AN OVERVIEW OF FACTORY AUTOMATION REQUIREMENTS AND DESIGN

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Foreword

Publication of this document as Auxiliary Information independent of any standards was authorized by a 2/3-majority vote of the North American Information and Control (I&C) Committee at a meeting on March 2, 2000. This action was subsequently approved by the I&C Global Coordinating Subcommittee by email ballot on April 10, 2000 and by the NA Regional Standards Committee by electronic ballot on April 10, 2000.

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The Semiconductor Equipment and Materials International (SEMI®) Software Roadmap Working Group (SWWG) originally requested publication of this information. The SEMI SWWG determined that having publicly available examples of factory automation requirements and selected scenarios that have been successfully applied would be beneficial to the industry. The examples in this document have been applied in a working semiconductor FAB, using 200-mm wafers with SMIF and RF Carrier ID tags. No assessment of their applicability to other factory environments has been made.

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REVISION 2 – Oct 28, 1999

Advanced Micro Devices

FAB 30 FACTORY AUTOMATION PROGRAM

AN OVERVIEW OF FACTORY AUTOMATION REQUIREMENTS AND DESIGN

Developed in conjunction with:

SYSTEMS & INFORMATION TECHNOLOGY GROUP

INTEGRATED SUPPLY CHAIN SOLUTIONS

Approved for Issue: _____

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Approval Date: October 28, 1999

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SECTION 1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide a high level overview of the 200mm factory automation strategy and design implemented by Advanced Micro Devices Saxony Manufacturing Group GmbH in AMD's FAB30, Dresden Germany, as it applies specifically to Process and Metrology machine tool supplier requirements.

1.2 SCOPE

The scope of this document is to provide a broad understanding of the basic machine tool design philosophy implemented by AMD in FAB 30. It is hoped that this information will provide useful for other semiconductor manufacturers to draw upon in developing their own detailed factory automation requirements and equipment designs for their 200mm factories.

1.3 BACKGROUND

The goal of the AMD Automation and CIM groups was to have, wherever possible, a consistent automation implementation across the tool set, both from the perspective of the FACTORY HOST computer system as well as from the Wafer Fab Technician's (WFT's). This required that all tools in the factory provide both a common set of predefined computer instructions and also a consistent set of material handling and loading characteristics.

AMD FAB30 was conceived from its earliest phases as a factory where a tool supplier's SMIF, Mini-Environment, and factory automation capabilities were to be given heavy consideration as a part of the procurement process in addition to evaluating a tools process or metrology capability. Automation was not an afterthought or something to bolt on later but given every consideration from the beginning of the tool's requirements definition, the supplier fact-finding, as will as the bid and selection process.

A technical Supplier Management capability was developed which allowed AMD to monitor a supplier's progress against the AMD Capital Equipment Procurement Document (CEPD) during procurement and, upon selection, supplier development. This capability also provided for Supplier source inspection as well as receiving inspection to insure that the CIM, SMIF, MENV, and AUTOMATION requirements that were agreed to by the suppliers were in fact delivered. A separate document that details the history of technical supplier management for automation is currently under development at AMD and may be released outside of AMD in the future.

1.4 COMMENTS AND FEEDBACK

Comments and feedback on this document should be addressed to the following, preferably via email.

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1.5 REFERENCED DOCUMENTS

No.	Title
1.	AMD Capital Equipment Procurement Document Appendix A Version 5.2
2.	AMD Move In – Move Out Scenarios Document Version 4.0
3	AMD AutoId System Technical Notes Document Version 4.0
4	

1.6 DOCUMENT DEVELOPMENT HISTORY

Date	Description	Name
09 July 99	Revision 1.0 – Initial Release	Thomas Hogel
28 Oct 99	Revision 2.0 – Document updated for SEMI publication 1. Specific reference to commercial MES system replaced with “MES” in Section 10: Material Move-In Scenario. 2. Minor typographical errors corrected in Section 1 and Section 3.	Les Marshall

SECTION 2.0 EQUIPMENT SUPPLIER AUTOMATION STANDARDS

2.1 STANDARDS

AMD FAB 30 Equipment Suppliers were required to conform to the following list of Standards as they apply to factory automation, where applicable. Where significant deviation was reported by a supplier during the fact-finding process or discovered during Source Inspection a careful evaluation and review was undertaken. The areas of least compliance were found to be with SEMI E10 and SEMI E30 as well as the load port height requirements in SEMI E19.

2.1.1 Federal Standards

Fed-Std-209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones.

2.1.2 SEMI Standards

SEMI E5	Equipment Communication Standard 2 Message Content (SECS II).
SEMI E14	Measurement of Particle Contamination Contributed to the Product from the process or support tools.
SEMI E15	Specification for Inter-Equipment Material Transport Interface.
SEMI E19	Standard Mechanical Interface (SMIF).
SEMI E23	Specification for Cassette Transfer Parallel I/O Interface.
SEMI E30	Generic Model for Communications and Control of SEMI Equipment.
SEMI E44	Guideline for Procurement and Acceptance of Mini Environments.
SEMI E47	Specification for 150/200 mm Pod Handles.
SEMI E48	Specification for SMIF Indexer Volume Requirement.
SEMI E50	Integrated SMIF Indexer Application Model for the Sensor/Actuator Network.
SEMI T4	Specification for 150 mm and 200 mm Pod Identification Dimensions.

SECTION 3.0 THE FULLY INTEGRATED AUTOMATION SOLUTION

Equipment suppliers to FAB 30 were required to take responsibility and to provide a fully operational and integrated piece of equipment from their factory. Integration on the shop floor was not allowed. From the perspective of CIM and Automation this required that the SMIF unit, the Lot Identification Hardware (AutoId System), and the SECSII/GEM Interface be under the control of the tool's computer hardware sub-system. From the perspective of interfacing the equipment to the Factory Host System this required using a single integrated communications link.

3.1 THE SINGLE WIRE SOLUTION

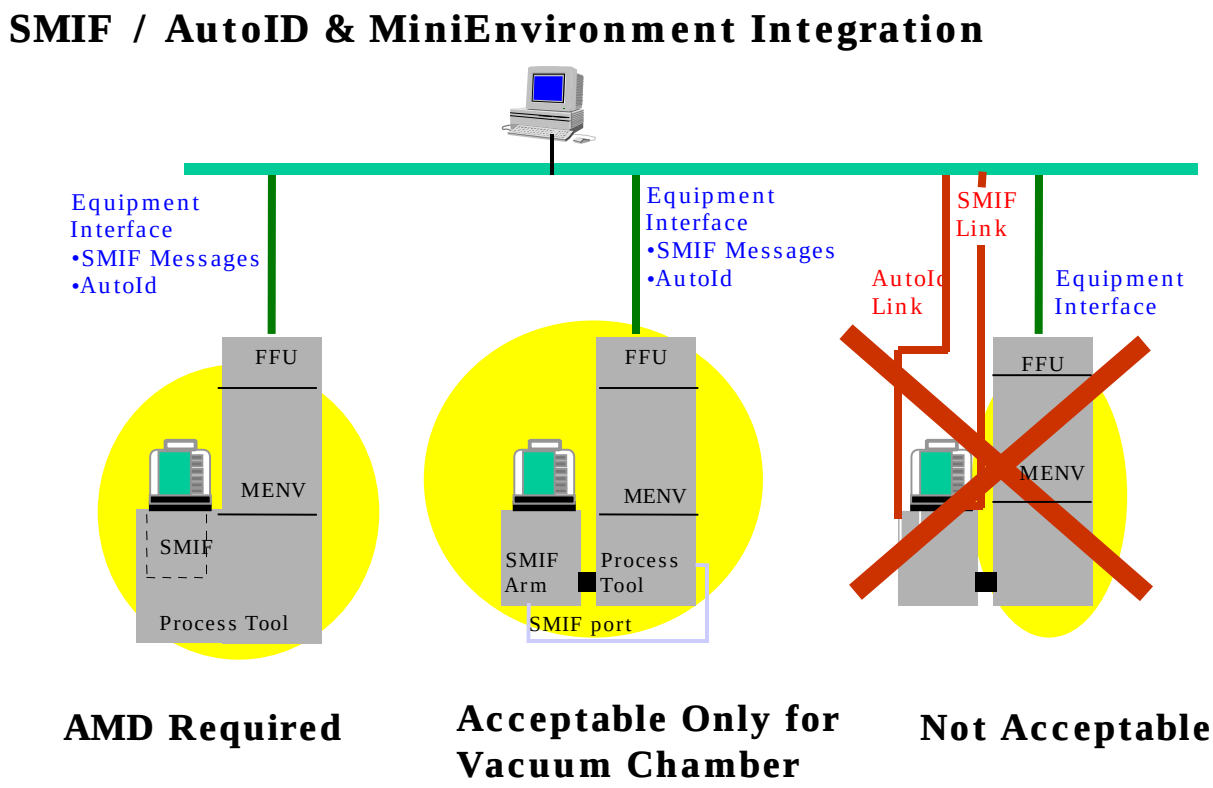


Figure 1-3 SMIF / AutoId & Mini-Environment Design

SECTION 4.0 EQUIPMENT COMMANDS

There are two basic command sets required of all tools within the FAB30 environment. OPERATOR COMMANDS and HOST COMMANDS. While similar, the major differences are that an operator is not required to enter Wafer Map or Cassette Map data when running the tool from the GUI.

4.1 OPERATOR COMMANDS

Operator Command	description	requires privilege	Mode	status
ACCEPT-LOT	the equipment needs a means to input material without automated material I.D. (not in normal process mode)			required
START	start process	No	normal	required
Confirm-START	the equipment starts processing after loading and material id validation after Confirm-START only. This capability can be switched on/off.	No	can be switched on/off	required
STOP	stop actual activity	No	normal	required
PAUSE	pause actual activity	No	normal	required
GO_LOCAL	enter local control mode	No	normal	optional
GO_REMOTE	enter remote control mode	No	normal	optional
PP-SELECT (1)	set current recipe	No	normal	required
CLAMP	clamp the pod on the port	Yes	maint.	optional
UNCLAMP	unclamp the pod on the port	No	normal	required
OPEN-POD	open the pod	Yes	maint.	optional
CLOSE-POD	close the pod	Yes	maint.	optional
SMIF-PORT-DOWN	move the SMIF port plate down	Yes	maint.	optional
SMIF-PORT-HOME	move the SMIF port plate home (up)	Yes	maint.	optional
OPEN-DOOR	open the equipment load lock door	Yes	maint.	optional
CLOSE-DOOR	close the equipment load lock door	Yes	maint.	optional
PUT-CASSETTE	put cassette from pod bottom plate into equipment	Yes	maint.	optional
GET-CASSETTE	get cassette from equipment onto pod bottom plate	Yes	maint.	optional
RE-SCAN	initiate a re-scan of the cassette slot map	Yes	maint.	optional
INITIATE-ID	initiate the Id transceiver to read	No	normal	required
ENTER-ID	operator enters material Id	configurable	normal	required
CONFIRM-ID	operator confirms that the material Id determined by the equipment is valid for being processing	configurable	normal	required

Figure 1-4 Operator Command Table

4.2 REMOTE COMMANDS

Command (RCMD)[1]	In Local State		In Remote State	
	From Panel	From S2F41	From Panel	From S2F41
PP-SELECT. The equipment selects one or more Process Programs for processing.	Yes	No	Yes/ No[1]	Yes
START. The equipment start processing. The exact meaning is Equipment-defined.	Yes	No	Yes/ No[1]	Yes
GO-LOCAL	No	No	Yes	No
GO-REMOTE	Yes	No	No	No
SMIF_PORT_DOWN: Move SMIF port plate down (optional).	Yes	No	No	No
SMIF_PORT_HOME: Move SMIF port plate up/home (optional).	Yes	No	No	No
OPEN_POD: Open the pod (optional).	Yes	No	No	No
CLOSE_POD: Close the pod (optional).	Yes	No	No	No
CLAMP: Clamp the pod.	Yes	No	No	No
UNCLAMP: Release the pod clamps.	Yes	No	Yes	Yes
LOAD: Open pod, move port plate down and load equipment (includes OPEN_POD, SMIF_PORT_DOWN, MAP_CASSETTE, and PUT_CASSETTE).	Yes	No	Yes	Yes
UNLOAD: Unload equipment move port plate home and close pod (includes CLOSE_POD, SMIF_PORT_UP, and GET_CASSETTE).	Yes	No	Yes	Yes

[1]Configurable by customer.

Figure 2-4 Remote Command Table

[1] SEMI E30 4.4 Remote Commands, specifically 4.4.3; data items PTN, MID, EMID, PPID etc. see SEMI E5

SECTION 5.0 COLLECTION EVENTS

Two types of collection events are possible under GEM processing. The first is where a unique collection event is sent for every state transition. The second is where a sub-system within the machine will send one collection event but within that collection event will exist differing state values. Both unique collection events and the use of a common collection event with unique state numbers were acceptable for FAB 30 equipment. When a common collection was used each sub-system must use a unique collection event. For example, the collection events would be different for the SMIF port system compared to the cassette handling system.

