300 mm Integrated Vision for Semiconductor Factories

I300I and J300E
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I300I CIM STUDY GROUP
SEMICONDUCTOR EQUIPMENT AND MATERIALS INTERNATIONAL (SEMI)
SEMI - JAPAN

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Preface to Release 3

It has been 8 months since we issued Release2 of this integrated commentary in March 1999. In this period of time, J300 has continued its activities under the new name of J300E, drafting several new guidelines. At the same time, a new trend has appeared in the standardization process. The purpose of this release is to explain these new developments.

The new guidelines will be explained in the following chapters.

Presently, the system of activities and standardization processes is as follows. Please refer to “Chapter 1 Background and Summary” for past system of activities and standardization process.

P1.0 Present System of Activities

Although J300 was made up of 5 organizations in the semiconductor industry, J300E comes under the sole jurisdiction of EIAJ. We will exchange information with the organizations in J300 through liaison sessions. As in the past, we will continue to produce the GJG (Global Joint Guidance), so as to further produce the SEMI and standards in cooperation with I300I (International SEMATECH). J300E considers the following to be the aims of its activities.

i. Encourage the standardization of 21st century semiconductor production technologies, including the 300 mm technology.

ii. Contribute to globalization efforts through encouragement of standardization.

iii. Cooperation to meet the standards based on the guideline.

As of now (November 1999), active work groups are CIM WG, Post Procedure Cassette WG, and Reticle Management WG.

![System of Activities Diagram]

Figure P1 System of Activities
P2.0 Standardization Process

Standardization in the system area had been carried following SEMI standards as a guide. However, in an effort to provide better direction in the development of standards so as to allow efficient standardizing, GJG, a standard fulfilling user demand for the 300 mm line was proposed. Many standards produced now are in accordance with GJG. However, in areas such as system structure or complex specification demands, a problem has arisen in that GJG alone is not enough to fully reflect user demands in standardization. To solve this problem, J300E/I300I has produced a document known as USRD (User System Requirement Document), which specifies functions required for standards. The framework of AMHS is the first example of USRD. With the inclusion of the background of GJG as well as finely defined functions and scenarios, this USRD provides support for the creation of correct standards from GJG. USRD is also a good reference for the actual implementation of the system.

On the other hand, factors such as line image and summaries of large demands or scenarios considered in the process of devising GJG are separately included in the URD (User Requirement Document). In the future, when standardizing of new fields are carried out, URD, GJG, USRD, standardization and implementation will be considered step-by-step. It is rightly supposed that with this process, standardized system correctly reflecting user needs can be constructed. This standard process is shown in the following diagram.

![CIM System Pyramid](image)

**Figure P2**  New Trends in Standardization Processes
Executive Summary

E1.0 Introduction

The semiconductor industry is at a significant turning point. Since the semiconductor market has reached $135B in revenue, an average annual industry growth rate of 16% will be difficult to sustain. To maintain industry profitability and growth, new ideas for cost effective manufacturing must be aggressively pursued that go beyond simply enlarging the scale of production to achieve efficiency. Reducing manufacturing cost of the entire industry by standardizing in pre-competitive areas is one of the new ideas being pursued for 300 mm. In Japan, five industry groups started working together as J300 in June 1996, to foster this industry standardization. In the US, Europe, and APAC countries, 13 IC manufacturers formed the I300I consortia in July 1996 to achieve similar objectives. Figure E.1 shows a vision for 300 mm factory standardization.

As a result of their joint collaboration, J300 and I300I have published their direction for industry standardization using a Global Joint Guidance (GJG) document. To help semiconductor suppliers and device manufacturers better understand the CIM area of the GJG document, this integrated standards document has been created. It contains background information, IC maker motivations, detail descriptions, answers to frequently asked questions, and also maps the relationship between CIM guidelines and SEMI standards. We expect that this detailed explanation of the GJG will lead to a better understanding of the guidelines, ensure that document users correctly implement the standards, and eliminate implementation variation. All of these motivations are targeted to help improved productivity and reduce cost through uniform implementation of standards to support the industry transition to 300 mm.

E2.0 CIM Standardization Activities

E2.1 J300 and I300I CIM Activity Structures

Figure E.2 shows the J300 CIM structure. The CIM Planning Working Group started working in March 1997, to foster CIM relating standardization under the J300 Planning Group. The WG mainly consists of members of five semiconductor companies. CIM Planning WG created the Global Joint Guidance, which is published with the approval of Planning Group. There is also a working group, which addresses equipment interfaces related to hardware under CIM Planning WG.
In April of 1997, I300I created the CIM study group to standardize software systems and equipment communication interfaces. The CIM study group also had as its membership 5 semiconductor companies from within I300I. Initially, the CIM study group focused on creating standard software interfaces and state models in response to 300 mm hardware standardization such as AMHS and SEMI E15.1 load ports. The group has since expanded this role to look at all areas of CIM. It also serves as the main conduit for continued physical interface standardization in the WIP area. It reports to the Factory Integration Working Group, which ratifies major directions and global agreements made with external partners. The Executive Steering Committee is the highest approval body for I300I and focuses on major 300 mm directions for the consortia, J300 and SELETE partnerships, and supplier agreements. Figure E.3 shows a relationship between these three groups.

Figure E.4 shows the structure of CIM standardization activity groups. The J300 CIM Planning WG collaborates with the I300I CIM Study Group to create user requirements in the form of industry guidelines. These standardization activities are characterized by the development of the guidelines and the concurrent development of standards by SEMI. Problems that are found while developing a SEMI standard are fed back to J300/I300I so that they can be reflected in the form of new or revised guidelines. J300 and I300I communicate the guidelines to the equipment manufacturers, learn their opinions through joint forums like SEAJ, and modify the course of the guidelines.
The structure and relationship between SELETE and J300 will change when standardization proceeds to the next phase. Discussion has already started on how to effectively study AMHS (Automated Material Handling System) and foster standardization.

![Current Organization of Standardization Activities](image)

**E2.2 300 mm Drivers for Standardization and Cooperation**

Figure E.5 depicts the background of automation in a schematic form. Many manufacturers consider that, in the era of 300 mm, custom LSI such as ASICs and general-purpose LSI will be mixed and manufactured together. The importance of shortening Turn-Around-Time (TAT) for a manufacturing line and optimizing the lines output become greater and greater. On the other hand, requirements for improved cleanliness and the more advanced automation is higher than ever because of the problems related to the transportation weight and finer products. An automated line and a CIM system, which provide the solutions to these problems, are sought.

![Background of Automation](image)
Some of the items to be developed for the above goals are listed below:

- the establishment of a best direction system for operations
- the construction of a most efficient transportation system
- the construction of the single wafer control technology

The construction of these technologies is estimated to require enormous cost. It is commonly acknowledged that semiconductor production has become global and that competition in an open environment is an essential premise. Thus, cost reduction through global standardization in non-competitive areas is inevitable. The strong desire for standardization is especially true in the area of interfaces between Host systems, AMHS, and production equipment. The J300 and I300I CIM standardization activities were performed based on this common background. Sharing of both technology and direction between companies in the pre-competitive areas has been gradually increasing which is leading toward more effective industry standards.

**E3.0 Guideline Overview**

This section explains the contents of the CIM guidelines, which are roughly classified as follows:

1. AMHS Interoperability guidelines
2. Production Equipment Material Handling
   - QTAT support
   - Production Equipment Interfaces
   - Interlock for both OHV and PGV
3. Process and Wafer Control guidelines
   - Carrier/slot management
   - Single wafer control

**E3.1 AMHS Guidelines**

AMHS related guidelines describe standardizing AMHS equipment together with standardizing the integration between AMHS and production equipment. These guidelines reflect the common recognition of device manufacturers that AMHS is one of the important topics for manufacturing of 300 mm wafers and that AMHS standardization as well as standardized production equipment will be one of the most important future topics. Since all IC manufacturers agree with the basic premise that automated intrabay transfer shall be implemented for 300 mm, it has become easier to determine the requirements for AMHS common to device manufacturers.

**AMHS Interoperability**

300 mm wafer manufacturing requires automatic transportation and storage of 300 mm wafer carriers for both Interbay and Intrabay applications due to ergonomic and safety issues related to increased carrier size and weight. Traditionally, AMHS equipment contains custom hardware and software interfaces specific to each transportation and storage supplier. Because of these custom interfaces, it is both difficult and costly to assemble different types of AMHS equipment from the same supplier, or different types of equipment from several AMHS suppliers, into a single transportation and storage system. The basic concept of AMHS Interoperability is to allow semiconductor manufacturers to design and construct an AMHS with the optimal combination of devices from various AMHS suppliers in order to meet 300 mm cost and functionality requirements. Figure E.6 is an illustration of this concept.
300 mm manufacturing will also require flexible AMHS components in order to meet phased factory startup and expansion requirements. It is possible that a single 300 mm factory may be brought online in phases, and AMHS components from different suppliers, or different generations of the same supplier, will be required to be integrated with AMHS components from previous phases. The AMHS Interoperability guideline from Phase 1 required the Interoperability of Intrabay Transport devices, while the Phase 2 guideline was enhanced to also include Interbay Transport and Stocker Interoperability. The Phase 3 GJG expands on this concept and partitions the Host system into an AMHS component, which integrates Interoperable Interbay Transport, Intrabay Transport and Stocker systems. Standardization of the AMHS Integration system is the final step required to meet the Interoperable AMHS vision put forth by device manufacturers for 300 mm wafer fabrication. These guidelines express the consensus requirements and vision of device manufacturers and are intended to facilitate the development of SEMI software and hardware standards necessary to implement such requirements.

**E3.2 Production Equipment Material Handling Guidelines**

The second major focus area is production equipment material handling which focuses on management of carriers. These requirements are reflected in the guidelines, which try to construct a standardized system to manage and control carriers to improve factory productivity and ensure a safe operating environment.

**QTAT Support**

“Global Joint Guidance for Semiconductor Factories for 300 mm Wafers” published by J300-I300I in July 1997, discussed hardware buffering and methods of implementing non-stop production equipment operation. The buffering guideline proposes that a specific number of buffering locations are mounted to the production equipment and that the next lot to be processed is moved to the buffer position before the current lot being processed is completed. The objective of this guideline is to achieve high throughput and utilization of production equipment.

A logical method of QTAT (Quick Turn Around Time) is important because many device manufacturers will manufacture both general-purpose LSI and custom LSI in 300 mm wafers. New product prototypes and hot lots must be manufactured with QTAT even in a mass-production line due to short product life cycles and customer needs.

There are two general concepts of QTAT: shortening of the average process time of a line, and running an urgent lot rapidly. Because the former heavily depends on the factory operation policy of each device manufacturer and is difficult to be standardized, the guideline addresses only QTAT of urgent lots. The overview of the guideline is described below.

“Production equipment must be able to set and change the order of processing as directed by the host and the operator interface.”
Figure E.7 shows an example of passing by an urgent lot by the manipulation of queues at two load ports. The improvement of TAT of urgent products by this capability has been evaluated in the simulation.

**Load Port Ordering Control**

- Load Port Ordering Control
  - Trial Manufacture Speed, Custom item Mixed Flow
  - Hot Lot QTAT Support
  - Buffer lot awaiting processing pre-empted by a hot lot

---

**Carriew Sensors and ID Readers at E15.1 Load Ports**

The intention of these guidelines is to standardize load ports with carrier related sensors and ID readers so that carrier management is consistent in an automated system. An overview of these guidelines specifies that

1) “A Carrier presence and placement sensors, integrated to the equipment control system, must be located at each E15.1 load port to indicate whether or not a carrier is in the port area and properly placed.”

2) “There must be a carrier ID reader at each E15.1 load port. ID data must be communicated through the equipment’s single communication connection.”

The purpose is to ensure that a carrier is correctly passed to a load port and, by reading the carrier ID, the passed carrier is the correct one. The factory system uses the carrier ID to keep track of stored lots. The guidelines imply that if a wrong carrier is placed it shall be withdrawn immediately.

**Handshake between Production and AMHS Equipment**

The intention of this guideline is to safely transfer carriers between production and AMHS equipment. It requires “An interface which can communicate directly with AMHS equipment shall be integrated in the production equipment.” To implement this, a SEMI handshake standard is required. The equipment executes a carrier transfer sequence using the handshake to safely move the carrier between production and AMHS equipment. Additional requirements to clarify signal definition, support simultaneous transfer of 2 carriers, and support error handling are added to E84. Figure E.8 shows the handshake between the carrier sensor and the carrier ID reader over a load port, the production equipment, and AMHS equipment.
Standardize Material Transfer Interface for Safe Handling of Carriers

**Figure E.8 Load Port Requirements**

**Loading/Unloading of Carriers in Equipment with Internal Buffer**

Two types of production equipment were classified through discussions:

1) **Fixed buffer type equipment** has only external load ports to buffer and process carriers.

2) **Internal buffer type equipment** has buffers located within the equipment to buffer and process carriers. External load ports are used as a pass through to the buffering and processing locations.

A typical example of an internal buffer type is batch processing production equipment like a diffusion furnace. Multiple carriers are loaded and unloaded together as part of a batch. Some intrabay AMHS equipment transfers two carriers simultaneously. The guideline clearly expresses the concept of loading/unloading of carriers in the equipment of the internal buffer type. The overview of the guideline specifies that:

"Carriers shall be loaded/unloaded into/from the internal buffer at the directions of HOST. The equipment shall continuously load/unload carriers specified by HOST."

"The equipment shall notify HOST of the change in available capacity of the internal buffer so as to determine if carriers can be loaded into the buffer."

The process in the equipment of the internal buffer type (many of which is the batch equipment) is a step with the potential problems regarding transfer load on AMHS. Therefore, it is probable that various types of AMHS equipment are introduced in the step. This is why the concept of loading/unloading needs to be clarified and this guideline is developed.

**Single Communication Link**

The guideline defines an EFEM (Front End Module) as the module, which contains load ports, E84 interface, carrier ID reader, and an internal buffer. The single communication link guideline for connecting Host and equipment including EFEM specifies that:

"A single physical communication connection must link the production equipment to the Host. A single physical communication connection means that the Equipment Front End Module (EFEM) is integrated through the production equipment rather than connected directly to the Host."

This is shown in Figure E.9. This specification is based on the requirement from the device manufacturers that EFEM, as a part of the production equipment, should be connected to the Host through the equipment controller.
Single Communication Link

Easily integrate production equipment including material handling interface to the Host.

Figure E.9 Production Equipment with Single Communication Link

Interlock for OHT-PGV

OHT is one type of AMHS intrabay equipment that offers potential for low cost since it saves valuable floor space by it running mounted to the ceiling over both operators and equipment load ports. One concern is the potential for a collision between an OHT and a PGV at a load port if both are trying to access the load port simultaneously as in Figure E.10.

PGV / OHT Interlocking

... Ensure the safety in OHT/PGV mixed operation

Figure E.10 Mixture of OHT and PGV

One method to prevent this is to use a door or light curtain at the load port to physically prevent simultaneous access, however, both J300 and I300I could not agree on whether this was necessary. From a systems level perspective, however, it was felt that a method could be devised to logically ensure that lots were not dispatched to the same location by both PGV and OHT. This guideline specifies that:

“A software-based interlock between the PGV/operator handling and OHT equipment must exist to prevent simultaneous access of the same load port to enhance human safety and prevent product damage. Production equipment and stockers should comprehend the access mode and decide whether it should be accessed by the OHT or PGV/operator handling. Based on the decision, the production equipment and stockers must reject all other requests other than the authorized mode.”
A related guideline specifies that “The production equipment shall be able to pass carriers to/from AMHS automatically even when the process can be executed manually.”

The intention of these guidelines is to allow carriers to be delivered to production equipment by an AMHS and then be processed manually without the use of host control.

**E3.3 Process and Wafer Level Control Guidelines**

The third major focus area is process and wafer level control related guidelines. In 300 mm manufacturing, reliable wafer control is required more than ever due to the value of a 300 mm wafer. For process equipment, single wafer control is required which is strongly reflected in the guideline document.

**Basics of 300 mm Wafers Management**

Managing the relationship between lot and carrier together with wafer and carrier slot is an important capability required for both factory software systems and equipment. One of the foundational elements to this strategy is the premise that wafers processed in the production equipment shall return to the same slot position of the same carrier. This concept is specified in the guideline as follows: “The production equipment must have the minimum capability of loading wafers to and from the same slot in the same carrier.”

**Slot Management**

In addition to the minimum slot integrity capability, there is another guideline that extends wafer management capabilities as follows: “Prior to processing wafers, production equipment must have the capability to detect which slots within a carrier have wafers. This information is used to verify the carrier/slot map.”

Slot management can be performed reliably by checking the slot positions of wafers before the process starts as specified by the guideline and illustrated in Figure E.11. If there is a discrepancy between the equipment data and the map stored on the host, then processing on that carrier will be stopped until the difference is reconciled.

![Slot management of wafers](image)

*Figure E.11 Reliable Slot Management*

In the guideline below, some extensions to the carrier/slot management are used for certain equipment in order to support sorting out of wafers that are not good and collecting of pilot wafers. This provides additional control necessary for efficient factory production.

“In addition to the minimum slot and carrier integrity capability, specific single wafer production equipment must be able to output wafers to a specific slot in a specific carrier different than the one from which it was taken.”
Single Wafer Control

In the 300 mm era, high efficiency in running a product of a smaller lot size is needed. For example, there might be a requirement that multiple lots within a carrier should be processed by directing the equipment to change processing conditions instead of splitting lots (Figure E.12).

**Figure E.12**  *Batch Processing of Mixed Lots (Single Wafer Control)*

In order to improve the processing efficiency of the production equipment and to perform the precise control of the process, the guideline contains the requirement for the single wafer control.

“Single wafer production equipment must be able to process some or all of the wafers in a carrier as specified by both the host and the operator interface. Single wafer process equipment must be able to process wafers based on an order specified by both the host and the operator interface.”

This guideline is intended to support the extraction processing of the inspection equipment and wafer randomization during processing for certain types of processing equipment.

“Single wafer production equipment must support the capability to set different recipes and/or variable parameters associated with subsets of wafers within a carrier in a standard way.”

This guideline could be applied to various processes such as the single wafer process control, the mixture of lots in a single carrier (Figure E.13), and the conditioning of a pilot lot. But how these single wafer control related requirements are used and when the requirements are presented depend on device manufacturers. Therefore, the guidelines were developed to facilitate the standardization by SEMI so that a unified method can be adopted regardless of purposes.
Mixed lots in a carrier

- Mixed lot in small size lot production
- Process Development and Conditioning

Lot 3 [Recipe 3]
Lot 2 [Recipe 2]
Lot 1 [Recipe 1]

Figure E.13  Mixture of Lots in Single Carrier

The guidelines are summarized as described above. Additional reference material is located in the core of this document.

**E4.0 Next Steps**

The objective of the vision document is to ensure proper and consistent implementation of the J300/I300 Global Joint Guidance. In Phase I, our focus has been on providing an integrated view of a 300 mm factory from an IC manufacturer perspective and giving background and motivation for most of the guidelines. All of these actions have been taken with the objective that suppliers and IC manufacturers alike have a broader perspective on how guidelines and standards will be implemented. It is expected that this understanding of the objectives will drive toward consistent implementations that help achieve cost effective manufacturing.

In Phase II of the vision document, we focused on providing greater details on what an integrated 300 mm factory will look like from an operations perspective. This includes a more detailed description of how these guidelines will be used as building blocks to support High Volume / Low Mix and High Volume / High Mix integrated factories in a cost effective manner.

Finally, I300I and J300 expect this document to be refined over time as improvements are made to new and existing standards. In 1999, it is expected that many of the current ballot initiatives will become full or provisional SEMI standards. Suppliers are expected to implement these new standards into their products in an expedient manner. We also recognize that standards will continue to be improved and revised over time. It is not our intention that all standards improvements will be adopted immediately by the industry and its supply base. We will review all changes on a case by case basis to determine whether we want to change the industry requirements. To ensure a level set within the industry, Table 5.1 will be revised to show all current expectations by I300I and J300 on standards required by the industry.

**E5.0 Summary**

The ultimate purpose of the J300/I300I Global Joint Guidelines is cost reduction. The guidelines are a summary of consensus requirements from device manufacturers, and how to realize them concretely has been discussed in the development efforts of SEMI standards. In order to get the result of the cost reduction, however, device manufacturers should require with one accord the implementation of SEMI standards based on the guidelines of the equipment manufacturers. Since the requirements are discussed openly while the guidelines are examined by J300-I300I, we are expecting that the device manufacturers will keep in step. Another important thing is that the guidelines and SEMI standards should be interpreted and used correctly. How to eliminate needless variations derived from minor differences is also important. This document is developed in expectation of facilitating the correct interpretation of the guidelines and helping the standardization function effectively. We intend to promote various plans so that the guidelines and SEMI standards are complied.
1.0 Introduction

1.1 Overview

The semiconductor industry is at a significant turning point. Since the semiconductor market has reached $135B in revenue, an average annual industry growth rate of 16% will be difficult to sustain. To maintain industry profitability and growth, new ideas for cost effective manufacturing must be aggressively pursued that go beyond simply enlarging the scale of production to achieve efficiency. Reducing manufacturing cost of the entire industry by standardizing in pre-competitive areas is one of the new ideas being pursued for 300 mm. In Japan, five industry groups started working together as J300 in June 1996, to foster this industry standardization. In the US, Europe, and APAC countries, 13 IC manufacturers formed the I300I consortia in June 1996 to achieve similar objectives. Figure 1.1 shows a vision for 300 mm factory standardization.

![Figure 1.1 Factory Standardization Vision](image_url)

As a result of their joint collaboration, J300 and I300I have published their direction for industry standardization using a Global Joint Guidance (GJG) document. To help semiconductor suppliers and device manufacturers better understand the CIM area of the GJG document, this integrated standards document has been created. It contains background information, IC maker motivations, detailed descriptions, answers to frequently asked questions, and also maps the relationship between CIM guidelines and SEMI standards. We expect that this detailed explanation of the GJG will lead to a better understanding of the guidelines, ensure that document users correctly implement the standards, and eliminate implementation variation. All of these motivations are targeted to help improved productivity and reduce cost through uniform implementation of standards to support the industry transition to 300 mm.

1.2 History and Background of Automation

In this section, automation history and background are discussed to provide context for the standardization activity. Figure 1.2 is the summary of the history of the automation. Individual facilities were automated first. Central control over the entire facilities by a Host system was then implemented. Finally, automated transportation system between groups of facilities was implemented. In some companies, unattended operations for routine actions are also realized by the automated transportation systems. Automation of non-routine operations will be discussed in the future.
Flexible Flow Manufacturing (Completely Integrated Automation System) ~ 2000
Interbay Material Handling Between Equipment (Large Scale Fab) ~ 1990
Intrabay Material Handling Between Equipment (Product and Operator Isolated from each other) ~ 1995
All Equipment Linked to Host (Prevent Misprocessing and Reduce Setup Time) ~ 1985
Independent Equipment (Limited by Human Operator Ability, Yield Improvements) ~ 1980

Milestones in Factory Automation

Figure 1.2 History of Automation

Figure 1.3 Background of Automation

Some of the items to be developed for the above goals are listed below:
- the establishment of a best direction system for operations
- the construction of a most efficient transportation system
- the construction of the single wafer control technology

The construction of these technologies is estimated to require enormous cost. It is commonly acknowledged that semiconductor production has become global and that competition in an open environment is an essential premise.
Thus, cost reduction through global standardization in non-competitive areas is inevitable. The strong desire for standardization is especially true in the area of interfaces between host systems, AMHS, and production equipment. The J300 and I300I CIM standardization activities were performed based on this common background. Sharing of both technology and direction between companies in the pre-competitive areas has been gradually increasing which is leading toward more effective industry standards.

### 1.3 J300 and I300I CIM Activity Structure

#### J300 and I300I CIM Activity Structures

Figure 1.4 shows the J300 CIM structure. CIM Planning Working Group started working in March 1997, to foster the CIM relating standardization under Planning Group. The WG mainly consists of members of five semiconductor companies. CIM Planning WG created the Global Joint Guidance, which is published with the approval of Planning Group. There is also a working group, which addresses equipment interfaces related to hardware under CIM Planning WG.

In April of 1997, I300I created the CIM study group to standardize software systems and equipment communication interfaces. The CIM study group also had as its membership 5 semiconductor companies from within I300I. Initially, the CIM study group focused on creating standard software interfaces and state models in response to 300 mm hardware standardization such as AMHS and SEMI E15.1 load ports. The group has since expanded this role to look at all areas of CIM. It also serves as the main conduit for continued physical interface standardization in the WIP area. It reports to the Factory Integration Working Group which ratifies major directions and global agreements made with external partners. The Executive Steering Committee is the highest approval body for I300I and focuses on major 300 mm directions for the consortia, J300and SELETE partnerships, and supplier agreements. Figure 1.5 shows a relationship between these three groups.
Figure 1.5 Structure I300I Groups

Figure 1.6 shows the structure of CIM standardization activity groups. The J300 CIM Planning WG collaborates with the I300I CIM Study Group to create user requirements in the form of industry guidelines. These standardization activities are characterized by the development of the guidelines and the concurrent development of standards by SEMI. Problems that are found while developing a SEMI standard are fed back to J300/I300I so that they can be reflected in the form of new or revised guidelines. J300 and I300I communicate the guidelines to the equipment manufacturers, learn their opinions through joint forums like SEAJ, and modify the course of the guidelines.

The structure and relationship between SELETE and J300 will change when standardization proceeds to the next phase. Discussion has already started on how to effectively study AMHS (Automated Material Handling System) and foster standardization.

Figure 1.6 Current Organization of Standardization Activities
Figure 1.7 shows the flow of activities between I300I and J300 during the past 18 months of engagement.

