a sufficient range of control, therefore, the use of multi-speed fans may be required.

4.1.5 Adjustable Louvers

1. Louvers can be a flat sliding plate, a butterfly valve, or other embodiment. Louvers only need to be manually adjustable. These louvers are not expected to be adjusted frequently. They should be underneath or along the side at the bottom of the M/E or at air exits of the M/E. The adjustment mechanism can be on either the bay side or chase side (if walls exist). If on the bay side, it cannot in any way interfere with bringing material to the loadport. Exhaust fans are acceptable, but are not a requirement and should not replace adjustable louvers.
2. The louvers should be provided with a method of positively securing them in their set position.

4.1.6 Seals between Filter and M/E Frame or Fan/Filter Unit

1. The gasket seal may not be reusable should the filter unit have to be removed for any reason. A reused gasket seal may not be adequate to isolate dirtier cleanroom air from being aspirated into the enclosure. The gasket seal may erode or break down with time causing leaks and particulate. Some gasket materials have been shown to “dry out” and disintegrate with time under normal cleanroom humidity conditions, so material supplier should provide proof this will not happen for any material chosen. Gasket seals may be used if they meet the outgassing criteria (Neoprene is not acceptable) and it can be demonstrated that they do not exhibit leakage under high particulate challenge (>1 million particles at 0.1 µm) when operating within the normal M/E delta P range (see Section 4.1.4).

2. The gel seal should be able to meet the outgassing criteria (see Section 4.1.8) and be capable of reuse without replacement. Urethane gel seal types have been shown to consistently meet these criteria. Silicone based gels are not acceptable. Gel seals have shown excellent resistance to leakage under higher delta P conditions than are likely to exist in M/Es.

4.1.7 Particle Generation and Aspiration

1. The integrated equipment with the M/E should meet the overall particles per wafer pass (PWP) budget of the specific process the equipment is configured for. M/Es can negatively impact PWP through:
   - Particle aspiration (creeping into) the M/E enclosure through gaps (or holes) between the M/E area and the equipment body or through the potential gap between the FIMS interface and the FOUP front mating surface.
   - Particles emanating from materials used the in M/E enclosure, including those from the HEPA/ULPA filters and the gaskets/seals/gels used in the M/E.
2. The integrated equipment with the M/E enclosure should be designed such that the minimum positive pressure inside the enclosure should effectively prevent any aspiration of particles from the bay or the chase area into the M/E.
3. The impact of air velocity inside the M/E should also be understood (direction, angle, and exit) to prevent particle aspiration arising from eddy currents (or low-pressure areas) observed with a pressure differential.
4. Any intentionally placed gaps should prevent particle aspiration into the M/E and those particulate, pressure, and airflow measurements should meet the process equipment requirements. Whereas it is not a requirement that the M/E be airtight, any gaps between M/E surfaces should prevent particle aspiration into the M/E.
5. For equipment with internal FOUP buffers such as the diffusion furnaces and wet stations, the design should ensure particle aspiration does not occur between the FOUP buffer location and the open wafer handling regions of the equipment.
6. Particle generation prevention: M/E enclosure materials and the surface treatment of these materials, all filter materials, mating surfaces, and gaskets/seals or gels used should be non-particle shedding type, low boron (0.5% or less), and should not outgas under normal operating conditions of the equipment. User requirements and testing methods will vary for outgas criteria and depend on the specific process for the equipment.

4.1.8 Materials of Construction/Airborne Molecular Contaminants

Concern: Materials of construction may contain chemicals that can outgas during normal use and contaminate exposed wafers. The selection of equipment materials should be chosen to be compatible and consistent with standard materials used for semiconductor manufacturing.

