Manufacturing Operation and Exception Scenarios for Reliable High Volume Manufacturing: Version 3.0

International SEMATECH Manufacturing Initiative
Technology Transfer #03084426C-ENG

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Abstract: This document from the MFGM021M project provides guidance for implementing factory integration and automation standards focused on the operational needs of high volume manufacturing (HVM). It is divided into three major topic areas: Material Delivery and Verification, Job Execution, and Exception Handling Capabilities. Each area contains specific guidance for particular functions, interactions, and usage. This guidance is not intended to be comprehensive, but is focused on key issue areas for fab operation and implementation. This document represents the consensus of International SEMATECH Manufacturing Initiative (ISMI) participating companies for the desired behavior in common requirements areas. This revision includes additional information under references and recipe download.

Keywords: Factory Automation, Manufacturing Systems, Computer Software, Standards, Automated Material Handling Systems, Exception Handling, Management Execution Systems

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1 EXECUTIVE SUMMARY

This document is intended to provide additional guidance for implementing factory integration and automation standards focused on the demanding operational needs of High Volume Manufacturing (HVM). The integration, automation, and factory systems in 300 mm factories represent a significant investment directly designed to contribute to manufacturing productivity and thus the bottom line. Optimizing the performance of these systems to meet the aggressive ramps and throughput volume is critical to return on investment. Although there are no new requirements, this guidance builds on existing guidance to clarify and promote open communication of the specific performance needs in the HVM environment.

The desired behaviors described in the *Manufacturing Operation and Exception Scenarios: Reliable High Volume Manufacturing* represent the consensus of the participating International SEMATECH Manufacturing Initiative (ISMI) companies in areas of common requirements from the end user point of view. The chance to accelerate performance improvement and to have all participating parties realize cost benefit provides powerful motivation to make the most of the opportunity that common language and clear requirements can provide.

Guidance is in three major areas:

- Material Delivery and Verification
- Job Execution
- Exception Handling Capabilities

The guidance is presented in use cases, scenarios, and tables at a level of detail designed for immediate deployment. It establishes a common reference point for further discussions, development, and issue resolution. Supplier feedback, input, and active participation for improvement are highly desired and welcome.

2 INTRODUCTION

The 300 mm integrated circuit (IC) factories were conceived and are designed and executed as highly integrated and fully automated manufacturing environments, requiring significantly more integration and standardization than in the past. The reasons for this are clear to original equipment manufacturers (OEMs), equipment suppliers, and IC makers alike in light of the productivity and economic pressures that drive the semiconductor industry. For factory integration these are generally represented in the Material Management, Job Execution, and Command and Control relationship of the equipment to the factory control systems.

The efforts to establish standards before implementation and to collaborate for more rapid and successful first-pass implementations have had significant benefits. However, the standards and requirements are complex and demanding. ISMI's participating companies have provided guidance documents to augment the SEMI standards, focused on providing the end user vision and intent in using the functions defined as a vehicle for better understanding and communication.

As the 300 mm SEMI standards and advanced levels of integration have been implemented, areas that require more communication and guidance have been identified. Often this entails documentation of the learning and solutions that IC makers and suppliers working together have identified. Such guidance clarifies, simplifies, and saves costs for everyone. It does not establish new requirements or change existing guidance, but adds to the ability to work together productively.

The Manufacturing Operation and Exception Scenarios (MOES) is guidance specifically focused on the behavior that is desired and that supports aggressive ramp plans and fully loaded volume manufacturing (i.e., HVM). The ISMI 300 mm Operational Flowcharts and Scenarios (Production Equipment) established the basic template for the desired solution space where the functions and elements of the standards are integrated and interact to support the fab operation and missions. The MOES guidance builds on this to provide yet another level of detail regarding interactions that can be influenced by the rate, loading, and volume of the material that the equipment is routinely expected to process. Additionally, the exception handling capability requirements and some typical exception handling scenarios are described.

The guidance in this document is the consensus of participating ISMI companies for the desired behavior in common requirements areas. Implementation by an individual IC maker may not require all of the functions covered here and may add specific requirements to augment the scenarios and guidance. The intent of this guidance is to provide the supplier community with information on the intended method of implementing the standards requirements that is consistent and common to all of the operational implementation modes that the participating companies will use. Further, this guidance will be representative of the requirements of implementations that take advantage of the advanced standards and methods for fully integrated IC factories.

In some cases, the guidance will contain information or additional elements that are not obvious, explicitly stated, or found in the SEMI standards. Often this is line-of-business information about the way that the IC makers operate and dramatically affects the desired behavior. There is no intent to address this additional information in a comprehensive way; it should be considered embedded in the guidance as presented. Whenever there has been a question about the alignment of the guidance with the standards, it has been clearly identified, and the interaction described in detail.

3 REFERENCE DOCUMENTS

3.1 300 mm Semiconductor Factory Guidelines

The following documents can be found at http://www.sematech.org/resources/standards/guidance/index.htm:

- *Global Joint Guidance for 300 mm Semiconductor Factories*
- *300 mm Integrated Vision for Semiconductor Factories: Release Three*
- *300 mm Operational Flowcharts and Scenarios (Production Equipment): Version 10,* Technology Transfer #04014484-TR

3.2 SEMI Standards

Copies of these documents are available from SEMI.

- SEMI E5, *SEMI Equipment Communications Standard 2 Message Content (SECS-II)*
- SEMI E30, *Generic Model for Communications and Control of Manufacturing Equipment (GEM)*
- SEMI E37, *High-Speed SECS Message Services (HSMS) Generic Services*
- SEMI E39, *Object Services Standard: Concepts, Behavior, and Services (OSS)*
- SEMI E40, *Standard for Processing Management*
- SEMI E84, *Specification for Enhanced Carrier Handoff Parallel I/O Interface*
- SEMI E87, *Provisional Specification for Carrier Management (CMS)*
- SEMI E90, *Specification for Substrate Tracking*
- SEMI E94, *Provisional Specification for Control Job Management*
- SEMI T7, *Specification for Back Surface Marking of Double-side Polished Wafers with a Two-dimensional Matrix Code Symbol*

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4 MANUFACTURING OPERATION AND EXCEPTION SCENARIOS GUIDANCE

This guidance is broken into three major topic areas: Material Delivery and Verification, Job Execution, and Exception Handling Capabilities. Each area contains specific guidance for particular functions, interactions, and usage. This guidance is not intended to be comprehensive, but is focused on key issue areas for fab operation and implementation. Over the course of revision, more topic and subject areas will be added to the guidance.

The guidance is in several different formats:

- Scenarios: tabular representations of a sequence of actions involving commands and communication elements from a variety of standards, states, and transitions intended to accomplish a given task in the consensus-desired method
- Tables: guidance along with specific use or condition information related to a content item
- Figures: graphical representations of flows or applications that represent the consensus-desired implementation or behavior
- Text: descriptions of the desired behavior or performance

The guidance is intended to communicate the desired and expected behavior from the end user point of view in a fully integrated factory. It is expected to be used by suppliers as an implementation template for the standards functions and the equipment performance. Further, it establishes a common reference point for further discussions, development, and issue resolution. Supplier feedback, input, and active participation for improvement are desired and welcome.

4.1 Material Delivery and Verification

A key element in the effective implementation and execution of highly integrated factories is material handling and delivery. A synopsis of the vision can be simply stated as the intent of the factory systems (specifically the MES and dispatch/prioritization systems) to have control over the scheduling and distribution of work/material flow, with the intent of managing and optimizing overall factory performance to meet weighted business needs. To achieve this, equipment in the factory must view its role as supporting that goal and the behavior of the equipment interface to and following the delivery of material must perform in a standardized manner consistent with that objective. In some cases, innovative or non-standard equipment performance for reasons that seem justified at the local level can adversely impact the overall factory performance and control; consequently, it is not desirable despite any perceived advantage.

While the automated material handling system (AMHS) is a key element of a material delivery system, the requirements and behavior of these distributed systems are not included in this guidance. For the MOES guidance, the AMHS is assumed capable of delivering the right material at the volume and timing commensurate with fully loading the production equipment at the maximum theoretical rate. Likewise, any potential impacts of work-in-process (WIP) quantity and queuing, capacity bottlenecks or installed capacity mismatch, or any other sources of manufacturing inefficiency not directly associated with equipment integration, capability, and operation will not be explored in this guidance. All scenarios will assume that all external factors are optimal for fully loading the equipment.

The Material Delivery and Verification section provides guidance for the following specific areas:

- E84/E87 Delivery While Processing
- CarrierRecreate Usage
- Material Map Verification
- Wafer ID Reader usage

4.1.1 E84/E87 Delivery While Processing Scenario

In a high volume fab, material should be delivered to the equipment at a rate and in a way that allows the equipment to remain processing in cascade mode of operation without interruption. This requires that material be delivered while other material is being processed, moved, staged, unloaded, or otherwise manipulated. The factory requires these things to happen simultaneously and without dependency upon each other. Specifically, delivery and removal of material by the AMHS, and all material handling on any loadport must be completely independent and capable of execution while material on another loadport is being processed. The sample scenario in Table 1 illustrates the consensus-desired behavior of such operations.