Figure 1.7 Engagement Flow Between J300 and I300I
1.4 Overview of J300 and I300I Collaboration

Overview of Activities

Strategy of the GJG Activities

The strategy of the GJG activity is to present requirements from semiconductor manufacturers as guidelines with the goal of improving the productivity of 300 mm factories and shortening Turn Around Time (TAT). J300 and I300I decided to develop global guidelines and to create concrete standards concurrently by participating in SEMI.

Progress of Activities and Future Plans

Standardization activities for J300/CIM restarted in March of 1997. J300 WG reviewed specific topics from the viewpoint of the entire production line, which were separately discussed by working groups designated as CIM1 and CIM2. Using this as a baseline, the WG discussed what standards are required, made them up into a list of items of candidates for standardization in June, and published it in SEMICON WEST in July.

The I300I CIM effort was initially born out of a need to integrated through standard software interfaces the mechanical standards being developed to facilitate 300 mm material handling. Initial focus was on basic communication, infrastructure, and AMHS standards.

In August of 1997, I300I and J300 decided to collaborate and activities to develop GJG were started. In October, SEMI-J chartered CIM/FA WG to examine standards corresponding to these activities as preparation for concurrent development of standards. The members of the J300/CIM Planning WG and the I300I CIM Study Group published Phase 1 of the CIM GJG, which was composed of 14 guidelines at SEMICON Japan and US in December of 1997. Immediately after that, J300 and I300I started developing CIM Phase 2 guidelines. On April 15, 1998, an interim report of the Phase 2 GJG was presented to the industry for feedback. Questionnaires were sent to equipment manufacturers and answers were then collected and analyzed. The interim guidelines for Phase 2 were further modified taking into account this supplier and industry feedback. J300 and I300I then added both the Phase 1 and 2 GJG contents together into a single unified set of guidelines. The combined Phase 1 and 2 GJG contained 32 items and was published in SEMICON West and in Japan in July 1998. This document summarizes the result of these activities through SEMICON Japan in December of 1998, as GJG in Phase 3.

Situation of CIM Guideline

The situation of CIM guidelines is shown in Figure 1.8. J300 and I300I CIM groups focused on AMHS (Automated Material Handling System) due to widely anticipated changes in material handling needed for 300 mm. This included material handling requirements and standards needed for Production Equipment. Standardization of Manufacturing Execution Systems (MES) areas was left for future discussion.

The numbers in parenthesis within Figure 1.8 indicate the number of guidelines for each area. Most of the guidelines are production equipment related, however, as noted these were focused on material handling requirements. The total number of guidelines published for CIM was 32 in July 1998. The guideline for the compatibility between the framework and the load ports of AMHS has been added as part of the Phase 3 activities and will be presented at SEMICON Japan in December 1998.
1.5 Document Structure

The objective of the vision document is to ensure proper and consistent implementation of the J300/I300 Global Joint Guidance. Our focus has been on providing an integrated view of a 300 mm factory from an IC manufacturers perspective, clarification and motivation for each GJG, and communicating J300/I300I expectations for the revision of SEMI standards that suppliers should use to comply with the GJG.

The vision document is divided into 4 main sections as described below:

1. 300 mm factory overview
2. Guideline clarification, motivation, and linkage
3. GJG Frequently Asked Questions
4. Table of GJG and SEMI Standards correlation, SEMI standards revisions, and standards gaps.

These sections are now discussed in greater detail.
2.0 300 mm Semiconductor Overview

2.1 Introduction and Assumptions

200 mm semiconductor factories use functional area layouts, where similar groups of processing equipment are located together in a single area. In 300 mm similar functional area layouts will also be adopted. Functional areas are further divided into groups of equipment called bays as is shown in Figure 2.1. The transportation system is composed of both an interbay and intrabay transport devices. This chapter briefly explains the components of a semiconductor factory for 300 mm wafers.

In 300 mm, IC manufacturers will use two types of wafer carriers. The first type is an OC (Open Cassette) where wafers are exposed to the clean room while the second type is an FOUP (Front Opening Unified Pod) where wafers are enclosed. In either case, an ID tag or label is placed on the carrier for identification. A single carrier may contain several lots with different processing requirements. There are various types of production equipment, which accept and process wafers in each carrier, such as the diffusion furnaces, the wet machines, and inspection machine.

Production equipment can also be roughly classified into two types for carrier transfer and buffering: 1) fixed buffer equipment and 2) internal buffer equipment.

![Diagram of Semiconductor Factory Components](image)

**Figure 2.1 Components of Semiconductor Factory for 300 mm Wafers**

A stocker is placed in each bay, which stores a certain amount of carriers and serves as a connection point between the interbay and intrabay transport systems. OHS (Over-Head Shuttle or monorail) is used to transfer carriers between stockers by running several vehicles along a rail. Devices which transfer carriers between the production equipment and stockers are OHT (Overhead Hoist Transport), AGV (Automated Guided Vehicle), RGV (Rail Guided Vehicle), and PGV (Personal Guided Vehicle). These types of intrabay transport equipment are typically chosen based upon bay characteristics. OHS, stockers, AGV, RGV, and OHT are called Automated Material Handling System Equipment (AMHS) equipment. Production, interbay AMHS, and intrabay AMHS equipment communicate to the factory host systems so that they can be integrated together.
2.2 **High Volume/Low Mix**

**Background**

Some wafer fabrication facilities are classified as high volume/low mix production facilities. Typically, the high volume nomenclature is assigned to fabs that start in excess of 20K wafer starts per month. Low mix indicates fewer products - about 80% of the wafer starts producing fewer than 10 different products. High volume fabs are generally characterized by relatively large cleanroom size – typically in excess of 6K m².

Figure 2-2 shows a conceptual layout of a cleanroom of a high volume fab, showing the typical characteristics of such an operation:

![Figure 2.2 Typical features of High Volume/Low Mix Fab](image)

**Manufacturing Characteristics for High Volume/Low Mix Type Production:**

1. The production equipment must be installed quickly and ramped to high volume in the shortest amount of time. The primary objective is to minimize the cycle time taken to qualify the equipment for production.

2. Production equipment utilization must be maximized so as to output the maximum number of good wafers per unit time per equipment. Consequently, lot size will be optimized, equipment will be configured to run non-stop between lots, and set-up time will be minimized. The operational focus will be to ensure the process is stable and equipment is running continuously.

3. Attention will be focused on how to minimize lot processing at metrology operations, either through aggressive lot level and/or wafer level sampling or both. Consequently, less metrology equipment will be needed.
4. Production equipment installation will be highly dense packed to produce the maximum output per meter of cleanroom space. WIP management policies will ensure the constraint equipment is always staffed and never allowed to run out of lots to process.

5. The interbay and the intrabay automated material handling systems will be configured so that they can sustain peak production rates and its variabilities over time. The material handling systems will be sized so that they do not gate production outputs of any bay. This is particularly important for bays with large processing batch sizes and as well as bays with very short processing times.

### Attributes for Production Equipment and CIM Systems to Support High Volume/ Low Mix Type Production:

<table>
<thead>
<tr>
<th>#</th>
<th>Typical characteristic of the high volume/low mix factory</th>
<th>Requirement on the Production equipment and AMHS equipment</th>
<th>Typical Attributes required for production equipment and CIM systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quick installation and start-up of hundreds of production equipment.</td>
<td>Production equipment must be installed quickly and ready to run. AMHS equipment must be installed and qualified quickly to meet production ramp targets.</td>
<td><strong>Single communication connection to the Host:</strong> Standard host connection reduces time for equipment set-up and qualification. This is particularly true when hundreds of production equipment must be qualified as rapidly as possible. <strong>AMHS interoperability:</strong> Enables Interbay and Intrabay AMHS to be installed and qualified rapidly. <strong>Interlock for PGV and OHT:</strong> Enables simultaneous qualification of production equipment and OHT - minimize cycle time of qualification.</td>
</tr>
<tr>
<td>2</td>
<td>High volume ramp up in a very short time.</td>
<td>Equipment must be successfully ramped to high volume in the shortest time.</td>
<td><strong>Compliance to Communication Standards:</strong> Enables thousands of process recipes to be centrally managed and controlled. Enables data to be collected and analyzed. Speed up information turns for optimum yield management.</td>
</tr>
<tr>
<td>3</td>
<td>Maximize production equipment utilization</td>
<td>Enable production equipment to run non-stop without any interruption.</td>
<td><strong>Bi-directional loadport:</strong> Supports non-stop processing. <strong>Slot and Carrier Integrity:</strong> Support buffering on loadport without need for internal buffer or additional loadports. <strong>Buffering for non-stop operation:</strong> Increases equipment utilization by supporting lot and reticle cascading. <strong>Process order control for equipment buffering:</strong> Support hot-lot operation. <strong>Utilization &amp; Reliability Management:</strong> Accurate data on utilization and reliability, and helps minimize set-up <strong>Carrier ID readers at loadports:</strong> To prevent delivery of wrong carrier to a load port and to enable recipe download. <strong>Compliance to Communication Standards:</strong> Enables thousands of process recipes to be centrally managed and controlled. Enables data to be collected and analyzed off-line</td>
</tr>
</tbody>
</table>

*Table 2.1* Equipment Attributes to Support High Volume/Low Mix Fabs
<table>
<thead>
<tr>
<th>#</th>
<th>Typical characteristic of the high volume/low mix factory</th>
<th>Requirement on the Production equipment and AMHS equipment</th>
<th>Typical Attributes required for production equipment and CIM systems</th>
</tr>
</thead>
</table>
| 4 | Minimize lot processing at metrology operations          | Metrology equipment must support statistical sampling of wafers and lots | **Wafer level control:** Metrology equipment can selectively sample specific wafers in the lot, and not the whole lot.  
**Carrier management and Host control of wafer process order:** Metrology equipment can "skip" certain lots or wafers within a lot depending upon the maturity of the process and/or equipment. |
| 5 | Dense packing of production equipment in the layout       | Install equipment in a dense manner - minimize space between equipment | **Bi-directional loadports:** Support buffering on loadport without need for internal buffer or additional loadports - minimize equipment dimensions  
**Carrier Sensors at the loadports:** Two sensors are required to enable the host system to determine whether or not a port is occupied and whether or not a carrier is placed correctly. If only one sensor is activated, the AMHS transporter will know that the port is occupied and will not permit another lot to be loaded to the port.  
**Rear User Interface:** Enables Intrabay OHT and Operator interactions to take place simultaneously without negative impact to packing density. |
| 6 | Interbay and Intrabay AMHS must support very high throughput | Interbay and Intrabay AMHS must be capable of supporting production variability of different bays, and must not negatively impact production equipment utilization. | **Interoperable Interbay AMHS:** Enables the highest throughput Stockers to be quickly and reliably interfaced to the highest throughput Interbay transport systems. This eliminates the need for multiple transport loops in the factory.  
**Interoperable Intrabay AMHS:** Enables the user to select the "best" intrabay system for each bay that matches the batching requirements, throughput needs, and cycle time needs specific to each bay. |

*Table 2.1 Equipment Attributes to Support High Volume/Low Mix Fabs (continued)*
2.3 High Volume / High Mix

2.3.1 BACKGROUND AND CHARACTERISTICS

Requirements for Short Lead Times

One of the issues of high volume manufacturing that is also required to support a high mix of different products or custom products (such as ASIC) is that it must optimize both the throughput (output) as well as support the specific manufacturing needs of these custom products. The number of customers requiring specialized products with short lead-time (lead-time is expressed in days) is continuing to increase in a big way. This is justified because early introduction of new/custom products provides significant competitive advantage to the customers. However, the typical manufacturing of semiconductor products generally takes several weeks to months to complete from the time raw wafers are introduced into the fab. High volume/high mix type manufacturing requires the factory to be very responsive to customer needs of quick turnaround of products; otherwise market share would be forever lost.

Manufacturing to Forecast and Fixed Order

In order to support a very short lead-time requirement, it is necessary to manufacture products tuned to the sales forecast. The goal is to reduce the lead-time between the receipt of orders and the subsequent delivery of products to customers. In order to be responsive to customer orders or sales forecast, wafers are often started and processed in larger quantities than what is actually needed up to a particular point in the production flow. This additional inventory of “partially processed wafers” are “stocked” at this particular point, typically prior to when metallization (personalization) layers are added. It waits here until a specific customer order is received. When a fixed order is received, the required number of wafers are released from this “stocking” point, and the metallization (wiring) layers are added. The quantity of wafers released and the time at which they are released are specific to the customer’s order and due date expectation. In such a scenario, it’s very important that in addition to the correct sales forecast, we continuously re-examine the forecast based on changes occurring in the market in real time, and link the new changes to the forecast to the manufacturing execution systems. As a result, a supply chain management system that links market forecasting, customer orders, manufacturing execution systems, and logistics management plays an important role in high volume/high mix type factories.

2.3.2. WAVER FAB REQUIREMENTS FOR HIGH VOLUME AND HIGH MIXED MANUFACTURING

Wafer Input (starts) Control and Mixed Lot Loading

Conventionally, a manufacturing plan responding to customer forecasts is created for each manufacturing group based on the current market trend and sales forecast. This is typically updated once per week/month. This requirement works very well for fabs that use a 25-wafer lot size carrier strategy. On the other hand, when fixed orders for customers change frequently, a need is created to have a manufacturing system that changes factory and equipment loading on a daily basis. This is generally based off daily sales activities. In this case, the due date and the order volumes to be processed depend upon a customer’s specific needs. The number of wafers in “stocked” inventory as well as the number of wafers in line after the stocked inventory point is likely to change on a daily basis. These are the reasons why it is important to know when and how many wafers must be put into the manufacturing line, and why the 25 wafers per lot paradigm is difficult to adopt. When we move to 300 mm wafers in such a manufacturing environment, there will be fewer wafers per batch (since there are more die per wafer), and this will result in more carriers in the fab with less than 25 wafers! This has great ramifications on the transaction and storage loading capabilities of interbay and intrabay transportation systems. First, this is likely to increase production equipment set-up times. Second, this causes reduced output from certain production equipment (typical example is vacuum process) due to more frequent loading/unloading. Third, it reduces the ability to run in a cascaded non-stop mode for long durations.

One of the ways by which the above problem can be minimized is to use mixed lot loading in a single carrier. In other words, there is more than one lot of wafers in each carrier. This strategy aims to minimize the problems described above by loading similar lots, with partially different processing conditions but with the same basic process flow, into one carrier. There are two possible mix patterns in this scenario. The first one is a combination of lots with the same process flow, but with partially different processing conditions such as metallization layers or wiring patterns. The second one is a combination of more than one lot in a carrier, all of which have a same process flow, but some of which have additional process steps as optional processes. For the first type, the process equipment
must have the capability to set different processing conditions (different recipes) for each lot or subset of wafers in a single carrier. For the second type, the process equipment used in the optional process step must have the capability to selectively process one or more wafers in a particular carrier, and leave the other wafers in the carrier unprocessed.

**QTAT (Quick Turn Around Time) Support of Hot Lot**

An order for a custom product may miss the sales forecast even though the factory has made major improvements in the speed with which they can respond. A typical example of such a situation is when an order from a customer for a particular product results in the realization that neither the type of wafers “stocked” nor the type of wafers in the production line match what is needed! In such a case, raw wafers for the product must be started into the fab at the starting point, and must be processed with the highest priority, in order to satisfy the delivery requirement (when and what quantity) of the customer.

Another example that needs QTAT support in custom manufacturing is the need to quickly recover from a (line yield) wafer loss in the manufacturing line. The number of wafers to be started into the manufacturing line is determined based on the customer ordered volume and the expected due date. But sometimes (line) yield is lower than the forecast, arising from situations such as excess wafer scrap due to equipment, process or handling problems. This makes it exceedingly difficult to successfully achieve the volume and delivery date requested by customer. In such a case, recovery lot(s) must be started into the manufacturing line and processed with the highest priority.

### 2.3.3. OPERATION MODEL OF SINGLE WAFER CONTROL

**Background of Development**

The development of a (single) wafer-level control model for 300 mm wafers is now required because of the mixed lot loading requirements described above. As we get into finer and finer geometries, yield must also be improved. This can be achieved by controlling the processing conditions of each wafer. The only way for improving operational efficiency and learning during yield experiments is to provide the capability of setting different process conditions (recipes) for each wafer in a carrier. In addition, the single wafer control methodology can also be utilized to automate the processing of NPW (Non Product Wafers) such as dummy wafers and reference wafers that could co-exist in the same carrier containing production wafers.

**Precondition for Operation**

This section summarizes the currently recognized pre-conditions for applying the single wafer control methodology to the first generation of 300 mm manufacturing. The pre-condition is carrier slot integrity, which is the method used to place each wafer in a specified (pre-determined) slot in the carrier all through the manufacturing process flow, and to identify each wafer with its fixed slot position. Applying this method, a wafer ID reader on each piece of production equipment becomes unnecessary, and helps reduce production equipment costs. The production equipment processes wafers according to processing conditions specified for each slot and uploads the process data of each wafer in each slot, if so required. The host sets the processing conditions (recipes) and collects the data based on a relational table of slots and corresponding wafer IDs. A wafer sorter reads wafer IDs and checks their slot positions periodically. Where a wafer sorter should be located in the manufacturing line and how often it should read wafer IDs, depends upon the operational model of each company; but in most cases, it will be generally located at a bay where IDs need to be read.

**Operation Model**

The single wafer control scheme can be utilized in various phases as is described in 3.1 Background of Development, and there can be many operational models. This section describes a basic one. Figure 2.3 shows an operation model of the single wafer control. Under normal operation, when a transport request is sent from production equipment to the host, a carrier is taken out from the stocker. The carrier is transported to the sorter by AMHS (AGV in the figure). The sorter reads the wafer IDs in the carrier and notifies the host of the relation between the wafer IDs and the slot positions. Then, with a host command, the AMHS transports the carrier to the equipment and sets it on the load port. The equipment sends the normal start report to the host. The host recognizes the single wafer control mode and then converts the processing conditions for each wafer ID to the ones for the corresponding
slot position, and downloads them to the equipment. The equipment processes wafers, changing the conditions at each slot, and reports the results to the host. The equipment sends the end report to the host when it has processed all the wafers to be processed in the carrier. Then the AMHS transports the carrier from the equipment to the stocker and then to the next bay.

### Operation Model for a Single Wafer Control

#### 2.3.4. QTAT OPERATIONAL MODEL

**Background of Development**

In custom products manufacturing, all lots started into the manufacturing line are assigned to products ordered by customers, and the due date of each lot is fixed. Some lots are “trial lots” or ES (Engineering Samples) lots. Some of these ES lots are used to examine and evaluate its commercial values by customers, and others are volume-manufacturing lots. It must be noted that the due date and number of wafers in a lot differs depending upon the type of lot. ES lots in particular aimed at customer evaluations require much shorter lead-time, primarily driven by the need to get products rushed to the customers in the shortest possible time. A shorter lead-time is also required to meet the original delivery date commitment if a recovery lot must be started in the fab because of line yield and wafer scrap issues.

**Precondition for Operation**

As explained above, custom manufacturing requires the fabricator to control lots with widely different due dates and different numbers of wafers in a carrier without decreasing the manufacturing efficiency of the manufacturing line. An ES lot often consists of less than 25 wafers. In these conditions, a short lead-time must be established taking into considering processing efficiency of batch equipment.

Generally speaking, a two-phase control can be adopted in the manufacturing line in order to reduce the cycle-time, and at the same time, improve on-time delivery of products. The first phase is to reduce the mean Turn Around Time (TAT) of the entire line. Each process step is balanced and the total Work-In-Process (WIP) is controlled (by regulating wafer starts) without decreasing the throughput (output) at bottleneck process steps. But it would still be difficult to attain the due date of each lot and satisfy the customer requirement with only this approach. In the second phase, a lot scheduling system with a simulation engine can be introduced to overlap the first phase. In addition, dispatching can be executed at the processing step of each bay based on the result of scheduling and status of actual lot progress. Dispatching defines the sequence of lot processing at each piece of production equipment.

**Operation Model**

As explained in section 4.2 (precondition for Operation), in the custom manufacturing factory, various management and control methods will be adopted to realize QTAT in order to satisfy the requirements of customers for shorter and shorter lead-times.
WIP in the manufacturing line contains various kinds of lots such as ES lots and high-volume manufacturing lots. Their lead-times are different, but the scheduler will determine the schedule of each lot when it is started into the manufacturing line. Although the scheduling algorithm depends on device manufacturers, QTAT methodology will generally enable a device maker to ship products to customers on due dates if the manufacturing line runs as planned.

But in real life, even with the control systems described above, the original production plan often cannot be executed due to unanticipated equipment, process issues, and failures. Consequently, lots are unable to be scheduled and processed when needed. For example, when dispatching has determined that a hot lot needs to be processed on a particular equipment, and all of a sudden this equipment fails, then the lot must be transported to another equipment, and it should be processed with the highest priority. This hot lot gets priority over all other lots currently staged on the buffer of the equipment. In other words, even though there are lots already waiting on the buffer (either loadports or internal buffers) this hot lot supercedes all other lots and gets processed first. This means the order of processing must also be changed between runs, when the priority of a lot changes while it is waiting to be processed in the internal buffer. When this strategy is employed, a shorter lead-time would be attained. This is the reason why the processing order control capability is required in the internal buffer type equipment.

2.4 PGV to Intrabay Transition from Startup to Ramp

Introduction

The production equipment usage scenario and the factory’s AMHS integration into production can be roughly divided into three phases: Phase I, II, and III. It must be noted there will be times in this transition when there is overlap between these different phases.

Phase I refers to the period during which production equipment process qualification occurs, including testing of its on-line functions and interfaces. At the end of this phase, the production equipment is generally ready to be controlled by the host computer. The material transfer operations in the bay are kept at “Manual mode”, and generally performed by Operators using PGV.

Phase II includes testing and integration of the Intrabay AMHS for material transfer from the stocker to the production equipment loadports and vice versa. During this period, both the PGV and the Intrabay AMHS will be used for material movement between Stockers and production equipment loadports. During PGV transfer, the production equipment is switched to “Manual mode”, and during Intrabay transfer, it is switched to “Auto”. At the end of this phase, all the transfer operations in the bay can be switched from “Manual” to “Auto.” Phase II will require all Intrabay AMHS to have fully functional/tested Safety systems.

Phase III is the final state during which all production equipment and Intrabay AMHS in the bay are on-line and controlled by host computers. Material transfer and production equipment stop/start are all performed automatically, without human intervention.

Note that in Phase II and during early Phase III, there will still be some manual interaction via the production equipment’s user-interface for certain instances of recipe download and process parameter setting on some equipment. This is generally attributed to the relative infancy of the process, and the absence of a host managed recipe download/parameter change capability.

Phase I Overview

This drawing shows Phase I operation for an internal buffer type piece of production equipment. The sketch shows the Equipment Front End Module (EFEM) which is composed of the E15.1 loadports and the internal buffers for carriers. The equipment is also shown with two User interfaces, one in the front and one in the rear. Since the equipment is not yet controlled by the host computer, a “hypothetical switch is shown OFF” in this drawing, indicating the equipment is not on-line. Therefore, the equipment is under Operator control only.

The arrow A indicates Operator interactions with the front user interface after the carrier has been loaded onto the loadport using a PGV. Following this operation, the Operator gives instructions B from the front user-interface, which causes the carrier to be transferred into the internal buffer. After the Operator sets the recipe and other processing parameters via instruction C (either from the front or the rear user interface), the wafers are transferred to the processing chamber and processing starts. It must be clearly noted that the Operator issues instructions A, B, and C sequentially from the User interface at this phase of equipment/process qualification.
Phase II Overview

This drawing shows Phase II production equipment operations under host computer control. This is diagrammatically represented by the host computer switch set to “ON”.

Similar to Phase I, arrow A indicates Operator interactions with the front user interface after the carrier has been loaded onto the loadport. At this point, the carrier ID is read, and the lot information is sent to the host computer. The host then automatically issues instruction B, which causes the carrier to be moved into the equipment’s internal buffer. Depending upon the maturity of the process parameters/recipe and its incorporation in the host system, instruction C (to initiate processing) could be evoked either manually by Operator from the rear user interface or by the host computer automatically.

At the same time, it is highly likely the Intrabay AGV is in the process of getting certified and qualified to support production. This includes route definitions and teaching robot points for carrier pick-up and set-down at the different loadport in the bay. The AGV must have all safety systems fully functional and tested to enable co-existence of Operator and AGV in process bays.

Figure 2.4 Phase I Operational Model for Internal Buffer Equipment
After this phase is successfully completed, the AMHS and the production equipment in the bay can be transitioned to Phase III.

**Phase III Overview**

This sketch shown final phase III operations, when both the AMHS and the production equipment are in fully automated mode, and running generally without Operator intervention. The load transfer by the Intrabay AGV is shown by A in the drawing. In this phase, for all normal operations, the Intrabay vehicle and the Operator can be separated; i.e., the AGV is in front performing all the carrier handling functions between the Stocker and the production equipment, and the Operator is in the rear of the production equipment. Again, depending upon process maturity and integration of recipe downloading into the host system, the Operator still has the flexibility to manually input these parameters and over-ride the host system from the user interface in the rear. This is shown as instruction C.
2.5 AMHS Operational Flow

The flow of a typical carrier transfer operation in a factory is briefly illustrated in Figure 2.3. A carrier, which has been processed at production equipment, is transferred to the nearest stocker by intrabay AMHS equipment such as an AGV or OHT. The factory system determines the next process location for the carrier and moves the carrier from its currently location in the source bay to a destination stocker in the next bay where processing must be performed.