COLLECTION EVENT NAME/LABEL	EQUIPMENT CONFIGURATION OR FUNCTION	EVENT DESCRIPTION	VIDs VALID UPON EVENT
Pod has been placed on port		Pod arrived	PTN, I/OPortState
Pod clamped		Pod has been clamped by port	PTN,I/OPortState
Pod unclamped		Pod has been unclamped by port	EMID, PTN, MID
EMID available		The Id transceiver has recognized the EMID of the newly arrived material.	EMID, PTN, MID
Scan data available		Slot contents has been scanned	PTN,EMID,MID, CassetteSlotMap, CassetteWaferMap
LOAD COMPLETE		Cassette has been transferred into equipment	PTN, EMID, MID
UNLOAD COMPLETE		Cassette has been transferred back to pod	PTN,MID,EMID, I/OPortState
SMIF indexer up		Port plate arrived in home (top) position	PTN, I/OPortState
Pod removed		Pod has been removed from port	PTN
Port$_n$ Door Open	Equipped with doors on I/O ports	Material input/output port “n” door has just opened.	PTN, CommandParms
Port$_n$ Door Closed	Equipped with doors on I/O ports	Material input/output port “n” door has just closed.	PTN, CommandParms
Door$_n$ Open	Equipped with internal doors	Door “n” on system has just opened.	PTN, CommandParms
Door$_n$ Closed	Equipped with internal doors	Door “n” on system has just closed.	PTN, CommandParms
SMIF port reset started		Reset of SMIF port has been started	PTN, I/OPortState
SMIF port reset complete		Reset of SMIF port has been completed	PTN, I/OPortStae

Figure 1-5 Table of Collection Events

SECTION 6.0 GEM DATA ITEM VARIABLES

The following information lists the minimum set of GEM data item variables required for each FAB 30 tool. Format 00 means that the equipment manufacturer may select a valid SECS data format

_____AutoStart Class: ECV Format: 00

Determines whether processing starts immediately, after the host has specified a Process Job (PP-SELECT with MID, PPID and optional WaferID's with PPID's) and the ECV "CheckMaterialId" is set to "not wait" and an EMID shows up at a port that matches MID.

_____BatchID$_n$ Class: SV Format: 20

Identifier of a batch definition.

_____CassetteID$_n$ Class: SV Format: 20

Identifier of the current cassette at location$_n$.

_____CassetteSlotMap$_n$ Class: SV Format: 10

Map of a cassette specifying the presence of wafer in slots. The cassette map is identified and made available to the host during loading at the input and during unloading at the output SMIF port. ASCII.

0 = slot empty

1 = slot occupied

2 = cross slot situation

3 = double slot situation

[25] = array of 25 per Map

_____CassetteWaferMap$_n$ Class: SV Format: 20

Identifiers of the wafer, in Wafer ID format, at location$_n$ in the cassette. The Wafer Identity Map can be transferred to the equipment from the host computer after loading and can be determined before unloading (the cassette map is logically transferred to the output cassette together with the physical wafer movement).

[25] = Array of 25 **WaferIds** per Map

[n] = One array per port

_____CheckCassetteMap Class: ECV Format: 00

This equipment constant switches the cassette map validation during loading of a pod on/off.

_____CheckMaterialId Class: ECV Format: 00

This equipment constant switches the behavior of equipment during material Id validation. If set to a value meaning "wait" for host confirmation, the equipment will read a material id (EMID) and wait for the host to either send an UNCLAMP host command (reject lot) or a PP-SELECT and START host command (process lot). If the constant is set to do "not wait" for host confirmation, the equipment will check, whether the host has already issued a PP-SELECT including a material id (MID) that matches the EMID. If MID matches EMID, the equipment will proceed to the next step. If MID does not match EMID, the equipment will autonomously reject the lot (perform UNCLAMP). The flow of material id validation is displayed on the equipment terminal.

_____CommandParms Class: DVVAL Format: 00

List of parameter name/value pairs associated with a given command issued to the equipment by either the host or operator panel. The parameter list must be sufficient to distinguish the exact nature and intent of the command on the equipment and its subsystems (if applicable). For example, the list of parameters might include such items as job ID, material ID, operator ID, process program ID, subsystem ID, command ID, material transfer source and destination locations, etc. The contents of the list must be structured as follows (equivalent to the structure of a Host Command Send, S2F41 message):

L,2

1. <RMCD>

2. L,n (n = number of parameters)

1. L,2

1. <CPNAME$_1$> parameter 1 name

2. <CPVAL$_1$> parameter 1 value

n. L,2

1. <CPNAME$_n$> parameter n name

2 <CPVAL$_n$> parameter n value

The above list value is valid upon the occurrence of any queued operator panel command and the initiation of a queued operator or host command.

_____DestinationID Class: DVVAL Format: 54

Destination location of an internal material transfer occurring on the equipment. Value is valid only upon detection of an internal material transfer.

_____E10State Class: Format: 00

Determines the machine state as per SEMI E10.

_____EquipID Class: ECV Format: 54

Equipment identifier. Enables host assignment of factory-specific equipment identifiers.

_____EquipName Class: ECV Format: 20

Equipment name. Enables host assignment of factory-specific equipment names. Maximum of 32 characters.

_____EquivalentMaterialID$_{s,n}$ Class: DVVAL Format: 20

ASCII identifier of an equivalent material ID determined by the equipment. The EMID is a defined unit of material residing at location "n" on system. This would be for each Material Input / Output Port. The length is ASCII 16 per SEMI E5.

_____IOPortState$_n$ Class: SV Format: 10

State of a given material transfer port$_n$ on the equipment. See the State tables for SMIF Port Loading, SMIF port unloading, Cassette transfer into equipment, cassette transfer out of equipment and material Identification. Each SMIF port and cassette transfer port will uniquely manage data items separately from those of the other ports.

_____InitialControlState$_{s,n}$ Class: ECV Format: 00

Determines whether the equipment goes to local or remote control state after power-up or initialize.

_____InitialCommunicationState$_{s,n}$ Class: ECV Format: 00

Determines whether the equipment goes to on-line of off-line communication state after power-up or initialize.

_____MaterialID$_{s,n}$ Class: DVVAL Format: 20

ASCII identifier of a factory-defined (host downloaded or operator defined) unit of material residing at location "n" on system. The length is ASCII 16 per SEMI E5.

_____NotificationTimeout Class: DVVAL Format: 50

Determines the time-out in seconds for advanced notification of cassettes or batch completion.

_____SubsystemID Class: DVVAL Format: 32

Identifier of a subsystem on the equipment. Parameter is to be used in reports identifying the current subsystem associated with an event occurring on the subsystem. Thus, it is valid for all events defined specifically for the subsystem.

_____SubsystemNumber Class: DVVAL Format: 20

Identifier of the currently referenced process chamber. Parameter is to be used in reports identifying the current subsystem associated with an event occurring on the subsystem. Thus, it is valid for all events defined specifically for the subsystem.

_____SmifRunCountS Class: SV Format: 50

Counter indicating the absolute number of runs which has been started on subsystems of the equipment. Value starts at zero for new equipment and continues to increment throughout the life of the equipment. This SV is re-set to zero from the equipment User Interface as defined by equipment maintenance procedures.

_____WaferIDS, Class: DVVAL Format: 20

ASCII identifier of a factory-defined unit of wafer residing at location “n” on system. The length will be 20.

SECTION 7.0 STATE MODELS

The success of the FAB 30 Automation Program can be directly attributed to the firm requirement that all equipment suppliers provide a CIM and Automation implementation that uses a State Model Architecture. While the actual State Model implementation was left up to equipment suppliers to design and implement, subject to AMD approval, the following models were defined as AMD preferences.

7.1 PORT STATE MODEL

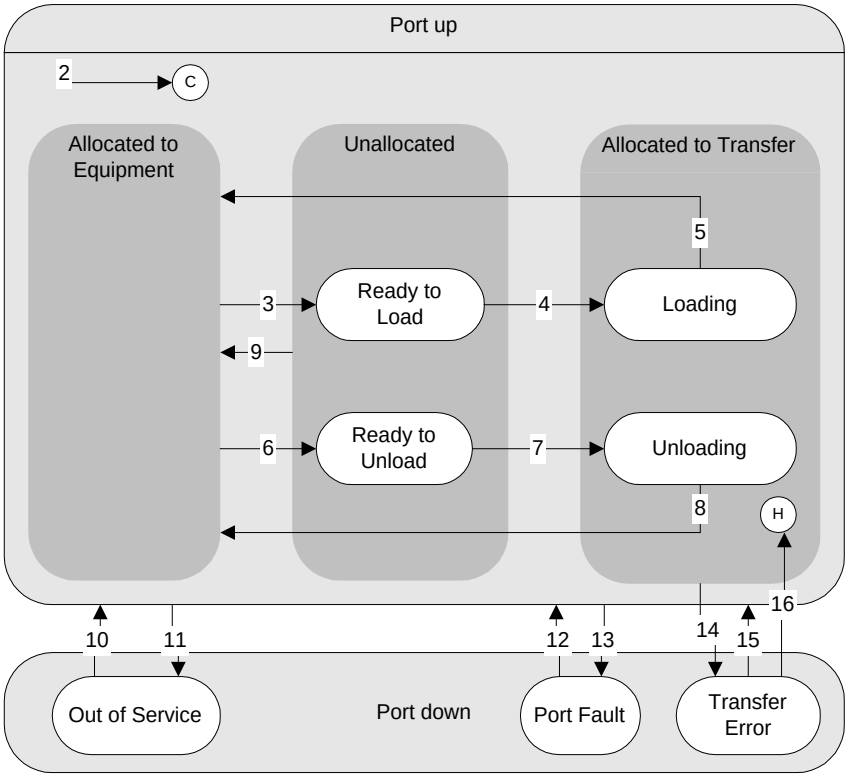


Figure 1-7 Port State Model

7.1.1 Port State Model Definition

State	Description
Port up	Port is in operation
Port down	Port is not in operation
Allocated to Equipment	The port is used by the equipment and may not be used for external load or unload.
Unallocated	The port may be used for external loading or unloading.
Allocated to Transfer	The port is involved in external loading or unloading.
Ready to Load	The port is ready to receive new material.
Ready to Unload	The port has material (1) ready to unload.
Loading	The port is in the process of loading. For SMIF ports, material is in the process of being placed on the port.
Unloading	The port is in the process of unloading. For SMIF ports, material is in the process of being unloaded from the port.
Out of Service	The port has been placed out of Service by the equipment or user.
Port Fault	A fault condition exists at the port.
Transfer Error	A transfer error has occurred and not been cleared.

Figure 2-7 Port State Model Definition

7.1.2 Port State Model Transitions

Transi-tion	Current State	Trigger	New State	Description and Equipment Activity
2		Power on.	Port up.	Equipment powers up port and performs prerequisites for operating (referencing axis etc.); follow up state depends on load status.
3	Allocated to Equipment.	Material Location is available.	Ready to Load.	The Equipment is ready to load material.
4	Ready to Load.	Material is being transferred to the port.	Loading.	The port is dedicated to the transfer of material to the port.
5	Loading.	Material transfer to the port is complete	Allocated to Equipment.	The equipment allocates the port again.
6	Allocated to Equipment.	The port is available to unload material.	Ready to Unload.	Material can be unloaded.
7	Ready to Unload.	Material is being unloaded from the port.	Unloading	The port is dedicated to the transfer of material from the port.
8	Unloading.	Unloading complete.	Allocated to Equipment.	The equipment allocates the port again.
10	Out of Service.	Equipment or user has placed the port back into Service.	Port up.	The port has been put explicitly back to service.
11	Port up.	Equipment or user has placed the port out of Service.	Out of Service.	When the port is out of service, it must be explicitly put back to service.
12	Port Fault.	All port related faults have been cleared.	Port up.	The port is no longer down, as all port related faults have been cleared.
13	Port up.	A port related fault has occurred.	Port Fault.	The port is down due to a fault.
14	Allocated to Transfer.	A transfer error has occurred.	Transfer Error.	Material may or may not be on the port. Operator assistance may be required.
15	Transfer Error	All transfer errors are cleared.	Port up.	The port does not return to the previous transfer activity. The transfer process is not resumed.
16	Transfer Error	The transfer process is resumed after all transfer errors are cleared.	Allocated to Transfer.	Port returns to the previous transfer activity, resumes the transfer process.

Figure 3-7 Port State Model Transitions

7.2 MATERIAL STATE MODEL

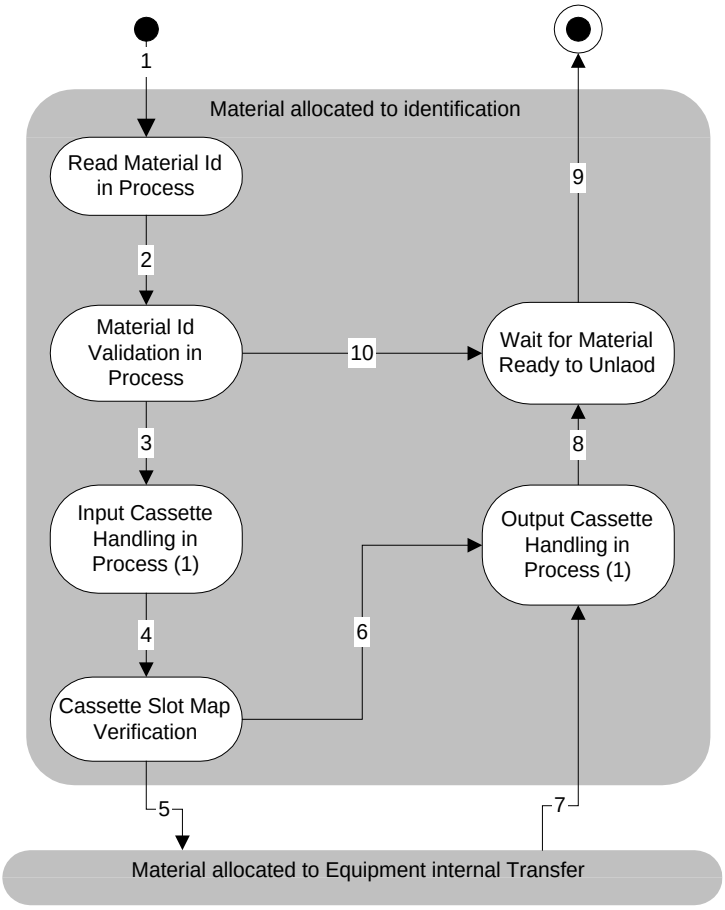


Figure 4-7 Material State Model

7.2.1 Material State Model Definitions

Material Allocated to Identification.	Material is dedicated for material identification and validation purposes and related supportive activities.
Read Material Id in Process.	The equipment determines the Id traveling with the material (the respective SECS variable is EMID).
Material Id Validation in Process.	The equipment compares the read Id (EMID) to the host downloaded Id (MID), if the download already occurred. If the download did not yet occur and the constant **CheckMaterialId** is set to "wait", the equipment waits for the respective message. If the download has not been issued yet and the constant **CheckMaterialId** is set to "not wait", the equipment rejects the material.
Input Cassette Handling in Process.	The cassette is being brought into a position that enabled the equipment to determine the cassette slot map (wafer presence map in cassette slots).
Cassette Slot Map Verification.	The cassette slot map is verified against the host downloaded WaferID's. If there is no host downloaded WaferID's, the verification always passes positive.
Material allocated to Equipment internal Material Transfer.	The material is being transferred inside the equipment to obtain the processing goal.
Output Cassette handling in Process.	The cassette is brought into a position, which allows the equipment to write the material Id at the output port.
Wait for Material ready to Unload.	This is a synchronization point with the Port State Model.