Table 1 E84/E87 Delivery While Processing Scenario

Scenario Operational Conditions:

- ***Fixed buffer equipment with multiple loadports***
- ***E87 Notification = Bind***
- ***Slot Map Verification = Equipment based***
- ***E87 Carrier Delivery = Auto***
- ***BypassReadID = False***
- ***E40-PRMtlType=Carrier***

Color Code Glossary		
	E30 Related Interactions	Lot(s) in material handling
	E84 Related Interactions	Lot(s) in processing
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84 Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
1	*Prior Association to Equipment Port via Bind service for Carrier 1*								*This scenario is for when material is delivered after being identified to tool*
2	Host sends a Bind command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment acknowledges Bind	S3F17/S3F18	Bind	H ⇒ E		Material Handling			For this scenario info provided by Bind includes CarrierID = CID1, PortID=1, Lot=A
3	Equipment notifies host of transition from Not Associated to Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Associated	H ⇐ E		Material Handling			Refers to E87 Association state model transition #2.
4	Host sends a Bind command for 2nd carrier containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment acknowledges Bind	S3F17/S3F18	Bind	H ⇒ E		Material Handling			For this 2nd message, info provided by Bind includes CarrierID = CID2, PortID=2, Lot=B
5	Equipment notifies host of transition from Not Associated to Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Associated	H ⇐ E		Material Handling			Refers to E87 Association state model transition #2.
6	*AMHS attempts material delivery on 1st LP of CID1*				X	Material Handling			
7	Equipment notifies Host that a carrier Xfer begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E	X	Material Handling			Refers to E87 Loadport Xfer state model transition #6. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
8	*AMHS completes material transfer (E84 transactions finish)*				X	Material Handling			
9	Equipment notifies host that Material has arrived : Material Received CEID (E30)	S6F11/S6F12	Material received	H ⇐ E		Material Handling			This event is required by E30 (GEM)
10	*Equipment determines value of internal equipment constant ByPassReadID and it equals FALSE*					Material Handling			

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
11	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges Event	S6F11/S6F12	ID Verification OK	H ⇐ E		Material Handling			Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID=CID1
12	Equipment sends CarrierChangeLocation event, from Placement to Docked for 1st LP (E87). Host acknowledges Event	S6F11/S6F12		H ⇐ E		Material Handling			
13	Carrier Opened CEID sent (E87). Host acknowledges Event	S6F11/S6F12	Carrier Opened	H ⇐ E		Material Handling			Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID=CID1
14	Equipment sends Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event.	S6F11/S6F12	Carrier In Access	H ⇐ E					Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
15	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges Event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E		Material Handling			Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in Bind service. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID=CID1 -SlotMap= Enumerated List
16						Material Handling			*At this point all preliminary AMHS/E87 delivery transactions have been completed & carrier verification is complete. In addition, the equipment has instantiated substrate objects using the ID's from the content map.*
17	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host	S7F1/S7F2	PP Load Inquire	H ⇒ E		Waiting			
18	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E		Waiting			Potentially host could upload recipe at this point rather than download

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
19	Host issues PJ Multi Create Command (E40) S16F15 PRJobMultiCreate. Equip. acknowledges PJ Multi Create command S16F16 PRJobMultiCreate Ack	S16F15/S16F16	PRJobMultiCreate	H ⇒ E		Waiting			With this message(E40 service), host attaches slot(s) to be run with recipe(s)
20	Equipment notifies host that PJ queued/pooled. <no state> to PRJobQueued/Pooled CEID (E40). Host acknowledges Event	S6F11/S6F12	PRJobQueued	H ⇐ E		Waiting			Refers to E40 Process Job State Model Transition #1
21	Host issues CJ Create Command (E94, E39) S14F9 Create Obj. Request. Equip. acknowledges CJ Create command S14F10 Create Obj. Ack	S14F9/S14F10	CJCreate	H ⇒ E		Waiting			This message (E94 service) contains mapping of all source to destination slots (& carriers)
22	Equip. notifies host that CJ created. <no state> to QUEUED CEID (E94). Host acknowledges Event	S6F11/S6F12	CJQueued	H ⇐ E		Waiting			Refers to E94 Control Job State Model Transition #1
23	Equip. sends CJ QUEUED to SELECTED CEID (E94). Host acknowledges Event	S6F11/S6F12	CJSelected	H ⇐ E		Waiting			Refers to E94 Control Job State Model Transition #3
24	Equip. sends CJ Selected to EXECUTING CEID (E94). Host acknowledges Event	S6F11/S6F12	CJExecuting	H ⇐ E		Waiting			Refers to E94 Control Job State Model Transition #5
25	Equip. sends transition from Queued/Pooled to SETTING UP CEID(E40). Host acknowledges Event	S6F11/S6F12	PRJobActive to Setting Up	H ⇐ E		Processing			Refers to E40 Process Job State Model Transition #2
26	Equip. sends PJ Setting Up to PROCESSING CEID (E40). Host acknowledges Event	S6F11/S6F12	PRJobProcessing	H ⇐ E		Processing			Refers to E40 Process Job State Model Transition #4
27	Wafers are pulled from carrier and processing begins					Processing			Refers to E87 Carrier state model transition #18. This event should be sent when first wafer is pulled out of carrier. For potential DVVALS attached to event, values: -CarrierID=CID1
28	*Equip. sends Substr. AT SOURCE to AT WORK CEID (E90). Host acknowledges Event	S6F11/S6F12	Substrate At Work	H ⇐ E		Processing			Refers to transition #2 of Substrate State Model
29	*Equip. sends Substrate NEEDS PROCESSING to IN PROCESS CEID (E90). Host acknowledges Event	S6F11/S6F12	Substrate In Process	H ⇐ E		Processing			Refers to transition #11 of Substrate State Model. Tool should send when processing/measurement has begun on wafer
30	*Equip. sends Substrate IN PROCESS to PROCESSING COMPLETE CEID (E90). Host acknowledges Event	S6F11/S6F12	Substrate Processing Complete	H ⇐ E		Processing			Refers to transition #12 of Substrate State Model. Equip. should send when all processing/measuring of wafer has been completed

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
31	*Equip sends Substr AT WORK to AT DESTINATION CEID(E90). Host acknowledges Event	S6F11/S6F12	Substrate At Destination	H ⇐ E		Processing			Refers to transition #5 of Substrate State Model. Equip. should send when wafer returned to carrier
32	**** Repeat Steps 27-30 for each substrate. All substrates for this process job should progress through the above sequence.***					Processing			
33	*AMHS attempts material delivery on 2nd LP*					Processing	X	Material Handling	*Note that the material delivery for 2nd FOUP is occurring in parallel to processing of carrier loaded on 1st loadport, without impact or interference*
34	Equipment notifies Host that a carrier Xfer begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E		Processing	X	Material Handling	**Note: Bind command for 2nd Carrier previously sent in Step 4 above.** Refers to E87 Loadport Xfer state model transition #6. For potential DVVALS attached, values: -PortID =2, -PortTransferState=1
35	*AMHS completes material transfer (E84 transactions finish)*					Processing	X	Material Handling	
36	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges Event	S6F11/S6F12	MaterialReceived	H ⇐ E		Processing		Material Handling	This event is required by E30 (GEM)
37	*Equipment determines value of internal equipment constant ByPassReadID and it equals FALSE*					Processing		Material Handling	
38	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges Event	S6F11/S6F12	ID Verivication OK	H ⇐ E		Processing		Material Handling	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete. For potential DVVALS attached to event, values: -PortID =2, -PortTransferState=1, -CarrierID=CID2
39	Equipment sends CarrierChangeLocation event, from Placement to Docked for 1st LP (E87). Host acknowledges Event	S6F11/S6F12		H ⇐ E		Processing		Material Handling	
40	Carrier Opened CEID sent (E87). Host acknowledges Event	S6F11/S6F12	Carrier Opened	H ⇐ E		Processing		Material Handling	Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =2, -PortTransferState=1, -CarrierID=CID2

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
41	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges Event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E		Processing		Material Handling	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in Bind Carrier service. For potential DVVALS attached to event, values: -PortID =2, -PortTransferState=1, -CarrierID=CID2 -SlotMap= Enumerated List
42						Processing		Material Handling	*At this point all preliminary AMHS/E87 delivery transactions have been completed & carrier verification is complete for 2nd carrier.*
43	***Multi-block recipe(s) downloaded for Carrier 2 - Lot B material, using the same sequence of events defined in Steps 16-17 above for Carrier 1 - Lot A (E30)***					Processing		Waiting	*The recipe(s) for the material in Carrier 2 must be downloaded before the completion of the in process material to support Cascade Processing*
44	***PJ and CJ created for Carrier 2 - Lot B, using the same sequence of events defined in Steps 18-21 above for Carrier 1 - Lot A***					Processing		Waiting	*The ProcessJob and ControlJob for the material in Carrier 2 must be created before the completion of the in process material to support Cascade Processing (no interruption between the last wafer of the first lot and the first wafer of the next lot)*
45	***PJ and CJ begin execution for Carrier 2 - Lot B, using the same sequence of events defined in Steps 22-25 above for Carrier 1 - Lot A***					Processing		Processing	*The ProcessJob and ControlJob for the material in Carrier 2 must begin execution before the completion of the in process material to support Cascade Processing (no interruption between the last wafer of the first lot and the first wafer of the next lot)*
46	***Wafers begin to be processed with substrate tracking as defined in Steps 27-30 for Carrier 1. All substrates in carrier should progress through the sequence***					Processing		Processing	*The first wafer from Carrier 2 must immediately follow the last wafer from Carrier 1 into processing to be cascade processing*
47	Equip. sends PRJOB Processing to PROCESS COMPLETE CEID (E40). Host acknowledges Event	S6F11/S6F12	PRJobComplete	H ⇐ E		Processing		Processing	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
48	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges Event	S6F11/S6F12	CJComplete	H ⇐ E		Processing		Processing	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
49	For carrier on LP1, Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges Event	S6F11/S6F12	Carrier Complete	H ⇐ E		Material Handling		Processing	Refers to E87 Carrier state model transition #19. This event should be sent when last wafer is returned and carrier door closed. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID=CID1
50	Carrier closed on LP1, Carrier Closed CEID sent (E87). Host acknowledges Event	S6F11/S6F12	Carrier Closed	H ⇐ E		Material Handling		Processing	Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID=CID1
51	Carrier is Undocked on LP1, Equip. sends Xfer Blocked to Ready to Unload CEID (E87). Host acknowledges Event	S6F11/S6F12	Ready to Unload	H ⇐ E		Material Handling		Processing	Refers to E87 Loadport transfer model transition #9. This event should be sent when carrier returned to unload position. **Should be unclamped at this point. For potential DVVALS attached, values: -PortID =1, -PortTransferState=3**
52	Equipment sends CarrierChangeLocation event, from Docked to Placement for 1st LP (E87). Host acknowledges Event	S6F11/S6F12		H ⇐ E		Material Handling		Processing	
53	*AMHS attempts material pickup (E84 trans. initiate) E84 Transactions*				X	Material Handling		Processing	
54	Carrier Unload begins on LP1, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E	X	Processing			Refers to E87 Load Port Transferstate model transition #7. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
55	*AMHS completes material pickup (E84 trans. finish)*				X	Material Handling		Processing	
56	Equipment notifies host that Material has departed Material Removed CEID(E30). Host Acknowledges Event	S6F11/S6F12	Material Removed	H ⇐ E		Material Handling		Processing	This event is required by E30(GEM)
57	Equipment notifies host of transition from Associated to Not Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Not Associated	H ⇐ E		Material Handling		Processing	Refers to E87 Association state model transition #3. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1