Next, the carrier stored in the destination stocker is selected based on a request from the production equipment in the next process step. It is unloaded from the stocker (Stock-Out), taken out of the stocker, and moved to the production equipment (Intrabay-Bay Transfer). These are the sequence of carrier unload operations initiated by the next lot request from the production equipment. This is combined with the carrier storage operations to create a carrier transfer operation between production equipment in different bays and at different operations of the process flow.

![Flow of Transfer Operations](image)

**Figure 2.7 Flow of Transfer Operations**

2.5.1 Manual Transfer Operational Scenario

Figure 2.4 illustrates and explains a possible transfer scenario of the transfer operation in the sequence of carrier unload operation initiated by the supply request from the production equipment, performed by the Host, the production equipment, the stocker, and the operator in Phase I. In this example, the production equipment and the stocker are connected to the Host.
When the production equipment is ready, it notifies the Host that it is available for the next lot (Next Lot Request). Upon receiving a request from the equipment, the Host selects the appropriate lot and sends the stocker a request to move the carrier from storage to a manual output port (Stock-Out Command). The stocker takes out the appropriate carrier (Stock-Out) and completes the request. The operator takes the carrier out of the output port. The operator then communicates with the stocker via the operation panel that the carrier has been taken out (Unload Comp). In some systems, the Unload Comp. is automatically sent after the carrier is removed from the port. The operator then moves the carrier to the appropriate production equipment, places it on the load port, and notifies the equipment via the operation panel (Load Comp). The equipment accepts the carrier, reads the carrier ID using the carrier ID reader installed on the load port, and reports it to Host (Carrier ID Report). The Host verifies the reported carrier ID (Verify Carrier ID), and proceeds to the next operations such as storage of the carrier in the internal buffer and process start (Next Operation Command).

### Figure 2.8 Scenario of Manual Transfer Operation

#### 2.5.2 AMHS Operational Scenario

Figure 2.5 illustrates and explains a possible scenario for an automated transfer of a carrier between a stocker and production equipment by an intrabay AMHS. When the production equipment is ready, it notifies the Host that it is available for the next lot (Next Lot Request). This is the same as the manual operational scenario. The Host accepts the command, selects the next appropriate lot, and sends to the stocker a request to move the carrier to the intrabay output port (Stock-Out Command). The stocker takes out the appropriate carrier (Stock-Out). After receiving the completion of the stock-out operation, the Host sends to the OHT a request to transfer the carrier from the stocker to the production equipment (Transfer Command). OHT performs the carrier transfer handshake with the stocker (Hand-Off Handshake). The OHT then moves the carrier to the appropriate production equipment (Intra-Bay Transfer), performs a transfer handshake with the production equipment to properly place the carrier, and reports the completion of the operation to the Host (Comp). The transfer handshake is executed through the parallel IO between the AMHS equipment and the equipment or the stocker. After being notified that the carrier is placed on the load port, the production equipment reads the carrier ID using the carrier ID reader installed on the load port, and reports the ID to the Host (Carrier ID Report). The Host accepts the report, verifies the carrier ID (Verify Carrier ID), and proceeds to the next operations such as storage of the carrier in the internal buffer and process start (Next Operation Command), as is done in the manual operation.
Figure 2.9 Scenario of Automatic Transfer Operation
3.0 Guideline Description

This chapter describes background and motivation for the Global Joint Guidance document published by I300I and J300. It also includes clarification on use of the guidelines as well as how individual guidelines fit together in an integrated factory.

3.1 Production Equipment Guidelines

This section focuses on generic guidance for production equipment.

3.1.1 Single Communication Link

Background

300 mm fabrication line will be highly automated with smooth carrier hand-off capability on production equipment. Use of AMHS (Automated Material Handling System) is required for system construction. To realize this functionality, production equipment load ports are a key component. It is the interface between AMHS and equipment for carrier handling. In an existing 200 mm production line, there exists many different load port locations and types. This was caused by processing restrictions or efforts to achieve wafer transfer efficiency. There were also several connection types between host and equipment as shown in Figure 3.1.

![Figure 3.1 Single Wire Connection Examples Between Equipment and the Host](image)

To resolve the complexity above, standardization of types and functions of the equipment front-end module and load port has been started. An EFEM (Equipment Front End Module) standard is under development. This standard treats the EFEM as an independent unit attached to equipment. Also, load port units with pod opening mechanisms for FOUPs (Front Opening Unified Pod, a kind of carrier used in 300 mm lines) can be supplied by dedicated suppliers. Under these conditions, the key issue is standardization of the EFEM itself and how to integrate the production equipment components.

Requirements of Users

Device makers are responsible for the host system requests interface standardization between the host and equipment. This will be based on the standardization of the integration scheme to the equipment. It must include EFEM control standardization. This standardization will reduce variations caused by different solutions by different suppliers.

The purpose of this guideline is to reduce costs. Cost reduction will come from reducing the time and resources required to integrate a tool into the factory information system. The single communication link should be the only communication necessary to operate the machine at its specified capability. No additional wires should be required for material identification, material management, material movement, recipe management (including recipe upload and download), carrier transfer to and from a material handling system, or to achieve the nominal processing capability of the equipment. Device manufacturers, fresh from integration difficulties encountered in 200 mm, equipment that required multiple wires to operate, specifically require only one wire for factory management functionality.
Guideline Text

Single Communication Link

A single physical communication connection must link the production equipment to the Host. A single physical communication connection means that the Equipment Front End Module (EFEM) is integrated through the production equipment rather than connected directly to the Host.

The supplier must provide hardware on the equipment to connect to the factory Local Area Network (LAN) per IC manufacturer’s requirement. This communication connection must comply with HSMS protocol and be able to transmit and receive all SECS-II messages.

**REQUIREMENTS:**
9. Increase Control of Factory Logistics and Production Scheduling
11.3. Factory Automation

**STANDARDS:**
SEMI E5, E30, E37, E37.1

**REFERENCES:**
I300I Factory Guideline 2.13

**RECOMMENDATIONS:** Goal is for equipment suppliers to deliver and support fully integrated equipment with a single communication link to the Host.

![Figure 3.2 Single Communication Link](image)

EFEM = Equipment Front End Module

**Interpretation**

**Key idea of single physical communication link**

The host view of EFEM functions are carrier hand-off and buffering. These functions are controlled by host, so that it can perform production operation. Therefore, the integration of EFEM to equipment means integration to primary communication link of equipment. This link must be capable of managing the production operations. These functions include carrier status management on the load port, indication of processing start, or process data collection.

Another key is that all device manufacturers require all equipment to support SECS-II messages over the single communication link. Whatever messages are necessary to run the equipment are required to be SECS-II messages. The equipment must not require non SECS-II messages to operate the equipment.
Additional Communication Link

This guideline does not prohibit users from requesting at their option, additional connections for other purposes such as process or status monitoring of process equipment. The key to this phrase is that any additional wire, for whatever reason, is the user’s option. Since this is a user option, the user can specify the kind and purpose of communication they would like. Some reasons device manufacturers may request additional communications, are large file transfer, monitoring detailed information of the equipment for comparison to like equipment, or piggyback monitors.

Way of Integration

Host is not aware how an EFEM controller is connected to the rest of part of equipment controller. The key idea is that equipment and EFEM are integrated into only one connection. This connection is through the controller which controls physical communication link in this guideline. This means the EFEM is not necessarily integrated into equipment controller itself.

3.1.2 Compliance to Communication Standards

Background and Motivation

The basic foundation to standardizing equipment interfaces are message protocols and common state models to define equipment and host system behavior. Standards exist in these areas today. HSMS defines the protocol for communicating messages between peer entities over Ethernet and TCP/IP. SECS-II provides a list of standard messages that can be used to communicate information between equipment and host systems. Finally, GEM defines specific messages and state models that should be used to achieve specific and general functionality for equipment.

In 200 mm factories, few pieces of equipment complied with both SECS-II and GEM. This in turn, has driven up the cost of integration for each new factory as the number and types of equipment increased. Also, SECS-I over RS-232 has limitations in its bandwidth that are an issue when large amounts of data must be transmitted from equipment to host systems.

As a baseline for factory systems integration in 300 mm, all messages used by equipment must comply with SECS-II. In addition, all equipment must be fully GEM capable with the exception of spooling which is not required and limits monitoring which is only required for specific tools as defined by IC manufacturers. Finally, all equipment must at a minimum support the HSMS Single Session protocol for communication. HSMS allows equipment to utilize the increased bandwidth of Ethernet to achieve 100x to 1000x improved performance over RS-232. The guideline is described below.
Guideline Text

“Production equipment must comply with SECS-II standard messages to communicate with the Host. Production equipment must also use standard state models for control and data processing. Automation software products must comply with these same standard messages and state models when communicating with and controlling production equipment. HSMS Single Session Mode is a minimum requirement.”

**Figure 3.4 Standard Communication Protocols and State Models**

3.1.3 Utilization and Reliability Management

**Background and Motivation**

The purpose of the utilization and reliability management guideline is to provide fundamental data on equipment productivity to both the users and suppliers. By having this data, factory operational and equipment changes can be made to maximize the utilization of equipment and operators in order to achieve greater output and improved productivity. Reliability data, such as equipment interrupts, can also provide essential metrics for measuring production equipment health and focus supplier attention on the most important areas for continuous improvement programs.

**Guideline Text**

“Production equipment must communicate utilization and reliability data to host systems using standard messages and state models. This is required to enhance data collection and analysis of equipment performance.”

**Next Steps**

Further analysis of both SEMI E10 and E58 to ensure that they can be implemented with the desired results from above. Currently, these standards require manual input from either the host computer or the equipment operator, which is not desired from a factory productivity perspective. This type of input could be avoided by trading-off some degree of data resolution. The maximum amount of equipment utilization data needs to be captured from production equipment, without requiring external inputs from other entities.
3.1.4 **Reliable Data Collection**

**Background and Motivation**

The purpose of the reliable data collection guideline is to provide better data quality and data collection capability on equipment to improve equipment and process monitoring. The data from the equipment will be correlated with data from add-on sensors and other equipment; therefore, the data must be accurately time-stamped at the time of the collection event and must correctly associated with the appropriate wafer and location in the equipment. The equipment and process data will be used to improve the process yield, reduce operating costs and maximize the equipment productivity, therefore increasing the factory output and profitability.

**Guideline Text**

“Data collected by production equipment must be time-stamped at the time of collection and not at the time of transmission.”

3.1.5 **Variable Parameter Support**

**Background and Motivation**

In order to improve process yield and improve equipment performance, there is a need to support recipe and process tuning. A simple method to supply this capability is through the use of variable parameters. These variable parameters will be identified by the equipment and will allow the fine-tuning of the process. Production equipment should support variable parameters within a recipe and provide a mechanism to modify or change this parameter between processing of wafers. A standard method for handling variable parameters needs to be developed through SEMI standards.

**Guideline Text**

“Production equipment must support variable parameters sent by the host or set from the operator interface.”

3.1.6 **Fault Free Date Transitions**

**Background and Motivation**

The industry is now preparing, at great cost and risk, to ensure that the date transition from 1999 to 2000 occurs without effecting factory output. As a lesson learned from the Year 2000 issue, it is imperative that all software systems developed for 300 mm be able to handle any date scenarios without issue. The guideline text is shown below.
Guideline Text

“Production and AMHS equipment must be capable of fault-free performance in processing date and date-related data in the 20th and 21st centuries. An example of this correct date management is fault-free processing for the year 2000 date transition.”

Actions for the Industry

Equipment should be tested to ensure that it meets both Year 2000 related requirements as indicated using industry documents such as the International SEMATECH test plan, as well as ensuring that all software and firmware is free from any future date related issues such as the Unix Year 2038 issue.

3.1.7 Mechanical Dry Run

Background and Motivation

Without methods for loading of carrier, processing of wafer, storage to carrier at destination and unloading of carrier, it would be impossible to implement and test new software standards such as SEMI E90 and E94 etc. Using the method called "Mechanical Dry Run", most functions can be carried out without hooking up the factory power system for process consumables (gas, distilled water, chemicals etc.) or without processing of wafers themselves. In most of the cases, with the Mechanical Dry Run, it is possible to substitute aluminum or ceramic wafers for silicon wafers. While usage of precious resources can be reduced when performing tests, demonstrations and continuous experiments at both supplier site and customer site separately, all this requires the functioning of the Mechanical Dry Run.

Environment sub system is not regarded as a part of process consumables. Instead, it is used for maintaining prescribed environmental conditions as in the case of vacuum load lock and particle detection sensor. Therefore, it is necessary that the environmental sub system is functioning.

Guideline Text

1.7 Mechanical Dry Run

Production equipment shall support the capability to perform a mechanical dry run. This allows material handling and software capabilities of the equipment to be exercised without full facility hookups or changes to the physical state of wafers. Environment control sub systems should not be affected by a mechanical dry run, nor should process consumables be expended.

Industry Actions

Equipment should be able to move materials within the system. This equipment should also be guaranteed, through materials and tests, that they fully realize the SEMI standards E30, E39, E40, E84, E87, E90, E94 as required for compliance to the GJG requisites.

3.2 Load Port Guidelines

This section focuses on specific guidance for production and AMHS equipment load ports.

3.2.1 Bi-Directional Load Ports

Background and Motivation

300 mm factories will have an increased level of automation due to the large size and weight of the wafer carriers. The need for efficiency in wafer and carrier handling is therefore increased. Placing and removing carriers from the same location reduces carrier movement within the machine. Guideline 4.5.5 requires that equipment have the capability for wafers to be returned to the same cassette and slot. Bi-directional load ports allow this to happen without movement of the carrier. In some internal buffer equipment, the user may decide to use one or more ports as load ports and one or more as unload ports. This is a user decision. All load ports must still be capable of loading and unloading carriers.
Guideline Text
“The E15.1 load port must be bi-directional for loading and unloading carriers at both fixed buffer and internal buffer production equipment.”

Interpretation
All production equipment load ports must be capable of loading and unloading carriers.

3.2.2 Enhanced Interface between Production and AMHS Equipment for Carrier Hand-off

Background and Motivation
Direct communication between AMHS and production equipment allow these systems to safely and reliably transfer carriers. In 200 mm factories, SEMI E23 is commonly implemented. E23, however, was written for floor based AGV or RGV transport equipment and could not be easily extended for OHV. In addition, the standard lacked safety interlocks and error handling, as well as allowances for continuous or simultaneous delivery of carriers. SEMI E84 incorporates these features into a new standard designed with 300 mm automation in mind. Both the original guideline for production to AMHS equipment interface and the enhanced version request are shown below.

Guideline Text
1. “Production equipment must include an interface to communicate directly with AMHS equipment. This communication handshake will help facilitate safe carrier transfer between production and AMHS equipment.”
2. “Production equipment and AMHS equipment must allow both continuous and simultaneous hand-off of up to two carriers at load ports and allow recovery from time-outs and hand-off errors.”

General Requirements
To ensure safe and reliable handoffs of carriers, IC manufacturers will implement E84 (in place of E23) in their 300 mm factories. Thus, an E84 interface must be integrated into the AMHS and production equipment. Based on their production equipment and AMHS, IC manufacturers will specify the E84 PIO (Parallel I/O) and loadport assignment option and location that will be required on the production equipment. Fixed buffer equipment will require 1 PIO device per loadport. Internal buffer equipment will require either 1 PIO per loadport or 1 PIO per 2 loadports, depending on the AMHS delivery system. There is no requirement for equipment suppliers to provide loadports than are able to implement both fixed and internal buffer options as defined in the standard. Figure 3.6 shows the PIO communication implementation between different intrabay AMHS transports and production equipment.

OHV Requirements
Intrabay OHV delivery will require 1 PIO per loadport. OHV users expect the equipment suppliers to provide a plug on the top of the equipment for E84 (1 per loadport). This plug (as specified within E84) would be the point of interface between the AMHS and the process equipment. The location of the plug is defined by the application note in E84. The details of how communication is implemented on the AMHS/OHV side of the plug is left up to the AMHS supplier.

AGV/RGV Requirements
Fixed buffer equipment, regardless of the type of AMHS delivery vehicle, will use 1 PIO per loadport. Internal buffer equipment (i.e., furnaces, wet stations, etc.) may use 1 PIO per 2 loadports for AGV/RGV delivery. E84 communication for RGV/AGVs will be primarily optical; however, some IC manufacturers may opt to use the plug option.
3.2.3 Carrier Hand-off Interface Enhancement

Refer to section 3.2.2 for further details.

3.2.4 PGV (Person Guided Vehicle) Docking Standard

Background

The transition from 200 mm to 300 mm has many challenges, including the impact to manual wafer carrier handling. A 300 mm carrier is 2x the weight and 3x the volume of a 200 mm carrier which is beyond the size and weight that can be safely and ergonomically carried by humans without mechanized assistance. This is a significant change to the manual handling model that has been in place since semiconductor products were first manufactured and requires the development of a new product that provides this mechanized assistance.

This product is now commonly known as a Person Guided Vehicles or PGV and is intended to provide two basic functions. This first is to support the weight of the carriers in transport between equipment loadports and the second is to provide a mechanized ergonomic assist for transferring the carriers between the PGV and the loadport. This is where the product differs from a basic 200 mm flat top cart where the operator must lift carriers between the cart and the equipment. In addition, to allow mechanized transfer to occur safely and efficiently, PGVs must be mechanically secured or docked in position relative to the loadport before initializing the transfer.

Industry Guidance and Standardization Activities

Analysis of PGV requirements in March of 1998 resulted in the development of a standard PGV docking interface, SEMI E64. This standard defines dimensions and mechanical requirements to create a floor mounted mechanical flange within an exclusion zone on a SEMI E15.1 load port. This allows a PGV to safely dock into a fixed position for loading and unloading of carriers to an E15.1 load port. This standard also provides interoperability between carriers, loadports, and PGVs.

Guideline Text

“Any PGV must be able to dock mechanically at any standard compliant load port through a standard PGV docking interface.”

Figure 3.6 Parallel I/O Handshake Between AMHS and Production Equipment
A standard is required to allow PGV’s from different suppliers to dock at the same or any E15.1 loadport.

**Figure 3.7** Interoperable PGV Example

Why is interoperability important?

When PGVs are interoperable, any PGV supplier that meets applicable standards will be able to dock to and transfer between any standard compliant loadport. There are several benefits of PGV interoperability. The first is that it allows for multiple configurations or types of PGV to co-exist in the same factory and allow each to access the same loadports. As an example, a two capacity PGV can be used in a typical functional area for normal operations with the flexibility to use a single capacity PGV for engineering or hot. This allows IC manufacturers to utilize the appropriate solution to the factory or operational requirements optimized on a bay by bay basis. With interoperability, changing to a different PGV is as easy as rolling out the old and rolling in the new pre-qualified units.

**Conclusion**

The SEMI PGV docking interface standards are now complete. These standards facilitate interoperability between PGVs and E64 / E15.1 compliant loadports in a factory. This key accomplishment will allow the IC manufacturers to apply the best PGV solutions to fit the functional or operational needs without having to be dedicated to specific configurations.

**3.2.5 Carrier Sensors at E15.1 Load Port**

**Background and Motivation**

One of the key goals for the 300 mm transition is to have safe, pervasive, cost-effective material transportation to all production equipment using AMHS. SEMI E15.1 provides a standard method to implement load ports on production
equipment which facilitates pervasive and cost effective AMHS delivery. SEMI E84 provides a standard method to have safe transfer of material between an intrabay AMHS and production equipment or stockers. It defines the communication necessary to synchronize carrier transfer between intrabay AMHS and production equipment.

**General Requirements**

In order for E84 to be effective, it must have proper inputs to ensure that a load port is actually empty or full. A carrier presence sensor at the load port is critical as an input device to enable the production or stocker equipment to correctly identify its load port state.

In addition, the equipment must also know whether or not the carrier is placed properly at the loadport to ensure that it can be safely acquired by the intrabay robots. Placement sensors are needed to ensure that the carrier is safe to be picked up by the robot. These two sensors are shown in the figure below.

**Guideline Text**

“Carrier presence and placement sensors, integrated to the equipment control system, must be located at each E15.1 load port to indicate whether or not a carrier is in the port area and properly placed, respectively. These sensors must be logically and physically independent of each other. They must also have externally viewable LEDs that are turned on when the carrier is present and properly placed. These sensors should be integrated to facilitate safe carrier transfer between production equipment and AMHS equipment.”

![Figure 3.9 Carrier Sensors at E15.1 Load Port](image)

### 3.2.6 Carrier ID Reader at E15.1 Load Port

**Background and Motivation**

With the increased value of 300 mm wafers, the need for highly reliable material management and tracking is required. One of the desired tools to assist in better material management and tracking is the Carrier ID reader on the equipment. Some IC manufacturers may also desire the additional ability to use writeable ID tags on the carriers in order to keep certain information with the carrier and material.

**General Requirements**

Each carrier may have an ID tag in a standard location on the carrier. A carrier ID reader may be located on either fixed load port or internal buffer equipment in a standard location as defined by SEMI standards. The carrier ID will be read when the carrier arrives at the equipment and a verification may be done. Internal buffer equipment may have an additional ID reader at the FIMS port for verification purposes. Some IC manufacturers will require write capability at these locations to update the material information that is on the ID tag. The ID technology, which may be RF (Radio Frequency), IR (infrared), barcode or other type, will be selected by the IC manufacturer. There are 3 guidelines in order to address the various equipment types and locations where ID readers may be needed. Standards to provide the necessary exclusion zones are complete and standards to define the communications protocol are in progress.
3.2.7 Carrier ID Reader for Internal Buffer Equipment

Refer to 3.2.6 for further details.

3.2.8 Carrier ID Reader for Fixed Buffer Equipment

Refer to 3.2.6 for further details.

3.2.9 Load Port Backward Compatibility

Background and Motivation

In 200 mm, cost of spares is a key issue. For 300 mm, IC manufacturers would like to reduce this cost by becoming more efficient in the number and different types of spares that the factory must maintain at its site while ensuring the factory is able to quickly recover from equipment failures. From this perspective, load port backward compatibility can have a tremendous operational impact to the factory.

General Requirements

The LPU interoperability guideline is intended to ensure production equipment suppliers are aware of the impact that different load port versions across different equipment sets across different suppliers on spares management within a semiconductor factory. Cleanliness requirements put factory real estate at a premium, making it cost prohibitive to store many different types of load ports. Production equipment suppliers are encouraged through this guideline to pursue lower costs of ownership for their equipment by working toward load port compatibility between equipment versions and generations. While backward compatibility of LPUs is one method of achieving the goal of overall cost of ownership reduction, this guideline is not intended to limit innovation by requiring backwards compatibility in the event that the same goal of overall equipment cost of ownership reduction can be achieved otherwise. The guideline text is shown in the next section.

Guideline Text

“Production equipment suppliers are encouraged to implement innovative ways to minimize the quantity of loadports carried as spares with the objective of reducing overall equipment and factory cost of ownership.”

Litho Track Equipment Example

An example of the implication of this guideline between different supplier equipment is shown in figure 3.10 below. In this example there are two different suppliers of litho track suppliers used in the same factory. Supplier A has two different generations of track equipment installed in the factory. This guideline suggests that first and second generation equipment from a supplier should be able to use the same load port spare parts. It does not require, however, that equipment from supplier A and B be compatible with each other from a load port spare parts perspective, regardless of equipment generation.
3.3 Production Equipment Material Handling Guidelines

This section focuses on specific guidance for material handling at production equipment.

3.3.1 Exclusive Access Mode and Mode Change Timing including Software Based Interlock Mechanism using OHT and PGV Simultaneously

Requirements of Users and Background

Background

In the 300 mm semiconductor manufacturing factory, lines are more automated, and the Automated Material Handling System (AMHS) becomes more important to supply the materials to the production equipment. PGV, AGV, and RGV have been mainly used as intra-bay transfer equipment, and now the introduction of OHT is under discussion.

PGV, AGV, and RGV transfer carriers horizontally to load ports, but OHT does so vertically. When OHT is adopted for the intra-bay transfer, the operator might transfer a carrier to a load port manually or using a PGV in front of the equipment while another carrier is being transferred to the same load port an OHT. Especially in periods of transition when OHT is first introduced into a line and the line is just started, both PGV and OHT will be operated simultaneously. Therefore, some mechanism will be required to provide safety and measurements.

Requirements of Users

Semiconductor manufacturers want safe standard solutions for carrier transfer to be implemented in the equipment to prevent accidents which may affect line operation. Safety standards, however, differ from manufacturer to manufacturer, and not all the semiconductor manufacturers want some hardware safety measures to be standardized because of the possible cost increase. Semiconductor manufacturers require the equipment to have access modes and provide the software based interlock mechanism as a common minimum requirement.

Text of Guidelines

3.1 Exclusive Access Mode and Mode Change Timing

The production equipment shall accept only access mode (PGV/AGV/OHT or PGV/Operator) and shall be able to switch the access modes any time other than at the carrier loading/unloading. The access mode shall be set for each piece of equipment, not for each loadport. Furthermore, the equipment shall reject any load/unload requests other than the one in access mode. The equipment with physically separated groups of load ports shall be able to accept the access mode separately for each group.
REQUIREMENTS:  
11.2 Safety of products  
11.3 Factory Automation (FA)  
22 Consideration to ergonomics  

STANDARDS:  
We request SEMI to develop new standards to be applied to this capability.  

REFERENCES:  
CIM Global Joint Guidance for 300 mm Factories [Release Two] Guideline 3.3  

NOTE:  
The access modes shall have the automatic access mode and the manual access mode. The phrase “at the carrier loading/unloading” refers to the period of time when a carrier is moving between production equipment and AMHS or PGV/Operator. Load Ports not in operation shall not affect load ports in operation.  