Figure 4-7 Material State Model Definitions

7.2.2 Material State Model Transitions

Transi-tion	Current State	Trigger	New State	Description and Equipment Activity
1		New material has been loaded.	Read Material Id in Process.	The arrival of new material triggers the start of the material identification cycle.
2	Read Material Id in Process.	Material Id is determined.	Material Id Validation in Process.	The Id attached to the material has been read (EMID). If the physical read process fails, the operator can still use the manual entry capability at the equipment terminal.
3	Material Id Validation in Process.	Material Id valid.	Input Cassette Handling in Process.	The equipment determines that it is valid to accept the material. This includes • Accept material for processing, if EMID equals MID. • Accept empty containers (pod/cassette) for unloading material. The details have to be designed matching the type of material input/ output at the equipment.
4	Input Cassette Handling in Process.	Cassette slot map is available.	Cassette Slot Map Verification.	At material input, the equipment design may require cassette handling to determine the cassette slot map.
5	Cassette Slot Map Verification.	Slot map valid or host has not specified slot map.	Material allocated to Equipment internal Transfer.	The equipment determined that the host downloaded slot map (included in the Wafer ID information) matches the determined slot map or the host did not

Transi-tion	Current State	Trigger	New State	Description and Equipment Activity
				specify a slot map/WaferID's. If the cassette is intended to receive wafers at an output port, the equipment shall make sure that no wafer is put into an occupied slot.
6	Cassette Slot Map Verification.	Slot map invalid.	Output Cassette Handling in Process.	The equipment determined that the host downloaded slot map (included in the Wafer ID information) did not match the determined slot map. This includes that a cassette intended to receive wafers at an output port is invalid, if the necessary cassette slots are not vacant.
7	Material allocated to Equipment internal Transfer.	Material transfers through equipment complete.	Output Cassette Handling in Process.	The equipment has transferred all material to the output cassette at the output port.
8	Output Cassette Handling in Process.	Output cassette handling complete.	Wait for Material ready to Unload.	The equipment may need to perform cassette handling to provide the cassette at the output port.
9	Wait for Material ready to Unload.	Material ready to Unload.		After the material is ready to unload, the material is not in the full control of the equipment any more. The Material Identification State model is completed for the respective material.
10	Material Id Validation in Process.	Material Id invalid.	Wait for Material ready to Unload.	The material Id validation as described in above in the table of states results in a reject of the material.

Figure 5-7 Material State Model Transitions

SECTION 8.0 LOAD PORT INDEPENDENCE AND ASYNCHRONICITY

AMD has found that many semiconductor process and metrology equipment suppliers impose unnecessary constraints on Wafer Fab Technicians (WFT) by forcing them to load material in a particular order and/or via a particular tool load port. When working with an MES system, such constraints reflect upwards into the Host software resulting in a need for the MES Job to specify the PORT NUMBER that material must be placed on. In addition, this information then has to be communicated to the WFT by some means. "LOAD PORT INDEPENDENCE" is a concept which totally removes these constraints.

For tools equipped with a means of automatic material identification and Load Port Independent tool software such as in FAB 30, WIP material may be placed at any vacant tool load port either before or after downloading the MES Job. On placement of material or on receipt of an MES Job, the tool software has the intelligence to check for a Job/Material association and to automatically process the material (if required) when such an association is found. The overall benefits of "Load Port Independent" behavior are increased tool throughput and, if work-flow can be balanced across available ports, reduced load port maintenance.

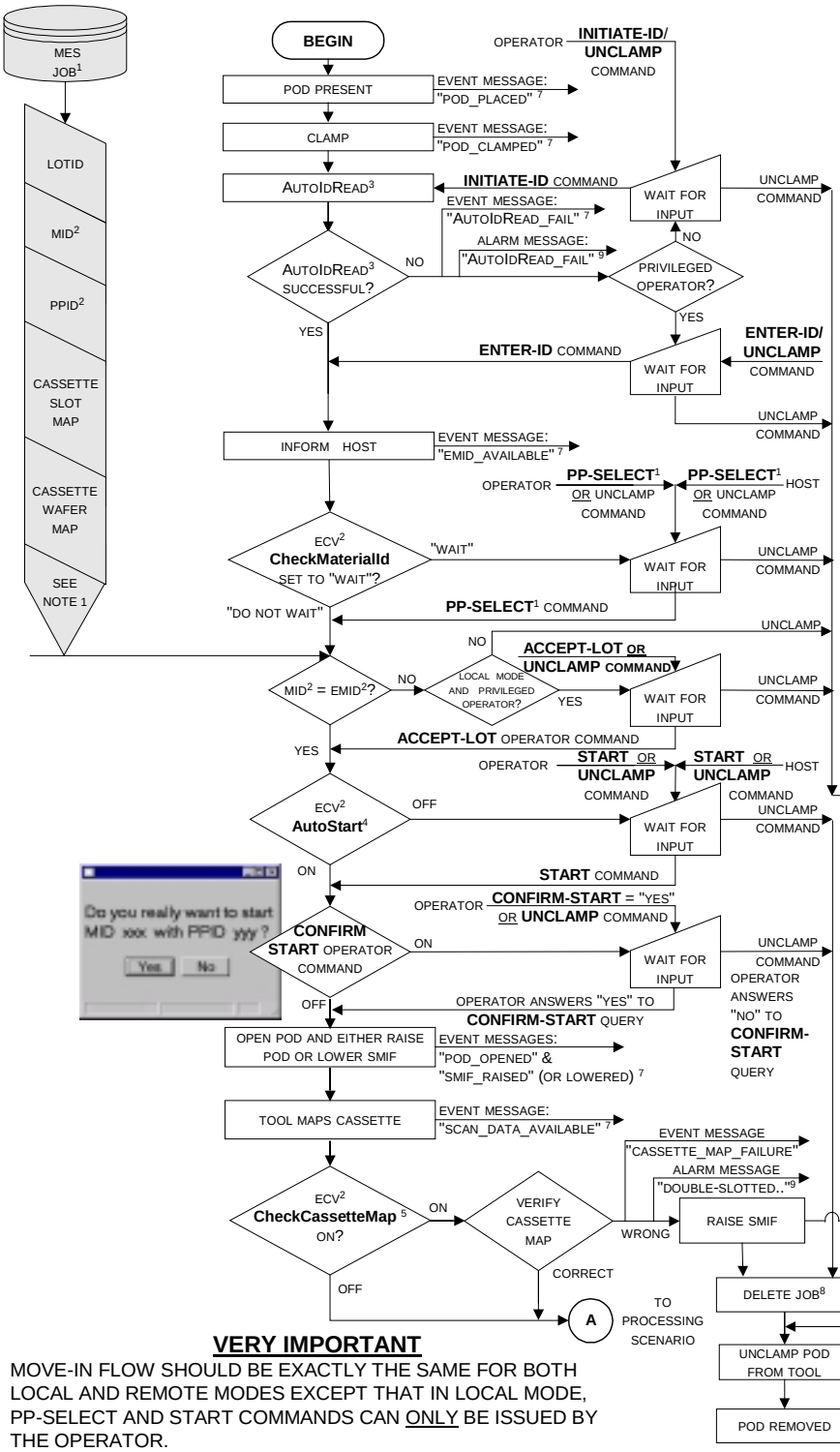
Another unnecessary constraint is that suppliers will sometimes require that material always be loaded at PORT 1 first, in a particular LOAD PORT ORDER, or that a SMIF I/O cannot begin the RAISE/LOWER process asynchronous with another SMIF I/O port on the same tool. The FAB30 design requires that, on a multi-ported tool, any valid material (pod) may be place on any valid port and the job that is associated with that material will be associated with and queued for that port, and that the SMIF I/O process will then begin. AMD has found this to be of practical value for tool throughput and WFT training considerations. In addition, it provides an operational fallback position on multi-ported tools. Should the SMIF I/O equipment fail on a particular port, the tool can remain operational while in a degraded mode. "LOAD PORT ASYNCHRONICITY" then is this concept, coupled with "LOAD PORT INDEPENDENCE"

SECTION 9.0 AN OVERVIEW OF MATERIAL MOVE IN, PROCESSING, AND MOVE OUT SCENARIOS

During the process of working with the FAB 30 machine tool suppliers during their detailed design phases it became apparent just how much ambiguity can be created when many people are working from a strictly written specification.

A set of diagrams, using old fashion FLOW CHART methodology, was developed as an aid for the equipment suppliers in interpreting the AMD FAB 30 Capital Equipment Procurement Specification, as it relates to FAB 30 automation requirements.

SECTION 10.0 MATERIAL MOVE IN SCENARIO



VERY IMPORTANT

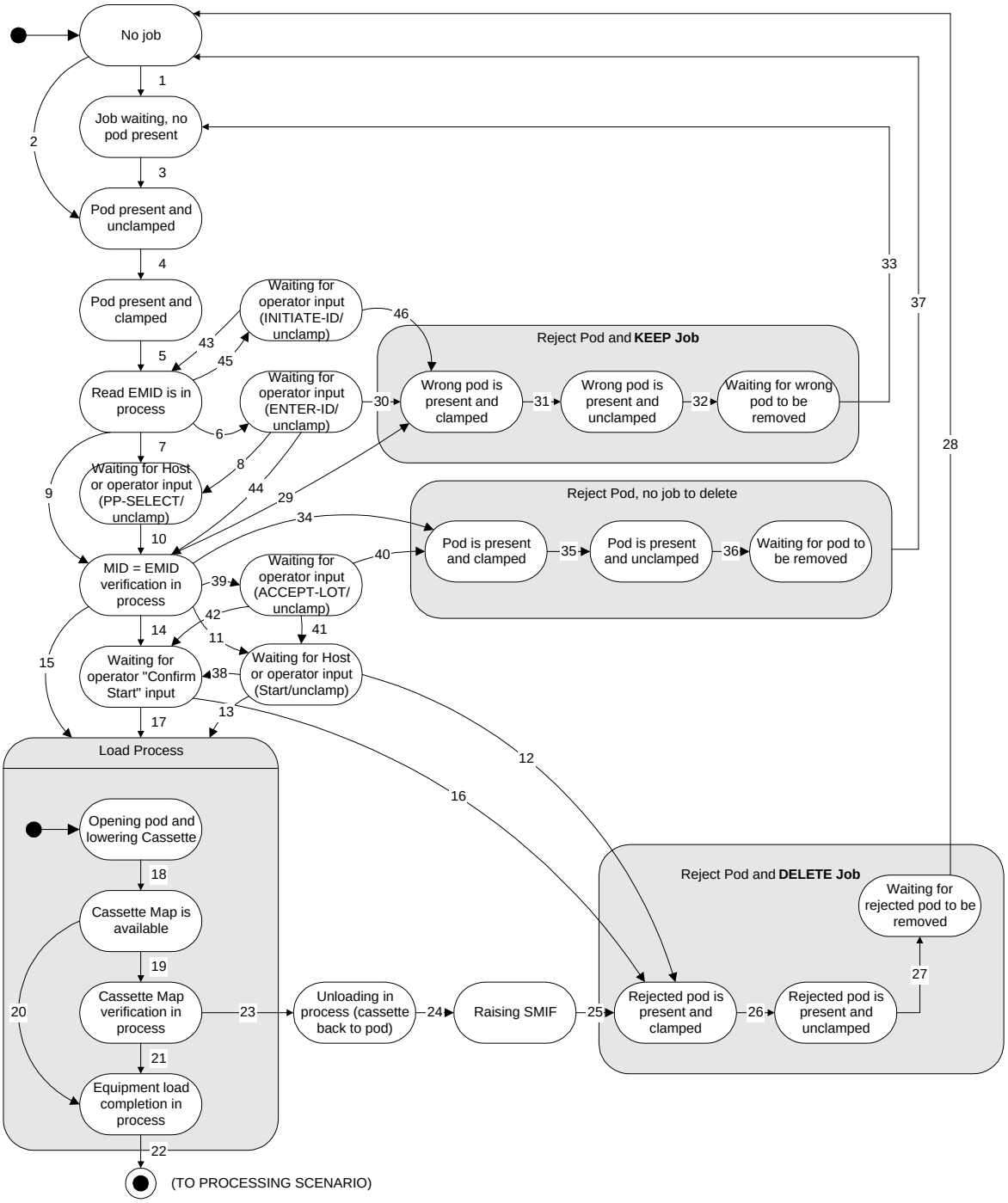
MOVE-IN FLOW SHOULD BE EXACTLY THE SAME FOR BOTH LOCAL AND REMOTE MODES EXCEPT THAT IN LOCAL MODE, PP-SELECT AND START COMMANDS CAN ONLY BE ISSUED BY THE OPERATOR.