1. The chemical composition of some of the usual construction materials may be governed by industry standards for their physical attributes. These may include, although not be limited to, hardness, fire retardancy, flexibility etc. To maximize certain attributes, additives are used that are known to be AMC concerns to wafer processing. These AMC compounds may be plasticizers, filler materials, mold release agents, fire retardants, UV blockers, anti-oxidants, catalyzers, and unreacted components. Some of the known compounds to be avoided are as below:
   - Dioctylpthalates (DOP) used in vinyl materials
   - Triethylphosphates (TEP) and other organo-phosphorus compounds used as fire retardants
   - Butylated hydroxytoluene (BHT) used in urethane foam sealants
   - Amine compounds
   - Cyclic siloxanes
   - Sodium, chloride, calcium, sulfate, ammonium, and potassium
   - Boron and phosphorus
2. The acceptance of materials used in construction should be based on test data submitted by the component suppliers. This data may be sufficient pending testing methods. Acceptable materials of construction include, but are not limited to, PTFE, glass, and certain Poron and Santoprene products. Metal surfaces (including fasteners) should be stainless steel, anodized aluminum, or baked powder-coated epoxy painted. All materials used in the construction of the M/E should be analyzed for organic contents using a dynamic headspace thermal desorption gas chromatograph mass spectrometer (GC/MS) by an independent laboratory skilled in this technique. In some cases, outgassing and actual deposition tests at room temperature using surface acoustic wave (SAW) and cold stage time-of-flight secondary ion mass spectrometer (TOF-SIMS) analysis may be required where a material exhibits a high content of AMC compounds, but has other desirable construction features.
3. In addition to natural emissions of the materials, the enclosure and air system should be resistant to acid and solvent vapors and should not emit volatile organic concentrations when in contact with the air stream. The materials used should be compatible with the use and duty of the process equipment and connected process support gases and chemicals. Materials of construction should be compatible with vapors, liquids, and gases that may be corrosive. The equipment supplier needs to verify that the materials used are compatible with the process equipment chemicals optical wavelength properties (light sensitive processes).

4. Components – All door operations, latching mechanisms, hinges, and fasteners should be designed to minimize particulate generation. Components should be of industrial grade quality and designed with consideration for prolonged manufacturing use. Component assemblies should be designed to eliminate the rubbing together of parts that generate contamination. All surfaces should be non-shedding, non-porous, and not easily scuffed, scraped, chipped, or worn during anticipated use.
5. Surfaces should be smooth (e.g., no snags, pitting) before finish application. Anodized aluminum and electropolished stainless steels are the preferred materials, except for vision areas. The only paints allowed (in order of preference) are elastomeric urethane, urethane enamels, epoxy enamels, or baked alkyd enamels. All surfaces should be protected against corrosion as applicable.
6. Transparent or translucent portions of the M/E enclosure should have properties consistent with the requirements for ESD protection, low outgassing, and flammability. Lexan and glass are the preferred materials for windows to meet these criteria. The necessity for window(s) is only a requirement of the process equipment for operational observation and (service) maintenance considerations and is not a requirement for M/E design.
7. Any lubricants used for components should be non-volatile and their use minimized. Dry powder and silicone-based lubricants/sealants may not be used. Sleeved hinges, which do not require lubrication, should be used.
8. No tape (single or double-faced) will be used as an adhesive or sealant for air sealing purposes.
9. All surfaces should be easy to clean and resistant to water-based and organic solvent based cleaners. All component joints inside the enclosure should be smooth and filled or rounded to eliminate particle traps and allow for cleaning.
10. The structure of all enclosure and air systems should be capable of meeting seismic bracing requirements as specified by member companies and compatible with SEMI S2 requirements.

4.1.9 Electrostatics

Concern: The build up of charge on a wafer can lead to increased particle deposition rates and/or electrostatic discharge events that can adversely impact the reliability of process equipment. There will be no ionization for wafer protection provided by the IC maker's facilities, as wafers will at all times are inside FOUPs or process equipment.

1. Use static dissipative or conductive materials for all parts that must come in direct contact with the wafer and wafer carrier (i.e., robot handler arms, wafer chucks, FOUP "landing pads," etc.)
2. All enclosure components should be made of static dissipative or conductive materials; static charge build-up on surfaces should not exceed ± 150 V/inch as measured with a handheld field meter.

3. M/E should be able to accommodate ionization technology, providing ionization coverage over areas where wafers will be outside of the FOUP enclosure. Ionization technology, if included, must be compatible with process performance (ultra-clean silicon composite tips, no tungsten emitter tips). Also, any ionization system should provide a self-contained audio or visual enunciator indicating ionization system malfunction.
4. Ionization technology should be designed to minimize equipment downtime impact. The equipment operator's manual and PM specifications should include information as to cleaning frequencies, calibration frequencies, and step-by-step directions on how to perform those activities and maintain optimum performance of the ionization systems.
5. EMI generated by M/E components should be compatible with the overall process equipment requirements and limits.