Table 1 E84/E87 Delivery While Processing Scenario (continued)

Item	Action	SECSMsg	SECSDesc	Primary Direction	E84: Loadport 1	Lot A Activity	E84: Loadport 2	Lot B Activity	Notes and Comments
58	Carrier Unload has completed for carrier on LP1, equipment sends a Transfer Blocked to Ready to Load CEID (E87). Host acknowledges Event	S6F11/S6F12	Ready to Load	H ⇐ E		Material Handling		Processing	Refers to E87 Loadport Transfer state model transition #8. After this event, the tool is ready to accept another carrier transfer. For potential DVVALS attached, values: -PortID =1, -PortTransferState=2
59	***Cascaded flow continues...***							Processing	*All E40/E90/E94 transactions outlined above would be mirrored for carrier on 2nd Loadport. During this period, another FOUP could be interleaved on 1st loadport while carrier on 2nd loadport continues to process. Eventually, when carrier on 2nd loadport completes, it would follow similar unload sequence as 1st carrier did above. Main purpose of this scenario is to show cascaded operations on tools should maintain integrity of data variables no matter what may be happening on other parts (or ports) on the tool.*

4.1.2 CarrierRecreate Service

In 2001, IC makers identified the need to re-introduce material from the same front opening unified pod (FOUP) as fundamental to the operations of a 300 mm factory. However, the way the E87 state models were defined made it difficult to accomplish that without physically removing the material off the equipment. In a fully automated AMHS factory, scheduling unplanned AMHS pick-ups and replacements to perform that physical manipulation is not a trivial task. To solve this, IC makers worked to gain consensus for the addition of a brand new service to E87 appropriately titled CarrierRecreate. This added a virtual FOUP pick-up and replacement utility.

While the CarrierRecreate service has solved several issues for re-introducing material, the way it is currently defined was too restrictive for some IC maker scenarios. For instance, while one can re-introduce a fully processed FOUP to a tool, if the FOUP is aborted before entering the ACCESSED state (no wafers yet removed), and then an attempt is made to re-introduce the FOUP by CarrierRecreate, this action will be hindered by the current definition of CarrierRecreate.

The consensus-desired behavior for the CarrierRecreate service is to allow the service to be invoked and/or used any time a carrier object is present on a loadport and the loadport state model is in the “Ready to Unload” state. *This solution does not fully comply with current standards (ver. 0703). It does not directly conflict with the content of the relevant standard, just asks that the function be implemented based on a subset of the conditional requirements. Efforts to effect this change in the standard are underway.*

4.1.2.1 Change to E87 CarrierRecreate Definition

What is documented here is a simple mechanism that allows the CarrierRecreate service to work in all scenarios.

The core of this issue existed in the restrictive nature of the CarrierRecreate definition. In and before E87-0703, the CarrierRecreate service stated that the tool must meet two conditions for the tool to accept it: a) Loadport state model = “Ready to Unload,” and b) Carrier Object state model, Carrier Accessing State = “Carrier Complete” or “Carrier Stopped.”

The simple solution, accepted as of E87-0304,consisted of removing condition (b) as a requisite for accepting the service and relying only on the condition of the loadport state model. Thus, the change from E87-0703 to E87-0304 exists as follows:

- In E87-0703, Table 15, the following items were changed:
  - **From:**

ServiceName	Type	Description
CarrierReCreate	R	This service shall cause the carrier object (and consequently, associated state models of the object) specified by the service to be re-created. This service shall be accepted only if the carrier accessing state is "Carrier Complete" or "Carrier Stopped" and the loadport is in the "Ready to Unload" state.

  - **To:**

ServiceName	Type	Description
CarrierReCreate	R	This service shall cause the carrier object (and consequently, associated state models of the object) specified by the service to be re-created. This service shall be accepted only if the ~~carrier accessing state is "Carrier Complete" or "Carrier Stopped" and the~~ loadport is in the "Ready to Unload" state.

- Similarly, the last sentence of E87-0703, section 16.4.14.1 was modified (as of E87-0304) to read as follows:

  16.4.14.1 The service shall be accepted only if the ~~current carrier Accessing Status is either Carrier Complete or Carrier Stopped and the~~ loadport is in the "Ready to Unload" state

4.1.3 Material Map Verification

Depending on the operational condition parameters in use (Material Type, Carrier Notification, etc.), the equipment may have several maps representing the material within a carrier. The expectation is that the content of the maps in use—the slot map, content map, wafer map, and PRMtlList—will be consistent. However, a mismatch is possible. The standard describes the expected behavior for a mismatch between the read slot map and the host supplied slot map, but the other cases are not clearly defined. The standards do not require that a content map or PRMtlList contain a value for every substrate in the slot map/carrier. While generally it is expected that each list will be fully populated as appropriate (PRMtlList by intent is a subset), partial or incomplete lists are not precluded. An example might be where a carrier contains product and monitor wafers, and only the product wafer ID's are listed in the content map; or where a breakdown has caused a slot map to be 'lost'. The purpose of the validation is to ensure that the content map or PRMtlList do not contain an ID for a slot that is not populated in the slot map/carrier.

The consensus desired behavior is to have the equipment reconcile the various maps at the earliest opportunity, to minimize error handling and recovery. This is especially important in cases where the jobs are created (and maps delivered) before material arrival, as it allows the opportunity for correction and recovery without the need to disposition the material with the requirement for manual intervention or material movement. The scenarios in Figure 1–Figure 4 provide guidance in validating the carrier maps and acting on the results:

- Figure 1 is the case for PJ/CJ created before the material arrives and the material type = carrier.
- Figure 2 is the case for PJ/CJ created after the material arrives, and the material type = carrier.
- Figure 3 is the case for PJ/CJ created before the material arrives, and the material type = substrate.
- Figure 4 is the case for PJ/CJ created after the material arrives, and the material type = substrate.