3.3 Software-Based Interlocking to Prevent Simultaneous OHT and PGV Operation  
The software-based interlock mechanism shall exist between OHT and PGV to prevent simultaneous access to the same load port by PGV/Operator and OHT so that the safety of the operator can be secured and product damage can be avoided. The production equipment and stockers shall have the access modes and shall determine which of the accesses to accept that are requested by OHT and PGV/Operator. The production equipment and stockers shall, based on decision, reject any requests other than the one in the approved mode.
**REQUIREMENTS:**
11.3 Factory Automation (FA)
22. Consideration to ergonomics

**STANDARDS:**
SEMI E84 and S2

**REFERENCES:**
I300I Factory Guideline 2.4

**NOTE:** The software-based interlock mechanism shall be standardized so as to provide the interface and operability common to all the production equipment and stockers.

PGV / OHT Interlocking

- Ensure the safety in OHT/PGV mixed operation

---

**Figure 3.13 Mixture of OHT and PGV**

**Interpretation**

(1) **Purpose**

The purposes of these guidelines are to secure the safety in the line operations and to perform flexible operation independent of the types of AMHS equipment. Securing the safety means the standardization of the interlocking and the flexible operation means the implementation of the mode change whenever necessary.

(2) **Access Modes**

The access modes shall have the automatic access mode and the manual access mode. The difference between them is described below:

- **Automatic access mode:** In this mode, a carrier is loaded/unloaded by AMHS equipment as is defined in SEMI E84. A carrier loaded/unloaded manually or by PGV causes an alarm.

- **Manual access mode:** In this mode, a carrier is loaded/unloaded manually or by PGV. A carrier is loaded/unloaded by AMHS equipment causes an alarm.

(3) **Mode Change Timing**

With the exception of loading/unloading time, the access modes can be switched at any time. A carrier is unloaded/loaded according to the current access mode. A carrier may be loaded in one of the modes and unloaded in another mode. For example, a carrier may be loaded manually and unloaded by AMHS equipment.
Restrictions and Prerequisites

(1) Communication Capability of PGV

PGV has no communication capability with Host or the equipment. Therefore, in manual access mode, the equipment can know when a carrier is loaded/unloaded only when the operator presses the operation switch of the equipment directly.

(2) In Lines with No OHT Introduced

Some semiconductor manufacturers may not introduce OHT for the intra-bay transfer. This capability, however, may be implemented as equipment standard even in lines with no OHT introduced. The reasons are: the automatic access mode is not a capability used in OHT but a common mode independent of types of AMHS equipment, and the intra-bay transfer equipment may be changed to OHT in the future.

3.3.2 Equivalent Handshaking for Carrier Hand-off

Background and Motivation

In 300 mm factory, carrier transfer and hand-off are mainly performed automatically by AMHS equipment. On the other hand, such operations are mainly performed manually by operator in the case of fab and/or equipment ramp up or new process qualification. The other case is that automated and manual transfer will be performed in the same bay when AMHS equipment is setting up. Therefore, production equipment should support functionality to handle both automated and manual transfer/hand-off operation. Smooth and reliable hand-off method is required for this operation. Also, operator and product safety must be ensured. To realize these capabilities, unified control policy for automated/manual hand-off and a mechanism to prevent irregular operation for safety must be established.

Guideline Text

“Switching between Manual Access Mode and Automatic Access Mode must be smooth and manual carrier hand-off must be safe. Production equipment must have the capability of handshaking during manual carrier hand-off in a manner similar to automated hand-off. In the manual handshaking procedure, the equipment must provide a simple input method of manual hand-off completion.”

Interpretation

An example of handshaking is shown in figure 3.14. This example includes the sequential operation of carrier loading on the empty carrier, carrier ID reading, and carrier unloading after the completion of processing. For AMHS operation case, carrier loading and unloading are performed with E84 standardized handshaking. The equipment is notified its hand-off completion by E84 sequence completion. For manual operation case, an operator loads the carrier on the load port and indicates the completion of loading to the equipment using operation panel. After processing, an operator removes the carrier on the load port and indicates the completion of unloading to the equipment in the same manner. Switching between Manual Access Mode and Automatic Access Mode is performed by easy operation mechanism such as operation panel.

Figure 3.14 Example of the Equivalent Handshaking Sequence
3.3.3 **Software-Based Interlocking to Prevent Simultaneous OHT and PGV Operation**

Refer to section 3.3.1 for further details.

**Guideline Text**

“A software-based interlock between the PGV/operator handling and OHT equipment must exist to prevent simultaneous access of the same load port to enhance human safety and prevent product damage. Production equipment and stockers should comprehend the access mode and decide whether it should be accessed by the OHT or PGV/operator handling. Based on the decision, the production equipment and stockers must reject all other requests other than the authorized mode.”

3.3.4 **Independent Control of Material Handling and Wafer Processing**

**Background and User Requirements**

The material handling and the wafer processing will be highly automated in 300 mm production lines. Neither the material handling nor wafer processing equipment can be operated automatically at all times. To be completely automated is the final goal of a production line, and the start up of a production line, which contains AMHS, the production equipment, and the Host system has to pass through several phases. A product to be manufactured also has to pass through several phases from making a prototype to the mass production. The operation level of the material handling and the wafer processing depends on those phases.

The possible phases are as follows:

- Start up the production equipment while AMHS is not started up, at the start up of a production line, start the production.
- Introduce a new production equipment to a running automated production line, and start up the equipment while AMHS is in operation.
- Supply a running automated production line with a pilot lot whose processing conditions are not yet determined.
- AMHS fails in a running automated production line, and materials cannot be transported automatically.

The conditions described above is summarized in Table 3.1.

<table>
<thead>
<tr>
<th>Material Handling</th>
<th>Wafer Processing (Who sets the processing condition?)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMHS</td>
<td>Host</td>
<td>Normal production</td>
</tr>
<tr>
<td>Operator</td>
<td>Host</td>
<td>AMHS being started up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AMHS failed</td>
</tr>
<tr>
<td>AMHS</td>
<td>Operator</td>
<td>Production equipment being started up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pilot lot (with processing condition undetermined) supplied</td>
</tr>
<tr>
<td>Operator</td>
<td>Operator</td>
<td>HOST system not in operation</td>
</tr>
</tbody>
</table>

**User Requirements**

With the background described above, the material handling capability and the wafer processing capability must be separated in the production equipment. It is necessary that each of the material handling capability and the wafer processing capability should be able to choose to operate automatically or manually.

**Guideline Text**

3.4 **Independent Control of Material Handling and Wafer Processing**

“Effective manufacturing in 300 mm factories requires the use of AMHS material delivery to production equipment even when the production equipment is operated by the operator. Therefore, production equipment must support automated and manual material handling interactions independent of wafer processing and measurement operations.”
REQUIREMENTS:  
11.3 Factory Automation (FA)
12 Cutting the time necessary to start the mass production

STANDARDS:  
We request SEMI to develop a new standard for the implementation of these guidelines

REFERENCES:  
None

RECOMMENDATIONS:  
E15.1 The control with the interlock needs to be developed to avoid the collision between a carrier transferred manually on a load port and another carrier transferred automatically by the equipment.

---

**Figure 3.15**  *Example of Independent Control of Equipment, Material Handling, and Wafer Processing*

**Guideline Interpretation**

(1) **Breakdown of Requirements for Production Equipment**

The production equipment shall satisfy the following items when it is connected to the Host and in the GEM On-Line state:

The equipment shall be able to switch at any time between automatic material handling and manual material handling independent of wafer processing. The access mode details are specified in GJG 3.1.

Independent of the material handling, the conditions for processing wafers can be set in the equipment remotely by HOST and locally by the operator via the operation panel of the equipment. The conditions set remotely by Host may be changed locally by the operator via the operation panel of the equipment.

(2) **Avoidance of Collision of Carriers in Equipment with Internal Buffer**

The equipment with the internal buffer transfers carriers between the load port and the internal buffer. A collision occurs if the operator transfers a carrier to the load port to which the equipment is unloading another carrier from the internal buffer. The equipment shall provide the interlock mechanism to avoid the collision of carriers. The carrier transfer control of the equipment with the internal buffer is specified in GJG 3.6.

(3) **Connection between Host and Equipment**

The Host and equipment are physically connected by a single communication line as is specified in GJG 1.1. However, it is desired that the material handling capability and the wafer processing capability shall be clearly separated in both the Host and the equipment and be implemented so that the relationship between these capabilities are loose. This concept is modeled in Figure 3.14.
As for the above model, the following items are required by GJG:

- Unified communication link (GJG 1.1)
- Compliance with the communication standards (GJG 1.2)

Action required for SEMI to develop methods to implement the above items as standards.

Prerequisites and Restrictions

(1) EFEM and Material Handling Capability

In principle, it is desirable that the material handling capability of the production equipment should be integrated physically in EFEM. But it’s not possible for all the equipment. The physical boundaries between the equipment and EFEM may be unclear. The independence of the material handling and the wafer processing is discussed in terms of the logical control only.

(2) Manual Wafer Processing

It is required that the operator should be able to perform the operations similar to those in OFFLINE such as processing a pilot wafer and conditioning even when the material handling is performed automatically.

3.3.5 Processing Order Control for Equipment Buffer

Below, a Guideline application for production equipment with fixed or internal buffer is described. These are only examples of the concept as the details relating to sequencing and timing are being examined by SEMI. First, the guideline to achieve Quick Turn Around Time (QTAT) is described along with operational examples.

Guideline Text

“The order of processing for a carrier or batch in the equipment buffer is independent of the order of its delivery. Production equipment must be able to set and change the order of processing as directed by the host and the operator interface. Equipment must always maintain the association between a carrier or batch and its processing instructions. This capability is especially important for supporting QTAT (Quick Turn Around Time) for a hot lot by putting it at the top of the order.”

(1) 2-port Type Fixed Buffer Production Equipment

For continuous wafer processing, production equipment should have at least two load ports; one load port for a carrier with wafers in process, and one load port open for exchange between carriers with processed wafers, and carriers with wafers to be processed. In this case, under normal circumstances, once the lot in process has finished, the carrier buffered on the other load port will immediately begin processing. However, to accommodate priority lots (hot lots), the lot buffered for processing may be preempted and processing put on hold such that the hot lot may begin processing once the lot in process has finished and the hot lot taken its place on the equipment load port. The sequence capability of intended by the Guideline is described below.
In Figure 3.17, frame 1 considers a regular production lot (A) in process with the arrival of a hot lot (C). Another regular production lot (B) is queued and awaiting processing. In frame 2, the buffered production lot (B) is put on hold while the lot which has just finished processing (A) is exchanged with the hot lot (C). Finally in frame 3, the hot lot (C) skips ahead of the queued production lot (B) and begins processing. This is the desired method to manage logical and physical queues on fixed buffer production equipment to achieve preemptive prioritization of processing due to hot lots or other circumstances.

(2) 3-port Type Fixed Buffer Production Equipment

For a three load port fixed buffer production equipment, the process sequence is described below. In this case, both the first two load port positions are occupied, while the third load port has not been filled.

Figure 3.18  Three Port Production Equipment Process Queue Interrupt

In Figure 3.18, frame 1 considers a regular production lot (A) in process with the arrival of a hot lot (C). Another regular production lot (B) is queued and awaiting processing on the production load port, while the hot lot (C) arrives and is delivered to the third load port. In frame 2, the buffered production lot (B) is put on hold for processing and preempted (as shown in frame 3) by the hot lot (C).
There may be situations depending on factory applications (operations) that require internal buffer type equipment with multiple carriers to manage a hot lot request for a carrier which has already been delivered into the internal buffer. The process sequence for this case is described below.

![Diagram of process queue interrupt for internal buffer equipment]

**Figure 3.19 Process Queue Interrupt for Internal Buffer Equipment**

In Figure 3.19, frame 1 considers a regular production lot (A) in process with another lot (B) also inside the equipment buffer, which is queued to start process next. Frame 2 represents a process order change made between lots in the internal buffer, where a hot lot (C) preempts the queued production lot (B) and begins processing as soon as the current lot (A) finishes processing. This is the desired method to manage logical and physical queues on internal buffer production equipment to achieve preemptive prioritization of processing due to hot lots or other circumstances.

### 3.3.6 Carrier Transfer Control of Internal Buffer Equipment

**Background and Users’ Requirements**

Some of process equipment have a mechanism of storing carriers internally in addition to a load port. They are called the internal buffer equipment. In the internal buffer equipment, the internal buffer is used as the pre-process and post-process buffer to reduce the speed and the batch-size diversity between the carrier transfer outside and internal process. It is also used in some type of process equipment as a stocker where non-product wafers (such as test wafers and dummy wafers) are stored.

The internal buffer equipment usually operates in the following sequence. A carrier loaded in a load port is stored in the internal buffer. The process start command initiates to move the carrier to the FIMS port and takes wafers out of the carrier. The process end initiates to put the wafers back to the carrier on the FIMS port and puts the carrier back to the internal buffer. The carrier is moved out to the load port and transferred to the external of the equipment.
It is expected that a future production line will produce a variety of mixed products. It requires more precise production control, which implies that the host system must be able to control and reduce the need for operator intervention on process equipment.

Loading/unloading of carriers between a load port and the internal buffer of the process equipment shall also be under the total control of the host because the internal buffer is considered to be a part of the buffer in a production line. Examples of host controlled items include, decision about the order of execution of loading/unloading including the automated loading/unloading, the decision about the order of unloading of processed carriers in the batch type equipment, and, when carriers for storing non-product wafers are transferred automatically, the commands to load/unload those carriers.

According to the background described above, the host should be able to control the carrier movement such as carrier in or carrier out between a load port and the internal buffer in the internal buffer equipment. However, intervention by operators is anticipated even though the circumstances would be highly controllable by the host. Therefore, we need to consider mixed situation with Automatic and Manually.

Guideline Text
3.6 Carrier Transfer Control of Internal Buffer Equipment

The internal buffer equipment shall provide standard carrier movement commands (which are sent from the host to the equipment) in order to implement a consistent carrier movement. When the carrier movement is controlled by the host, the carrier movement shall be controlled through the standard carrier movement commands, and the carrier movement between the internal buffer and a load port shall be under the control of the host unless ordered otherwise by the host, or the operator through the operator interface.

Interpretation
1) Carrier Movement Commands Sent from Host
The internal buffer equipment shall provide at least the following carrier movement commands so that the host can move carriers:
   – the command to move in a carrier from a load port to the internal buffer
   – the command to move out a carrier from the internal buffer to a load port

2) Consistent Carrier Movement by Host
In this guideline, it is assumed that carriers are moved at the direction of the host, or the operator through the operator interface. The internal buffer equipment is required to execute the consistent movement of carriers without fail at the direction of the host. That is, a carrier movement command sent by the operator must be rejected when the carrier movement is under the control of the host. The equipment shall have modes of identifying if the carrier...
movement is currently controlled by the host or by the operator. Additionally the host, or the operator through the operator interface, can switch the mode. It is particularly requested that the equipment shall provide a host command to switch the host control mode to the operator control mode.

Preconditions and Restrictions
Carrier movement is executed at the direction of the host, or the operator through the operator interface.

3.3.7 Internal Buffer Capacity Notification

Background and User Requirements
In a 300 mm production line, the host may control the movement of carriers between the internal buffer of the internal buffer equipment and a load port. In that case, it is necessary for the host to know how much capacity is currently available since the internal buffer must have a certain amount of available capacity when a carrier is loaded in from the external.

Guideline Text

3.7 Internal Buffer Capacity Notification
The internal buffer equipment shall report to the host the available capacity of the buffer at the request of the host and when the amount of the available capacity changes.

Interpretation
The following scenario is an example of carrier movement.

![Figure 3.21 Example of Scenario of Carrier Movement](image)

Precondition and Restrictions
Since some type of the internal buffer equipment requires non-product wafers, it is necessary to logically allot the capacity of the internal buffer for uses.

3.3.8 FOUP Open and Close Notification

Background
Use of Front Opening Unified Pods (FOUP) is widely planned by many IC manufacturers for their first 300 mm factories for contamination and cost reduction reasons. This poses many new hurdles with respect to equipment control since most of these companies used open cassette for their 200 mm factories. To facilitate this transition, IC
manufacturers have defined some minimum capabilities for production equipment to ensure control and notification of status for FOUPs are properly distributed within the factory.

**Motivation and General Requirements**

In a mini-environment based factory, the chance for contaminating wafers is much greater without a well-defined and executed model of control. This guideline is intended to clarify responsibility for control of FOUPs while they are at the production equipment. Using sensors and a well defined state model, the factory equipment is the best source to determine when it is safe to open and close FOUPs after receiving high level processing instructions from the host or operator. Another aspect is that the host system needs specific event triggers to ensure that it properly integrates production equipment control and material handling. Therefore, knowledge of when FOUPs are opened and closed can be crucial for factory scheduling and coordination at the host system level. Therefore, equipment must be capable of sending event notifications per GEM specifications. Actual enabling of these GEM events and any specific GEM reports associated with them will be managed by each IC manufacturer. The guideline is shown below.

**Guideline Text**

“Production equipment that supports FOUP must control FOUP opening and closing and have the capability to send corresponding event notification to the host through standard event messages. This does not apply to equipment that supports open cassette carrier interfaces only.”

### 3.4 Production Equipment Material Management Guidelines

This section focuses on specific guidance production equipment material management including wafer level control.

#### 3.4.1 Slot Number and Load Port Number Assignment

**Background and Motivation**

In 200 mm, each equipment supplier numbered both slots and load ports without any standard. An effect to this lack of standardization was the requirement that host systems interfacing to equipment often used different numbering schemes to address slots and ports, which increases software complexity. For 300 mm, this numbering is now well defined through this guideline and will be consistently implemented into standards requiring a slot or load port numbering scheme. The guideline text is described below.

**Guideline Text**

“A slot number for each carrier must be assigned incrementally from the bottom, starting with “1.” Load port number must be assigned incrementally from the left facing to equipment front, starting with “1.””

**Implementation Example**

Figure 3.22 shows how wafer slots and load ports should be numbered. For wafer slots, numbering starts at 1 from the bottom of the carrier and increases sequentially. For load ports, numbering starts at the lower left and increases sequentially toward the right.
3.4.2 Empty Carrier Management

Background and Motivation

300 mm factories will have an increased level of automation due to the large size and weight of the wafer carriers. The need for efficiency in wafer and carrier handling is therefore increased. Therefore, reducing the number of carrier movements is critical. The total number of carrier movements the AMHS is required to make is drastically reduced when the production equipment is responsible for managing empty carriers, after the wafers have been removed for processing.

Guideline Text

“All carriers that are at the E15.1 load port or within an internal buffer must be managed by the production equipment. The production equipment is responsible for managing and storing the empty carrier while its associated wafers are being processed.”

Interpretation

All production equipment must manage all carriers at the load port or in an internal buffer. This includes both empty carriers and carriers containing wafers. Management of a carrier includes understanding of the carrier location, identification of the use of the carrier, and ability to return the wafers that were removed from the carrier when required.

3.4.3 Carrier Slot Verification

Background and Motivation

With the high cost of 300 mm wafers, it is necessary to add more checks and verifications in the factory operation to detect and identify problems at the earliest possible moment. One place to check for problems is when a carrier arrives at equipment and before any processing occurs. Carrier slot verification compares an actual scan of the carrier to determine which slots contain wafers with a map of wafers in slots maintained by the host. The comparison may be done either by the host or the equipment. If there is a discrepancy in the carrier from the map stored on the host, then processing on that carrier will be stopped until the difference is reconciled. This test will identify missing or broken wafers and will assist with preventing misprocessing of wafers.

Guideline Text

“Prior to processing wafers, production equipment must have the capability to detect which slots within a carrier have wafers. This information is used to verify the carrier/slot map.”
3.4.4 Host Control of Wafer Process Order

Background and Motivation

Host control of the wafer processing order in one of the capabilities required in order to have precise control of the equipment and process and improve production equipment processing efficiency. This capability supports many different operational scenarios:

1) Multiple lots in a carrier
2) Processing of specific wafers within a carrier for equipment and process qualification
3) Randomization of processing order to aid in problem detection and resolution
4) Extraction processing at inspection equipment
5) General equipment and processing IC manufacturer

Guideline Text

“Single wafer production equipment must be able to process some or all of the wafers in a carrier as specified by both the host and the operator interface. Single wafer process equipment must be able to process wafers based on an order specified by both the host and the operator interface.”

Implementation Example

Figure 3.23 shows two examples. In the left most example, the process order is randomized to facilitate an experiment to understand equipment or process issues. In the right most example, a metrology or inspection tool is taking samples of specific wafers within a carrier for measurement. In this case, not all wafers must be checked for throughput and cycle time reasons, however selecting specific wafers for test gives greater control over the sampling.

3.4.5 Slot and Carrier Integrity

Background

To achieve a safe and highly productive factory, 300 mm is projected to use a much greater percentage of intrabay AMHS transport to move lot carriers from equipment to equipment. Many IC manufacturers are planning for 100% intrabay for 300 mm factories running at high volume after pilot line and process technology development.

Equipment configuration is an important factor to allow IC manufacturers to implement a high percentage of automated material delivery to production equipment in 300 mm. One of the more important capabilities to support highly productive manufacturing is for equipment to load wafers to and from the same slot in the same carrier to maintain wafer slot-to-slot integrity. The guideline is described below.
Guideline Text

“Production equipment must have the minimum capability of loading wafers to and from the same slot in the same carrier to maintain wafer slot-to-slot integrity. If slot integrity is lost, the equipment will send an event message to the host. Wafer sorters or equipment that splits lots into multiple carriers by design are an exception to the slot-to-slot and carrier integrity.”

General Requirements

The guideline requires several production equipment capabilities. The first core capability is that the wafer handling robot within the production equipment must be able to load and unload wafers to each slot within a carrier. Next, the equipment must be able to coordinate moving preprocessed wafers out of their slot within the carrier and return post processed wafers back to their original slot within the carrier. This is shown in the figure below.

![Example of Wafer Flow Within a Plasma Etcher](image1)

**Figure 3.24** Example of Wafer Flow Within a Plasma Etcher

Finally, when the equipment is not able to return a post processed wafer back to its original slot within the carrier, it should send an event message to the host indicating that an error in slot to carrier integrity has occurred. An example of an error might be the detection of another wafer in the carrier slot that the wafer handling robot wants to place a post processed wafer. In this case, the equipment cannot return the wafer to its original slot because it would result in a wafer collision and lost of product. Therefore it would send an event message to the host indicating the failure and enter an error state. Figure 3.25 illustrates this.

![Event Notification Due to Slot/Integrity Error](image2)

**Figure 3.25** Event Notification Due to Slot/Integrity Error

Note that there are some equipment that are not designed to have slot to carrier integrity such as wafer sorters or equipment that measure wafers and deposit bad wafers into a separate scrap carrier. In these cases, this requirement is waived. IC manufacturers will specify the types of equipment that fall into this category to equipment suppliers.
Motivation

There are 2 primary reasons to support Slot and Carrier Integrity in a 300 mm factory, which are described below.

(1) Reduced equipment cost and footprint for lot buffering

One key to a highly productive 300 mm factory is to ensure its equipment runs non-stop and is highly utilized. To help ensure continuous processing, lot buffering for process and high use metrology equipment is required. Minimum buffering is 1+1 which means that there is 1 lot processing while 1 buffer lot is at the equipment and ready to process when the first lot finishes.

With slot to carrier integrity where the same carrier is used to hold the preprocessed and post processed wafers at equipment, this minimum buffering requirement means that there will be 2 load ports for single wafer process equipment. When a separate send and receive carrier are used, this doubles the required load port positions to meet the same minimum 2 lot buffer. This is because the equipment must now have a position for a source carrier and a destination carrier for each lot processed. Additional load ports directly add to the equipment cost and also increase the footprint that the equipment occupies within a factory. In the case of narrow equipment, this extra footprint also means that less equipment can be installed into the factory, thereby severely impacting overall factory productivity.

Figure 3.26 shows a comparison between equipment, A, without slot to carrier integrity (top of the figure) and equipment, B, with slot to carrier integrity. Equipment A requires more complex design to accommodate the extra width required to have 4 carrier stations instead of 2. This results in additional footprint and allows Equipment B to have 1.5x the number of tools within the same width at a smaller depth. This is a major motivation to having slot and carrier integrity.

(2) Reduction in material handling costs and risk

Other sections of this document describe in detail IC manufacturers’ direction in the area of material handling. In summary, a 300 mm is expected to use large amounts of intrabay material handling to safely and cost effectively move material from equipment to equipment. When equipment is configured to use separate send and receive carries, this means that AMHS transport equipment must move not only full carriers, but also handle empty carriers. This actually doubles the amount of movement required from the AMHS transport. For low to medium throughput bays, this can as much as double the number of AGV or OHT vehicles used to move wafers, thereby increasing IC manufacturer costs. For high throughput bays, simulation studies by I300I have shown that current AMHS equipment
is not capable meeting the delivery requirements for certain bay configurations. From a cost reduction and risk perspective, slot to carrier integrity is crucial to the conversion.

### 3.4.6 Additional Wafer Control after Processing or Measurement

#### Background and Motivation

In order to improve efficiency of equipment and the manufacturing operation, some equipment will need to have the capability to redirect wafers to different slots and/or carriers. This capability may be used to support handling of test wafers and non-product wafers, support swapping of carriers and support the extraction processing of inspection equipment.

#### Implementation Example

Figure 3.26 shows an example of how this capability might be used. A source carrier, A, is placed at load port 1 and an empty carrier, B, is placed at load port 2. A single wafer is processed from Carrier A and the equipment is instructed to move this into a specific slot within carrier B. Carrier B with the single wafer is then sent to an inspection station. Once the results are understood, the remaining wafers in Carrier A can be processed with the wafers returning into the same slot within Carrier A after processing is complete. Carrier B’s wafer is merged with carrier A’s wafers at a lot sorter later.