4.1.10 Quality Assurance/Measurement Access Port

Concern: Factory users need the ability to externally measure and monitor the M/E using instrumentation such as particle counter tubes, sensors, etc.

1. An access port covered by a blank plate, typically 7.6 cm (3 inch) diameter, should be provided (see Figure 2).
2. The quantity of these access ports and blank adapter plates will be as necessary to ensure performance and obtain measurements throughout the entire M/E. A larger M/E will require more than one such port.
3. The location of the access port(s) should be such that it is easily accessible from the outside and any wires or tubes run through it do not interfere with the moving parts inside the M/E.
4. No such port is required for FOUP buffers.
5. The blank cover plate is to be provided by the equipment supplier. Device manufacturers will supply the measurement adapter plate.

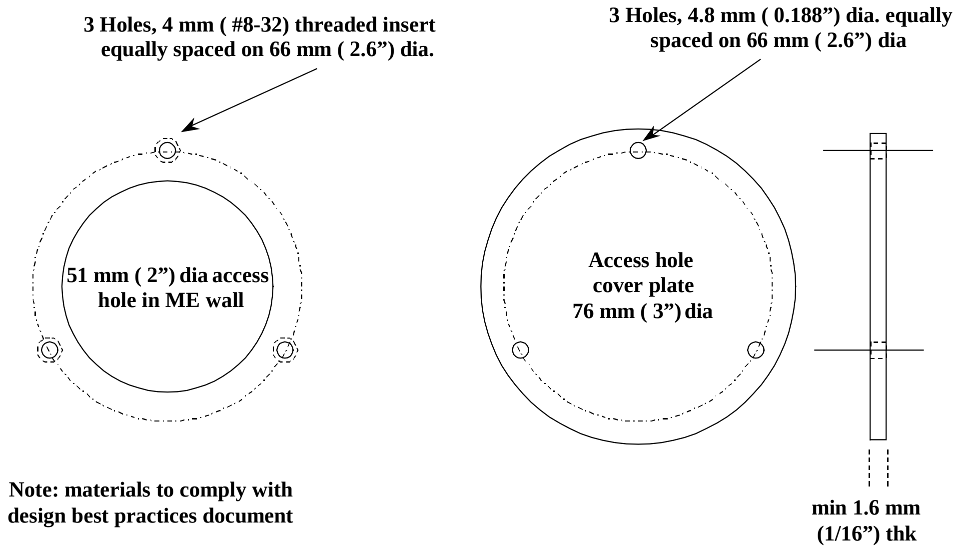

Figure 2 Example QA Measurement Access Port

4.1.11 Lighting

1. The M/E should have sufficient lighting to operate and maintain the equipment. Nominally, the inside of the enclosure should be illuminated with a minimum of 269 lumens/m^2 (25 foot-candles per square foot).
2. Any lighting inside the enclosure should be fluorescent cleanroom lights and should be compatible with the process equipment light sensitivities.
3. Any electrical wiring and cables to support internal lights should be integrated with the enclosure, supported by the enclosure, and designed to minimize turbulence.

4.2 Air Quality Section

4.2.1 Active Environmental Control of the M/E

1. Air and/or inert gas flows within the M/E should be maintained consistent with wafer cleanliness requirements during normal equipment operations (non-maintenance). Automated closed -loop gas flow control is not required.
2. Active, closed-loop humidity and/or temperature control of the M/E environment during normal equipment operation is not necessary unless required by the equipment process, in which case, it should be specified separately by the equipment supplier and/or user. (Examples are lithography systems.)

4.2.2 Inert Environment

1. An inert gas environment capability is not necessary unless required by the equipment process.

4.3 Support

4.3.1 Servicing

1. The M/E design should take into consideration the need for service technicians to access process equipment components.
2. The weight and bulk of M/E components should be considered for servicing. Each panel and door should have an opening handle and quick release latch. Any doors or panels, which might be removed, should be compatible with SEMI S8.
3. All doors and panels covering the positive pressure area should have gaskets to provide a positive seal.
4. The MEV fan/filter unit is expected to be operational during basic servicing.

4.3.2 Recovery After Servicing

1. Equipment M/Es should be able to recover and attain processing level conditions inside the M/E within one minute after being closed after a scheduled maintenance or unscheduled downtime event.

4.3.3 M/E Reliability

Concern: A functioning M/E is required for wafer processing. Therefore, the reliability of the M/E will affect the reliability of the integrated equipment.