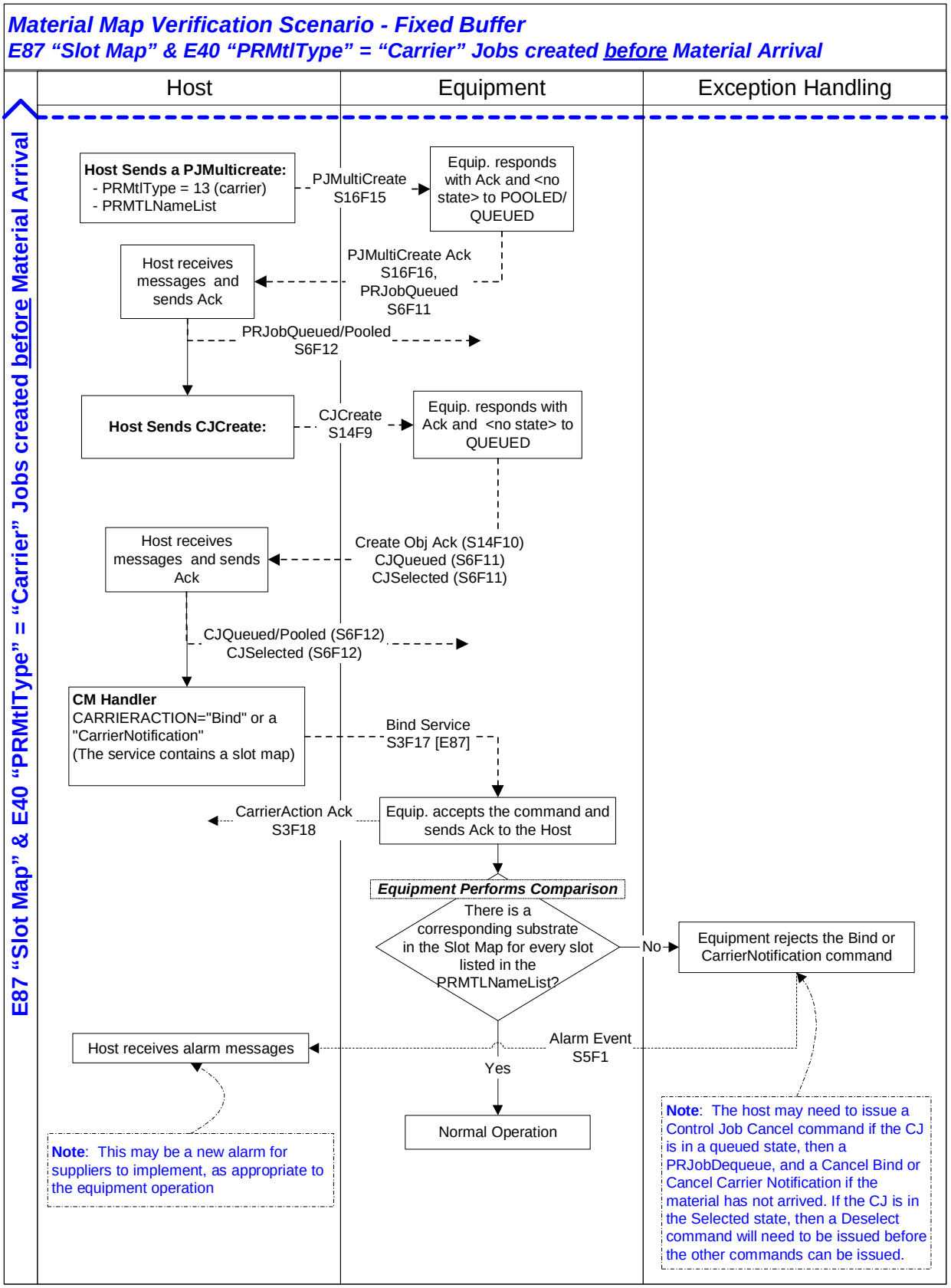

Figure 1 PJ/CJ Before Material (material type = carrier)

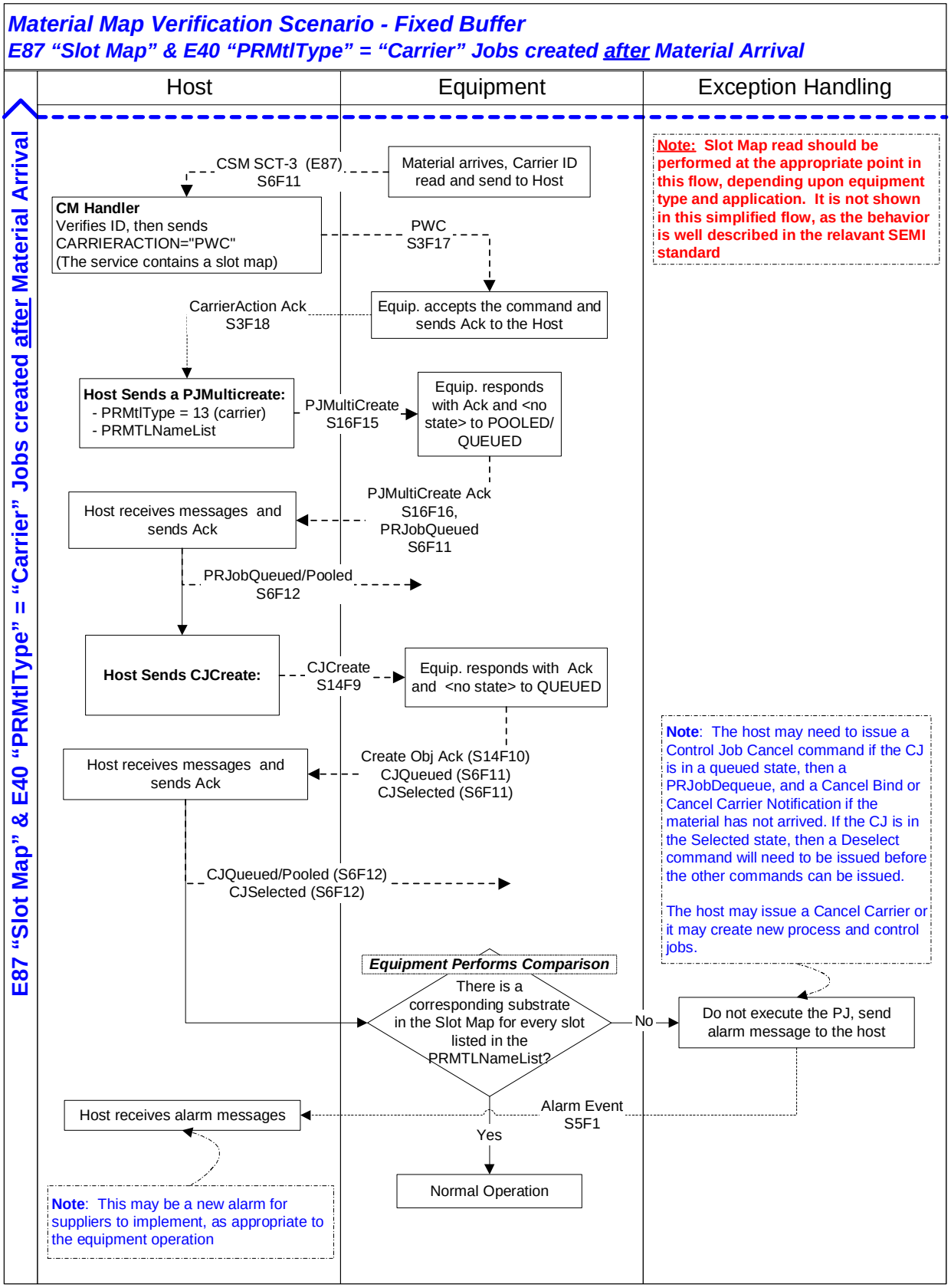

Figure 2 PJ/CJ After Material (material type = carrier)

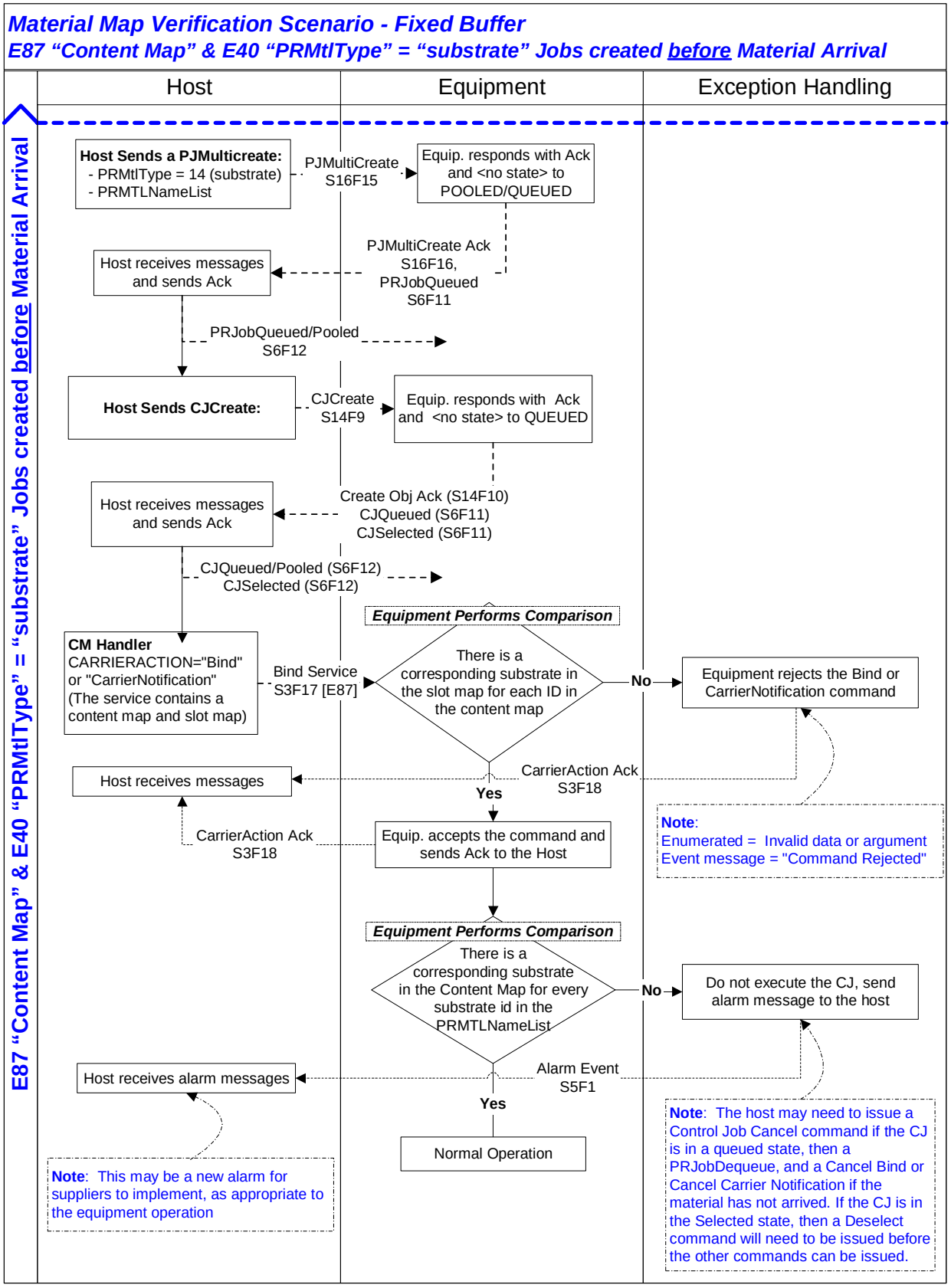

Figure 3 PJ/CJ Before Material (material type = substrate)