*Figure 3.27 Send Ahead Wafer Example*

**Guideline Text**

“In addition to the minimum slot and carrier integrity capability, specific single wafer production equipment must be able to output wafers to a specific slot in a specific carrier different than the one from which it was taken.”

### 3.4.7 Multi-Module Wafer Tracking Events

#### Background and Motivation

A 300 mm wafer is very expensive, so there is a need to have precise and accurate information concerning the location of the wafer, the time that a wafer is at a location, the condition of the wafer and what is being done to the wafer. All equipment should be able to report information about each wafer while the wafer is in or under control of the equipment. This information will be used to identify and solve equipment and process problems, allowing the IC manufacturer to improve both product yield and equipment productivity. The guideline text is shown below.

**Guideline Text**

“Multi-module single wafer processing equipment must track the movement of each wafer through the modules and report this information to the host. The equipment must be capable of associating data collected at a module with the wafer being processed at that module.”

#### Current Standardization Activities

A SEMI task force is currently working to improve the SEMI standards for tracking wafer-related events. A key standard is Specification for Substrate Tracking, SEMI E90.
3.5 Production Equipment Single Wafer Control Guidelines

This section focuses on specific guidance for production equipment process control.

3.5.1 Recipe and Variable Parameter Control

User Requirements and Background

Since the development and manufacturing of 300 mm wafers require more improvement of the productivity and the development efficiency, processes must be controlled and managed on the wafer level. It is also expected that on a device development line where TAT is important and on a mass production line of custom LSI, the number of wafers which compose a single lot will be less than 25, and will ultimately be only one.

In order to improve the productivity of the equipment, a carrier may contain several lots with different processing conditions and be loaded on the equipment. It is also desirable to maintain more stable control over the process equipment is even when a carrier contains lots of only a single type. Therefore, it is necessary that the equipment should be able to set the processing conditions for each wafer and execute the process.

2) Purpose

With the background described above, the process equipment should have the capability to allow the host to set different processing conditions for each wafer and to execute the processing so that a single carrier can contain several lots/wafers with different processing conditions.

2. GUIDELINES

5.1 Recipe and Variable Parameter Change Between Wafers

In the 300 mm wafer manufacturing, the process control and management on the wafer level is required to improve the productivity, the development speed, and the precision of process control. In order to implement this requirement while satisfying the cost effectiveness, the single wafer process equipment should be able to set either of recipes or variable parameters or both of them, which vary among wafer groups in a single carrier using a standardized method. Implementation of this requirement requires the standardization of the concept, the state models, and the communication interfaces.

REQUIREMENTS: 3. International participation is essential.
9. Improvement of the distribution system and the controllability over production plans of the factory
11.3 Factory Automation (FA)

STANDARDS: SEMI E5, SEMI E94
We request SEMI to create a new standard.

REFERENCES: I300I Factory Guideline 2.13

NOTE: The word of recipe used in this document is a generic term and may contain process programs. (A process program is a kind of recipe as defined in E5, E30, and E42.)

☐ Mixed lot in small size lot production
☐ Process Development and Conditioning

Lot 3
Recipe 3
Lot 2
Recipe 2
Lot 1
Recipe 1

Figure 3.28 Recipe and Variable Parameter Change Between Wafers
5.2 Variable Parameter Change Between Wafers

The single wafer process equipment may optionally have to support the variable parameter change by the host while it is running. A standardized method should be adopted to implement this capability.

REQUIREMENTS:  
3. International participation is essential.  
11.3 Factory Automation (FA)

STANDARDS:  
SEMI E5  
We request SEMI to create a new standard.

REFERENCES:  
I300I Factory Guideline 2.13

Figure 3.29 Variable Parameter Change Between Wafers

3. INTERPRETATION

1) Recipe and Variable Parameter Change Between Wafers

It will be necessary for a single carrier to contain several lots with different processing conditions in order to improve the productivity and the development efficiency in the 300 mm wafer manufacturing. The single wafer process equipment should have the capability to set either recipes or variable parameters or both between wafers. These processing conditions will be set at the request of the host.

2) Variable Parameter Change Between Wafers

The single wafer process equipment may optionally have to support the capability to modify variable parameters for each wafer of a lot currently processed at the request of the host in order to achieve the more precise control over a process. When variable parameters can be modified depends on the location of a wafer (such as in the carrier on the load port or in the process chamber) and the condition of a wafer (such as the setting of the processing conditions for the wafer is completed or not) in the equipment, and may vary among the equipment types. But in any case, a standardized method must be adopted to implement this capability.

3) Operation Scenario

In the normal operation, the processing conditions are set by the host prior to the process start. But in the 300 mm wafer manufacturing, there may be a case where variable parameters for a lot being processed should be modified by the host in order to control the process more precisely.

4. PRECONDITIONS AND RESTRICTIONS

(1) As is shown in Guideline 1.1, the process equipment is connected to the host via a single physical communication line and is controlled through the directions of the host.

(2) The processing conditions for a wafer are set with the recipe ID and variable parameters.
3.6 AMHS Equipment Guidelines

This section focuses on specific guidance for AMHS equipment and host systems.

3.6.1 Interoperable AMHS Equipment (Interbay and Intrabay) or AMHS Framework

User Requirements and Background

Simply stated, the role of AMHS in a 300 mm wafer fabrication factory is to remove post-process material from, and deliver pre-process material to, factory production equipment. This concept is illustrated in Figure 3.30. The final implementation of this system, however, has proven to be both costly and complex due to varying user requirements and the custom nature of current AMHS.

In a semiconductor factory, the processing batch size and the processing time of the source production equipment differ from those of the destination production equipment. For example, an etcher processes wafers one at a time from a single carrier, while a diffusion furnace processes multiple wafers from multiple carriers all at once. It is because of these differing source and destination production equipment characteristics that the temporary storage capability of a Stocker is the first requirement of the AMHS. In order to automatically transfer wafer carriers between these Stockers, it is necessary to link such Stockers with a transport system known as the Interbay Transport system. Furthermore, in order to realize the ultimate AMHS requirement of automatic pickup and delivery of wafer carriers to and from production equipment, a second type of transport system is required to link Stockers and production equipment, known as the Intrabay Transport system. Typically, a single transportation system cannot fulfill the roles of both Interbay and Intrabay transport due to differing throughput and layout requirements placed on each functionality. It is for this reason that a distinction has been made between Interbay and Intrabay Transport systems.

Historically, 200 mm AMHS has been most commonly used for automated storage using Stockers and Interbay transfer between Stockers throughout a factory. These Interbay Transport systems and Stockers have been implemented either as stand alone factory systems or integrated in a custom fashion with the factory host system depending upon user requirements. Intrabay Transport and overall AMHS integration has been used inconsistently in 200 mm wafer fabrication factories by different device manufacturers due primarily to differing user requirements and the custom nature of current AMHS. It is for these reasons that current AMHS implementations are costly, complex, and vary greatly in their capabilities and integration to other factory systems on an implementation by implementation basis.

300 mm wafer fabrication factories will continue to require the baseline capabilities of Stocker storage and Interbay Transport. In addition to these baseline capabilities, Intrabay Transport will be added as a result of ergonomic and safety requirements brought about by the increased size and weight of 300 mm wafer carriers. These Stocker, Interbay Transport, and Intrabay Transport systems will be required to be fully integrated with each other and the factory Host system in the 300 mm wafer fabrication factory in order to realize the full vision of cost effective automated carrier transfer to and from production equipment.
Purposes

The first purpose of Interoperable AMHS is to allow device manufacturers to optimize AMHS equipment selections on a bay by bay basis best suited for realizing throughput requirements, layout flexibility, and cost effectiveness, as illustrated by Figure 3.31. For example, a device manufacturer may require RGV (Rail Guided Vehicle) implementations in high throughput bays at the cost of layout and operator flexibility. However, in other bays, AGV (Automatic Guided Vehicle) or OHT (Overhead Hoist Transport) implementations may be required depending on the characteristics of each bay. It is for this reason that the standardization of AMHS hardware and software interfaces is required in order to facilitate the selection and integration of different AMHS equipment types in different bays.

Figure 3.31 Optimal AMHS Configurations on a Bay-by-Bay Basis

The second purpose of these guidelines is to allow AMHS reconfiguration in a cost and time effective manner in response to changing wafer fabrication requirements. It is rare that a wafer fabrication factory completes its life cycle
without changing layout and throughput requirements many times along the way. If factory requirements are modified significantly, AMHS components such as RGV, OHT, and Stockers may require reconfiguration or replacement in order to meet new product line or layout requirements (see Figure 3.31 and Figure 3.32). It is for this reason that the standardization of AMHS hardware and software interfaces is required in order to facilitate the replacement of Interbay, Intrabay, and Stocker AMHS.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Model Product : DRAM</td>
<td>Model Product : ASIC</td>
</tr>
<tr>
<td>Mfg Volume : 20 lot/day</td>
<td>Mfg Volume : 40 lot/day</td>
</tr>
</tbody>
</table>

Figure 3.32  Easily Replaceable AMHS Equipment

The third purpose of AMHS Interoperability is to improve overall system reliability and cost effectiveness of AMHS integration by eliminating custom software development for both users and AMHS suppliers. Currently, the boundary between factory HOST systems and AMHS components depends upon device manufactures specific requirements. This results in custom software interface development for both AMHS suppliers and users, which leads to decreased reliability and high overall cost of the integrated AMHS. A clear boundary, standardized message sets, and standardized state models are required between the Host and AMHS components in order to eliminate custom software development and improve integrated reliability and cost effectiveness of 300 mm AMHS.

Figure 3.33  Standard AMHS Software Interfaces – Physical View
Device manufactures expect that all AMHS equipment will conform to the AMHS Interoperability guidelines and standards during the first generation of 300 mm AMHS equipment. In other words, users expect to purchase AMHS equipment, which complies with the AMHS Interoperability SEMI standards from their first equipment order.

**Guideline Text**

6.1 Interoperable AMHS Equipment (Interbay and Intrabay)

IC manufacturers want to ensure the optimal AMHS solution for the overall factory to realize desired bay throughput, layout flexibility, and cost effectiveness. 300 mm factories require the combination of different types of AMHS components from different suppliers to meet different material handling requirements. Standard communication protocols, state models, and interfaces are required to achieve these goals.

**REQUIREMENTS:**
3. International participation is essential.
9. Increased control of factory logistics and production scheduling
11. Factory Automation (FA)

**STANDARDS:**
SEMI E5, E30, E37, E37.1, E84, Doc 2878. Action required for SEMI to develop Specific Equipment Models (SEMs) for Intrabay transport, Interbay transport, and Stockers. Action required for SEMI to develop communication interfaces and hardware interfaces between stockers and interbay transport systems.

**REFERENCES:**
I300I Factory Guideline 2.13

**RECOMMENDATIONS:** AMHS equipment suppliers should be involved in the standards development.

![AMHS Interoperability](image-url)
Guideline Text

6.2 AMHS Framework

Semiconductor factories that have AMHS require an integration software system to realize automated material movement. The AMHS Integration System must be interoperable with AMHS Equipment Controller and Host Systems from different suppliers. In order to achieve this goal, the AMHS Integration System must conform to standard communication protocols, state models and interfaces. This includes coordination and integration of AMHS Equipment as well as integration with the Factory Host systems.

**REQUIREMENTS:**
3. International participation is essential.
9. Increased control of factory logistics and production scheduling
11.3 Factory Automation (FA)

**STANDARDS:**
SEMI E5, E30, E37, E37.1, E81, E82, E88, E96, Doc 2824A Action required for SEMI to develop standard communication interfaces between AMHS Integration Systems and Host System software layers.

**REFERENCES:**
None

**RECOMMENDATIONS:**
The minimum recommended functionality of the AMHS Integration System is to determine AMHS routes and issue transfer commands to the AMHS Equipment. AMHS Equipment Suppliers, AMHS Integration System suppliers and Host System suppliers should be involved in the standard’s development.

**Interpretation**

1) AMHS Framework

A baseline requirement of Interoperable AMHS equipment is efficient integration with the host system. The purpose of the AMHS Framework is to realize cost effective integration of the Interoperable AMHS. Once standard interfaces and state models of the Interbay Transport, Intrabay Transport, and Stocker systems have been defined through SEMI standards, an additional standard must be defined which specifies the minimum functionality of the AMHS Integration system and its interface to the factory Host System. This standard will eliminate custom interface requirements for both the AMHS supplier and device manufacturer communities, and facilitate cost effective integration of AMHS equipment into 300 mm wafer manufacturing factories.

The AMHS Framework guideline requires that an additional software standard be developed for the AMHS Integration system, which specifies its minimum functionality requirements and interface to the factory Host System, as illustrated in Figure 3.34. This figure depicts a 3 tiered approach to AMHS integration as follows.

The top layer is representative of the factory Host system, which is responsible for logical lot progress though the processing flow, equipment control, and lot dispatching or scheduling to and from production equipment. It is noted that these capabilities may be partitioned into several discrete modules depending upon user requirements, but are collectively labeled as the Host System because they are not the focus of AMHS Framework effort.
The bottom layer is representative of the AMHS Interbay Transport, Interbay Transport, and Stocker system controllers as described in the Interoperable AMHS discussion. These distinctions have been made in order to achieve the goals related to GJG guideline 6.1. Currently, SEMI standards are being defined for the Interbay Transport system through the Transport System Specific Equipment Model (TSSEM), the Intrabay Transport System through the Intrabay Transport Specific Equipment Model (IBSEM), and Stocker System through the Stocker Specific Equipment Model (Stocker SEM). These standards will ensure Interoperable AMHS equipment software interfaces and state models.

(1) A Macro transfer request is received from the Host System:
   \[ \text{Carrier: Carrier A} \]
   \[ \text{Src: Pro. Eq. 1} \]
   \[ \text{Dest: Stocker 2} \]

(2) The AMHS Route is determined by the AMHS Integration System:

\[ \text{Pro. Eq. 1} \rightarrow \text{AGV 1} \rightarrow \text{Stocker 1} \rightarrow \text{OHS 2} \rightarrow \text{Stocker 2} \]
The middle layer is representative of the focus of this guideline, the AMHS Integration System. The minimum functionality of this software layer is to determine wafer carrier routes through the AMHS, and issue Transfer commands per the SEMI Specific Equipment Models to the Interbay Transport, Intrabay Transport, and Stocker systems. An AMHS Route is defined as the Material’s path between AMHS equipment and/or production equipment loadports, and is illustrated in Figure 3.36. A Transport Command is defined as a command issued to move material within AMHS equipment, and is illustrated in Figure 3.37.

In order for the benefits of the AMHS Integration System to be realized, a SEMI standard must be defined that specifies these minimum capabilities and the interface to the factory Host System.

**Figure 3.37** Transfer Command Example

Transfer Operation Scenarios

Figure 3.37 illustrates an example of a fully integrated scenario for a wafer carrier transfer operation including the exchange of information between logical layers of the AMHS Framework. A brief explanation is described below.

**Figure 3.38** Integrated AMHS Framework Scenario Example
Upon process completion of a lot (Process Job Comp.), the supervisor (Host System) selects the next lot to be processed on the production equipment. The Host System then instructs the production equipment to prepare for processing, and sends a command to the integrator (AMHS Integrator) for the entire wafer carrier transfer operation (Macro CMD). The AMHS Integration System determines the AMHS route for the wafer carrier, and commands and coordinates each piece of AMHS equipment through Transfer Commands in order for the carrier to reach its ultimate destination of the production equipment. The AMHS Integration System also coordinates delivery to the production equipment loadport through coordination with the Host System. When the entire wafer carrier transfer operation has been completed (Comp), the Host System initiates processing of the lot (Process Job Start CMD).

**Prerequisites and Restrictions**

1. **Units of AMHS**

The individual units of the AMHS are illustrated in Figure 3.38. This figure illustrates a typical bay which is composed of the production equipment, the Intrabay Transport equipment, and Stockers which are the interface between bays. Bays are connected via the Interbay Transport equipment. The AMHS is made up of these pieces of equipment excluding the production equipment.

**Figure 3.39 AMHS Units**
3.7  Factory Systems Guidelines

3.7.1  AMHS Framework

Background, User Demand

Most of the production systems in semiconductor manufacturing plants in operation presently are developed independently by device makers. Although packaged systems are available commercially, it is not possible to construct a factory system with only these parts. Therefore, device makers have no choice but to separately develop machines which are identical among device makers, thus resulting in a waste of time and resources.

With the increase in caliber of the 300 mm process, automatic transportation and leaf control have become a necessity. As a result, investment in development expenditure has shot up. To cut down on such investment expenditure, device makers have chosen to cooperate by standardizing their demands, which then allows for joint development in fields that are non-competitive. AMHS equipment as well as factory system functionality and interface, which are follow-ups from production equipment, have come into attention as targets for standardization.

As factory system covers a very wide scope, it is necessary to consider each component separately when attempting standardization. Therefore the role, function and interface of each component must be standardized, and software for factory systems supplied by different suppliers must be interoperable.

The following are some requisites for components of the 300 mm factory system.

- AMHS equipment integration component-- In order to standardize individual AMHS equipment as well as their interfaces, suitable components are required of the factory systems.
- Production equipment online connection component-- To standardize interface of production equipment, suitable components are required of the factory systems.
- Scheduler/Dispatcher-- For self-regulation of AMHS equipment and production equipment, components of factory systems which takes into account above mentioned AMHS equipment integration components and production equipment online connection components are needed.

Guideline Text

7.1  Factory Systems

The 300 mm semiconductor factories are moving toward open standard based factory systems to realize flexibility and cost effectiveness. Software solutions and components from different suppliers need to be interchangeable and interoperable. To achieve this goal, software solutions and components of factory systems must conform to standard functionality, frameworks, interfaces and communication protocols.

Interpretation

It is expected that in the 300 mm semiconductor factory, factory systems will move towards an open standard format so as to increase flexibility and reduce cost. To achieve this, it is necessary to separate factory systems into components and standardize each component. Role, functionality, interface etc. of components must be standardized. This refers to the standardization efforts of the CIM Framework carried out under SEMI presently.

Software for factory systems supplied by package software supplier should be interoperable between suppliers. To achieve this, above-mentioned standards must be adhered to.

Figure 3.40 shows the component structure of a factory system.
**Preconditions and Restrictions**

A derivation of common demands of device makers, separation of components as well as a regulation of internal/external specifications for separate components with regards to the factory system must be achieved. Furthermore, the problem of connection (differences in infrastructure, etc.) between existing central devices (as owned by individual device makers) and new standardized equipment must be solved amongst device makers.

### 3.7.2 AMHS Framework

**Guideline Text**

7.2 AMHS Framework

Semiconductor factories that have AMHS require an integration software system to realize automated material movement. The AMHS Integration System must be interoperable with AMHS Equipment Controller and Host Systems from different suppliers. To achieve this goal, the AMHS Integration System must conform to standard communication protocols, state models and interfaces. This includes synchronization and integration of AMHS Equipment as well as integration with the Factory Host systems.

For explanations, please refer to Chapter 3.6.1.
3.7.3 Production Equipment Integration

Background, User Demand
Software for online connection of production equipment always exists in a factory system. Acting as a bridge between system control software performing operations such as process control/management and production equipment, this software absorbs differences between communication interface specifications of production equipment and provides a logical interface for system control software carrying out process management/control.

With 300 mm manufacturing equipment, guidelines have been drafted for a wide range of communication interfaces, such as automatic transport control. This in effect means that the communication interface for the 300 mm manufacturing equipment follows a different specification from that for other manufacturing equipment presently in use (such as the 200 mm process), which utilizes separate communication interface for every production equipment. 300 mm production equipment must not only follow the communication standard laid down, but at the same time, the software providing online connection must also adhere to the 300 mm communication standard.

Users therefore require manufacturing equipment with communication interface conforming to the 300 mm communication standard as well as online connection software compliant with communication interface of the 300 mm communication standard.

Guideline Text
7.3 Production Equipment Integration
300 mm factory production equipment integration software must be interoperable with all production equipment. To achieve this goal, this integration software must conform to production equipment communication standards. In addition, this integration software must be interoperable with the factory system. Production equipment integration software must conform to standard functionality, framework, interfaces and communication protocols.

Interpretation
As the 300 mm factory production equipment integration software is a component of the factory system, it comes under the above mentioned production equipment online connection software. This software must be interoperable between all connected production equipment. In other words, it must conform to the 300 mm production equipment communication standard. Furthermore, it must be interoperable with other components of the factory system, which means it must conform to the standard functionality and interfaces of each component of the factory system.

It is assumed that the production equipment connectivity standard is made up of the present SECS, HSMS, GEM, PM as well as the newly formulated CMS, CJM, STS and so on. CIM framework is assumed to be the factory system component standard.

Pre-requisites and Conditions
This guideline assumes that the production equipment connection interface and production equipment online connection software should be standardized between device makers. As factory system belongs solely to each device maker, there is no standing agreement between device makers regarding the extent of standardization of online connection software of production equipment, or in other words, no set arrangement between software performing process control/management and production equipment online connection software. Factory system infrastructure (especially communication middleware) also differs with each device maker. Therefore, the pre-requisite is thus that co-ordination is possible between device makers.

3.7.4 Scheduler / Dispatcher
This section is proposed as a first draft for consideration as an addition to the 300 mm Integrated Vision for Semiconductor Factories corresponding to the new Global Joint Guideline on Scheduler / Dispatcher.
Background and Motivation

The Global Joint Guideline on Scheduler / Dispatcher helps address four of the basic requirements on IC makers introduced by the advent of 300 mm processing.

3. International participation is essential.
9. Increase control of factory logistics and production scheduling
11.3 Factory Automation (FA)
15. Inventory reduction (both half-finished and finished products)
20. Reduction of turn-around time

The use of an automated Scheduler / Dispatcher is a key enabler to achieving these requirements. First, increased control over operations requires an active Scheduler / Dispatcher that can respond to factory events and changes in state and dynamically adjust the schedules for material processing and transport and coordinate equipment maintenance to minimize impact on schedules.

Second, the Scheduler / Dispatcher can react to inventory levels of WIP in the factory to adjust the priorities of material to minimize queue sizes and ensure that use of bottleneck equipment is optimized to keep WIP levels as low as possible. Visibility to inventory allows greater control to achieve desired inventory levels.

Third, the Scheduler / Dispatcher can minimize the turn around time (TAT) by coordinating material transport (for substrates and durables) with processing to minimize equipment idle time. Schedules can sequence processing to minimize setup time. The Scheduler / Dispatcher can also respond to scheduled and unscheduled equipment downtime to minimize impact on turn around time. In addition to minimizing overall TAT, it can react to the priorities for urgent lots to move them through the process flow in the minimum possible time while adjusting the schedules of lower-priority lots that are impacted.

These requirements are further complicated by the need to smoothly coordinate material processing and transport in the 300 mm factory where Automated Material Handling Systems are required for movement of material containers. The Scheduler / Dispatcher must dispatch the carriers to the next location for processing or storage in coordination with the processing to be performed on the lots contained in the carriers.

Finally, the need to comprehend mixed lots within a single carrier requires a Scheduler / Dispatcher capability to optimize processing activities that involve either partially different processing or additional process steps for a subset of the wafers in a carrier. Knowledge of the mixture of lots in a carrier and the special processing required can be factored into scheduling decisions involving the transport of the carrier and the processing activities required.

Guideline Text

7.4 Scheduler / Dispatcher

300 mm factory scheduler/dispatcher software must be interoperable with the factory system. To achieve this goal, scheduler/dispatcher software must conform to standard functionality, framework, interfaces and communication protocols with the factory system.

REQUIREMENTS:
3. International participation is essential.
9. Increase control of factory logistics and production scheduling
11.3 Factory Automation (FA)

STANDARDS:
SEMI E81 Provisional Specification for CIM Framework. Action required for SEMI to develop and define standard interfaces for factory systems.

REFERENCES: None
Interpretation

The diagram below illustrates the topology for scheduling / dispatching within the overall factory system environment. Planning systems may provide input to multiple factories, however, the scheduling/dispatching system will only be concerned with optimizing the output of a single factory. The Scheduler / Dispatcher interacts with other factory system components to determine the current state of the material and resources of the factory and to provide decisions on the activities that should be dispatched for execution.

Factories will use a Scheduler/Dispatcher to optimize factory resources to meet commitments as supplied by the enterprise & factory planning systems. The scheduler's policy for starting lots may be more reactive to the current state of the factory than the planned releases supplied by the planning systems. For instance, the scheduler may either pull in or push out planned starts of product substrates to optimize factory loading.

In addition to scheduling product substrates, the Scheduler/Dispatcher can schedule all non-product substrates released in the factory. (e.g. Monitor, Test, and Dummy wafers). The Scheduler/Dispatcher will be able to automatically start non-product substrates into the factory when product starts or factory usage necessitates it.

The Scheduler/Dispatcher will be able to schedule delivery for all material and durables within the factory. For AMHS systems that support delivery directly to the equipment load port, the Scheduler/Dispatcher will be able to schedule and dispatch activities for automated delivery. The Scheduler/Dispatcher will also be able to utilize information on predicted delivery times to effectively coordinate WIP processing goals with material delivery times to the extent that such information is available from the AMHS.

The Scheduler/Dispatcher will be able comprehend and manage the constraints and opportunities imposed by the factory equipment. This includes items such as equipment maintenance, equipment capabilities (multi-lot batch capabilities, cascading, etc.), and equipment limitations.

The Scheduler/Dispatcher will comprehend and appropriately provide supporting capabilities & 'what if' analysis systems. These reporting and simulation systems would be used to monitor and optimize the performance of the Scheduler / Dispatcher system.
4.0  Frequently Asked Questions (FAQ)

In this section, answers to frequently asked questions regarding the guidelines are documented. The objective is to clarify specific elements of the guidelines, their motivation, and linkage to other standards.