1. To minimize the impact of M/E system on equipment availability, it is expected that the mean time between failures (MTBF) be > 70,000 hours and the mean time to repair (MTTR) be ≤ 1 hour.

4.3.4 Monitoring/Alarming

Concern: There are certain conditions for which an alarm signal should be sent to the embedded controller of the process or metrology equipment and an alarm enunciated. These conditions define what sensors/monitors should be included in the M/E design.

The following are the *only* requirements for on-line M/E monitoring and alarming:

1. Fan failure – The failure of the fan unit should result in an alarm signal being sent to the embedded controller and an alarm enunciated.
2. M/E's should have controls capable of detecting failure of the air supply, or other problems that cause a loss of pressure within the M/E. These controls should not be so sensitive that process equipment motion or minor exhaust fluctuations cause false alarms. The notification purpose is that the operator or technician be informed that a M/E malfunction may be occurring.
3. Internal ionization systems – The ionization system should provide a self-contained audio or visual enunciator indicating ionization system malfunction. No enunciation through the equipment’s embedded controller is required.
4. Door/panel interlocks should be provided where hazards exist, according to SEMI S11, and send an appropriate SEMI S2 message to the process equipment operator interface when M/E panels remain opened.
5. Any of these alarm/notification conditions should prevent the equipment being placed into manufacturing ready mode. Maintenance override of these alarm/notifications is acceptable for service activity.

4.3.5 Noise Limits

1. The M/E noise contribution should be included in the overall process equipment noise level requirements. The M/E cannot prevent the equipment from meeting equipment noise limits.

4.3.6 Vibration Limits

1. The M/E vibration contribution should be included in the overall process equipment vibration level requirements. The M/E cannot prevent the equipment from meeting equipment vibration limits.

4.3.7 Documentation

1. Design drawings should indicate dimensions, materials of construction, electrical and piping schematics and integration into the process equipment.
2. Air fluid dynamics modeling data should be provided to demonstrate that the design is proper for airflow, turbulence, exhaust, heat, etc.
3. Maintenance manuals should include service directions for the M/E.
4. The equipment operator’s manual and PM specifications should include information as to cleaning frequencies, calibration frequencies, and step-by-step directions on how to perform those activities and maintain optimum performance of the ionization systems.
5. Recovery procedures should be documented for M/E component failures and product protection.
6. Documentation for the chemical materials used for lubricants or sealants should be provided.

4.4 Buffers

4.4.1 FOUP Buffer Air Flow

1. FOUP buffer cleanliness (for applicable equipment such as the vertical furnace and the wet stations) requirements are generally the same as the ambient cleanliness class of the IC manufacturer’s cleanroom.
2. For FOUP buffers that require their own air handling system to meet the ambient fab conditions, it is expected that the related sections of this document be applied for airflow monitoring and performance.

4.5 Certification/Safety

4.5.1 Safety

1. The fan/motor operation should be integrated with the equipment emergency off button (EMO).
2. The M/E and its integrated aspects are to be included in safety inspections and any third-party evaluations.
3. The M/E design should comply with SEMI S11.

4.5.2 Flammability

Concern: M/E see-through windows and panels could make up a significant portion of the plastic in the fab, and therefore are a factor in fire risk.

1. M/E window and panel materials should be selected based on the user’s flammability guidelines and requirements.
2. The M/E design should comply with SEMI S2 and related fire protection documents.

5 FACTORY INTEGRATION CONSIDERATIONS

1. The M/E is included within the equipment footprint dimensions for 300 mm equipment.
2. The M/E design should not impact or affect loadport or FOUP loading operations.
3. All loadport mechanisms and wafer handling systems are included in the coverage of the M/E
4. Panels or doors should be interlocked to prevent collision with overhead hoist systems. The design should adhere to requirements for overhead hoist easements as defined in SEMI E15.1.

5.1 Impact of Bay Wall thickness and its Location on M/E Clearances

Concern: The design of the M/E should provide for access by maintenance personnel or process intervention by an operator. Minimal exposure to the fab ambient is required. The design should consider these access points for operators and technicians. Some IC manufacturers may choose to install a bay wall between the front face of the equipment, where the E15.1 loadports reside, and the rest of the equipment body. Use of this bay wall may pose access difficulties to certain elements of the M/E or the equipment themselves.