FILE: MOVE IN 001K.VSD

NOTES:

1. JOB DEFINED BY HOST OR WFT ANY TIME BEFORE MID=EMID COMPARISON, ASYNCHRONOUS TO POD ARRIVAL.
2. DEFINITIONS AS PER SEMI E5.
3. **AUTOIDREAD** IS CASSETTE ID (*i.e.* EMID) READ OPERATION.
4. **AutoStart** DEFINED AS PER CEPD APPENDIX A, PARAGRAPH 3.6.4.4.2.
5. **CheckCassetteMap** DEFINED AS PER CEPD APPENDIX A, PARAGRAPH 3.6.4.4.7.
6. **TOOL JOB DATA QUEUE SHOULD EQUAL THE NUMBER OF LOAD PORTS.**
7. EVENT MESSAGES AS PER CEPD APPENDIX A, PARAGRAPH 3.6.3.2.
8. "DELETE JOB" CAN OCCUR AT ANY TIME BEFORE THE NEXT POD IS PLACED OM THE LOAD PORT, BUT IS SHOWN HERE PRIOR TO THE "UNCLAMP POD FROM TOOL" ACTION FOR CONSISTENCY.
9. ALL S5F1 TOOL ALARM MESSAGES SHOULD BE PRECEDED BY S6F11 EVENT MESSAGES. ALARM TEXT SHOULD PROVIDE ENOUGH DETAIL TO EASILY IDENTIFY ROOT CAUSE.
10. **READ-EMID** OPERATOR COMMAND ONLY USED IN MAINTENENCE MODE TO VERIFY AUTOID READER.

10.1 MATERIAL MOVE IN SCENARIO: STATE MODEL



FILE: MOVE IN STATE DIAGRAM 001j.VSD

10.2 MATERIAL MOVE IN SCENARIO: STATE TABLE

State	Description
No Job	Waiting for next MES Job (Process Program) from Host.
Job waiting, no Pod present	MES Job received but no Pod to process.
Pod present and unclamped	Pod has been placed on port by Operator.
Pod present and clamped	Equipment has auto-clamped the Pod.
Read EMID is in process	Equipment has started reading the Cassette ID (i.e. EMID).
Waiting for Host or Operator input (PP-SELECT/unclamp)	CheckMaterialId ECV was set to “wait”, so equipment is waiting for “PP-SELECT” or “unclamp” from Host or Operator.
MID=EMID verification in process	Equipment is checking whether the Cassette ID (i.e. EMID) is the same as the Material ID (MID) sent from the Host, to make sure that the correct Cassette has been loaded for the PP-SELECT that has been downloaded by the Host.
Waiting for Operator input (ACCEPT-LOT/unclamp)	In LOCAL MODE ONLY, CheckMaterialId is set to “DO NOT WAIT” and a pod is placed before a PP-SELECT has been downloaded from the Host. If the current Operator has no privileges, then the pod is automatically unclamped by the equipment. If the current Operator is privileged, then the equipment waits for the Operator to either enter ACCEPT-LOT or unclamp the pod.
Waiting for Host or Operator input (Start/unclamp)	The AutoStart ECV was set to “OFF”, so equipment is waiting for “Start” or “unclamp” from Host or Operator.
Waiting for “Confirm Start” or “unclamp” input from Operator	Equipment’s “Confirm Start” parameter is set to “ON”.
Opening Pod and lowering Cassette	MID=EMID has been verified true, so the equipment has opened the Pod and is scanning the Cassette Map during the Cassette lowering process.
Cassette Map is available	The Cassette Map has been read and is available at the equipment.
Cassette Map verification in process	The equipment is checking that the scanned Cassette Map is the same as the Cassette Map downloaded from the Host within the Process Program.
Equipment load completion in process	Equipment specific load completion actions are taking place. These will be different for each distinct equipment.
Unloading in process	The Cassette is being unloaded from the equipment back into a Pod.
Raising SMIF	The SMIF is raising the Cassette to the home (top) position.
Rejected Pod is present and clamped	Pod has been rejected and is being unloaded but is still clamped. Pod has been rejected due to either: (a) Cassette Map verification failure, or (b) (unknown) Operator reason. Job needs to be deleted from Equipment.
Rejected Pod is present and unclamped	Rejected Pod has been unclamped by the equipment.
Waiting for rejected Pod to be removed	Equipment is waiting for the Operator to remove the rejected Pod.
Waiting for Operator input (ENTER-ID/ unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID) and a privileged Operator is logged on, so the equipment is waiting for the Operator to either enter the EMID (using the ENTER-ID function) or to request that the Pod be unclamped.
Waiting for Operator input (INITIATE-ID/ unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID) and a NON-privileged Operator is logged on, so the equipment is waiting for the Operator to either use the INITIATE-ID function to force another AUTOIDREAD of the EMID from the cassette, or to request that the Pod be unclamped.
Wrong Pod is present and clamped	The Cassette ID (EMID) did not match the MID sent from the Host, so the Pod is being unloaded but is still clamped. The Job does not need to be deleted from the Equipment.
Wrong Pod is present and unclamped	The Cassette ID (EMID) did not match the MID sent from the Host and the Pod has been unclamped by the equipment.
Waiting for wrong Pod to be removed	The Cassette ID (EMID) did not match the MID sent from the Host and the equipment is waiting for the Operator to remove the Pod.
“Pod is present and clamped”, “Pod is present and unclamped” and “Waiting for pod to be removed”	CheckMaterialId is set to “not wait”. A pod is placed and its EMID is read by the equipment before the Host has downloaded a job containing an MID. The MID = EMID comparison is performed by the equipment and fails because there is not MID to compare against. The pod is automatically unclamped by the equipment and there is no job to delete.

10.3 MATERIAL MOVE IN SCENARIO: TRANSITION TABLE

#	Current State	Trigger	New State	Action	Comment
1.	No Job	MES Job arrives at equipment	Job waiting, no Pod present	Job is queued by equipment	Case where MES Job arrives before Pod
2.	No Job	Pod presence is detected by equipment	Pod present and unclamped	Equipment sends “Pod arrived” event message to Host	Case where Pod arrives before MES Job
3.	Job waiting, no Pod present	Pod presence is detected by equipment	Pod present and unclamped	Equipment sends “Pod arrived” event message to Host	Case where Pod arrives after MES Job
4.	Pod present and unclamped	Equipment clamps Pod	Pod present and clamped	Equipment sends “Pod clamped” event message to Host	
5.	Pod present and clamped	“Pod clamped” event message send is completed	Read EMID is in process	Equipment reads EMID	
6.	Read EMID is in process	AUTOIDREAD operation completes, but has failed to read EMID	Waiting for Operator input (ENTER-ID/ unclamp)	Equipment sends “AUTOIDREAD fail” event message	Equipment is unable to read Cassette ID; Operator is privileged
7.	Read EMID is in process	AUTOIDREAD operation completes and EMID has been read successfully	Waiting for Host or Operator input (PP-SELECT/unclamp)	Equipment sends “EMID available” event message to Host	
8.	Waiting for Operator input (ENTER-ID/ unclamp)	Operator inputs EMID using ENTER-ID function	Waiting for Host or Operator input (PP-SELECT/unclamp)	Equipment sends “EMID_ AVAILABLE” event message to Host	Case where AUTOIDREAD has failed and privileged Operator enters EMID manually
9.	Read EMID is in process	CheckMaterialId ECV is set to “not wait”	MID=EMID verification in process	Equipment sends “EMID_ AVAILABLE” event message to Host	Case where AUTOIDREAD is successful and CheckMaterialId ECV is set to “not wait”
10.	Waiting for Host or Operator input (PP-SELECT/unclamp)	Host inputs Job (LOTID, MID, PPID, Port Select, Cassette Slot Map, Cassette Wafer Map)	MID=EMID verification in process	Equipment verifies MID against EMID	Check to see that actual Cassette ID matches Job Cassette ID
11.	MID=EMID verification in process	MID=EMID successful and AutoStart ECV is not set	Waiting for “Start” or “unclamp” from Host or “unclamp” from Operator	Equipment waits for “Start” or “unclamp” from Host, or “unclamp” from Operator	
12.	Waiting for Host or Operator input (Start/unclamp)	Operator enters “unclamp” (N.B. reason unknown)	Rejected Pod is present and clamped	None	Start of unclamp process
13.	Waiting for Host or Operator input (Start/unclamp)	“Start” received from Host	Opening Pod and lowering Cassette	Pod opened and lowered and Cassette map scanned by equipment	Load Process
14.	MID=EMID verification in process	Equipment’s “Confirm Start” parameter is set to “on”	Waiting Operator input (Confirm-Start/ unclamp)	Equipment waits for “Confirm Start” input from Operator	
15.	MID=EMID verification in process	MID=EMID successful, AutoStart ECV is set and “Confirm Start” is off	Opening Pod and lowering Cassette	Equipment does not wait for “Start” command from Host	Load Process
16.	Waiting for “Confirm Start” or “unclamp” input from Operator	Operator enters “No” to “Confirm Start” request from equipment	Rejected Pod is present and clamped	None	Start of unclamp process

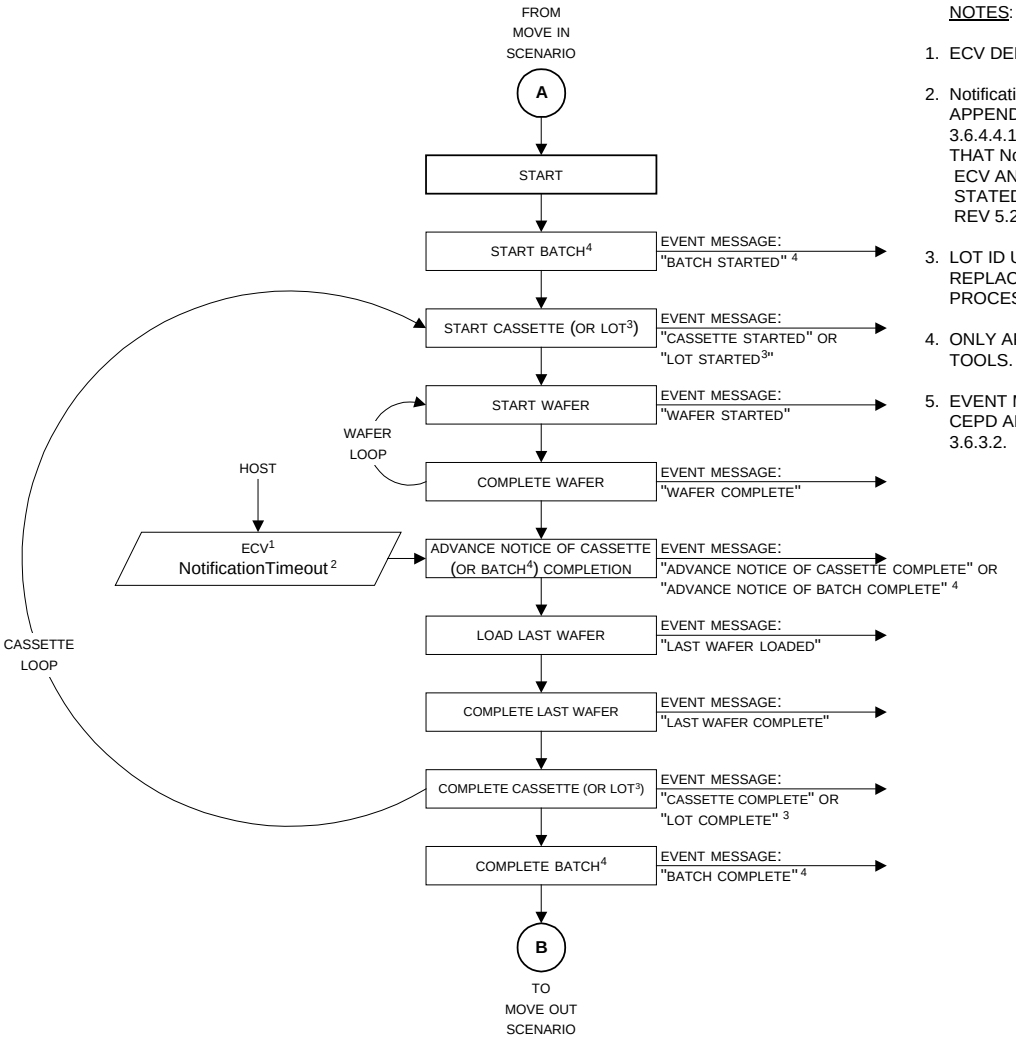
Material Move In Scenario: Transition Table (continued)

#	Current State	Trigger	New State	Action	Comment
1.	Waiting Operator input (Confirm-Start/ unclamp)	Operator enters "Yes" to "Confirm Start" request from equipment	Opening Pod and lowering Cassette	Equipment opens Pod, lowers Cassette and scans Cassette Map	Load Process
2.	Opening Pod and lowering Cassette	Cassette arrives in bottom position	Cassette Map is available	Equipment sends "Load complete" and "Scan data available" event messages	Load Process
3.	Cassette Map is available	CheckCassetteMap ECV is set to "on"	Cassette Map verification in process	Equipment verifies scanned Cassette Map against Cassette Map sent from Host	
4.	Cassette Map is available	CheckCassetteMap ECV is set to "off"	Equipment load completion in process	Equipment specific load completion actions	
5.	Cassette Map verification in process	Scanned Cassette Map verified against Cassette Map sent from Host or no Cassette Map sent from Host	Equipment load completion in process	Equipment specific load completion actions	EMID and Cassette Map found to be correct, so processing may continue or no Cassette Map sent from Host
6.	Equipment load completion in process	Completion of Cassette load operation internal to equipment	Waiting for equipment to start processing[1]	Equipment sends equipment specific state change message to Host	[1]Initial state of PROCESSING SCENARIO
7.	Cassette Map verification in process	Scanned Cassette Map failed to verify against Cassette Map sent from Host	Unloading in process	Cassette transferred back to Pod	Start of unclamp process
8.	Unloading in process	Cassette has been transferred back to Pod	Raising SMIF	Equipment sends "Unload complete" event message	
9.	Raising SMIF	Cassette reaches home (top) position	Rejected Pod is present and clamped	Equipment sends "SMIF Indexer Up" event message[1]	[1] If applicable
10.	Rejected Pod is present and clamped	Equipment unclamps Pod	Rejected Pod is present and unclamped	Equipment sends "Pod unclamped" event message	
11.	Rejected Pod is present and unclamped	Equipment requests Operator to remove Pod	Waiting for rejected Pod to be removed	Equipment waits for Pod to be removed	
12.	Waiting for rejected Pod to be removed	Operator removes Pod	No Job	Operator deletes Job and equipment waits for next Pod	
13.	MID=EMID verification in process	MID=EMID failure	Wrong Pod is present and clamped	Reject Pod but keep Job	
14.	Waiting for Operator input (ENTER-ID/ unclamp)	Operator enters "unclamp" (N.B. reason unknown)	Wrong Pod is present and clamped	Equipment prepares to unclamp Pod	
15.	Wrong Pod is present and clamped	Equipment unclamps Pod	Wrong Pod is present and unclamped	Equipment sends "Pod unclamped" event message	
16.	Wrong Pod is present and unclamped	Equipment prompts Operator to remove Pod	Waiting for wrong Pod to be removed	Equipment waits for wrong Pod to be removed	
17.	Waiting for wrong Pod to be removed	Operator removes Pod	Job waiting, no Pod present	Equipment sends "Pod removed" event message	