4.1  Production Equipment Guidelines

4.1.1  Single Communication Link

“A single physical communication connection must link the production equipment to the Host. A single physical communication connection means that the Equipment Front End Module (EFEM) is integrated through the production equipment rather than connected directly to the Host. The supplier must provide hardware on the equipment to connect to the factory Local Area Network (LAN) per IC manufacturer’s requirement. This communication connection must comply with HSMS protocol and be able to transmit and receive all SECS-II messages.”

1.  Can user request optional communication link rather than single physical link?
   •  This guideline does not prohibit users from requesting at their option, additional communication link(s) such as process or status monitoring of process equipment.

2.  What kind of information is exchanged through single communication link (primary link)?
   •  All information necessary to run.

3.  Is this guideline applied to in-line equipment such as litho-track?
   •  It depends on the configuration user required. Two cases can be applied. One is 1 physical link for the stepper and 1 physical link for the track (2 tools). The other is 1 physical link for controller which integrates the stepper and the track (1 tool).

4.  Who has maintenance responsibility for integrated equipment whose EFEM part and equipment parts are different?
   •  Equipment suppliers own this responsibility.

5.  Do all kinds of production equipment have to be able to handle all SECS-II messages?
   •  All equipment must be able to send and receive the SECS-II messages necessary to operate.

4.1.2  Compliance to Communication Standard

“Production equipment must comply with SECS-II standard messages to communicate with the Host. Production equipment must also use standard state models for control and data processing. Automation software products must comply with these same standard messages and state models when communicating with and controlling production equipment. HSMS Single Session Mode is a minimum requirement.”

1.  What protocol standard does equipment, which is not categorized to production equipment such as AMHS equipment, have to comply?
   •  At present E5, E30, E37, E37.1, IBSEM, Stocker SEM, Transport SEM, and Carrier Management

2.  How is HSMS multi-session implemented or used?
   •  HSMS multi session is not required.

3.  What standard state models for control and data processing means?
   •  These requirements refer to developing standards such as Control Job Management, Process Management, Substrate Tracking, Carrier Management, ARAMS.

4.  Do all production equipment need to support full GEM capability as is stated in recommendation?
   •  All production equipment must be fully GEM capable; however, limits monitoring and spooling are not required on all tools.

4.1.3  Utilization and Reliability Management

“Production equipment must communicate utilization and reliability data to host systems using standard messages and state models. This is required to enhance data collection and analysis of equipment performance.”
1. Is single communication link necessary to be applied to collect utilization data?
   • Yes
2. What is standard message and state model?
   • SECS-II, GEM, and ARAMS.
3. What is detail requirement for signal tower usage corresponding ARAMS states and S2?
   • Action is required for SEMI to develop a signal tower standard considering both ARAMS and S2.
4. What base time is applied to calculate MTBF? Base time is total or productive time?
   • This is a business question not associated with CIM.
5. What is current status of utilization and reliability management standardization?
   • E10 and ARAMS must be reviewed and improved by SEMI members.

4.1.4 Reliable Data Collection

“Data collected by production equipment must be time-stamped at the time of collection and not at the time of transmission.”

1. What is interval and precision of time-stamped data?
   • Current SEMI standards for time-stamping are centi-seconds.
2. Why time stamped data collection required?
   • To allow equipment data to be correlated against time.
3. What is reference time for time-stamping?
   • Reference time is whatever the factory sets. Equipment time can be set through a SECS message.
4. Is real time data transfer required at the time of data being sampled?
   • Device makers may require real time data transfer so long as it does not interfere with the equipment’s processing and throughput capability.
5. What is advantage or merit of time-stamped data collection?
   • To allow equipment data to be correlated against time.
6. Is it needed to support daylight-saving time?
   • No this is not the purpose.

4.1.5 Variable Parameter Support

“Production equipment must support variable parameters sent by the host or set from the operator interface.”

1. What is an application example of variable parameter?
   • Part of recipe that can change between runs like time or temperature.
2. What is difference between recipe and variable parameter?
   • Variable parameter is included in recipe and can be set by the host or operator. Variable settings, which can be set in a recipe, include gas flow, pressure, temperature, current, and voltage.
3. Who changes recipe and variable parameter? Operator, engineer, or host?
   • The company and factory operational model defines this.
4. What is expected function to realize variable parameter support?
   • The expected function is to set and change processing conditions by using key process parameters without changing the entire recipe.
5. Are equipment parameters (i.e. PID parameter) included in variable parameter?
   • All adjustable parameters, which can be set by host or operator, are variable parameters. PID (Proportional, Integral, and Derivative) parameters are included if device maker requires them.

4.1.6 Fault-Free Data Transition

“Production and AMHS equipment must be capable of fault-free performance in processing date and date-related data in the 20th and 21st centuries. An example of this correct date management is fault-free processing for the year 2000 date transition.”
1. **How can we check whether fault-free transition is performed or not?**
   - Supplier should test equipment against known date transition issues such as Year 2000 using methodologies such as the SEMATECH test plan.

2. **Is there any fault-free data transition issue (i.e. daylight-saving time)?**
   - Yes. Examples include leap years, daylight saving time, and Year 2000 issues which must be handled correctly. Motivation for this guideline is to ensure that the industry does not incur the same cost and risk when implementing around the year 2000 or more importantly in the future for such Unix issues such as the 2038 issue.

3. **Is there any SEMI standard activity for year 2000 problem?**
   - There is no Year 2000 SEMI activity; however, SEMI has updated SECS-II messages address the Year 2000 issue. Also, International SEMATECH has a test plan.

### 4.1.7 Mechanical Dry Run

**Guideline Text**

1.7 Mechanical Dry Run

Production equipment shall support the capability to perform a mechanical dry run. This allows material handling and software capabilities of the equipment to be exercised without full facility hookups or changes to the physical state of wafers. Environment control sub systems should not be affected by a mechanical dry run, nor should process consumables be expended.

### 4.2 Load Port Guidelines

#### 4.2.1 Bi-directional Load Port

“The E15.1 load port must be bi-directional for loading and unloading carriers at both fixed buffer and internal buffer production equipment.”

1. **Is a uni-directional type equipment permitted?**
   - Bi-directional load ports are a minimum GJG requirement. Uni-directional load ports are permitted, but only if they can also be configured as bi-directional load ports.

2. **Are bi-directional load ports still required in the case that uni-directional load ports are permitted?**
   - Bi-directional load ports are a minimum GJG requirement. Uni-directional load ports are permitted, but only if they can also be configured as bi-directional load ports.

3. **In the case of internal buffer equipment, must the carrier-out port be the same as carrier-in port? And does load port for the special use correspond to this?**
   - Bi-directional load ports are a minimum GJG requirement. Uni-directional load ports are permitted, but only if they can also be configured as bi-directional load ports.

#### 4.2.2 Interface between Production Equipment and AMHS Equipment

“Production equipment must include an interface to communicate directly with AMHS equipment. This communication handshake will help facilitate safe carrier transfer between production and AMHS equipment.”

1. **Must the production equipment use one hand-off interface per load port?**
   - Both 1:1 and 2:1 configurations are allowed in the E84 carrier hand-off standard. Fixed buffer equipment will use the 1:1 configuration. Internal buffer equipment may use the 2:1 configuration only when AGVs and RGVs are the intrabay transport.

2. **Must the same production equipment allow for both the OHT and AGV/RRGV?**
   - Production equipment must support both OHT and AGV/RRGV as options defined in the E84 standard, but not both options together on the same tool.

3. **What interface must the production equipment support for OHT implementations?**
   - Production Equipment Supplier is responsible for providing an E84 wire based compatible plug at the
top of the equipment. The scope between the production equipment E84 plug and the OHT equipment is determined by the AMHS supplier and the user.

4. **Is production equipment required to support both infra-red and wire, or infra-red only interfaces?**
   - OHT implementations will use a wire based connection, while AGV/RGV implementations may use either a wire based or infra-red connection.

### 4.2.3 Carrier Hand-off Interface Enhancement

“Production equipment and AMHS equipment must allow both continuous and simultaneous hand-off of up to two carriers at load ports and allow recovery from time-outs and hand-off errors.”

1. **Are production equipment required to perform continuous transfer and simultaneous transfer at once?**
   - Yes, this is supported in the E84 standard with which the production equipment must comply.

2. **Will two different types AMHS equipment access one production equipment?**
   - Only one type of AMHS equipment will access production equipment. Multiple suppliers of the same type of AMHS equipment may be used in different bays as long as they conform to the E84 standard.

3. **What are the definitions of continuous transfer and simultaneous transfer?**
   - See E84 for further information.

4. **How can the production equipment distinguish between continuous transfer and simultaneous transfer?**
   - See E84 for further information.

5. **Are AMHS equipment required to perform continuous transfer and simultaneous transfer at once?**
   - No.

6. **How must the AMHS equipment and the production equipment recover from errors?**
   - See E84 for further information.

7. **How can the production equipment realize continuous transfer and simultaneous transfer?**
   - See E84 for further information.

### 4.2.4 PGV (Person Guided Vehicle) Docking Standard

“Any PGV must be able to dock mechanically at any standard compliant load port through a standard PGV docking interface.”

1. **Where does the Docking-I/F belong?**
   - PGV docking interface must be located within the load port exclusion zone for cart docking per SEMI E64, but mounted to the floor rather than to the load port.

2. **Is the Docking-I/F installed in every Load port? How does this relate to Continuous loading and Simultaneous-Loading?**
   - For all PGV applications, the docking interface must be installed per the standard (SEMI E83).
   - Production equipment must conform to GJG 4.3.2 “Equivalent Handshaking for Carrier Hand Off” to facilitate PGV usage and action is required for SEMI to include this in CIM standards.

3. **What is the Docking-I/F?**
   - Docking interface is a mechanical interface used to align PGV and load port for carrier hand-off. Refer to the standard SEMI E83 for more details.

4. **What is the purpose of Docking-I/F? (What does Docking-I/F exist for?)**
   - The purpose is to facilitate safe transfer of carriers between PGVs and load ports by ensuring that the PGV does not move during the transfer process.
   - The docking interface standard also facilitates interoperability between load ports and PGVs: Any PGV and load port can be used together as long as the load port conforms to E15.1 and the docking mechanism conforms to E64.

5. **Who must supply the Docking-I/F?**
   - Load port and Production Equipment suppliers must ensure that their equipment conform to the exclusion zone requirements in E64. PGV suppliers must ensure compatibility to the interoperable mechanism.
defined in SEMI E83. The supplier of the Docking I/F is user defined.

4.2.5 Carrier Sensors at E15.1 Load Port

“Carrier presence and placement sensors, integrated to the equipment control system, must be located at each E15.1 load port to indicate whether or not a carrier is in the port area and properly placed, respectively. These sensors must be logically and physically independent of each other. They must also have externally viewable LEDs that are turned on when the carrier is present and properly placed. These sensors should be integrated to facilitate safe carrier transfer between production equipment and AMHS equipment.”

1. What specifically are carrier presence and placement sensors?
   - The presence sensor determines whether or not a carrier is in the load port area. The placement sensor determines whether or not a carrier is placed correctly on the load port. These are designed to facilitate safe carrier transfer.

2. What is the reason why the carrier sensor must be physically independent to each other?
   - The presence and placement sensors must be independent because both measurements must be made in order to determine load port safety.

3. Do SEMI standards of the color, position, shape, and the method of the display etc. about LED exist?
   - No, action required for SEMI to develop this standard.

4. Does a restriction exist about the quantity of sensors?
   - No. The equipment must be able to correctly identify conditions when a carrier is present at the load port and when it is correctly placed.

5. Does a SEMI standard exist for the locations of sensors?
   - See E15.1.

4.2.6 Carrier ID Reader at E15.1 Load Port

“There must be a carrier ID reader at each E15.1 load port. The ID reader type (IR, Bar Code, RF, etc.) will be determined by the IC manufacturer. The carrier ID must be in a standard location on the carrier. A standard exclusion zone on the E15.1 load port must be defined for the carrier ID reader. ID data must be communicated through the equipment’s single communication connection per CIM Guideline 4.1.1.”

1. When is the reading timing of carrier ID?
   - For fixed load ports, this should be done after carrier drop off and before door opening.

2. Is carrier ID location of open cassette and FOUP the same places?
   - This is an open issue in SEMI standards.

3. Is it necessary for a Stocker to perform carrier ID writing?
   - This is a user defined option.

4.2.7 Carrier ID Reader for Internal Buffer Equipment

“Internal buffer production equipment must support the capability to read the carrier ID at the load/unload position on the E15.1 load port. Carrier ID writing shall be supportable by internal buffer production equipment at all internal FIMS port locations. While writing data to an ID tag, the carrier must be physically locked relative to the read/write device. Read/write functions shall be outside of hand-off transactions.”

1. Is carrier ID device for writing an option?
   - Yes this is an option as defined in the GIG.

2. Is the location of carrier ID devices for read and/or writing at the FIMS port a SEMI standard?
   - No standard exists for internal buffer equipment, action required for SEMI to standardize this position.

3. Why is there a difference in the writing position and the reading position?
   - The writing position is only at the FIMS port since it is only necessary to update the information on a write device after processing.

4. What is the meaning of "Read/Write functions shall be outside of hand-off transactions?"
Reading and writing should be done after the load is successfully transferred between the AMHS or PGV to the process equipment. This is to ensure that the reading/writing time does not increase the cycle time of the AMHS equipment.

5. Why is the writing function necessary?
   • This depends on factory operational model. In general, the writing function is necessary to update lot information after processing.

6. When is locking released?
   • The FOUP locking is released after the door is closed. Exact timing is not standardized and depends on sub-supplier implementation.

4.2.8 Carrier ID Reader for Fixed Buffer Equipment

"IC manufacturers will use either read-only or read/write carrier ID technologies based on operational requirements. The carrier must be located at a different position on the load port during an ID operation depending on the technology used. When read-only carrier ID is specified, Fixed Buffer Equipment must support the capability to read the carrier ID at the load/unload position on the E15.1 load port. When read/write carrier ID is specified, Fixed Buffer Equipment must support the capability to read/write the carrier ID at the FIMS position on the E15.1 load port. While data is being written to an ID tag, the carrier must be physically locked relative to the read/write device."

1. The R/W device is installed, and it is used in Read only mode. In this case, where is the reading position?
   • User defined.

2. When is locking released?
   • The FOUP locking is released after the door is closed and prior to AMHS/PGV pickup. Exact timing is not standardized and depends on sub-supplier implementation.

3. Is a TAG installed for open cassette carriers?
   • The user will specify this option.

4.2.9 Load Port Backward Compatibility

“Production equipment suppliers are encouraged to implement innovative ways to minimize the quantity of loadports carried as spares with the objective of reducing overall equipment and factory cost of ownership.”

1. What does Backward Compatibility mean?
   • Load port backward compatibility refers to the ability of load ports used on more recent equipment versions of the same model to be interoperable with earlier versions of that equipment and continue to meet SEMI E15.1. Furthermore, more recent versions of load ports must be interoperable not only with the current equipment versions, but also earlier equipment versions.

2. What is the definition of "replacement time" for quick maintainability?
   • It defines time needed for the trouble shoot or scheduled maintenance, as defined by the MTTR definition in SEMI Standard E10. In the case of loadport replacement, this implies time between when that production equipment is stopped for the replacement and when the production equipment is put into production after the loadport is replaced and adjusted for AMHS delivery function. This definition assumes all the necessary and possible work is done prior to stopping the nearby production equipment, and it does not include time necessary to stop the AMHS, such as AGV.

3. What is the maintainability for “non-modular loadports” or load ports integrated into the equipment?
   • In the case of a loadport, which is integrated into equipment and can not be dismounted from the loadport site as an individual unit, the defective loadport can not be readily replaced, and, therefore, the entire loadport should be serviced as it is assembled at the location of equipment. Production equipment suppliers are responsible for providing equipment with the same quick maintainability for these non-modular load ports as for the modular type loadports even if it has an integrated loadport type front end. Since the impact of load port failure to the automated material handling utilization is considerably large, these types of loadports must have a far better reliability than that of the non-modular load ports.
4. **What are the utilities requirements for loadports?**
   - Simpler utilities requirements are always better for loadports. It is recommended that the interface be well standardized for vacuum, pressurized air, electricity, and N2 if necessary.

5. **Is finger pinch protection by area-sensor or any other means necessary?**
   - Finger pinch protection by 1) sensors or 2) a door with a locking switch or 2) both are required by some device makers. There is, however, no common standard other than S2/S8 that must be adhered with here.

6. **What is the better method for load port mounting for the end users?**
   - Alignment procedures should be simple enough to apply among the many different load port suppliers. The number of mechanical tools used in maintenance has to be minimized. Load port replacement should require no more than 2 people. The case where a load port is sandwiched between adjacent load ports should be well examined. RGV rails or PGV rails on the floor in front of the load ports can become obstacles, and should also be well considered.

7. **Is there a load port weight requirement?**
   - Although no definite figure has been agreed upon, no more than two people should be required in the replacement of a load port unit, as mentioned earlier.
4.3 Production Equipment Material Handling Guidelines

4.3.1 Exclusive Access Mode and Mode Change Timing

“Production equipment must accept only one Access Mode (RGV/AGV/OHT or PGV/Operator) at a time, and allow the Access Mode to change at any time except during carrier hand-off. The mode shall be applied by equipment, and not by individual load ports, and the Production equipment must reject all requests other than requests within the accepted mode. Equipment that has physically separated loadport groups must allow different access modes for the different loadport groups.”

1. What does “physically separated load ports” mean?
   - Load ports that are not connected physically or electrically are considered separate. There is no specific dimension defined in a standard regarding physically separate load port groups, however, the definition means that one load port can be accessed by one physical delivery vehicle (PGV, AGV, OHT) while another load port on the tool can safely be accessed by another delivery vehicle. This allows both ports to be loaded and unloaded simultaneously by separate material handling vehicles.

2. What is “access mode”?
   - Access mode refers to manual (PGV) or automated (OHV/RGV/AGV) access to the equipment load ports. Refer to Carrier Management Standard (SEMI E87).

3. What is the definition of a carrier hand-off interval?
   - The carrier Hand-off interval is the period in which a carrier is being transferred between production equipment and AMHS or PGV/Operator. Refer to the E84 standard.

4. Is it applicable to carrier hand-off by operator with PGV?
   - Yes

5. Is access mode reflected on control signals (load request, access permitted, and so on) which is exchanged between production equipment and AMHS equipment?
   - Yes, the CMS standard E87 and the E84 standard coordinate these access mode control signals.

6. Why is the access mode applied by equipment and not by individual load ports?
   - In order to allow for safe manual access to load ports, automatic delivery to load ports is required to be disabled during manual carrier transfers.

7. Is individual access mode such as RGV-access, AGV-access set for each AMHS equipment?
   - No, the equipment will have only 2 access modes, manual (PGV) and automated (AGV or OHV or RGV).

8. Is this guideline applied to Uni-directional production equipment?
   - Uni-directional configured load ports are also covered by this guideline.

9. What does PGV/Operator mean?
   - ‘PGV/Operator’ means manual carrier handoff with or without the use of a cart.

4.3.2 Equivalent Handshaking for Carrier Hand-off

“Switching between Manual Access Mode and Automatic Access Mode must be smooth and manual carrier hand-off must be safe. Production equipment must have the capability of handshaking during manual carrier hand-off in a manner similar to automated hand-off. In the manual handshaking procedure, the equipment must provide a simple input method of manual hand-off completion.”

1. What is a manual handshake?
   - A manual handshake should consist of a physical or logical signal which is equivalent to the E84 load/unload complete signals.

2. Are there a well defined or standard method of input for a manual handshake?
   - There are no standardization activities in this area.

3. Which part of the automatic access mode process must be the same as the manual access process?
   - The physical carrier handoff completion signal is the minimum requirement.
4.3.3 Software-Based Interlocking to Prevent Simultaneous OHT and PGV

“A software-based interlock between the PGV/operator handling and OHT equipment must exist to prevent simultaneous access of the same load port to enhance human safety and prevent product damage. Production equipment and stockers should comprehend the access mode and decide whether it should be accessed by the OHT or PGV/operator handling. Based on the decision, the production equipment and stockers must reject all other requests other than the authorized mode.”

1. What is the relationship between this guideline and GJG 3.1 Exclusive Access mode?
   • This guideline is the baseline requirement for loadport access, and requires an interlock to prevent OHT and PGV access (automatic and manual) at the same time. Guideline 3.1 is an extension to GJG 3.3, and addresses when the equipment access mode can be changed between automatic and manual carrier transfer and that this change can only be made on an equipment by equipment basis.

2. Must Stockers comply to this guideline?
   • Yes, any loadport that can be accessed both manually and automatically is covered by this guideline.

3. Is the Hardware Based Interlocking unnecessary?
   • Software Based interlocking via the E84 standard is the minimum GJG requirement. Hardware based interlocking may be specified by the user.

4. What does Software-Based mean?
   • Parallel I/O interface and Access Mode are considered to be Software-Based. Please refer to E84 and Carrier Management Standard (SEMI E87) for details.

5. Are PGV and RGV sometimes used at the same time in one bay?
   • No, but PGV and RGV can be used in the same bay at different times.

4.3.4 Independent Control of Material Handling and Wafer Processing

“Effective manufacturing in 300 mm factories requires the use of AMHS material delivery to production equipment even when the production equipment is operated by the operator. Therefore, production equipment must support automated and manual material handling interactions independent of wafer processing and measurement operations.”

1. How does one implement this capability?
   • The basic idea is to be able to deliver carriers to and from the loadport regardless of the production equipment processing state. Action required for SEMI to standardize the concrete implementation. Refer to the vision document for details.

2. How should existing standards be used to implement the modes?
   • The possibility exists to use the existing GEM standard, but action is required for SEMI to standardize the specific implementation.

3. Does this apply to internal buffer equipment?
   • Yes, this guideline and the resulting standard apply to internal buffer equipment.
4.3.5 Processing Order Control for Equipment Buffer

“The order of processing for a carrier or batch in the equipment buffer is independent of the order of its delivery. Production equipment must be able to set and change the order of processing as directed by the host and the operator interface. Equipment must always maintain the association between a carrier or batch and its processing instructions. This capability is especially important for supporting QTAT (Quick Turn Around Time) for a hot lot by putting it at the top of the order.”

1. What is the requirement in this guideline?
   - This guideline supports QTAT (Quick Turn Around Time) for Hot Lot processing requirements. The purpose of this guideline is to require that carriers can be processed in any order, no matter in what order they were delivered to the tool. The first carrier delivered to the tool does not necessarily mean that it will be the first carrier to be processed.

2. Is it possible to remove a pre-process carrier at the load port and move to a stocker for a hot lot?
   - This is a possibility but not a requirement.

3. Do you interrupt the current lot’s processing for a hot lot?
   - No, the current process will be allowed to complete, but the next lot to be processed may be chosen by priority and not delivery order.

4. What effect is achieved from this guideline?
   - This guideline allows high priority carriers to be processed ahead of other carriers already in the fixed or internal buffer. This support QTAT for hot lot processing requirements.

5. Is it possible to remove a pre-process carriers from an internal buffer in order to make room for a hot lot?
   - This is a possibility but not a requirement.

6. Do you require this guideline on metrology equipment?
   - Yes, this is required for metrology equipment.

7. How is a HOT LOT designated?
   - A hot lot is designated by the user through the host system. The production equipment only needs to now that the order of processing lots at its buffer locations can be changed by the host anytime before processing starts for a carrier.

4.3.6 Carrier Transfer Control of Internal Buffer Equipment

“To achieve consistent carrier handling within internal buffer equipment, standard carrier handling commands (sent from the host to the equipment) must be supported by the equipment. When the equipment’s carrier handling is controlled by the host:

a) Carrier movement must be controlled by using these commands.

b) Carrier movement between the internal buffer and the load port must remain under host control until further specified by the host or from operator interface.”

1. What is the objective of this guideline?
   - This allows for host control of internal buffer movement. This guideline requires a standardized way of moving carriers into and out of internal buffer equipment. Refer to the Carrier Management Standard (SEMI E87) for details.

2. Is it always necessarily that host controls internal buffer?
   - No, it is optional in the SEMI standard E87 (Carrier Management Standard).
4.3.7 **Internal Buffer Capacity Notification**

“Internal Buffer Equipment must report the available buffer capacity to the host whenever the available capacity changes and when requested by the Host.”

1. **Why is the report necessary?**
   - It is necessary to report the equipment available buffer capacity so the Host knows the available buffer capacity in order to initiate carrier delivery.

2. **Is it necessarily that the equipment reports to the host at the equipment starting?**
   - This is defined in the SEMI Carrier Management Standard (E87), please see this standard for all reporting requirements and formats.

3. **Can the Host inquire about the contents of the internal buffer?**
   - Yes. This is defined in the SEMI Carrier Management Standard (E87). Please see this standard for all reporting requirements and formats.

4. **Doesn’t the fixed buffer equipment need a similar kind of notification?**
   - No, this is defined in the SEMI Carrier Management Standard (E87), please see this standard for all reporting requirements and formats.

5. **Available load-ports will be reported from the equipment to the host, independent of the available buffer capacity. Is it OK?**
   - In some cases this is OK, but please see the SEMI Carrier Management Standard (E87) for all reporting requirements and formats.

4.3.8 **FOUP Open and Close Notification**

“Production equipment that supports FOUP must control FOUP opening and closing and have the capability to send corresponding event notification to the host through standard event messages. This does not apply to equipment that supports open cassette carrier interfaces only.”