1. For an installation with bay walls, it is important to design a “wall intersection exclusion zone” where the bay wall is most likely going to be installed. This exclusion zone will intersect the equipment on three sides of the equipment, as shown in Figure 3. The width of this exclusion zone (denoted by X in Figure 3) is dependent on the height of the equipment at the wall intersection zone. If the equipment height is ≤ 3378 mm, the wall intersection reserved zone should be ≥ 76 mm. If the equipment height is > 338 mm, then the intersection zone should be ≥ 91 mm.
2. The M/E designs should ensure that access panels, doors, door handles, and other serviceable items of the M/E or the equipment should be installed clear of this zone reserved for the IC maker wall location.

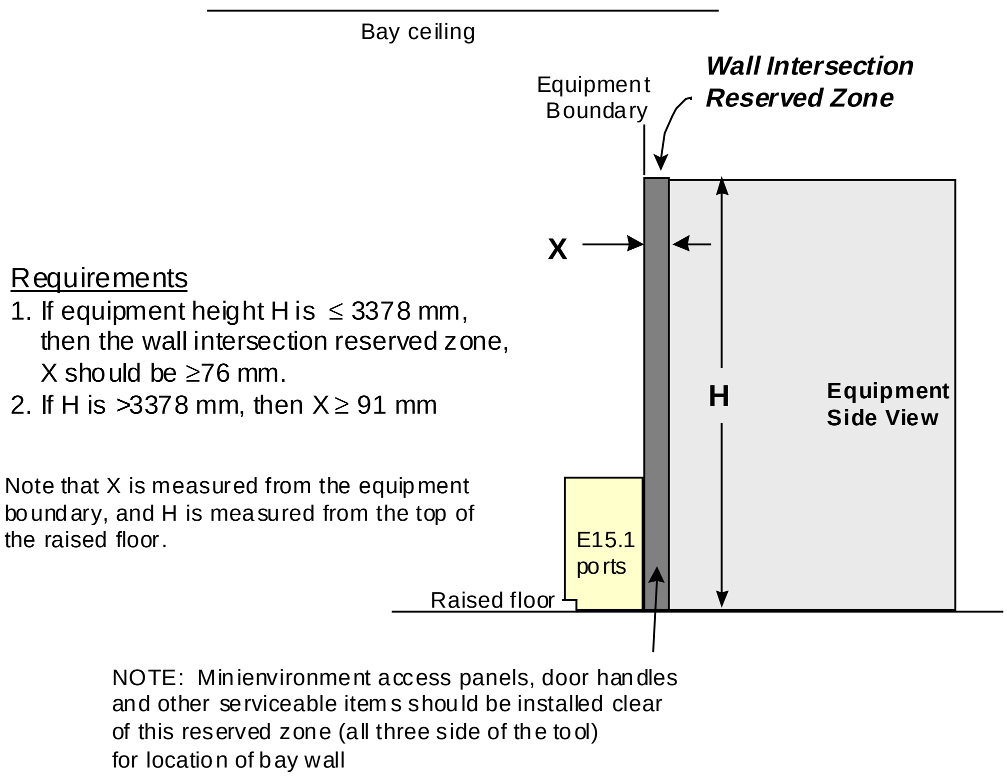

Figure 3 Wall Intersection Zone Requirements

6 REFERENCE DOCUMENTS

- *Safety Guidelines for Semiconductor Manufacturing Equipment*, SEMI S2.
- *Safety Guidelines for Ergonomics/Human Factors Engineering of Semiconductor Manufacturing Equipment*, SEMI S8.
- *Environmental, Safety and Health Guidelines for Semiconductor Manufacturing Equipment Minienvironments*, SEMI S11.
- *Safety Guidelines for Operation and Maintenance manuals used with Semiconductor Manufacturing Equipment*, SEMI S13.
- *Guide for Tool Accommodation Process*, SEMI E70.
- *Provisional Specification and Guide for 300-mm Equipment Footprint, Height and Weight,* SEMI E72.
- *Testing ULPA Filters*, IES-RP-CC007.
- *Air Filter Units*, UL900.
- *I300I Factory Guidelines* (Version 4 or later).
- *I300I Factory Guideline Compliance: Factory Integration Maturity Assessment for 300 mm Production Equipment*, I300I, Technology Transfer #98023468B-TR, March 5, 1998.

SEMATECH Technology Transfer
2706 Montopolis Drive
Austin, TX 78741

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