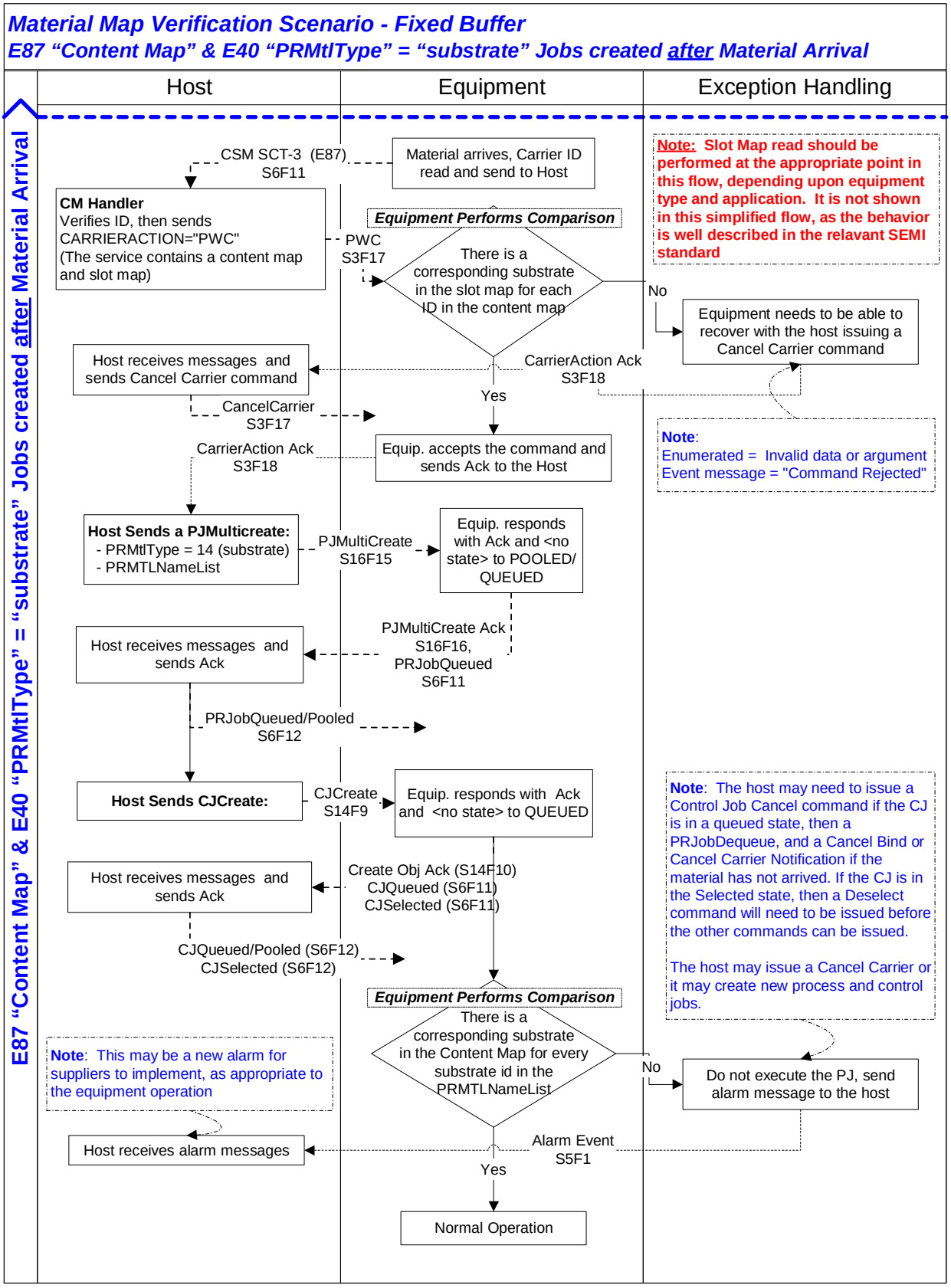

Figure 4 PJ/CJ After Material (material type = substrate)

4.1.4 Wafer ID Reader Usage

Some equipment will incorporate wafer ID readers, capable of directly “reading” the alphanumeric SEMI T7 scribe. There are a variety of applications for this capability from sorters to establish the initial identification or verify the MES-supplied carrier content map to production tools to validate the ID for processing or to execute a lot split, among others.

The scenarios in Figure 5–Figure 7 describe the consensus guidance expected sequence of events to be used when the ID reader is to be used as part of the equipment capability and process.

- Figure 5 is the case for Equipment Control Mode, where ID validation is done at the equipment only.
- Figure 6 is the case for Host Decision Mode, where ID validation is done at the equipment but exceptions are referred to the host for direction.
- Figure 7 is the case for Host Control Mode, where ID validation is done exclusively by the Host.

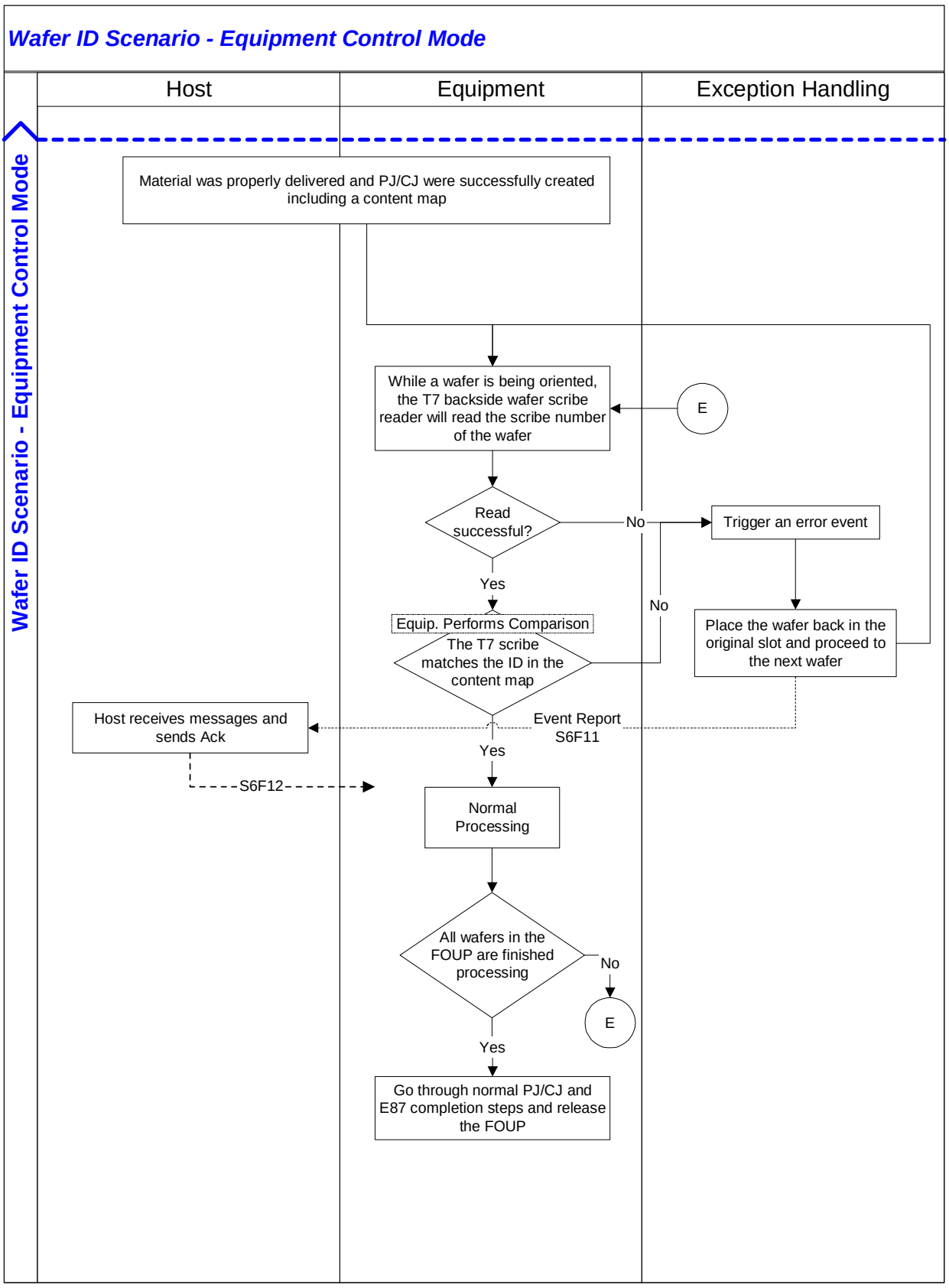

Figure 5 Wafer ID Reader Usage (Equipment Control Mode)