1. **Why does the host need this information?**
   - The host may need this information to track and coordinate carrier delivery and loading with control job management. Note that GEM requires that equipment support events that signify significant equipment change. FOUP opening and closing is one such physical event.

2. **Does the 3rd carrier belong to Open cassette (OC) or FOUP?**
   - The 3rd carrier is not a GJG requirement.

4.3.9 **Other Production Equipment Load Port Questions and Answers**

1. **Does a basic production equipment configuration have two load ports?**
   - Analyses have shown that most production equipment needs 2 load ports for continuous operation. The exact number of load ports on production and metrology equipment is defined by the run rate of the equipment, cycle time of the AMHS, and factory operations model.

2. **Is metrology equipment with just one load port special?**
   - Refer to I300I/J300 GJG dated July 1997, equipment operation guideline 14.

3. **Is it required that metrology equipment have two operation panels, one for the backside and the other for the front-side?**
   - Refer to I300I/J300 Factory GJG, guideline 12.

4. **The backside user interface of metrology equipment is for measurement and inspection control and the front-side one is for material control. Is this a correct guideline interpretation?**
   - No, both interfaces should have equivalent functionality. Refer to I300I/J300 Factory GJG, guideline 12.

5. **How is remote login implemented through the GJGs?**
   - Remote login is not addressed by the I300I/J300 GJG.
4.4 Production Equipment Material Management Guidelines

4.4.1 Slot number and load port number assignment

“A slot number for each carrier must be assigned incrementally from the bottom, starting with “1.” Load port number must be assigned incrementally from the left facing to equipment front, starting with “1.””

1. Is stocker included in the equipment?
   • Yes, this is defined in stocker SEM

2. Does load port number assignment require physical (and visible) numbering to the port?
   • Note required in the guideline, but would be useful for the operator during manual delivery as a user option.

3. Should the assigned number be reassigned if a load port is added or removed to keep the incremental numeric order?
   • Reassignment should not be necessary. To avoid reassignment, equipment supplier pre-assigns the load port number based on the maximum number of load ports possible to attach the equipment.

4. If the equipment or stocker has both load port (Height is less than 2600 mm) for OHT and that for PGV, AGV and RGV (Height is 900mm) defined in SEMI E15.1, how the numbering rule should be applied?
   • Numbering should start from left to right and bottom to top.

4.4.2 Empty carrier management

“All carriers that are at the E15.1 load port or within an internal buffer must be managed by the production equipment. The production equipment is responsible for managing and storing the empty carrier while its associated wafers are being processed.”

1. What is the meaning of managing “All carriers” and “the empty carrier” by the equipment? What is the coverage of management?
   • Production equipment must know the location and status of all carriers at E15.1 load ports or within internal buffers.
   • Internal buffer equipment must know the availability of all internal buffer locations to store empty carriers after wafers have been transferred from the carrier into the process module.
   • The production equipment must know at which buffer position the empty carrier is stored at and which wafers being processed belong to that empty carrier.

2. Must internal buffer equipment store empty carriers while their wafers are being processed?
   • Yes.

3. How are exception cases between the host and equipment handled?
   • Exception cases will be defined and resolved by the SEMI standards activities (i.e. Carrier Management Standards, Substrate Tracking, etc.).

4.4.3 Carrier Slot Verification

“Prior to processing wafers, production equipment must have the capability to detect which slots within a carrier have wafers. This information is used to verify the carrier/slot map.”

1. Who verifies the slot map, equipment or host?
   • Either by equipment, host or operator. For equipment and host verification, the SEMI standard will define the actual specification. Refer to CMS (Carrier Management Standard). For operators, the front panel will display the slot map and the operator will verify.

2. When should equipment detect wafers to slots?
   • Before removing any wafers or beginning any processing, equipment must verify which slots have wafers and which do not. In the case of a FOUP, the most logical time is at door opening. The specification for this requirement should be defined by SEMI standards. Refer to CMS (Carrier Management Standard, SEMI E87).

3. What should equipment do after detecting wafers in slots?
• If the host will verify the slot map, then the equipment should report the slot map data to the host. If the equipment is requested to verify the slot map, then the equipment will verify the slot map to the host. The specification for this requirement should be defined by SEMI standards. Refer to CMS (Carrier Management Standard, SEMI E87).

4. What is the difference between “processing wafers” and “processing and measurement” in the title of guideline 4.6?
• They have the same meaning. The processing in the production equipment includes both wafer processing and measurement.

4.4.4 Host control of wafer processing order
“Single wafer production equipment must be able to process some or all of the wafers in a carrier as specified by both the host and the operator interface. Single wafer process equipment must be able to process wafers based on an order specified by both the host and the operator interface.”

1. Can host specify the processing order for wafers over different carriers for the single wafer process equipment with multiple carriers as a batch? (Example) Process Carrier A/slots 1, 3, 4; Carrier B/slots 13, 25, 14; then Process Carrier A/slots 10, 9, 25.
• For the single wafer processing equipment which is designated to take multiple carriers with the same process start, processing order may be specified across different carriers. The specification for this requirement should be defined by SEMI standards. Refer to SEMI Standards (Control or Process Job).

4.4.5 Slot and carrier integrity
“Production equipment must have the minimum capability of loading wafers to and from the same slot in the same carrier to maintain wafer slot-to-slot integrity. If slot integrity is lost, the equipment will send an event message to the host. Wafer sorters or equipment that splits lots into multiple carriers by design are an exception to the slot-to-slot and carrier integrity.”

1. Is only the event message required when equipment can not keep the slot integrity? How about alarm message?
• Guideline requires an event message only, but it does not prevent the equipment from sending an alarm message if it is a safety issue.

2. What is the meaning of “if slot integrity is lost?”
• This means that the equipment cannot return a wafer to the original slot in the original carrier. The equipment should send an event and specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).

4.4.6 Additional wafer control after processing or measurement
“In addition to the minimum slot and carrier integrity capability, specific single wafer production equipment must be able to output wafers to a specific slot in a specific carrier different than the one from which it was taken.”

1. Who decides if the equipment is in the category of “specific single wafer production equipment?”
• Device manufacturers.

2. Does the primary equipment mentioned in NOTE need to follow this guideline?
• The suppliers of the equipment mentioned in the note need to be aware that device makers will likely require this capability. These suppliers should contact their device maker customers to get specific requirements.

3. What happens if the equipment cannot place the wafer to the designated slot in the destination carrier?
• The equipment should send an event indicating the issue. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).
4. Who will specify the “specific slot in a specific carrier” to output wafers, host, operator or equipment by itself?
   • The host may do the assignment when setting up the equipment for processing material; the operator may also do this assignment through the local interface screen. The equipment will have a default mode of operation, which will normally be to return the wafer to the same slot and carrier.

5. If “specific slot in a specific carrier” is not specified, the equipment should keep slot and carrier integrity as a default?
   • Yes

6. If the equipment outputs wafers to “specific slot in a specific carrier,” is it supposed to send an event message according to guideline 4.5?
   • This event should be a standard equipment capability, but is a different event from that specified in guideline 4.5. The host may or may not enable this event for transmission.

7. What should equipment do if a wafer already exists in a specified slot in a specified carrier? Should equipment check carrier/slot map for specified carrier?
   • If the equipment recognizes that it is attempting to place a wafer to a slot that is already occupied, it should stop sending the wafer to the slot and send an event and alarm message to the host.

4.4.7 Multi-Module wafer tracking events

“Multi-module single wafer processing equipment must track the movement of each wafer through the modules and report this information to the host. The equipment must be capable of associating data collected at a module with the wafer being processed at that module.”

1. What is the information of “tracking the movement of each wafer through the modules?”
   • Equipment should track and be able to report the wafer ID and the location. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).

2. Who will define the boundary of modules?
   • The equipment supplier should provide the boundaries, but if this is not sufficient, the user may require more specific location identifiers. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).

3. Does the equipment need to report tracking information each time a wafer moves through a module?
   • The equipment should be able to report all movements. Actual event reports will be defined and enabled by the host. The equipment will also provide wafer tracking history information. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).

4. What is “data collected at a module?” How do you associate module data with a wafer? (by using what kind of wafer identification scheme)
   • Wafer process data and processing time for a module must be collected as well as event data and data defined for trace data collection. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Substrate Tracking).

5. Is the equipment expected to keep the collected data? If so, is the tracking data included?
   • Equipment must keep collected data as predefined by the user. This includes tracking data.
4.5 **Production Equipment Single Wafer Control Guidelines**

4.5.1 **Recipe and variable parameter changes between wafers**

“300 mm manufacturing requires wafer level process control and management for higher production efficiency, development speed and fine process control. To realize this requirement with cost effectiveness, single wafer production equipment must support the capability to set different recipes and/or variable parameters associated with subsets of wafers within a carrier in a standard way. Standardizing concept, state models and communication interfaces are necessary to fulfill this goal.”

1. **What can be variable parameters and who will decide them?**
   - Variable settings which can be set in a recipe, such as gas flow, pressure, temperature, current and voltage and which are open to user to set externally by host or operator. Principally device maker chooses variable parameters from among those opened by supplier. If equipment does not support enough variable parameters, device maker may request additional variable parameters.

2. **Should the case of the same wafer group distributed among multiple carriers taken into account?**
   - Yes.

3. **What is the relation between lot and wafer group in the figure E.12?**
   - Lot number in the figure is one example of showing the wafer group ID.

4. **Can recipe and/or variable parameters be modified at the timing other than “runtime” in guideline 5.2?**
   - Yes, specific details must be defined in SEMI standards. Refer to SEMI Standards (Control and Process Job).

4.5.2 **Process parameter change between wafers**

“Single wafer process equipment may optionally need to support runtime variable parameter modification by host. When implemented, it must be done in a standard way.”

1. **What is the definition of “runtime” and its timing?**
   - Runtime means during the actual processing for the material. Specific details must be defined in SEMI standards. Refer to SEMI Standards (Control and Process Job).
4.6 AMHS Equipment Guidelines

4.6.1 Interoperable AMHS Equipment (Interbay and Intrabay)

“IC manufacturers want to ensure the optimal AMHS solution for the overall factory to realize desired bay throughput, layout flexibility, and cost effectiveness. 300 mm factories require the combination of different types of AMHS components from different suppliers to meet different material handling requirements. Standard communication protocols, state models, and interfaces are required to achieve these goals.”

1. What is transferred by the AMHS?
   • A carrier which stores wafers is what is transferred by the AMHS. There are two types of carriers: the front opening unified pod (FOUP) type and the open cassette (OC) type (see Figure 4.1).

![Figure 4.1 25-Wafer Front Opening Unified Pod (FOUP) and Open Cassette](image)

2. What types of interbay transport are there?
   • Different types of Intrabay Transport equipment are shown in Figure 4.2
   • OHT is suspended from the ceiling and performs loading/unloading carrier transfers using the hoist for each carrier.
   • AGV is a trackless transfer robot typically with a single hand, a single arm and 2 buffers. A buffer refers to a place on the vehicle where one or two carriers can be placed. Loading/unloading for each carrier and transfer for 2 carriers can be performed.
   • RGV is a rail-guided transfer robot of several types with various numbers of hands, arms, and stages. The example in Figure 11 is a distinctive type with a single arm, 2 hands, and without buffers. RGV can perform simultaneous loading/unloading and simultaneous transfer for 2 carriers.
   • Finally, PGV is a person guided vehicle of several types like the RGV.

<table>
<thead>
<tr>
<th>OHT</th>
<th>AGV</th>
<th>RGV</th>
<th>PGV</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="OHT Diagram" /></td>
<td><img src="image" alt="AGV Diagram" /></td>
<td><img src="image" alt="RGV Diagram" /></td>
<td><img src="image" alt="PGV Diagram" /></td>
</tr>
</tbody>
</table>

*Figure 4.2 Types of Intrabay Transfer Equipment*
3. **What types of interbay transport are there?**
   - The types of Interbay Transport equipment are shown in Figure 4.3.
   - Vehicles of the interbay transfer equipment are classified into the active vehicle type and the passive vehicle type. Vehicles of the active vehicle type have a mechanism to load/unload a carrier onboard the vehicle, while those of the passive vehicle type use an external mechanism to load/unload a carrier.
   - Vehicles of the active vehicle type are further classified into OHT which is suspended, uses the hoist to load/unload a carrier, and is also used for Intrabay Transport, and With-Arm type which has an arm on the vehicle itself.
   - Vehicles of the passive vehicle type are further classified into the On-Top type, which carries a carrier on the vehicle, and the Hanging type which carries a carrier by hanging it under the vehicle.
   - The conveyer rail type, which has no vehicle but makes a carrier run on the mechanized rail, is also under discussion as well as the above categories.

<table>
<thead>
<tr>
<th>Active Vehicle Type</th>
<th>Passive Vehicle Type</th>
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<tbody>
<tr>
<td>OHT</td>
<td>On-Top</td>
</tr>
<tr>
<td>With Arm</td>
<td>Hanging</td>
</tr>
</tbody>
</table>

*Figure 4.3  Interbay Transport Equipment Types*

4. **What is the definition of AMHS Interoperability?**
   - Interoperability is defined as a standard method that allows the use of the same or different types of AMHS components from different suppliers. Table 4.1 shows different AMHS components that must be interoperable with each other along with the SEMI standard that facilitates this capability.

<table>
<thead>
<tr>
<th>Standard Interface</th>
<th>Interoperable Component #1</th>
<th>Interoperable Component #2</th>
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</thead>
<tbody>
<tr>
<td>E15.1</td>
<td>All Load Ports</td>
<td>PGV, OHT, AGV, RGV</td>
</tr>
<tr>
<td>AMHS Interoperability</td>
<td>AMHS Interbay Transport</td>
<td>AMHS Stockers</td>
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<tr>
<td>IBSEM</td>
<td>AMHS Integrator</td>
<td>Intrabay Transport System Controller (TSC)</td>
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<tr>
<td>Stocker SEM</td>
<td>AMHS Integration System</td>
<td>Stocker Controller</td>
</tr>
<tr>
<td>Transport SEM</td>
<td>AMHS Integration System</td>
<td>Interbay Transport System Controller (TSC)</td>
</tr>
</tbody>
</table>

*Table 4.1  SEMI Standards that all Components to be Interoperable*
• An example is the use of a standard E15.1 load port. This allows AGVs, RGVs, OHTs, and PGVs from different suppliers to be mixed and matched with stockers from different suppliers.
• For interbay, an AMHS interbay transport system can interface with stockers from different suppliers.

5. **How is an emergency stop provided?**
   • Emergency stop should be provided using the standard S2/S8 and CE requirements.

6. **What are the standard communication interfaces?**
   • The Standard communication interfaces for AMHS equipment are SECS-II, GEM, HSMS, and the appropriate SEM for the type of equipment (see Figure 4.4)
   • Interbay Transport Equipment = Transport SEM
   • Intrabay Equipment = Intrabay SEM (IBSEM)
   • Storage Equipment = Stocker SEM

7. **When will interoperable AMHS equipment be required from suppliers?**
   • The first generation 300 mm AMHS equipment is expected to support both hardware and software interoperability for interbay and intrabay from the beginning.

8. **How does GEM relate to Intrabay, Stocker, and Transport SEMs?**
   • Please refer to the SEMI standards for specifications.
   • Intrabay, Stocker, and Transport SEMs build upon GEM and contain specific messages, state models, events, and alarms necessary to control and monitor AMHS equipment.

9. **Should reticle carriers be handled by the same AMHS as lots carriers?**
   • This capability is not required in the I300I/J300 CIM GJG.

10. **Who controls the Equipment Front End Module (EFEM)?**
    • EFEM (Equipment Front End Module) represents the integrated loadport of the production equipment, and is controlled by the factory Host System via a single communication link with the production equipment. The only contact point between AMHS and EFEM is the parallel IO interface defined in E84 SEMI standard.
4.7 Factory Systems Guidelines

4.7.1 Factory Systems

300 mm semiconductor factories are moving toward open standards based factory systems to realize flexibility and cost effectiveness. Software solutions and components from different suppliers need to be interchangeable and interoperable. To achieve this goal, software solutions and components for factory systems must conform to standard functionality, framework, interfaces, and communication protocols.

4.7.2 AMHS Framework

Semiconductor factories that have AMHS require an integration software system to realize automated material movements. The AMHS Integration System must be interoperable with AMHS Equipment Controller and Host Systems from different suppliers. To achieve this goal, the AMHS Integration System must conform to standard communication protocols, state models and interfaces. This includes synchronization and integration of AMHS Equipment as well as integration with the Factory Host systems.

1. When will interoperable AMHS framework be required from suppliers?
   • This has not been decided yet by I300I and J300 and is under discussion. The consortia expect that the standard will be completed by SEMICON Japan 1999, and that implementation to the standard should take no more than 6 months.

2. What is the relationship between AMHS framework and the CIM framework effort that is being discussed in SEMI? Why is there a separate AMHS framework?
   • The AMHS framework started as a separate analysis by I300I and J300 to understand whether the equipment level standardization for 300 mm could be applied to host level systems. Jointly, they agreed that this is possible and have extended GJG standardization activities into the host area. After reviewing the requirements, J300 and I300I have agreed to use the existing CIM framework activities for Material Movement to realize the AMHS framework vision.
   • J300 and I300I have decided to include AMHS framework discussions within the CIM framework "Material Movement standard.” Both efforts are merged into a single effort now to define standards between the AMHS integrated and host (MES) systems.

4.7.3 [NEW] Production Equipment Integration

300 mm factory production equipment integration software must be interoperable with all production equipment. To achieve this goal, this integration software must conform to production equipment communication standards. In addition, this integration software must be interoperable with the factory system. Production equipment integration software must conform to standard functionality, framework, interfaces and communication protocols.

4.7.4 [NEW] Scheduler / Dispatcher

300 mm factory scheduler/dispatcher software must be interoperable with the factory system. To achieve this goal, scheduler/dispatcher software must conform to standard functionality, framework, interfaces and communication protocols with the factory system.
# 5.0 GJG and SEMI Standards Index

## 5.1 SEMI Standards Revision Matrix

Table 5.1 is a matrix that maps Global Joint Guidelines to SEMI standards. This mapping indicates where a SEMI standard is referenced in the GJG document. The table also specifies the revision number of the SEMI standard that should be used by IC makers and suppliers for implementation purposes so that they comply with J300 and I300I requirements in the GJG document.

<table>
<thead>
<tr>
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<th>Standard Title</th>
<th>Revision</th>
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<tr>
<td>1.</td>
<td>SEMI Equipment Communications Standard 2 Message Content (SECS-II)</td>
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<td>1.1 Single Communication Link</td>
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<td>1.6 Fault-Free Date Transitions</td>
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<td>2.6 Carrier ID Reader at E15.1 Load Port</td>
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Table 5.1 Revisions of SEMI Standards Required to Meet GJG Compliance
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| 6. | SECS-II Support for Standard Processing Management Standard | E40.1-0996 | 1.1 Single Communication Link  
1.2 Compliance to Communication Standards  
1.5 Variable Parameter Support  
3.5 Processing Order Control for Equipment Buffer  
5.1 Recipe and Variable Parameter Change Between Wafers  
5.2 Process Parameter Change Between Wafers |
| 7. | Recipe Management Standard (RMS) | E42-0697 | 1.5 Variable Parameter Support |
| 9. | SECS-II Support for ARAMS | E58.1-0697 | 1.3 Utilization and Reliability Management |
| 10. | Provisional Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers | E1.9-0699 | 2.4 PGV (Person Guided Vehicle) Docking Standard  
2.5 Carrier Sensors at E15.1 Load Port  
2.6 Carrier ID Reader at E15.1 Load Port  
4.1 Slot Number and Load Port Number Assignment |
| 12. | Provisional Specification for 300 mm Tool Load Port | E15.1-0200 | 2.1 Bi-directional Load Port  
2.4 PGV (Person Guided Vehicle) Docking Standard  
2.5 Carrier Sensors at E15.1 Load Port  
2.6 Carrier ID Reader at E15.1 Load Port  
2.7 Carrier ID Reader for Internal Buffer Equipment  
2.8 Carrier ID Reader for Fixed Buffer Equipment |
| 13. | Cassette Transfer Parallel I/O Interface | E84-0999 | 2.1 Bi-directional Load Port  
2.2 Interface between Production Equipment and AMHS Equipment  
2.3 Carrier Hand-off Interface Enhancement  
2.5 Carrier Sensors at E15.1 Load Port  
3.2 Equivalent Handshaking for Carrier Hand-off  
3.3 Software-Based Interlocking to Prevent Simultaneous OHT and PGV Operation  
6.1 Interoperable AMHS Equipment |
| 14. | Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers | E47.1-0200 | 2.1 Bi-directional Load Port  
2.4 PGV (Person Guided Vehicle) Docking Standard  
2.5 Carrier Sensors at E15.1 Load Port  
2.6 Carrier ID Reader at E15.1 Load Port |

*Table 5.1  Revisions of SEMI Standards Required to Meet GJG Compliance (continued)*
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| 15.| Provisional Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Carriers | E57-0299 | 2.1 Bi-directional Load Port     
|    |                                                                                 |   | 2.4 PGV (Person Guided Vehicle) Docking Standard                                   
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| 17.| Provisional Specification for 300 mm Cart to E15.1 Docking Interface Port      | E64-0698 | 2.4 PGV (Person Guided Vehicle) Docking Standard                                   |
| 18.| Safety Guidelines for Semiconductor Production equipment                        | S2-93A   | 3.2 Equivalent Handshaking for Carrier Hand-off                                   
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| 19.| Control Job Management (CJM)                                                    | E94-0200 | 1.1 Single Communication Link                                                    
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| 20.| Substrate Tracking (STS)                                                        | E90      | 1.1 Single Communication Link                                                    
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| 21.| Carrier Management (CMS)                                                        | E87-0999 | 1.1 Single Communication Link                                                    
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Table 5.1   Revisions of SEMI Standards Required to Meet GJG Compliance (continued)
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<td></td>
<td></td>
<td></td>
<td>2.8 Carrier ID Reader for Fixed Buffer Equipment</td>
</tr>
<tr>
<td>34.</td>
<td>CIM Framework Global Declarations and Abstract Interfaces</td>
<td>E97-0200</td>
<td>7.1 Factory Systems</td>
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<td></td>
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<td>7.2 AMHS Framework</td>
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<td></td>
<td>7.3 Production Equipment Integration</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>7.4 Scheduler/Dispatcher</td>
</tr>
</tbody>
</table>

*Table 5.1 Revisions of SEMI Standards Required to Meet GJG Compliance (continued)*
### 5.2 GJG and SEMI Standards Gap Matrix

Table 5.2 is a matrix that maps SEMI standards to Global Joint Guidelines. The intention is to show gaps where existing or developing standards do not completely satisfy the requirement set by the GJG. Next steps for the industry is to create new standards or extend existing ones to close these gaps so that integrated circuit manufacturers and suppliers are able to develop products and systems that meet the GJG requirements.