Material Move In Scenario: Transition Table (continued)

#	Current State	Trigger	New State	Action	Comment
1.	MID=EMID verification in process	MID=EMID failure (no MID available to compare against)	Pod is present and clamped	Equipment sends "Pod placed with no job" event message	Case where MID=EMID comparison fails and Operator is NOT privileged
2.	Pod is present and clamped	Equipment unclamps Pod	Pod is present and unclamped	Equipment sends "Pod unclamped" event message	
3.	Pod is present and unclamped	Equipment prompts Operator to remove Pod	Waiting for pod to be removed	Equipment waits for Pod to be removed	
4.	Waiting for pod to be removed	Operator removes Pod	No Job	Equipment sends "Pod removed" event message	
5.	Waiting for Host or Operator input (Start/unclamp)	Host or Operator provides Start command	Waiting for Operator input (Confirm-Start/ unclamp)	Equipment waits for Confirm-Start or unclamp from Operator	Case where Confirm-Start equipment parameter is set to ON
6.	MID=EMID verification in process	MID=EMID failure (no MID available to compare against)	Waiting for Operator input (ACCEPT-LOT/unclamp)	Equipment enables ACCEPT-LOT and unclamp options	Case where MID=EMID comparison fails and Operator IS privileged
7.	Waiting for Operator input (ACCEPT-LOT/unclamp)	Operator enters UNCLAMP command (Local mode ONLY)	Pod is present and clamped	Equipment prepares to unclamp Pod	Applicable for Local mode ONLY
8.	Waiting for Operator input (ACCEPT-LOT/unclamp)	Operator enters ACCEPT-LOT command (Local mode ONLY)	Waiting for Host or Operator input (Start/unclamp)	Equipment waits for Start/unclamp from Host or Operator	Case where in Local mode ONLY, privileged Operator accepts lot and AutoStart ECV is set to OFF
9.	Waiting for Operator input (ACCEPT-LOT/unclamp)	Operator enters ACCEPT-LOT command (Local mode ONLY)	Waiting for Operator input (Confirm-Start/ unclamp)	Equipment waits for Confirm-Start/ unclamp from Operator	Case where privileged Operator accepts lot, AutoStart ECV is set to ON and Confirm-Start equipment parameter is set to ON
10.	Waiting for Operator input (INITIATE-ID/ unclamp)	Non-privileged Operator uses INITIATE-ID command	Read EMID is in process	Equipment requests an AutoIDRead of the cassette EMID	Operator is NOT privileged
11.	Waiting for Operator input (ENTER-ID/ unclamp)	Privileged Operator uses ENTER-ID command	MID=EMID verification in process	Equipment verifies MID from PP-SELECT against manually entered EMID	Operator is privileged
12.	Read EMID is in process	AUTOIDREAD operation completes, but has failed to read EMID and Operator is NOT privileged	Waiting for Operator input (INITIATE-ID/ unclamp)	Equipment waits for INITIATE-ID/ unclamp from Operator	Operator is NOT privileged
13.	Waiting for Operator input (INITIATE-ID/ unclamp)	Operator enters UNCLAMP command	Wrong Pod is present and clamped	Equipment prepares to unclamp Pod	Operator is NOT privileged

SECTION 11.0 MATERIAL PROCESSING SCENARIO

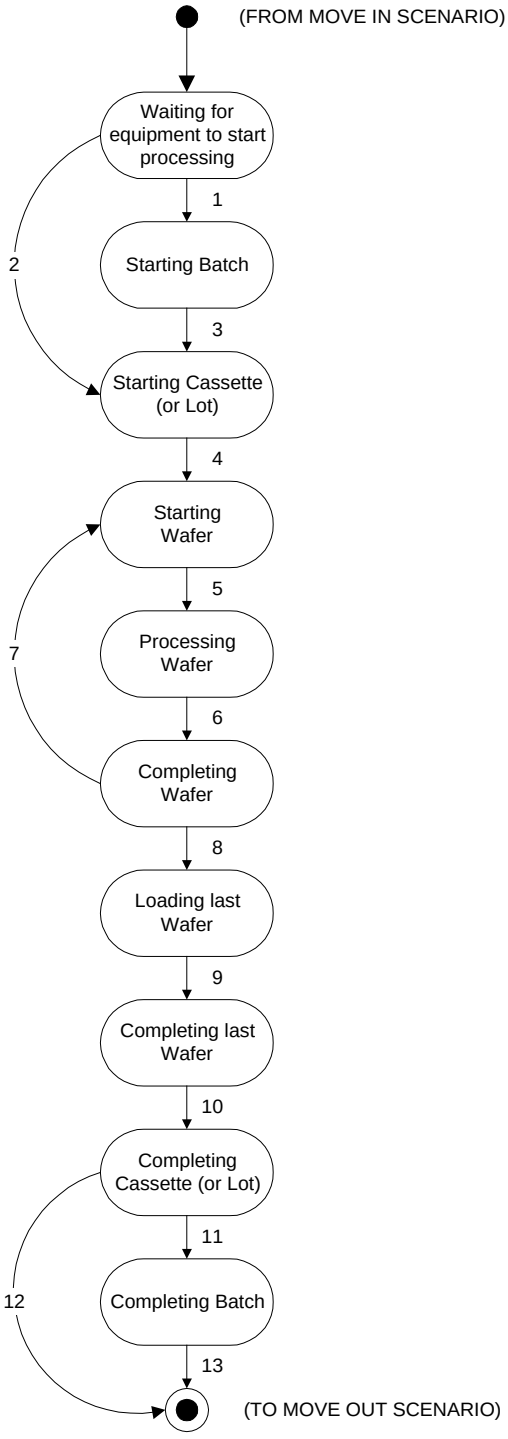


FILE: PROCESSING 001a.VSD

NOTES:

1. ECV DEFINITION AS PER SEMI E5.
2. NotificationTimeout: SEE CEPD APPENDIX A, PARAGRAPH 3.6.4.4.19. (N.B. PLEASE NOTE THAT NotificationTimeout IS AN ECV AND **NOT** A DVVAL AS STATED IM THE CEPD, (*i.e.* THE REV 5.25 CEPD IS IN ERROR).
3. LOT ID USED FOR TOOLS THAT REPLACE CASSETTE DURING PROCESSING.
4. ONLY APPLICABLE FOR BATCH TOOLS.
5. EVENT MESSAGES AS PER CEPD APPENDIX A, PARAGRAPH 3.6.3.2.

11.1 MATERIAL PROCESSING SCENARIO: STATE MODEL



FILE: PROCESSING STATE DIAGRAM 001a.VSD

11.2 MATERIAL PROCESSING SCENARIO: STATE TABLE

State	Description
Waiting for equipment to start processing	START *Remote Command* (see CEPD Section 3.6.2.3.2) has been issued but the equipment has not yet started actual processing.
Starting Batch	Equipment is starting a Batch processing run (only applicable to Batch tools).
Starting Cassette (or Lot)	Equipment is starting a Cassette (or Lot) processing run.
Starting Wafer	Equipment is starting a Wafer processing run.
Processing Wafer	Equipment is processing a Wafer.
Completing Wafer	Equipment is performing Wafer completion actions after processing.
Loading last Wafer	Equipment is loading Last Wafer of run for processing.
Completing last Wafer	Equipment is performing last Wafer completion actions after processing.
Completing Cassette (or Lot)	Equipment is performing Cassette (or Lot) completion actions after processing.
Completing Batch	Equipment is performing Batch completion actions after processing (only applicable to Batch tools).

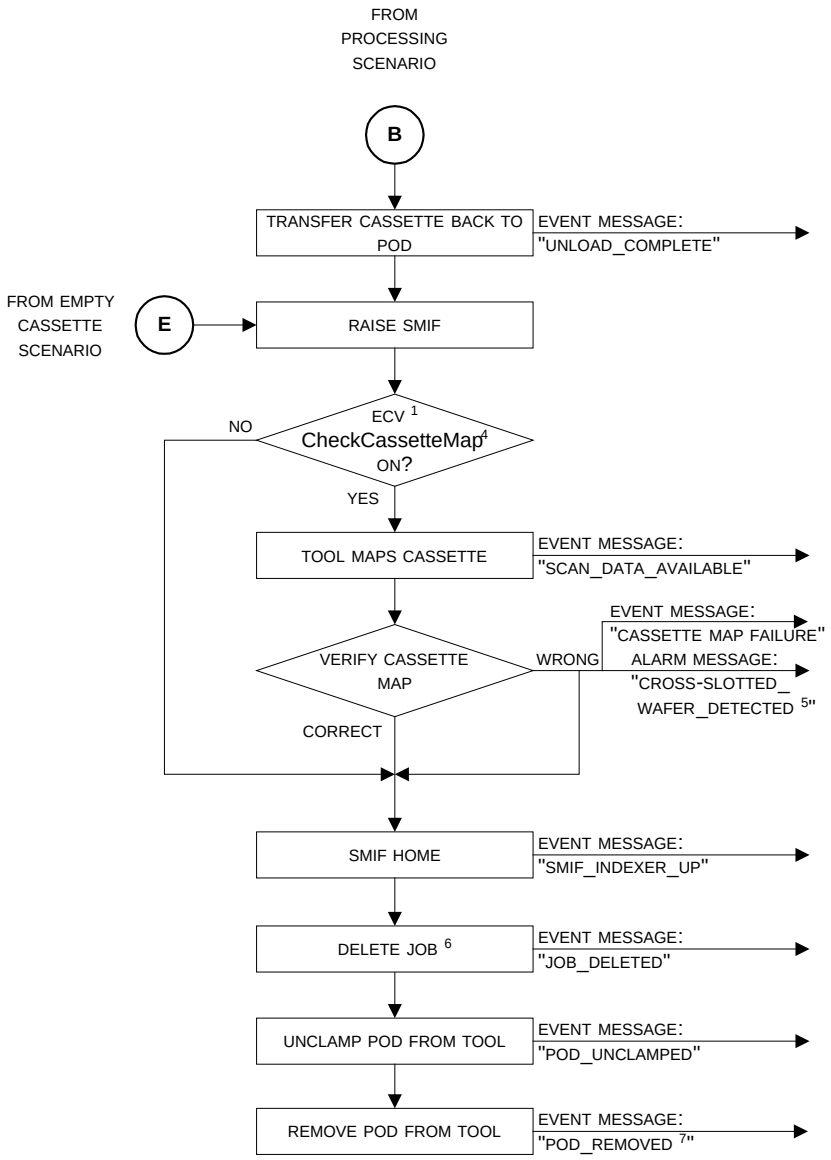
11.3 MATERIAL PROCESSING SCENARIO: TRANSITION TABLE

#	Current State	Trigger	New State	Action	Comment
1.	Waiting for equipment to start processing	Equipment issues its own “start processing” command	Starting Batch	Equipment sends equipment specific state change message to Host	Only applicable to Batch tools.
2.	Waiting for equipment to start processing	Equipment issues its own “start processing” command	Starting Cassette (or Lot)	Equipment sends equipment specific state change message to Host	Equipment internal state change only.
3.	Starting Batch	Equipment starts processing first Cassette(s) of Batch	Starting Cassette (or Lot)	Equipment sends “Batch Started” event message	Only applicable to Batch tools.
4.	Starting Cassette (or Lot)	Equipment starts processing first Wafer of Cassette (or Lot)	Starting Wafer	Equipment sends “Cassette Started” (or “Lot Started”) event message	
5.	Starting Wafer	Equipment has moved Wafer to processing chamber	Processing Wafer	Equipment sends “Wafer Started” event message	
6.	Processing Wafer	Equipment has finished processing a Wafer	Completing Wafer	Equipment sends equipment specific state change message to Host	Equipment internal state change only.
7.	Completing Wafer	Equipment finishes Wafer processing completion actions	Starting Wafer	Equipment sends “Wafer Complete” event message	
8.	Completing Wafer	Equipment finishes Wafer processing completion actions and NotificationTimeout ECV is set	Loading last Wafer	Equipment sends “Advance Notice of Cassette (or Batch) Complete” event message	Event message is not sent if NotificationTimeout ECV is not set
9.	Loading last Wafer	Equipment has moved last Wafer to processing chamber	Completing last Wafer	Equipment sends “Last Wafer Loaded” event message	
10.	Completing last Wafer	Equipment finishes last Wafer processing completion actions	Completing Cassette (or Lot)	Equipment sends “Last Wafer Complete” event message	

11.	Completing Cassette (or Lot)	Equipment finishes Cassette processing completion actions	Completing Batch	Equipment sends "Cassette Complete" (or "Lot Complete") event message	Only applicable to Batch tools.
12.	Completing Cassette (or Lot)	Equipment finishes Cassette processing completion actions	Transferring Cassette back to Pod[2]	Equipment sends "Cassette Complete" (or "Lot Complete") event message	
13.	Completing Batch	Equipment finishes Batch processing completion actions	Transferring Cassette back to Pod[2]	Equipment sends "Batch Complete" event message	

[2] Initial state of MOVE OUT SCENARIO.