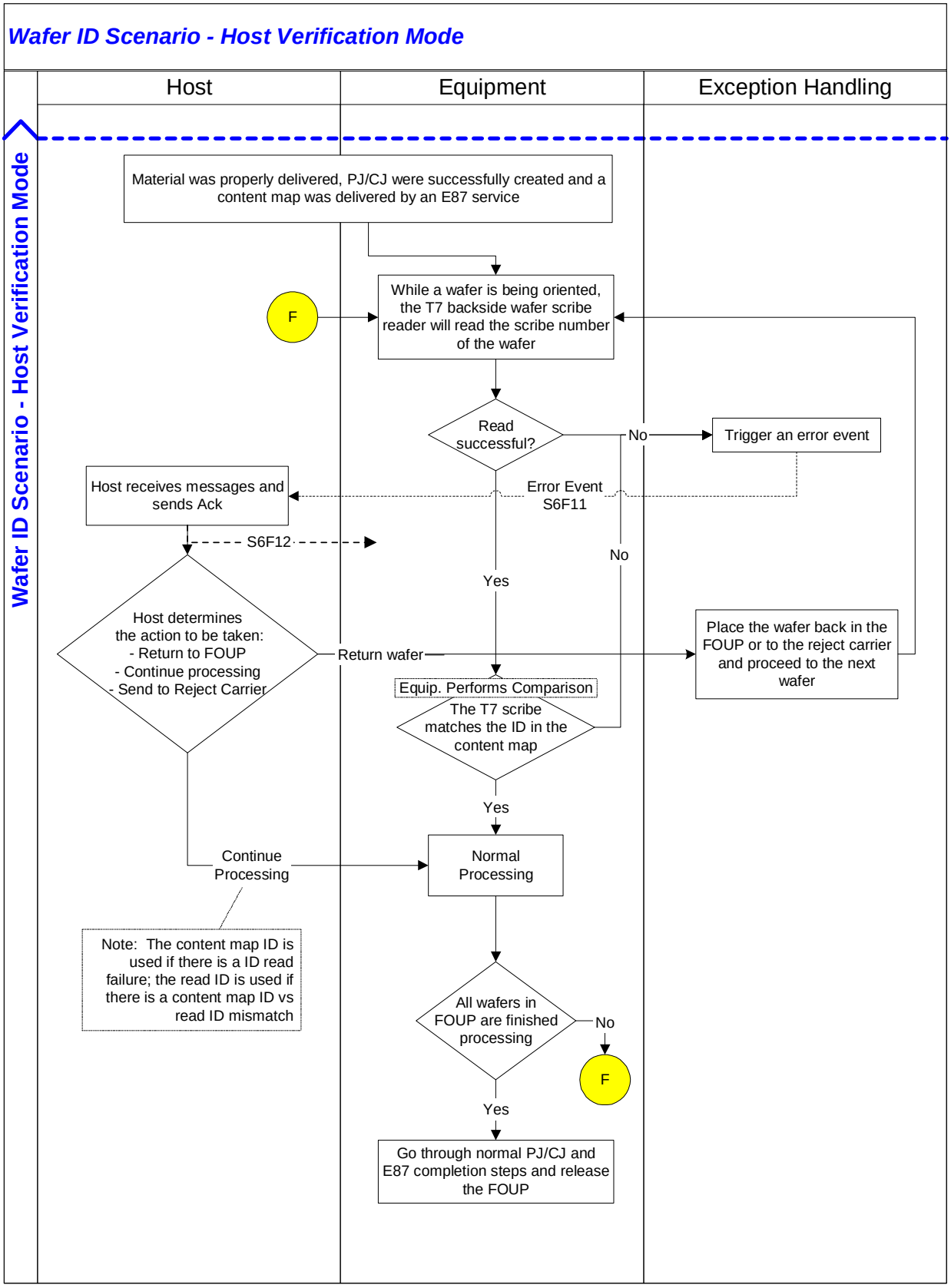

Figure 6 Wafer ID Reader Usage (Host Decision Mode)

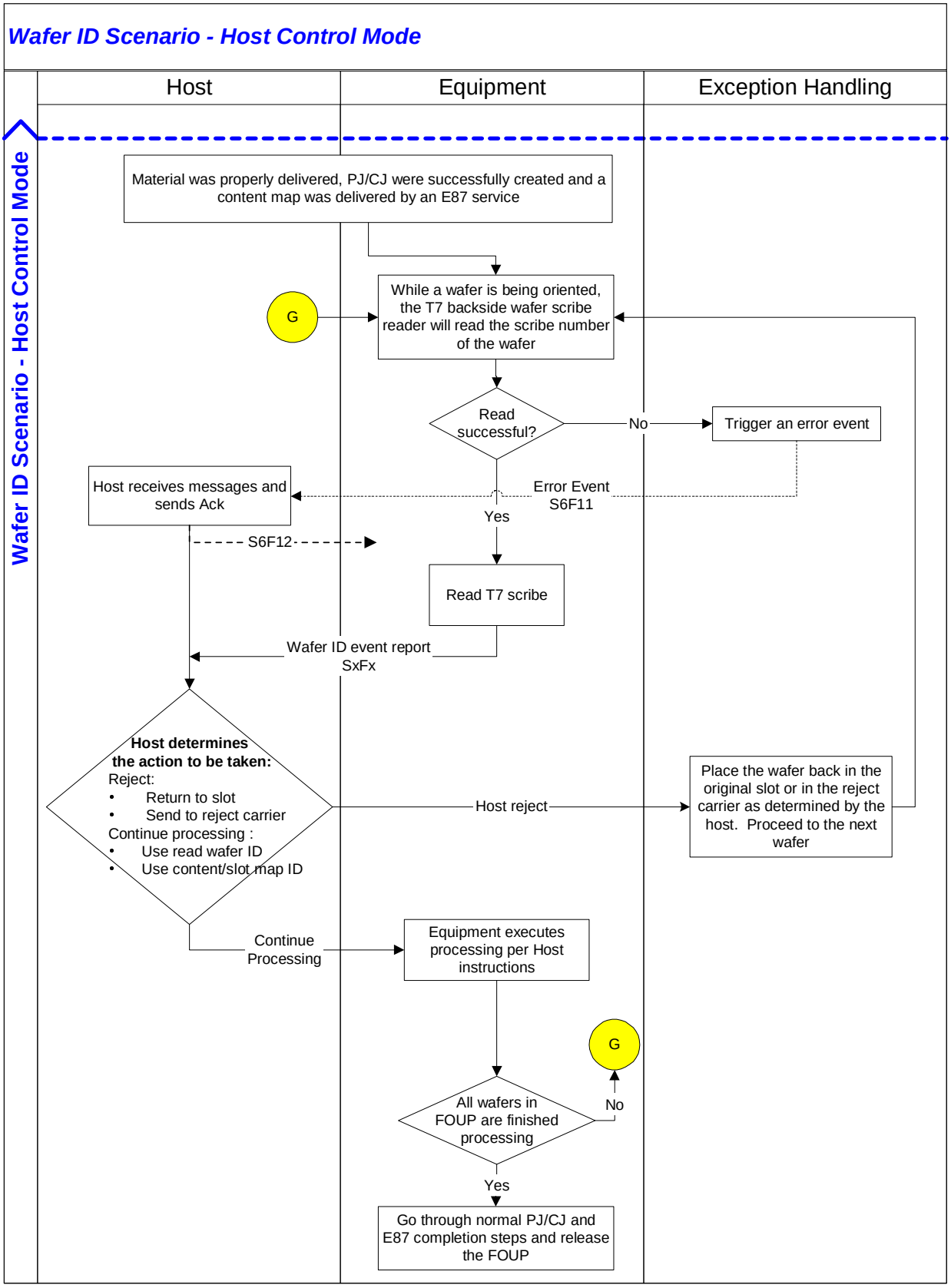

Figure 7 Wafer ID Reader Usage (Host Control Mode)

4.2 Job Execution

The relationship between the Control Job (E94) and the Process Job (E40) and other job elements such as recipes can be complex in an HVM environment. Traditionally, the process recipe was considered the primary, and largely unchanging, control point for material processing. In current advanced factories, advanced process control (APC), fault detection and classification (FDC), equipment control systems (ECS), and other advanced manufacturing methodologies often require variations in processing from lot to lot or even at the individual wafer level. This is a significant change to the fundamental philosophy of job execution and management. The operational processing as the primary focus point for results, with job execution elements that support that viewpoint, results in complex interactive relationships that are difficult to describe and model in a way that represents all the desired modes.

Ultimately, the recipe, process job, and control job are expected to work together seamlessly to ensure that each wafer is processed correctly. Doing this can require complex management of the job elements as they relate to multiple lots/wafers simultaneously without any impact to the integrity of other queued or executing jobs or to the equipment throughput and productivity. This can be especially challenging in the fully loaded HVM environment, particularly with the addition of lot prioritization.

HVM-capable equipment is expected to manage multiple in-queue process jobs, control jobs, and iterations and versions of the recipes (often parameter variations of the same root named recipe). Further, the equipment is expected to concurrently process multiple process jobs and control jobs, ensuring that the correct processing is executed for each wafer. By performing these functions simultaneously, the equipment can meet the requirement of cascade processing.

In the guidance for job execution, the scenarios are representative samples. Changing even one operational condition parameter, such as the choice between Auto and Manual start, can change the order and sequence of the scenario actions. The focus is on the relationships between the functional elements of the different standards and the sequence relationships in the scenarios that represent the intended behavior and performance. Knowledgeable engineers are expected to be able to extrapolate these scenarios to match other sets of operational condition parameters.

The Job Execution section provides guidance for the following areas:

- Concurrent processing (parallel scenarios)
- Multiple Sequential PJs with the Same Wafers
- Control Job Stop/Pause/Abort Usage
- Recipe Download Without Affecting In-Process Jobs
- PRMtlType = Substrate
- Recipe Tuning

4.2.1 Concurrent Processing (parallel scenarios)

Concurrent processing is intended to literally mean running two or more jobs simultaneously without adverse impact on processing or equipment productivity. Thus, equipment is expected to be able to have more than one process and/or control job running (executing and actively processing wafers) at the same time.