<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Standard Title</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 1. | 1.1 Single Communication Link | • SECS-II (E5)  
• GEM (E30)  
• HSMS (E37)  
• HSMS-SS (E37.1) | Requirement fully met by these standards                                                  |
| 2. | 1.2 Compliance to Communication Standards | • SECS-II (E5)  
• GEM (E30)  
• HSMS (E37)  
• HSMS-SS (E37.1) | Requirement fully met by these standards                                                  |
| 3. | 1.3 Utilization and Reliability Management | • (E10)  
• ARAMS (E58)  
• SECS-II (E5) | Action required for SEMI to review and improve ARAMS                                      |
| 4. | 1.4 Reliable Data Collection | • SECS-II (E5)  
• GEM (30) | Requirement fully met by these standards                                                  |
| 5. | 1.5 Variable Parameter Support | • SECS-II (E5)  
• RMS (E42)  
• Standard Process Management (E40)  
• Control Job Management (E94) | Action required for SEMI to include support for variable parameters in these standards. |
| 6. | 1.6 Fault Free Date Transitions | • SECS-II (E5) | Standards can not meet this requirement.                                                  |
| 7. | 2.1 Bi-directional Load Port | • Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers (E47.1)  
• Provisional Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Carriers (E57)  
• Provisional Specification for 300 mm Tool Load Port (E15.1)  
• Cassette Transfer Parallel I/O Interface (E84)  
• Provisional Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers (E1.9)  
• Parallel I/O Enhancements (E84)  
• Carrier Management (E87) | Requirement fully met by these standards.                                                 |
<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Standard Title</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 8. | 2.2 Interface between Production Equipment and AMHS Equipment | • Cassette Transfer Parallel I/O Interface (E84)  
• Parallel I/O Enhancements (E84) | Requirement not fully met by this standard. |
| 9. | 2.3 Carrier Hand-off Interface Enhancement | • Cassette Transfer Parallel I/O Interface (E84)  
• Parallel I/O Enhancements (E84) | Requirement not fully met by this standard. |
| 10. | 2.4 PGV (Person Guided Vehicle) Docking Standard | • Provisional Specification for 300 mm Cart to E15.1 Docking Interface Port (E64)  
• PGV Docking Flange (E83) | Requirement not fully met by this standard. |
| 11. | 2.5 Carrier Sensors at E15.1 Load Port | • Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers (E47.1)  
• Provisional Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Carriers (E57)  
• Provisional Specification for 300 mm Tool Load Port (E15.1)  
• Provisional Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers (E1.9)  
• Enhanced Carrier Handoff Parallel I/O (E84)  
• Carrier Management (E87) | Requirement not fully met by these standards. |
| 12. | 2.6 Carrier ID Reader at E15.1 Load Port | • Provisional Specification for 300 mm Tool Load Port (E15.1)  
• Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers (E47.1)  
• Provisional Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers (E1.9)  
• GEM (E30)  
• Carrier Management (E87)  
• Carrier ID Reader/Writer Functional Standard (E99) | This requirement is fully met by this standard. |

Table 5.2 Guideline Gap Matrix (continued)
<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Standard Title</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 13 | 2.7 Carrier ID Reader for Internal Buffer Equipment | • Provisional Specification for 300 mm Tool Load Port (E15.1)  
• Carrier ID Reader/Writer Functional Standard (E99) | Requirement not met by this standard. |
| 14 | 2.8 Carrier ID Reader for Fixed Buffer Equipment | • Provisional Specification for 300 mm Tool Load Port (E15.1) | Requirement not met by this standard. |
| 15 | 3.1 Exclusive Access Mode and Mode Change Timing | • Carrier Management (E87) | Requirement is not met by any standard. |
| 16 | 3.2 Equivalent Handshaking for Carrier Hand-off | • Carrier Management (E87)  
• Enhanced Parallel I/O (E84) | Requirement not met by any standard. |
| 17 | 3.3 Software-Based Interlocking to Prevent Simultaneous OHT and PGV Operation | • Enhanced Carrier Handoff Parallel I/O (E84)  
• Carrier Management (E87)  
• Intrabay/Interbay SEM (E82) | Requirement not fully met by this standard. |
| 18 | 3.4 Independent Control of Material Handling and Wafer Processing | • GEM (E30) | Requirement not fully met by any standard. Work must be completed by the industry to meet requirement. |
| 19 | 3.5 Processing Order Control for Equipment Buffer | • Control Job Management (E94)  
• Processing Management (E40) | Requirement not met by any standard. |
| 20 | 3.6 Carrier Transfer Control of Internal Buffer Equipment | • Carrier Management (E87) | Requirement not met by any standard. |
| 21 | 3.7 Internal Buffer Capacity Notification | • Carrier Management (E87) | Requirement not met by any standard. |
| 22 | 3.8 FOUP Open and Close Notification | • Carrier Management (E87) | Requirement not met by any standard. |
| 23 | 4.1 Slot Number and Load Port Number Assignment | • Provisional Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers (E1.9)  
• Carrier Management (E87) | Requirement not fully met by this standard. |
| 24 | 4.2 Empty Carrier Management | • Carrier Management (E87) | Requirement not met by any standard. |
| 25 | 4.3 Carrier Slot Verification | • Carrier Management (E87) | Requirement not met by any standard. |
| 26 | 4.4 Host Control of Wafer Process Order | • Control Job Management (E94)  
• Processing Management (E40) | Requirement not met by this standard. |
| 27 | 4.5 Slot and Carrier Integrity | • Control Job Management (E94) | Requirement not fully met by any standard. |

Table 5.2 Guideline Gap Matrix (continued)
<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Standard Title</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>28.</td>
<td>4.6 Additional Wafer Control after</td>
<td>• Control Job Management (E94)</td>
<td>Requirement not met by any standard.</td>
</tr>
<tr>
<td></td>
<td>Processing or Measurement</td>
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</tr>
<tr>
<td>29.</td>
<td>4.7 Multi-Module Wafer Tracking Events</td>
<td>• Substrate Tracking (E90)</td>
<td>Requirement not met by any standard.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>5.1 Recipe and Variable Parameter Change</td>
<td>• Control Job Management (E94)</td>
<td>Requirement not met by any standard.</td>
</tr>
<tr>
<td></td>
<td>Between Wafers</td>
<td>• Processing Management (E40)</td>
<td></td>
</tr>
<tr>
<td>31.</td>
<td>5.2 Process Parameter Change Between</td>
<td>• Processing Management (E40)</td>
<td>Requirement not met by any standard.</td>
</tr>
<tr>
<td></td>
<td>Wafers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>6.1 Interoperable AMHS Equipment (Interbay</td>
<td>• SECS-II (E5)</td>
<td>Requirement not fully met by these standards.</td>
</tr>
<tr>
<td></td>
<td>and Intrabay)</td>
<td>• Cassette Transfer Parallel I/O Interface (E23)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• GEM (E30)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• HSMS (E37)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• HSMS-SS (E37.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Intrabay/Interbay SEM (E82)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stocker SEM (E88)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Transport SEM (E82)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enhanced Carrier Handoff Parallel I/O Interface (E84)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Physical AMHS Stocker to Interbay Transport System Interoperability (E85)</td>
<td></td>
</tr>
<tr>
<td>33.</td>
<td>7.1 Factory Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>7.2 AMHS Framework</td>
<td>• SECS-II (E5)</td>
<td>Requirement not fully met by these standards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• GEM (E30)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• HSMS (E37)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• HSMS-SS (E37.1)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>• Intrabay/Interbay SEM (E82)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Stocker SEM (E88)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provisional Specification for CIM Framework Domain Architecture (E81)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Guide for CIM Framework Technical Architecture (E96)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CIM Framework Material Movement Group (Doc 2824A)</td>
<td></td>
</tr>
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</table>

Table 5.2 Guideline Gap Matrix (continued)
<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Standard Title</th>
<th>Comments</th>
</tr>
</thead>
</table>
| 35 | 7.3 Production Equipment Integration | • SECS-II (E5)  
• GEM (E30)  
• HSMS (E37)  
• HSMS-SS (E37.1)  
• Carrier Management (E87)  
• Control Job Management (E94)  
• Substrate Tracking (E90)  
• Processing Management (E40)  
• Provisional Specification for CIM Framework Domain Architecture (E81)  
• Guide for CIM Framework Technical Architecture (E96)  
• CIM Framework Global Declarations and Abstract Interfaces (E97) | Requirement not fully met by these standards. |
| 36 | 7.4 Scheduler/Dispatcher       | • SECS-II (E5)  
• GEM (E30)  
• HSMS (E37)  
• HSMS-SS (E37.1)  
• Carrier Management (E87)  
• Control Job Management (E94)  
• Substrate Tracking (E90)  
• Processing Management (E40)  
• Provisional Specification for CIM Framework Domain Architecture (E81)  
• Guide for CIM Framework Technical Architecture (E96)  
• CIM Framework Global Declarations and Abstract Interfaces (E97) | Requirement not fully met by these standards. |

Table 5.2 Guideline Gap Matrix (continued)
### 5.3 GJG and SEMI Standards Requirements Matrix

Table 5.3 is a matrix that maps Global Joint Guidelines and SEMI standards to the types of equipment that must be complied with these requirements.

<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Equipment Type</th>
<th>Standard Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Single Communication Link</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>1.2</td>
<td>Compliance to Communication Standards</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>1.3</td>
<td>Utilization and Reliability Management</td>
<td>B</td>
<td>≥</td>
</tr>
<tr>
<td>1.4</td>
<td>Reliable Data Collection</td>
<td>B</td>
<td>≥</td>
</tr>
<tr>
<td>1.5</td>
<td>Variable Parameter Support</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>1.6</td>
<td>Fault Free Date Transitions</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>1.7</td>
<td>[New] Mechanical Dry Run</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Bi-directional Load Port</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>2.2</td>
<td>Interface between Production and AMHS Equipment</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>2.3</td>
<td>Carrier Hand-off Interface Enhancement</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>2.4</td>
<td>PGV (Person Guided Vehicle) Docking Standard</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Carrier Sensors at E15.1 Load Port</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>2.6</td>
<td>Carrier ID Reader at E15.1 Load Port</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>2.7</td>
<td>Carrier ID Reader for Internal Buffer Equipment</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>Carrier ID Reader for Fixed Buffer Equipment</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>Loadport Backward Compatibility</td>
<td>C</td>
<td>≥</td>
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<tr>
<td>3.1</td>
<td>Exclusive Access Mode and Mode Change Timing</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>3.2</td>
<td>Equivalent Handshaking for Carrier Hand-off</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>3.3</td>
<td>Software-Based Interlocking to Prevent Simultaneous OHT and PGV Operation</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>3.4</td>
<td>Independent Control of Material Handling and Wafer Processing</td>
<td>A</td>
<td>≥</td>
</tr>
<tr>
<td>3.5</td>
<td>Processing Order Control for Equipment Buffer</td>
<td>B</td>
<td>≥</td>
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</table>

**Table 5.3 Guideline and Standards Requirements Matrix**
### Table 5.3  Guideline and Standards Requirements Matrix (continued)

<table>
<thead>
<tr>
<th>#</th>
<th>CIM GJG Reference</th>
<th>Priority</th>
<th>Equipment Type</th>
<th>Standard Name</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Process Equipment - Fixed Buffer</td>
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<tr>
<td></td>
<td></td>
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<td>Process Equipment - Internal Buffer</td>
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<td></td>
<td></td>
<td></td>
<td>Metrology - Fixed Buffer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metrology - Internal Buffer</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Carrier Transfer Control of Internal Buffer Equipment</td>
<td>A</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>Internal Buffer Capacity Notification</td>
<td>A</td>
<td>✓</td>
<td></td>
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<tr>
<td>3.8</td>
<td>FOUP Open and Close Notification</td>
<td>A</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Slot Number and Load Port Number Assignment</td>
<td>A</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Empty Carrier Management</td>
<td>A</td>
<td>✓</td>
<td></td>
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<tr>
<td>4.3</td>
<td>Carrier Slot Verification</td>
<td>A</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Host Control of Wafer Process Order</td>
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</tr>
<tr>
<td>4.5</td>
<td>Slot and Carrier Integrity</td>
<td>A</td>
<td>✓</td>
<td></td>
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<td>4.6</td>
<td>Additional Wafer Control after Processing or Measurement</td>
<td>A</td>
<td>2 2 2 2</td>
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<td>4.7</td>
<td>Multi-Module Wafer Tracking Events</td>
<td>B</td>
<td>2 2 2 2</td>
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<tr>
<td>5.1</td>
<td>Recipe and Variable Parameter Change Between Wafer</td>
<td>A</td>
<td>2 2 2 2</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Process Parameter Change Between Wafer</td>
<td>C</td>
<td>2 2 2 2</td>
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<td>6.1</td>
<td>Interoperable AMHS Equipment (Interbay and Intrabay)</td>
<td>A</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Factory Systems</td>
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<td>7.2</td>
<td>AMHS Framework</td>
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</tr>
<tr>
<td>7.3</td>
<td>[New] Production Equipment Integration</td>
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</tr>
<tr>
<td>7.4</td>
<td>[New] Scheduler/Dispatcher</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

✓ = Required; 1 = Manual and Intrabay input port only; 2 = Single wafer process equipment only;
6.0 Vision Document Next Steps

The objective of the vision document is to ensure proper and consistent implementation of the J300/I300 Global Joint Guidance. In Phase I, our focus has been on providing an integrated view of a 300 mm factory from an IC manufacturers perspective and giving background and motivation for most of the guidelines. We have also provided a list of frequently asked questions and their answers. All of these actions have been taken with the objective that suppliers and IC manufacturers alike have a broader perspective on how guidelines and standards will be implemented. It is expected that this understanding of the objectives will drive toward consistent implementations that help achieve cost effective manufacturing.

Each of the IC manufactures that have contributed to this document have factories with slightly to widely different operational models. 300 mm will force a reduction in these variations simply through constraints that all users will have from a material handling perspective. In addition, the standards themselves will further narrow operational model variance as many of the building blocks for a factory will be very well defined. From a business perspective, however, there will always be fundamental differences in some operational models driven primarily by High Volume / Low Mix and High Volume / High Mix environments.

In Phase II of the vision document, we focused on providing greater details on what an integrated 300 mm factory will look like from an operations perspective. This includes a more detailed description of how these guidelines will be used as building blocks to support High Volume / Low Mix and High Volume / High Mix integrated factories in a cost effective manner.

Finally, I300I and J300 expect this document to be refined over time as improvements are made to new and existing standards. In 1999, it is expected that many of the current ballot initiatives will become full or provisional SEMI standards. Suppliers are expected to implement these new standards into their products in an expedient manner. We also recognize that standards will continue to be improved and revised over time. It is not our intention that all standards improvements will be adopted immediately by the industry and its supply base. We will review all changes on a case by case basis to determine whether we want to change the industry requirements. To ensure a level set within the industry, Table 5.2 will be revised to show all current expectations by I300I and J300 regarding standards required from suppliers.
7.0 Summary

The ultimate purpose of the J300/I300I Global Joint Guidelines is cost reduction. The guidelines are a summary of consensus requirements from device manufacturers, and how to realize them concretely has been discussed in the development efforts of SEMI standards. In order to get the result of the cost reduction, however, device manufacturers should require with one accord the implementation of SEMI standards based on the guidelines of the equipment manufacturers. Since the requirements are discussed openly while the guidelines are examined by J300-I300I, we are expecting that the device manufacturers will keep in step. Another important thing is that the guidelines and SEMI standards should be interpreted and used correctly. How to eliminate needless variations derived from minor differences is also important. This document is developed in expectation of facilitating the correct interpretation of the guidelines and helping the standardization function effectively. We intend to promote various plans so that the guidelines and SEMI standards are complied.
Appendix A – References

3. SEMICON Kansai, “J300 CIM/Automation, Standardization Status”, SEMI Japan, 1998/6
Appendix B – Contact Information

For more information about this document or referenced, please contact the following:

**J300E CIM Working Group**

Address: Electronic Industries Association of Japan (EIAJ)
3-2-2 Marunouchi, Chiyoda-ku, Tokyo 100, Japan

Phone: +81-3-3213-1065
Fax: +81-3-3211-0993

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Phone</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michio Honma</td>
<td>NEC</td>
<td>+81-42-779-6305</td>
<td><a href="mailto:Michio_honma@sgm-vme02.ccgw.nec.co.jp">Michio_honma@sgm-vme02.ccgw.nec.co.jp</a></td>
</tr>
<tr>
<td>Giichi Inoue</td>
<td>Toshiba</td>
<td>+81-45-770-3273</td>
<td><a href="mailto:g-inoue@amc.toshiba.co.jp">g-inoue@amc.toshiba.co.jp</a></td>
</tr>
<tr>
<td>Koji Kitajima</td>
<td>Toshiba</td>
<td>+81-45-770-3273</td>
<td><a href="mailto:kitajima@amc.toshiba.co.jp">kitajima@amc.toshiba.co.jp</a></td>
</tr>
<tr>
<td>Tadashi Kiriseko</td>
<td>Fujitsu</td>
<td>+81-44-754-3423</td>
<td><a href="mailto:kiriseko@cim.ed.fujitsu.co.jp">kiriseko@cim.ed.fujitsu.co.jp</a></td>
</tr>
<tr>
<td>Satoshi Kono</td>
<td>Fujitsu</td>
<td>+81-44-754-3423</td>
<td><a href="mailto:kono@cim.ed.fujitsu.co.jp">kono@cim.ed.fujitsu.co.jp</a></td>
</tr>
<tr>
<td>Takayuki</td>
<td>Hitachi</td>
<td>+81-29-270-2663</td>
<td><a href="mailto:wakabayt@cm.musashi.hitachi.co.jp">wakabayt@cm.musashi.hitachi.co.jp</a></td>
</tr>
<tr>
<td>Jyunji Iwasaki</td>
<td>Mitsubishi Electric</td>
<td>+81-727-84-7083</td>
<td><a href="mailto:iwasaki.junji@lsi.melco.co.jp">iwasaki.junji@lsi.melco.co.jp</a></td>
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**I300I CIM Study Group**

Address: International 300 mm Initiative
2706 Montopolis Drive, Austin, Texas, 78741

Phone: (512) 356-3232
Fax: (512) 356-7080

Web: www.sematech.org/public/division/300/guide.htm

Note: All documents (GJG, Vision, etc.) can be downloaded free from the Sematech.

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<th>Name</th>
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<tr>
<td>Blaine Crandell</td>
<td>TI</td>
<td>+1-972-927-5844</td>
<td><a href="mailto:b-crandell@ti.com">b-crandell@ti.com</a></td>
</tr>
<tr>
<td>Gino Crispieri</td>
<td>Intel Sematech</td>
<td>+1-512-356-7547</td>
<td><a href="mailto:gino.crispieri@intel.sematech.org">gino.crispieri@intel.sematech.org</a></td>
</tr>
<tr>
<td>Dave Bloss</td>
<td>Intel</td>
<td>+1-480-554-1099</td>
<td><a href="mailto:david.a.bloss@intel.com">david.a.bloss@intel.com</a></td>
</tr>
<tr>
<td>Nehal Desai</td>
<td>Intel</td>
<td>+1-480-552-7925</td>
<td><a href="mailto:nehal.g.desai@intel.com">nehal.g.desai@intel.com</a></td>
</tr>
<tr>
<td>Len Foster</td>
<td>TI</td>
<td>+1-972-995-3626</td>
<td><a href="mailto:fos2@ti.com">fos2@ti.com</a></td>
</tr>
<tr>
<td>Karl Gartland</td>
<td>IBM</td>
<td>+1-802-769-2529</td>
<td><a href="mailto:kgartlan@us.ibm.com">kgartlan@us.ibm.com</a></td>
</tr>
<tr>
<td>Bob Hodges</td>
<td>TI</td>
<td>+1-972-927-5932</td>
<td><a href="mailto:bhodges@ti.com">bhodges@ti.com</a></td>
</tr>
<tr>
<td>Dave Partington</td>
<td>SEMI-NA</td>
<td>+1-512-301-2568</td>
<td><a href="mailto:partingd@admin.inetport.com">partingd@admin.inetport.com</a></td>
</tr>
<tr>
<td>Jeffrey Pettinato</td>
<td>Intel</td>
<td>+1-480-554-4077</td>
<td><a href="mailto:jeffrey.s.pettinato@intel.com">jeffrey.s.pettinato@intel.com</a></td>
</tr>
<tr>
<td>Dev Pillai</td>
<td>Intel</td>
<td>+1-480-554-5178</td>
<td><a href="mailto:devadas.pillai@intel.com">devadas.pillai@intel.com</a></td>
</tr>
<tr>
<td>Margaret Pratt</td>
<td>SEMATECH</td>
<td>+1-512-356-3107</td>
<td><a href="mailto:margaret_pratt@sematech.org">margaret_pratt@sematech.org</a></td>
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</tr>
<tr>
<td>Stefan Radloff</td>
<td>Intel</td>
<td>+1-480-554-1062</td>
<td><a href="mailto:stefan.e.radloff@intel.com">stefan.e.radloff@intel.com</a></td>
</tr>
<tr>
<td>Ed Sherwood</td>
<td>IBM</td>
<td>+1-914-894-4161</td>
<td><a href="mailto:sherwood@us.ibm.com">sherwood@us.ibm.com</a></td>
</tr>
<tr>
<td>Alex Stewart</td>
<td>Intel</td>
<td>+1-480-554-5327</td>
<td><a href="mailto:alex.f.stewart@intel.com">alex.f.stewart@intel.com</a></td>
</tr>
<tr>
<td>Stephen Sumner</td>
<td>Intel</td>
<td>+81-3-5223-9313</td>
<td><a href="mailto:stephen.w.sumner@intel.com">stephen.w.sumner@intel.com</a></td>
</tr>
<tr>
<td>Jeff Toth</td>
<td>AMD</td>
<td>+1-512-602-2343</td>
<td><a href="mailto:jeff.toth@amd.com">jeff.toth@amd.com</a></td>
</tr>
<tr>
<td>Harald Linde</td>
<td>Siemens</td>
<td>+49-351-886-2072</td>
<td><a href="mailto:haraldlinde@sc300.de">haraldlinde@sc300.de</a></td>
</tr>
<tr>
<td>Randy Goodall</td>
<td>I300I</td>
<td>+1-512-356-7622</td>
<td></td>
</tr>
</tbody>
</table>

**Semiconductor Equipment and Materials International (SEMI)**

W. Murray Bullis  
Vice President of International Standards  
Phone:+1-650-940-7980  
Fax: +1-650-940-7943

**SEMI - Japan**

Naoko Tani  
Vice President of Japan Standards  
Phone: +81-3-3222-5755  
Fax: +81-3-3222-5757
Appendix C – Key Document Contacts

*Bold denotes the primary section author.

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### 5.0 GJG and SEMI Standards Index

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Table C.1  Key Vision Document Contacts (continued)
Appendix D – Glossary

**Access Mode** — the way in which carriers can be loaded or unload from a load port. This can be either automatic or manual.

**AMHS Route** — Material’s path between AMHS equipment and/or production equipment loadports.

**Automatic Guided Vehicle (AGV)** — Floor based Vehicle with Robot Arm, operates without the need for operator assistance.

**Automated Material Handling System (AMHS)** — an automated system to store and transport materials within the factory.

**Automation** — the capability of managing material and data within the factory.

**Automatic Access Mode** — the state in which the AMHS (OHT/AGV/RGBV) may access the load port.

**Available Buffer Capacity** — the number of additional carriers the equipment is able to accept.

**Batch** — a group of product that is processed simultaneously. Depending on the process technology and equipment architecture, the size of the batch may be greater or less than the size of a carrier.

**Bi-directional load port** — a load port used for loading and unloading carriers.

**Buffer** — a set of one or more locations for holding carriers at the production equipment.

**Carrier** — a FOUP or Open cassette used to hold wafers for transport or during process.

**Carrier ID** — a readable and unique identifier for the carrier.

**Carrier/Slot Map** — a map showing which slot in a carrier has a wafer present.

**Chemical Mechanical Polishing (CMP)** — Process used in Semiconductor manufacturing for planarizing wafers or removing excess material from the surface of the wafer.

**Continuous Hand-off** — two or more carrier movements occurring in immediate sequence between AMHS and/or production equipment. For example, one carrier is unloaded from a production equipment loadport, and then another carrier is loaded to the same loadport.

**Equipment Front End Module (EFEM)** — a subsystem of production equipment that includes load ports, carrier ID readers, internal buffers, carrier openers, and E23 interfaces. This provides the primary interface to the factory material handling system.

**Fixed buffer equipment** — production equipment that has only fixed load ports and no internal buffer for carrier storage. Wafers are loaded and unloaded directly from the carrier at the load port for processing. Refer to figure E3.

**FIMS Position** — the position on a load port where the carrier is docked to the production equipment.

**FOUP** — Front Opening Unified Pod used for holding wafers. Refer to figure D1.

**Fully GEM Capable** — use definition from the GEM specification.

**Hand-off** — The act of moving a carrier between a loadport and a material handling system. A hand-off is normally associated with the transfer of ownership and responsibility for the carrier.

**Host** — the factory computer system, or an intermediate system, that represents the factory and the user to the equipment [SEMI E58].

**ID Tag** — a readable and writeable device attached to the carrier.

**Internal buffer** — locations within the equipment to store carriers. These locations exclude load ports.

**Internal buffer equipment** — equipment that uses an internal buffer. Refer to E3.
**Load port** — the interface location on the equipment where carriers are delivered.

**Lot** — a group of product that is traced as a unit of work that moves through a sequence of process steps in the factory.

**LPU Backward Compatibility** — refers to the ability of LPUs used on more recent equipment versions of the same model to be interoperable with earlier versions of that equipment and continue to meet SEMI E15.1. Furthermore, more recent versions of LPUs must be interoperable not only with the current equipment versions, but also earlier equipment versions.

**Metrology Equipment** — equipment used to inspect or measure wafers. This excludes process and material handling equipment.

**Multi-Module Equipment** — Production equipment that consists of multiple process module, such as wetsink(s) and/or chamber(s).

**Open Cassette** — an open structure that holds one or more wafers. Refer to D2

**Operator Interface** — the terminal on the equipment which the operator can use to supply instructions to the equipment.

**Overhead Shuttle (OHS)** — Rail guided vehicle, over head mounted with shuttle

**Overhead Hoist Transport (OHT)** — Rail guided vehicle, over head mounted with hoist

**Overhead Hoist Vehicle (OHV)** — Vehicle used to transport Material above the factory floor and the heads of fab personnel. These vehicles are on rail system.

**Person Guided Vehicle (PGV)** — Ground based Vehicle, without Electrical Assist, directed and moved by Fab personnel

**Person Rail Guided Vehicle (PRV)** — Gound based Vehicle guided by rails but moved by Fab Personnel without Electrical Assist.

**Process Equipment** — equipment used to make semiconductor devices. This excludes metrology and material handling equipment.

**Processing Instructions** — host direction on which wafers to process with which recipe.

**Production equipment** — equipment used to produce semiconductor devices, including wafer sorting, process, and metrology equipment and excluding material handling equipment.

**Quick Turn Around Time Lots (QTAT)** — Material in the fab meant to moved rapidly thru it’s process routing. These may be product, pilot or send ahead wafers, or monitors.

**Rail guided Vehicle (RGV)** — Vehicle guided with rails with Robot, floor mounted

**Recipe** — The predefined and reusable portion of the set of instructions, settings, and parameters on equipment that determine the processing environment seen by the wafers. It may be subject to change between runs or processing cycles.

**Scheduler/Dispatcher** — Factory systems component responsible for optimizing factory productivity by recommending coordinated production, transport, and maintenance activities based on current factory status and prioritization policies.

**Simultaneous Hand-off** — two or more carrier movements occurring in parallel between AMHS and/or production equipment. For example, two carriers are loaded at the same time to a piece of production equipment.

**Single Wafer Process Equipment** — equipment used to make semiconductor devices in which wafers are handled and processed individually. This excludes metrology, wafer sorting, and material handling equipment.
**Single Wafer Production Equipment** — equipment used to produce semiconductor devices in which wafers are handled and processed individually. This includes wafer sorting, process, and metrology equipment and excludes material handling equipment. The wafers are handled and processed individually.

**Slot-to-slot integrity** — all wafers removed from a carrier are returned to the same slot in the same carrier from which they were originally removed.

**Total Buffer capacity** — The total number of carrier locations of internal buffer.

**Transfer Command** — A command issued to move material within AMHS equipment.

**Variable Parameter** — A formally defined setting (parameter) included in the body of a recipe which permits the actual value to be supplied externally.