SECTION 12.0 MATERIAL MOVE OUT SCENARIO

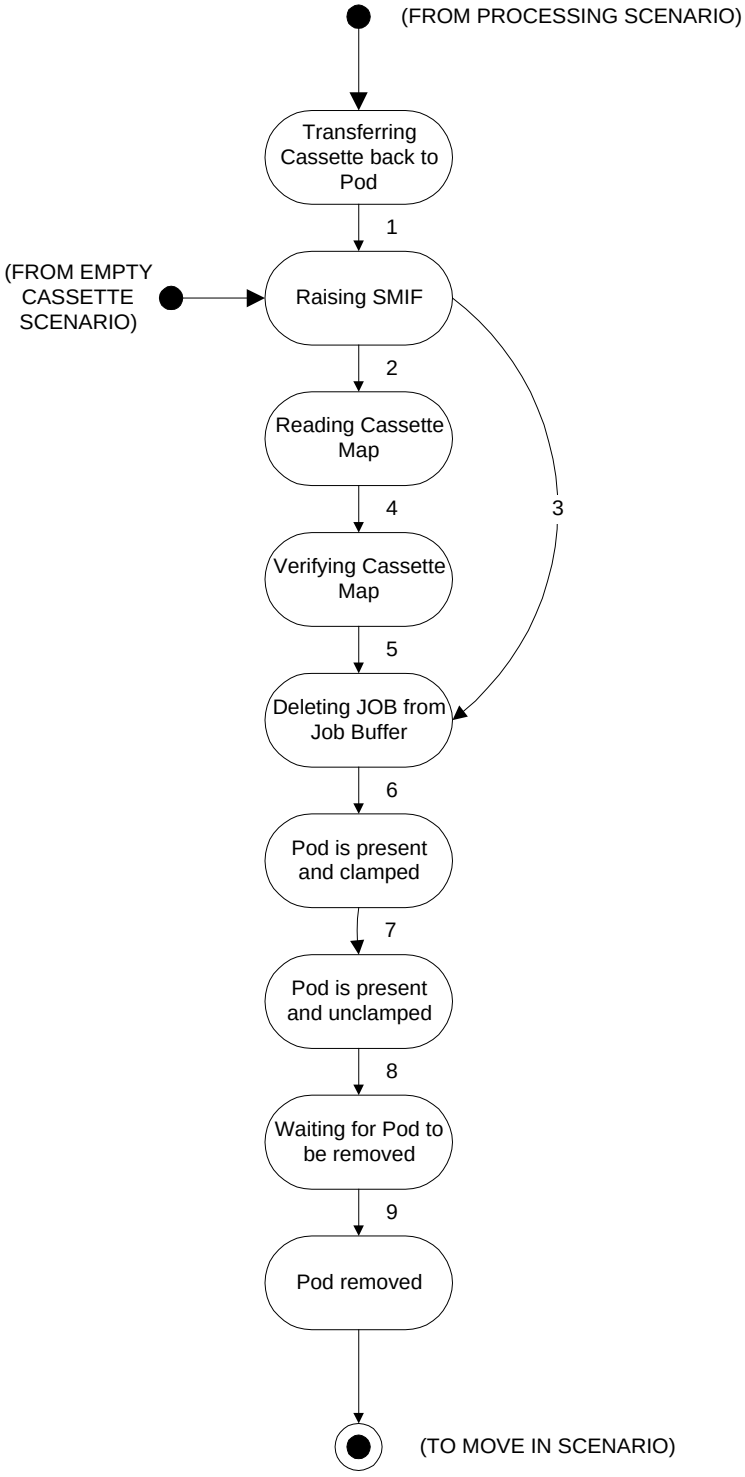


FILE: MOVE OUT 001c.VSD

NOTES:

1. ECV DEFINITION AS PER SEMI E5.
2. AUTOIDREAD ON EXIT FROM TOOL ONLY REQUIRED IF TOOL CANNOT GUARANTEE THAT WAFERS EXIT TOOL IN THE SAME CASSETTE IN WHICH THEY ENTERED.
3. EVENT MESSAGES AS PER CEPD APPENDIX A, PARAGRAPH 3.6.3.2.
4. CheckCassetteMap DEFINED AS PER CEPD APPENDIX A, PARAGRAPH 3.6.4.4.7.
5. ALARM MESSAGE SHOULD CONTAIN SUFFICIENT DETAIL TO IDENTIFY ROOT CAUSE OF ALARM CONDITION. EXAMPLE SHOWN RELATES TO CROSS-SLOTTED WAFER DETECTION.
6. JOB (PP-SELECT) SHOULD BE DELETED FROM JOB BUFFER AND USER INTERFACE DURING MOVE-OUT. IF BATCH TOOL, THEN DELETE JOB DURING MOVE OUT OF **LAST** CASSETTE FROM TOOL.
7. REMOVAL OF POD SHOULD CAUSE ALL INFORMATION RELATING TO POD TO BE REMOVED FROM TOOL USER INTERFACE.

12.1 MATERIAL MOVE OUT SCENARIO: STATE MODEL



FILE: MOVE OUT STATE DIAGRAM 001c.VSD

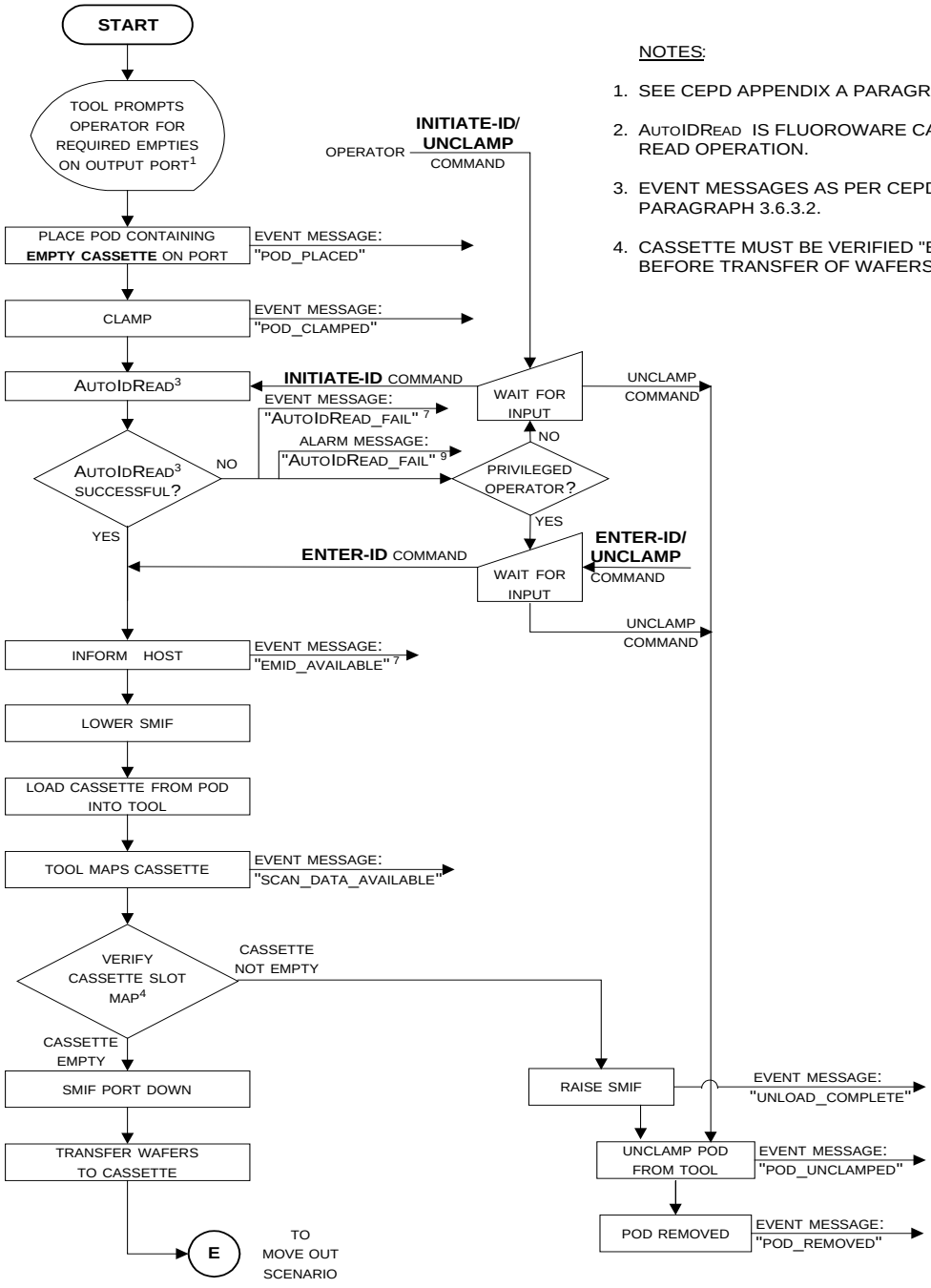
12.2 MATERIAL MOVE OUT SCENARIO: STATE TABLE

State	Description
Transferring Cassette back to Pod	The Cassette is being unloaded from the equipment back into a Pod.
Raising SMIF	The SMIF is raising the Cassette to the home (top) position.
Reading Cassette Map	The Cassette Map is being scanned whilst the Cassette is being raised to the home (top) position.
Cassette Map verification in process	The equipment is verifying the scanned Cassette Map.
Deleting Job from Job Buffer	The equipment performs internal housekeeping by deleting the completed Job (PP-SELECT) from its Job Buffer and removing any Job-related information from the User Interface.
Pod is present and clamped	The Cassette has reached the home (top) position and the Pod is still clamped.
Pod is present and unclamped	The Pod has been unclamped by the equipment.
Waiting for Pod to be removed	The equipment is waiting for the Operator to remove the Pod.
Pod removed	The Operator has removed the Pod from the equipment port and the equipment reoves any pod-related information from the User Interface.

12.3 MATERIAL MOVE OUT SCENARIO: TRANSITION TABLE

#	Current State	Trigger	New State	Action	Comment
1.	Transferring Cassette back to Pod	Cassette has been transferred back to Pod	Raising SMIF	Equipment sends “Unload complete” event message	
2.	Raising SMIF	CheckCassetteMap ECV is set to “on”	Reading Cassette Map	Equipment scans Cassette during SMIF raise	
3.	Raising SMIF	CheckCassetteMap ECV is set to “off” and Cassette arrives the home (top) position	Deleting Job from Job Buffer	Equipment sends “SMIF indexer up” event message[1]	[1] Where applicable
4.	Reading Cassette Map	Cassette arrives the home (top) position	Cassette Map verification in process	Equipment sends “Scan data available” event message	
5.	Cassette Map verification in process	Equipment has: verified Cassette Map against Cassette Map sent from Host or: verification has failed	Deleting Job from Job Buffer	Equipment sends “SCAN_DATA_AVAILABLE” or: Equipment sends “Failed Cassette Map verification” event message	
6.	Deleting Job from Job Buffer	Equipment sends “JOB_DELETED” message	Pod is present and clamped	Equipment prepares to unclamp pod	
7.	Pod is present and clamped	Equipment unclamps Pod	Pod is present and unclamped	Equipment sends “Pod unclamped” event message	
8.	Pod is present and unclamped	Equipment requests Operator to remove Pod	Waiting for Pod to be removed	Equipment waits for next Pod	
9.	Waiting for Pod to be removed	Operator removes Pod	Pod removed	Equipment sends “Pod removed” event message	

SECTION 13.0 POD WITH EMPTY CASSETTE SCENARIO

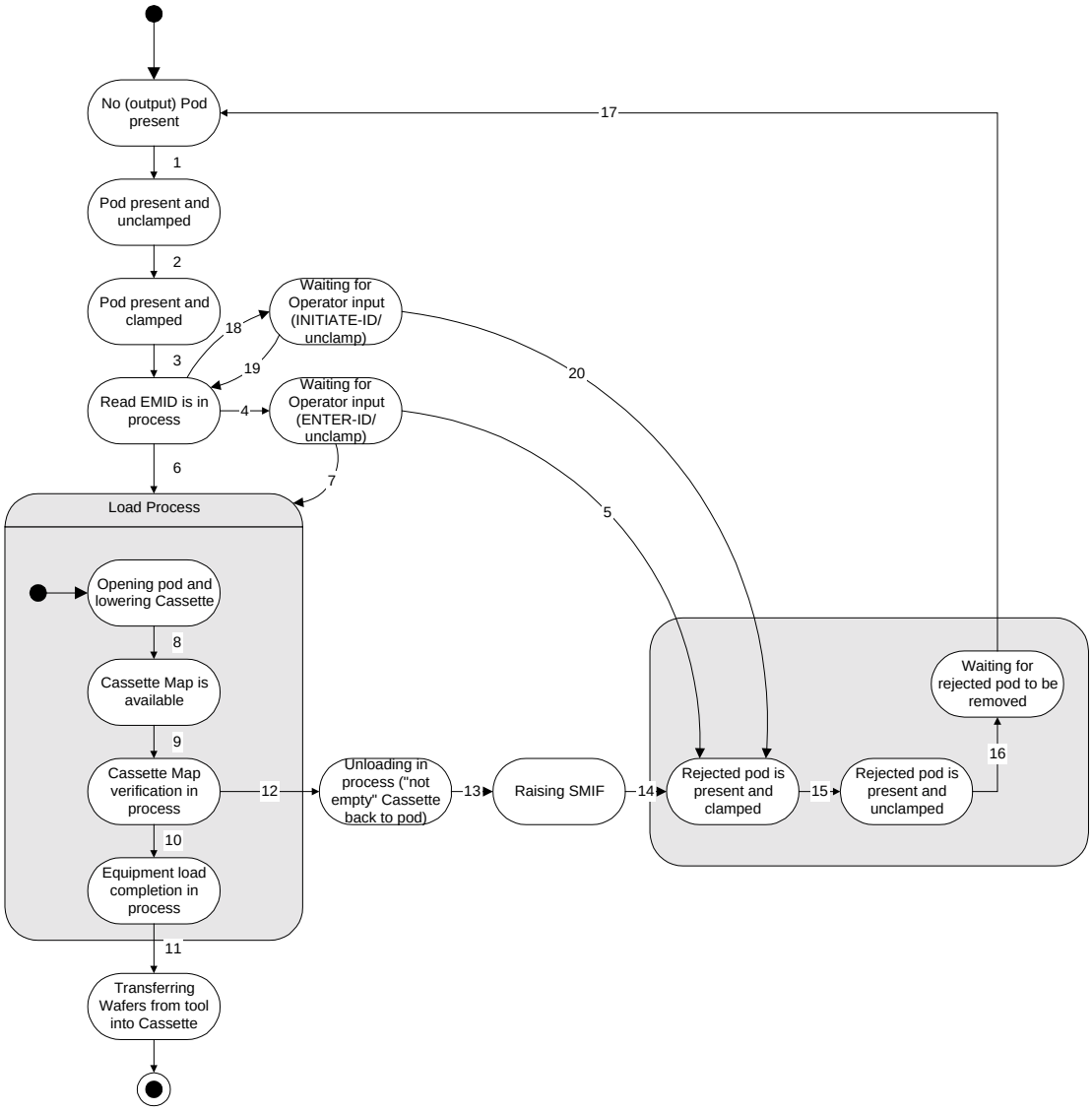


NOTES:

1. SEE CEPD APPENDIX A PARAGRAPH 3.5.9.1.8.
2. AUTOIDREAD IS FLUOROWARE CASSETTE ID READ OPERATION.
3. EVENT MESSAGES AS PER CEPD APPENDIX A, PARAGRAPH 3.6.3.2.
4. CASSETTE MUST BE VERIFIED "EMPTY" BEFORE TRANSFER OF WAFERS.