The first scenario (Table 2) represents the relatively simple case of one control job with two process jobs concurrently executing. The second scenario (Table 3) is the more complex case of two control jobs, one with two process jobs and the second with one process job executing simultaneously. This second scenario actually represents a routine occurrence in cascade processing, since by definition the next PJ/CJ in the queue should always start executing before the completion of the in-process job.

Table 2 Concurrent Process Job Execution

Scenario Operational Conditions:

- **Fixed buffer equipment with multiple loadports**
- **E87 Notification = CarrierNotification**
- **Slot Map Verification = Equipment based**
- **E87 Carrier Delivery = Auto**
- **BypassReadID = False**
- **E40 PRMtlType=Carrier**
- **E40 PR Start = Manual**

Color Code Glossary	E30 Related Interactions	
	E84 Related Interactions	
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
1	Host sends a 'CarrierNotification' command containing Carrier ID, Slot Map and Content Map (E87) for the Carrier. Equipment acknowledges 'CarrierNotificaton'	S3F17/S3F18	CarrierNotification	H ⇒ E	<No State>	<No State>	<No State>	For this scenario info provided by 'CarrierNotification'
2	AMHS attempts material delivery	—			<No State>	<No State>	<No State>	
3	Equipment notifies Host that a carrier Xfr begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges event.	S6F11/S6F12	Transfer Blocked	H ⇐ E	<No State>	<No State>	<No State>	Refers to E87 Loadport Xfr state model transition #6. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
4	Equipment sends CarrierLocationChange event, at Placement CEID (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	
5	AMHS completes material transfer (E84 transactions finish)	—			<No State>	<No State>	<No State>	
6	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges event.	S6F11/S6F12	MaterialReceived	H ⇐ E	<No State>	<No State>	<No State>	This event is required by E30 (GEM)
7	*Equipment determines value of internal equipment constant 'ByPassReadID' and it equals 'FALSE'*				<No State>	<No State>	<No State>	
8	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges event.	S6F11/S6F12	Waiting for Host	H ⇐ E	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete
9	Equipment notifies host of transition from Not Associated to Associated CEID (E87). Host acknowledges event.	S6F11/S6F12	Associated	H ⇐ E	<No State>	<No State>	<No State>	Refers to E87 Association state model transition #2. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
10					<No State>	<No State>	<No State>	At this point all preliminary AMHS/E87 delivery transactions have been completed & carrier verification is complete for all carriers in batch

Table 2 Concurrent Process Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
11	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host (for PJ1, "This Recipe")	S7F1/S7F2	PP Load Inquire	H ⇒ E	<No State>	<No State>	<No State>	
12	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E	<No State>	<No State>	<No State>	
13	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host (for PJ2, "That Recipe")	S7F1/S7F2	PP Load Inquire	H ⇒ E	<No State>	<No State>	<No State>	
14	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E	<No State>	<No State>	<No State>	
15	Host issues PJ MultiCreate Command (E40) S16F15 PRJobMultiCreate for 2 process jobs. Equip. acknowledges PJ Multi Create command S16F16 PRJobMultiCreate Ack	S16F15/S16F16	PRJobMultiCreate	H ⇒ E	<No State>	<No State>	<No State>	**Job1 Attributes**: PRJobID= "PJ1", CARRIERID="03459398", SlotIDList="<U2 1> <U2 3> <U2 5>", RCPSPEC="ThisRecipe" PRPROCESSSTART = Manual **Job2 Attributes:** PRJobID="PJ2", CARRIERID="03459398", SlotIDList="<U2 7> <U2 9> <U2 11>", RCPSPEC="ThatRecipe" PRPROCESSSTART = Manual
16	Equipment notifies host that PJ 'PJ1' QUEUED/ POOLED. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #1, PJ1
17	Equipment notifies host that PJ 'PJ2' QUEUED/ POOLED. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	<No State>	Refers to E40 Process Job State Model Transition #1, PJ2
18	Host issues CJ Create Command (E94, E39) S14F9 Create Obj. Request, specifying both PJ's. PJ2 is first in list order. Equip. acknowledges CJ Create command S14F10 Create Obj. Ack	S14F9/S14F10	CJCreate	H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	<No State>	**CJ1 Attributes:** ObjID="CJ1", ProcessOrderMgmt=3 (LIST), ProcessingCtrlSpec="<A PJ2> <A PJ1>" **Note that ProcessOrderMgmt = LIST, and because PJ2 is listed first in ProcessingCtrlSpec, it will be run prior to PJ1. StartMethod = false, User start**
19	Equip. notifies host that CJ created. <no state> to QUEUED CEID (E94). Host acknowledges event.	S6F11/S6F12	CJQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E94 Control Job State Model Transition #1
20	Equip. sends CJ QUEUED to SELECTED CEID (E94). Host acknowledges event.	S6F11/S6F12	CJSelected	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED /POOLED (Enumeration = 0)	SELECTED (Enumeration = 1)	Refers to E94 Control Job State Model Transition #3

Table 2 Concurrent Process Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
21	Equip. sends CJ Selected to WAITING FOR START CEID (E94). Host acknowledges event.	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	Refers to E94 Control Job State Model Transition #6
22	Host. sends CJStart (E94). Equipment acknowledges command CJStart	S16F27/S16F28		H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	
23	Equipment sends WAITING FOR START to EXECUTING Host acknowledges event.	S6F11/S6F12	CJExecuting	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #7
24	Equip. sends transition PRJob from QUEUED/ POOLED to SETTING UP CEID(E40)	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #2 for PJ2
25	Equipment sends CarrierLocationChange event, from Placement to Docked for 1st LP (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	
26	Carrier opened, Carrier Opened CEID sent (E87). Host acknowledges event.	S6F11/S6F12	Carrier Opened	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E87 "Additional Events"- not related to any state model transitions
27	Equipment sends Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event.	S6F11/S6F12	Carrier In Access	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
28	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges event.	S6F11/S6F12	SlotMapVerif OK	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in 'Carrier Notification' service (verify the slot map)
29								The equipment has instantiated substrate objects using the ID's from the content map.
30	Equip. sends PJ Setting Up to WAITING FOR START CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJob Waiting for Start	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #3 for PJ2
31	Host. sends PRJOB Command STARTPROCESS CEID (E40). Equipment acknowledges PRJOBCommand	S16F5/S16F6		H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	
32	Equipment sends WAITING FOR START TO PROCESSING. Host acknowledges event.	S6F11/S6F12	PRJobProcessing	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #5 for PJ2
33	Wafers are pulled from carrier and processing begins				QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	

Table 2 Concurrent Process Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
34	E90 substrate tracking is performed for each wafer in PJ2 as processed, based upon the requirements of the standard and equipment configuration				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	This is a summary requirements statement, the related commands and messages are not reflected in this scenario
35	Equip. sends transition from QUEUED/ POOLED to SETTING UP CEID for PJ1 (E40). Host acknowledges event.	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	SETTING UP (Enumeration = 1)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #2 for PJ1.
36	Equip. sends PJ Setting Up to WAITING FOR START (E40). Host acknowledges event.	S6F11/S6F12	PRJob Waiting for Start	H ⇐ E	WAITING FOR START (Enumeration = 2)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #3 for PJ1
37	Host. sends PRJOB Command STARTPROCESS (E40). Equipment acknowledges PRJOBCommand	S15F3/S15F4		H ⇒ E	WAITING FOR START (Enumeration = 2)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	
38	Equip. sends PJ WAITING FOR START to PROCESSING CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJobProcessing	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #5 for PJ1
39	E90 substrate tracking is performed for each wafer in PJ1 as processed, based upon the requirements of the standard and equipment configuration				PROCESSING (Enumeration =3)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	This is a summary requirements statement, the related commandsand messages are not reflected in this scenario
40	Equip. sends PRJOB Processing to PROCESS COMPLETE for PJ2 CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete for PJ2
41	Equip. sends PRJOB Processing to PROCESS COMPLETE for PJ1 CEID (E40). Host acknowledges event.	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete for PJ1
42	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event.	S6F11/S6F12	CJCompleted	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed
43	Carrier closed on LP1, Carrier Closed CEID sent (E87). Host acknowledges event.	S6F11/S6F12	Carrier Closed	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID='CID1'
44	For carrier on LP1, Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges event.	S6F11/S6F12	Carrier Complete	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 Carrier state model transition #19. This event should be sent when last wafer is returned and carrier door closed. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID='CID1'

Table 2 Concurrent Process Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
45	Equipment sends CarrierLocationChange event, from Docked to Placement for 1st LP (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
46	At this point the carrier is Undocked on LP1, Equip. sends Xfr Blocked to Ready to Unload CEID (E87). Host acknowledges event.	S6F11/S6F12	Ready to Unload	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 Loadport transfer model transition #9. This event should be sent when carrier returned to unload position. **Should be unclamped at this point.** For potential DVVALS attached, values: -PortID =1, -PortTransferState=3
47	*AMHS attempts material pickup (E84 trans. initiate) E84 Transactions*				PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
48	Carrier Unload begins on LP1, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges event.	S6F11/S6F12	Transfer Blocked	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 Association state model transition #7. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
49	Equipment sends CarrierLocationChange event from Placement at unload CEID (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
50	*AMHS completes material pickup (E84 trans. finish)*				PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
51	Equipment notifies host that Material has departed CEID(E30). Host acknowledges event.	S6F11/S6F12	Material Departed	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	This event is required by E30(GEM)
52	Equipment notifies host of transition from Associated to Not Associated CEID (E87). Host acknowledges event.	S6F11/S6F12	Not Associated	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 Association state model transition #3. For potential DVVALS attached, values: -PortID =1, -PortTransferState=1
53	Carrier Unload has completed for carrier on LP1, equipment sends a Transfer Blocked to Ready to Load CEID (E87). Host acknowledges event.	S6F11/S6F12	Ready to Load	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E87 Loadport Transfer state model transition #8. After this event, the tool is ready to accept another carrier transfer. For potential DVVALS attached, values: -PortID =1, -PortTransferState=2
54	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ2 (E40). Host acknowledges event.	S6F11/S6F12	PRJobDeleted	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	<No State>	COMPLETED (Enumeration = 5)	Refers to E40 Process Job State Model Transition #7 for PJ2.