FILE: POD WITH EMPTY CASSETTE 001b.VSD

13.1 POD WITH EMPTY CASSETTE SCENARIO: STATE MODEL



13.2 POD WITH EMPTY CASSETTE SCENARIO: STATE TABLE

State	Description
No (output) Pod present	Waiting for (output) Pod to be placed on port.
Pod present and unclamped	Pod has been placed on port by Operator.
Pod present and clamped	Equipment has auto-clamped the Pod.
Read EMID is in process	Equipment has started reading the EMID.
Opening Pod and lowering Cassette	The equipment has opened the Pod and is scanning the Cassette Map during the Cassette lowering process.
Cassette Map is available	The Cassette Map has been read and is available at the equipment.
Cassette Map verification in process	The equipment is checking that the scanned Cassette Map to ascertain whether or not the Cassette is empty and hence, whether or not it is safe to transfer Wafers into the Cassette.
Equipment load completion in process	Equipment specific load completion actions are taking place. These will be different for each distinct equipment.
Transferring Wafers from tool into Cassette	Wafers are being transferred from the equipment into the (output) Cassette.
Waiting for Operator input (ENTER-ID/ unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID) and a privileged Operator is logged on, so the equipment is waiting for the Operator to either enter the EMID (using the ENTER-ID function) or to request that the Pod be unclamped.
Waiting for Operator input (INITIATE-ID/ unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID) and a NON-privileged Operator is logged on, so the equipment is waiting for the Operator to either use the INITIATE-ID function to force another AUTOIDREAD of the EMID from the cassette, or to request that the Pod be unclamped.
Waiting for Operator input (ENTER-ID/unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID), so the equipment is waiting for a privileged Operator to enter either the EMID or to request that the Pod be unclamped.
Waiting for Operator input (INITIATE-ID/unclamp)	AUTOIDREAD has failed to read the Cassette ID (EMID), so the equipment is waiting for a NON-privileged Operator to enter either the EMID or to request that the Pod be unclamped.
Unloading in process (“not empty” Cassette back to Pod)	The Cassette Map verification process has determined that the Cassette is “not empty” and so the Cassette is being unloaded from the equipment back into a Pod.
Raising SMIF	The SMIF is raising the Cassette to the home (top) position.
Rejected Pod is present and clamped	Pod has been rejected and is being unloaded but is still clamped. Pod has been rejected due to either: (a) failure to read its EMID, or (b) Cassette Map verification failure, or (c) an unknown Operator reason.
Rejected Pod is present and unclamped	Rejected Pod has been unclamped by the equipment.
Waiting for rejected Pod to be removed	The equipment is waiting for the Operator to remove the rejected Pod.

13.3 POD WITH EMPTY CASSETTE SCENARIO: TRANSITION TABLE

#	Current State	Trigger	New State	Action	Comment
1.	No (output) Pod present	Pod presence is detected by the equipment.	Pod present and unclamped	Equipment sends “Pod arrived” event message.	
2.	Pod present and unclamped	Equipment clamps the Pod.	Pod present and clamped	Equipment sends “Pod clamped” event message.	
3.	Pod present and clamped	“Pod clamped” event message send is completed.	Read EMID is in process	Equipment attempts to read EMID.	
4.	Read EMID is in process	AUTOIDREAD operation completes, but has failed to read EMID	Waiting for Operator input (ENTER-ID/ unclamp)	Equipment sends “AUTOIDREAD fail” event message	Equipment is unable to read Cassette ID. Case where Operator is

					privileged.
5.	Waiting for Operator input (ENTER-ID/ unclamp)	Operator enters “unclamp” (N.B. reason unknown)	Rejected Pod is present and clamped	Equipment prepares to unclamp Pod	Privileged Operator
6.	Read EMID is in process	Equipment has successfully read the EMID	Opening Pod and lowering Cassette	Equipment sends “EMID available” event message	
7.	Waiting for Operator input (ENTER-ID/ unclamp)	Operator enters EMID	Opening Pod and lowering Cassette	Equipment sends “EMID available” event message	Privileged Operator
8.	Opening Pod and lowering Cassette	Cassette arrives in bottom position	Cassette Map is available	Equipment sends “Load complete” and “Scan data available” event messages	
9.	Cassette Map is available	“Load complete” and “Scan data available” event message sends have been completed	Cassette Map verification in process	Equipment determines whether or not the Cassette is empty	
10.	Cassette Map verification in process	Equipment determines that Cassette is empty	Equipment load completion in process	Equipment positions Cassette to receive Wafers	
11.	Equipment load completion in process	Equipment has positioned Cassette to receive Wafers	Transferring Wafers from tool into Cassette	Equipment transfers Wafers into Cassette	
12.	Cassette Map verification in process	Equipment determines that Cassette is “not empty”	Unloading in process (“not empty” Cassette back to Pod)	Equipment transfers “not empty” Cassette back to Pod	
13.	Unloading in process (“not empty” Cassette back to Pod)	Cassette has been transferred back to Pod	Raising SMIF	Equipment sends “Unload complete” event message	
14.	Raising SMIF	Cassette reaches home (top) position	Rejected Pod is present and clamped	Equipment sends “SMIF indexer up” event message	
15.	Rejected Pod is present and clamped	Equipment unclamps Pod	Rejected Pod is present and unclamped	Equipment sends “Pod unclamped” event message	
16.	Rejected Pod is present and unclamped	Equipment prompts Operator to remove Pod	Waiting for rejected Pod to be removed	Equipment waits for Pod to be removed	
17.	Waiting for rejected Pod to be removed	Operator removes Pod	No (output) Pod present	Equipment sends “Pod removed” event message	
18.	Read EMID is in process	AUTOIDREAD operation completes, but has failed to read EMID and Operator is NON-priveleged	Waiting for Operator input (INITIATE-ID/ unclamp)	Equipment waits for Operator to enter INITIATE-ID or unclamp command	NON-priveleged Operator
#	**Current State**	**Trigger**	**New State**	**Action**	**Comment**
1.	Waiting for Operator input (INITIATE-ID/ unclamp)	Operator enters INITIATE-ID command	Read EMID is in process	Equipment attempts to read EMID	NON-priveleged Operator
2.	Waiting for Operator input (INITIATE-ID/ unclamp)	Operator enters UNCLAMP command	Rejected Pod is present and clamped	Equipment prepares to unclamp Pod	NON-priveleged Operator

SECTION 14.0 REPRESENTATIVE SECS II MESSAGE DATA STRUCTURES

14.1 EVENTS

14.1.1 POD_PLACED: S6F11 W

```
<L
     <U4 1>
     <U1 3> * CEID
     <L
        <L
             <U4 111>
             <L
                 <U1 1> * PORT ID
              >
        >
      >
>.
```

14.1.2 POD_CLAMPED: S6F11 W

```
<L
     <U4 1>
     <U1 2> * CEID
     <L
        <L
             <U4 111>
             <L
                 <U1 1> * PORT ID
              >
        >
      >
>.
```

14.1.3 POD_UNCLAMPED: S6F11 W

```
<L
     <U4 1>
     <U1 4> * CEID
     <L
        <L
             <U4 111>
             <L
                 <U1 1> * PORT ID
              >
        >
      >
>.
```

14.1.4 POD_REMOVED: S6F11 W

```
<L
     <U4 1>
     <U1 5> * CEID
     <L
        <L
             <U4 111>
             <L
                 <U1 1> * PORT ID
              >
        >
      >
>.
```

14.1.5 EMID_AVAILABLE: S6F11 W

```
<L
     <U4 1>
     <U1 1> * CEID
     <L
         <L
            <U4 112>
            <L
                <U1 1 > * PORT ID
             <A "Z65"> * CassetteID
               >
             >
     >
>.
```

14.1.6 LOAD_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 6> * CEID
     <L
        <L
             <U4 113>
             <L
                 <U1 1> * PORT ID
            <A "Z65"> * CassetteID
               >
        >
      >
>.
```

14.1.7 UNLOAD_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 7> * CEID
     <L
        <L
             <U4 113>
             <L
                 <U1 1> * PORT ID
            <A "Z65"> * CassetteID
               >
        >
      >
>.
```

14.1.8 CASSETTE_STARTED: S6F11 W

```
<L
     <U4 1>
     <U1 8> * CEID
     <L
        <L
             <U4 114>
             <L
            <A "Z63"> * CassetteID
               >
        >
      >
>.
```

14.1.9 CASSETTE_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 9> * CEID
     <L
        <L
             <U4 114>
             <L
            <A "Z63"> * CASSETTEID
               >
        >
      >
>.
```

14.1.10 WAFER_STARTED: S6F11 W

```
<L
     <U4 1>
     <U1 10> * CEID
     <L
        <L
             <U4 115>
             <L
            <A "WAFERID_1"> * WAFER ID
       >
        >
      >
>.
```

14.1.11 LOT_STARTED: S6F11 W

```
<L
     <U4 1>
     <U1 11> * CEID
     <L
        <L
             <U4 116>
             <L
           <A "M708010"> * LotID
            >
        >
      >
>.
```

14.1.12 BATCH_STARTED: S6F11 W

```
<L
     <U4 1>
     <U1 12> * CEID
     <L
        <L
             <U4 117>
             <L
           <U1 1> * BATCH ID
             >
        >
     >
>.
```

14.1.13 WAFER_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 13> * CEID
     <L
         <L
            <U4 115>
            <L
                <A "WAFERID_1"> *WAFER ID
            >
         >
      >
>.
```

14.1.14 LOT_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 14> * CEID
     <L
        <L
             <U4 116>
             <L
           <A "M708010"> * LOTID
       >
        >
      >
>.
```

14.1.15 BATCH_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 15> * CEID
     <L
        <L
             <U4 117>
             <L
           <U1 1> * BATCH ID
              >
        >
      >
>.
```

14.1.16 LAST_WAFER_COMPLETE: S6F11 W

```
<L
     <U4 1>
     <U1 16> * CEID
     <L
         <L
            <U4 115>
            <L
                <A "WAFERID_5"> *WAFER ID
            >
         >
      >
>.
```

14.1.17 SCAN_DATA_AVAILABLE: S6F11 W

```
              <L
                   <U4 1>
                   <U1 17>    * CEID
                   <L
                      <L
                        <U4 118>
                              <L
                      <U1 1>
                      <A "Z63" >
                               <B[25/1] 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 > * CASSETTE SLOT MAP
                                    <L
                         <A "WAFERID_1">
                      <A "WAFERID_2">
                      <A "WAFERID_3">
                      <A "WAFERID_4">
                      <A "WAFERID_5">
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                      <A "" >
                                    >
                                    >
                                   >
                               >
                         >.
```

14.2 REMOTE COMMANDS

14.2.1 UNLOAD: S2F41 W

```
          <L
            <A 'UNLOAD'>* rmcd
            <L
              <L
                <A 'PTN'>
                <U1 1>
              >
             >
          >.
```

14.2.2 UNCLAMP: S2F41 W

```
<L
  <A 'UNCLAMP'>* rmcd
  <L
    <L
      <A 'PTN'>
      <U1 1>
    >
  >
>.
```

14.2.3 LOAD: S2F41 W

```
<L
  <A 'LOAD'>
  <L
    <L
      <A 'PTN'>
      <U1 3>
    >
  >
>.
```

14.2.4 START: S2F41 W

```
<L
  <A 'START'>
  <L

  >
>.
```

14.2.5 PP_SELECT1: S2F41 W (for a process tool)

```
                    <L
                      <A 'PP-SELECT'> *S2F41 REMOTE COMMAND FOR A PROCESS TOOL
                      <L
                        <L
                          <A 'PPID'>
                          <A 'RECIPE01'>* ppid
                        >
                        <L
                          <A 'LOTID'>
                          <A 'M708010'> *LOTID
                        >
                        <L
                          <A 'MID'>
                          <A 'Z63'> * MID
                        >
                        <L
                          <A 'CassetteSlotMap'>
                          <B 01 01 01 01 01 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 >  * CassetteSlotMap
                        >
                        <L
                          <A 'CassetteWaferMap'>* CassetteWaferMap
                          <L
                            <A 'waferID1'>
                            <A 'waferID2'>
                            <A 'waferID3'>
                            <A 'waferID4'>
                            <A 'waferID5'>
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                            <A ‘’ >
                          >
                        >
                      >
                    >.
```

14.2.6 PP_SELECT2: S2F41 W (for a metrology tool)

```
                    <L
                      <A 'PP-SELECT'> *S2F41 REMOTE COMMAND FOR A METROLOGY TOOL
                      <L
                        <L
                          <A 'PPID'>
                          <A 'RECIPE01'>* ppid
                        >
                        <L
                          <A 'LOTID'>
                          <A 'M708010'> *LOTID
                        >
                        <L
                          <A 'MID'>
                          <A 'Z63'> * MID
                        >
                        <L
                          <A 'CassetteSlotMap'>
                          <B 01 01 01 01 01 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 >  * CassetteSlotMap
                        >
                        <L
                          <A 'CassetteWaferMap'>* CassetteWaferMap
                          <L
                            <L
                              <A 'waferID1'>
                              <A 'waferID2'>
                              <A 'waferID3'>
                              <A 'waferID4'>
                              <A 'waferID5'>
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                              <A '' >
                      >
                      <L
                              <A 'RecipeMap'>* Recipe Map
                              <L
                               <L
                                <A 'Recipe1'>
                                <A 'Recipe2'>
                                <A 'Recipe3'>
                                <A 'Recipe4'>
                                <A 'Recipe5'>
```

```
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                        <A '' >
                            >
                          >
                         >
                       >.
```

14.2.7 PP_SELECT3: S2F49 W (for a process tool)

```
<L,4
    <A
    <A
    <A 'PP-SELECT3'    *S2F49 REMOTE COMMAND FOR A PROCESS TOOL
    <L,5
        <L,2
            <A 'PPID'> *PPID SPECIFICATION ON NEXT LINE
            <A 'SEQ1'> *ACTUAL PPID NAME
        >
        <L,2
            <A 'LOTID'>   *LOT I.D. SPECIFICATION ON NEXT LINE
            <A 'M708011'> *ACTUAL LOT I.D.
        >
        <L,2
            <A 'MID'>  *MID SPECIFICATION ON NEXT LINE
            <A 'Z65'>  *3 CHARACTER MID
        >
        <L,2
            <A 'CassetteSlotMap'>
            <B 01 01 01 01 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 >  * CassetteSlotMap
        >
        <L,2
            <A 'CassetteWaferMap'>
            <L
              <A 'waferID1'>
              <A 'waferID2'>
              <A 'waferID3'>
              <A 'waferID4'>
              <A 'waferID5'>
              <A '' >
              <A '' >
              <A '' >
              <A '' >
```

```
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                   >
               >
          >
     >.
```

14.2.8 PP_SELECT4: S2F49 W (for a metrology tool)

```
     <L,4
          <A
          <A
          <A 'PP-SELECT4'    *S2F49 REMOTE COMMAND FOR A METROLOGY TOOL
          <L,6
               <L,2
                    <A 'PPID'> *PPID SPECIFICATION ON NEXT LINE
                    <A 'SEQ1'> *ACTUAL PPID NAME
               >
               <L,2
                    <A 'LOTID'>   *LOT I.D. SPECIFICATION ON NEXT LINE
                    <A 'M708011'> *ACTUAL LOT I.D.
               >
               <L,2
                    <A 'MID'>  *MID SPECIFICATION ON NEXT LINE
                    <A 'Z65'>  *3 CHARACTER MID
               >
               <L,2
                    <A 'CassetteSlotMap'>
                    <B 01 01 01 01 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 >  * CassetteSlotMap
               >
               <L,2
                    <A 'CassetteWaferMap'>
                    <L
                      <A 'waferID1'>
                      <A 'waferID2'>
                      <A 'waferID3'>
                      <A 'waferID4'>
                      <A 'waferID5'>
                      <A '' >
                      <A '' >
                      <A '' >
                      <A '' >
                      <A '' >
                      <A '' >
                      <A '' >
                      <A '' >
```

```
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                   >
              >
              <L,2
                  <A 'RecipeMap'>
                  <L
                    <A 'Recipe01'>
                    <A ''>
                    <A 'Recipe02'>
                    <A 'Recipe03'>
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                    <A '' >
                   >
              >
         >
    >.
```

14.2.9 JOB_DELETED: S6F11 W

```
<L
  <U4 1>
  <U1 1>        *CEID
  <L
    <L
      <U4 119>
      <L
        <U1 1>      *PORTID
        <A 'Z65'>   *EMID
        <A 'M708011'>  *LOT I.D.
        <A 'B1232456'> *BATCH I.D.
      >
  >
>
```

14.3 ALARM MESSAGES

14.3.1 ALARM: S1F5 W

```
<L
 <B 82>       *ALCD (Alarm Code)
 <U4 36>      *ALID (Alarm I.D.)
 <A 'H2 GAS HIGH'   *ALTX (Alarm Text)
>
```

SECTION 15.0 AUTO_ID MATERIAL IDENTIFICATION SYSTEM

The AutoId Material Identification Systems consists of a Radio Frequency emitting 'Pill", which is embedded into each FAB 30 cassette and which is encoded with a unique identification number. This information is read by a receiver which is integrated into each process and metrology tool by the equipment supplier. An antenna for this system is integrated by the SMIF supplier into each SMIF system port plate. This antenna is in close physical proximity to the cassette's RF "Pill" when the Pod is clamped on the SMIF port plate.

15.1 AUTO_ID SYSTEM TECHNICAL NOTES

The Auto ID System is a material tracking and identification system designed to support the overall factory material handling process. The system uses a radio frequency (RF) based read/write identification tag (MicroTag) that is embedded into each wafer carrier (cassette). This allows the Auto ID System to operate with a very high degree of data integrity. The MicroTag receives power from the RF energy generated by an Antenna. An Antenna, used at each Read Point (*e.g.* equipment I/O ports), transmits low power RF signals to the MicroTag, causing its circuits to respond with a unique tag number. The system hardware component to be used in AMD Fab 30 is a Utility Module, consisting of a Power Supply and Master Controller. Each SMIF Interface will have an Antenna mounted adjacent to the SMIF pod port.

15.2 BASIC ARCHITECTURE

According to the CIM & Automation part of the CEPD, the Auto ID components will be integrated mechanically and electrically into the process equipment. The process equipment software design should incorporate the SMIF and identification related functionality into its GEM interface. The communication to the Master Controller is currently a proprietary protocol and is over an RS232 line.

SMIF / AutoID Integration

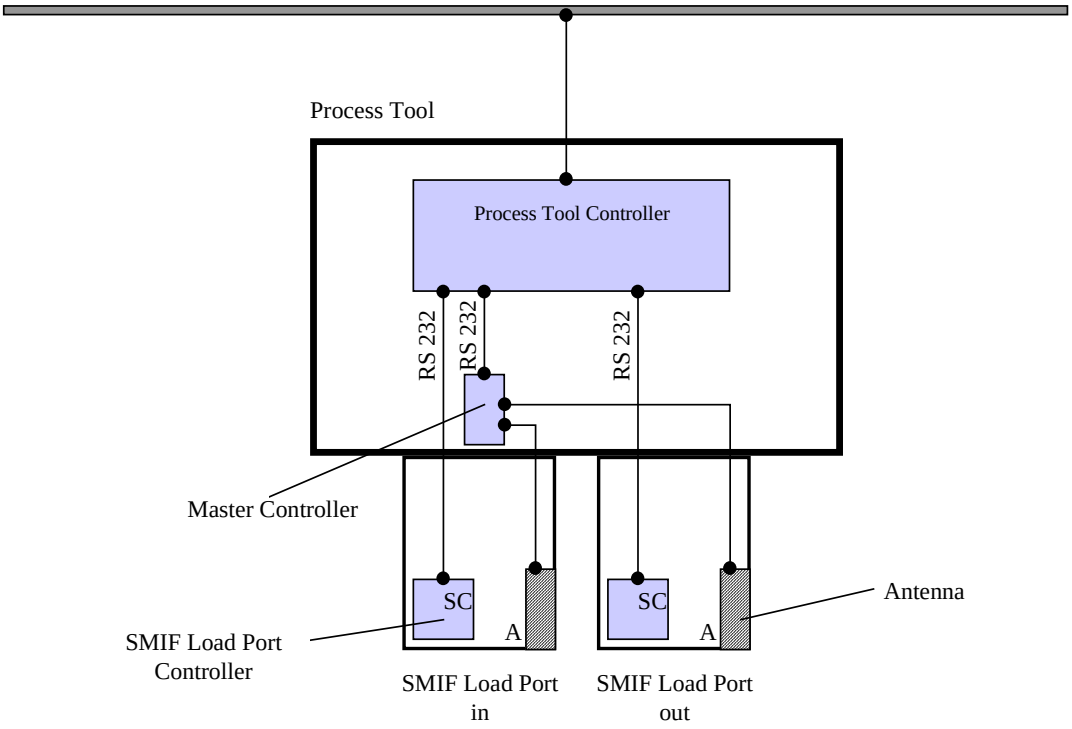


Figure 1-10 SMIF / AutoId System Integration

15.3 MECHANICAL INTEGRATION

Each SMIF I/O load port shall be equipped with an Antenna. The SMIF I/O units are shipped to each OEM with the Antenna already installed. The Antenna is located within the read envelope of the MicroTag (about 4.5”). The presence signal is delivered via the existing pod presence sensor of the SMIF port plate. The reading signal is protected against radio frequency interference with other equipment components, however, the positioning of “high field” devices within the vicinity of the Antenna or SMIF port plate should be avoided.

IMPORTANT

CRT screens should be located at least 18” away from the read point in order to minimize radio frequency interference.

The Utility Module (Master Controller *et. al.)* should be located inside the process tool. A worst case ambient operating temperature range of +15° C to +50° C is required. The process equipment should provide all electrical power for SMIF and Auto ID. Master Controller power supplies require 220V 50Hz within 6 cable feet.

15.4 COMMUNICATIONS INTERFACE

All Cassette ID, Lot and Wafer tracking (where applicable) on the load ports and inside of the equipment should be controlled by the process tool controller inclusive of the Auto ID information. Read commands should be sent to the Master Controller from the equipment controller.

The Auto ID information should be incorporated in the single line GEM interface of the process tool controller to the Fab host. The Auto ID read process needs to be synchronized with the load/unload process at the SMIF port. The Auto ID information from load ports should be communicated to the process tool controller using RS232 serial communications.

The process tool controller should support automatic error detection of the Auto ID components. All Auto ID component errors detected by the process tool controller should be corrected by initializing or resetting the Auto ID components.

15.5 TAG READ / WRITE DATA FORMAT

15.5.1 Tag Read

To read the tag shown in the above example:

1. Formulate a "read-page" command for the Master Controller containing the following 5 ASCII characters:

   [ETX]nn[SO]A

2. Assuming that everything works correctly, the following 27-character response should be received:

   nn[STX]54394B0000000000D090FEA[ETB]

where "D090" is the bcc, "FE" defines a read/write tag, and "A" is the page indicator.

15.5.2 'C' Code Tag Read Example

```
    ...
    char uid[3], tagid[17], mid[9];
    ...

    /* Send a read-page command to the appropriate read point. */
    readtag(uid, &tagid);

    /* Convert the 16-character tagid to the 8-character mid. */
    tagid2mid(mid, tagid);

    ...
}
```

```
void tagid2mid(char *mid, char *tagid)
{
  int i, hex1, hex2, hi, lo;

  /* Convert every two characters of tagid to a single character in
mid. */
  for (i = 0; i < 8; i++) {
    hex1 = tagid[i*2];
    hex2 = tagid[i*2+1];
    hi = (hex1 > '9') ? (hex1-'A'+10) : (hex1-'0');
    lo = (hex2 > '9') ? (hex2-'A'+10) : (hex2-'0');
    mid[i] = hi*16 + lo;
  }
  /* Terminate the string, just to be sure */
  mid[8] = 0;
}
```

15.5.3 Tag Write

Note: There is no formal requirement for equipment suppliers to incorporate any kind of Tag Write mechanism within their equipment software, however, the following Tag Write information may be useful for test purposes.

To write the following three ASCII characters ('T9K') to a MicroTag:

1. Translate each ASCII character into two hex characters ('T' to '54', '9' to '39' and 'K' to '4B') and pad the remainder of the 16 [4-bit] nibble (8 byte) tag with ASCII nulls, giving the following sixteen hex characters:

   54394B0000000000

2. Formulate a "write-page" command for the Master Controller that would contain the following 22 ASCII characters:

   [ETX]nn[SI]A54394B0000000000[ETB]

   where characters in [] are control characters, nn is the two-digit address of the read point, and the 'A' after the [SI] is the MicroTag page indicator.

3. The Master Controller should respond with the following message:

   nn[ACK][SI]A54394B0000000000[ETB]

   which signifies a successful write.

15.5.4 ‘C’ Code Tag Write Example

```
...
char uid[3], tagid[17], mid[9];
...

/* Convert the 8-character mid to the 16-character tagid. */
```

```
  mid2tagid(tagid, mid);

  /* Send a write-page command to the appropriate read point. */
  writetag(uid, tagid);

  ...
}

void mid2tagid(char *tagid, char *mid)
{
  int i, ch, asc, j;

  /* Convert every character in mid into two characters in tagid. */
  for(i = 0; i < strlen(mid); i++) {
    asc = mid[i]/16;
    tagid[i*2] = (asc > 9) ? (asc - 10 + 'A') : (asc + '0');
    asc = mid[i] % 16;
    tagid[i*2+1] = (asc > 9) ? (asc - 10 + 'A') : (asc + '0');
  }
  /* Fill the remainder of tagid with '0's. */
  for (j = i*2; j < 16; ) {
    tagid[j++] = '0';
  }
  /* Terminate the string, just to be sure. */
  tagid[16] = 0;
}
```

SECTION 16.0 NOTES