Table 2 Concurrent Process Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Notes
55	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ1 (E40). Host acknowledges event.	S6F11/S6F12	PRJobDeleted	H ⇐ E	<No State>	<No State>	COMPLETED (Enumeration = 5)	Refers to E40 Process Job State Model Transition #7 for PJ1. At this stage all PJ's defined have been completed.
56	Equip. sends CJ COMPLETED to <no State> CEID (E94). Host acknowledges event.	S6F11/S6F12	CJDeleted	H ⇐ E	<No State>	<No State>	<No State>	Refers to E94 Control Job State Model Transition #13. Tool should send when all process jobs contained in control job are completed

Table 3 Concurrent Process and Control Job Execution

Scenario Operational Conditions:

- **Fixed buffer equipment with multiple loadports**
- **E87 Notification = CarrierNotification**
- **Slot Map Verification = Equipment based**
- **E87 Carrier Delivery = Auto**
- **BypassReadID = False**
- **E40-PRMtlType = Carrier**
- **E40-PRStart = Manual**

Color Code Glossary	E30 Related Interactions	
	E84 Related Interactions	
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
1	Host sends a 'CarrierNotification' command containing Carrier ID, Slotmap and Content Map (E87) for Each Carrier. Equipment acknowledges 'CarrierNotification'	S3F17/S3F18	CarrierNotification	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	For this scenario info provided by 'CarrierNotification'
2	AMHS attempts material delivery to LP1				<No State>	<No State>	<No State>	<No State>	<No State>	
3	Equipment notifies Host that a carrier Xfr begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges event	S6F11/S6F12	Transfer Blocked	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E87 Loadport Xfr state model transition #6. For potential DVVALS attached, values: -PortID =1 -PortTransferState=1
4	Equipment sends CarrierLocationChange event, at Placement CEID for LP1 (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	
5	AMHS completes material transfer (E84 transactions finish)				<No State>	<No State>	<No State>	<No State>	<No State>	
6	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges event	S6F11/S6F12	MaterialReceived	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	This event is required by E30 (GEM)
7	*Equipment determines value of internal equipment constant 'ByPassReadID' and it equals 'FALSE'*				<No State>	<No State>	<No State>	<No State>	<No State>	
8	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges event	S6F11/S6F12	Waiting for Host	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID='CID1'

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
9	Equipment sends CarrierLocationChange event, from Placement to Docked for LP1 (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	
10	Carrier Opened CEID sent (E87). Host acknowledges event	S6F11/S6F12	Carrier Opened	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID='CID1'
11	Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier In Access	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
12	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in 'CarrierNotification' service. For potential DVVALS attached to event, values: -PortID =1, -PortTransferState=1, -CarrierID='CID1' -SlotMap= Enumerated List
13										The equipment has instantiated substrate objects using the ID's from the content map.
14	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host	S7F1/S7F2	PP Load Inquire	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	For 'ThisRecipe', used in PJ1 and PJ3
15	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	For 'ThisRecipe', used in PJ1 and PJ3
16	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host	S7F1/S7F2	PP Load Inquire	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	For 'ThatRecipe', used in PJ2

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
17	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	For 'ThatRecipe', used in PJ2
18	Host issues PJ Multi Create Command (E40) PRJobMultiCreate for 2 process jobs. Equip. acknowledges PJ Multi Create command	S16F15/S16F16	PRJobMultiCreate	H ⇒ E	<No State>	<No State>	<No State>	<No State>	<No State>	**Job1 Attributes**: PRJobID= "PJ1", PRMtlOrder=LIST, SlotIDList="<U2 1> <U2 3> <U2 5>", CARRIERID="CID1", RCPSPEC="ThisRecipe", PRProcessStart = FALSE **Job2 Attributes:** PRJobID="PJ2", PRMtlOrder=LIST, SlotIDList="<U2 7> <U2 9> <U2 11>", CARRIERID="CID1", RCPSPEC="ThatRecipe", PRProcessStart = FALSE
19	Equipment notifies host that PJ QUEUED/ POOLED for PJ1. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	<No State>	<No State>	Refers to E40 Process Job State Model Transition #1
20	Equipment notifies host that PJ QUEUED/ POOLED for PJ2. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	<No State>	Refers to E40 Process Job State Model Transition #1
21	Host issues CJ Create Command specifying 2 PJ's (PJ1, PJ2). PJ2 is first in list order. Equip. acknowledges CJ Create command	S14F9/S14F10	CJCreate	H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	<No State>	CJ1 Attributes: ObjID="CJ1", ProcessOrderMgmt=3 (LIST), ProcessingCtrlSpec="<A PJ2> <A PJ1>", CARRIERID="CID1" Note that ProcessOrderMgmt = LIST, and because PJ2 is listed first in ProcessingCtrlSpec, it will be run prior to PJ1. StartMethod = false, User start
22	Equip. notifies host that CJ created. <no state> to QUEUED CEID (E94). Host acknowledges event	S6F11/S6F12	CJQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #1 for CJ1
23	Equip. sends CJ QUEUED to SELECTED CEID (E94). Host acknowledges event	S6F11/S6F12	CJSelected	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	SELECTED (Enumeration = 1)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #3 for CJ1

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
24	Equip. notifies host that CJ1 to WAITING FOR START. Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #6 for CJ1
25	Host. sends CJStart (E94) (CJ1). Equipment acknowledges command CJ Waiting for Start (CJ1) to EXECUTING event	S16F27/S16F28		H ⇒ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	<No State>	<No State>	
26	Equip. sends CJ WAITING FOR START to EXECUTING CEID (E94). Host acknowledges event	S6F11/S6F12	CJExecuting	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED/ POOLED (Enumeration = 0)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #7 for CJ1
27	Equip. sends transition PJ2 from QUEUED/ POOLED to SETTING UP CEID(E40). Host acknowledges event	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #2 for PJ2
28	Equip. sends PJ2 PJ Setting Up to WAITING FOR START CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobWaitingFor Start	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #3
29	Host. sends PRJOB Command STARTPROCESS PJ2 (E40). Equipment acknowledges PRJOBCommand	S16F5/S16F6		H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	<No State>	<No State>	
30	Equipment sends WAITING FOR START TO PROCESSING PJ2. Host acknowledges event	S6F11/S6F12	PRJobProcessing	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #5
31	Wafers are pulled from carrier and processing begins				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration =3)	<No State>	<No State>	
32	E90 substrate tracking is performed for each wafer in PJ2 as processed, based upon the requirements of the standard and equipment configuration				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration =3)	<No State>	<No State>	This is a summary requirements statement, the related commands and messages are not reflected in this scenario
33	AMHS attempts material delivery to LP2				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration =3)	<No State>	<No State>	

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
34	Equipment notifies Host that a carrier Xfr begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges event	S6F11/S6F12	Transfer Blocked	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E87 Loadport Xfr state model transition #6. For potential DVVALS attached, values: PortID =2 PortTransferState=1
35	Equipment sends CarrierLocationChange event, at Placement CEID for LP2 (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	
36	AMHS completes material transfer (E84 transactions finish)				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	
37	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges event	S6F11/S6F12	MaterialReceived	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	This event is required by E30 (GEM)
38	*Equipment determines value of internal equipment constant 'ByPassReadID' and it equals 'FALSE'*				QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	
39	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges event	S6F11/S6F12	Waiting for Host	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete. For potential DVVALS attached to event, values: -PortID =2 -PortTransferState=1, -CarrierID='CID2'
40	Equipment sends CarrierLocationChange event, from Placement to Docked for LP2 (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	
41	Carrier Opened CEID sent (E87). Host acknowledges event	S6F11/S6F12	Carrier Opened	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E87 "Additional Events"- not related to any state model transitions. For potential DVVALS attached to event, values: -PortID =2, -PortTransferState=1, -CarrierID='CID2'

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
42	Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier In Access	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
43	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in 'CarrierNotification' service. For potential DVVALS attached to event, values: -PortID =2, -PortTransferState=1, -CarrierID='CID2' -SlotMap= Enumerated List
44										The equipment has instantiated substrate objects using the ID's from the content map.
45	Host issues PJ Multi Create Command (E40) for 1 process job. Equip. acknowledges PJ Multi Create command	S16F15/S16F16	PRJobMultiCreate	H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	**Job3 Attributes**: PRJobID= "PJ3", RCPSPEC="ThisRecipe", CARRIERID="CID2", PRProcessStart = FALSE
46	Equipment notifies host that PJ QUEUED/ POOLED for PJ3. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	<No State>	Refers to E40 Process Job State Model Transition #1
47	Host issues CJ Create Command (CJ2) (E94, E39) S14F9 Create Obj. Request, specifying one PJ (PJ3). Equip. acknowledges CJ Create command S14F10 Create Obj. Ack	S14F9/S14F10	CJCreate	H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	<No State>	**CJ2 Attributes:** ObjID="CJ2", ProcessingCtrlSpec="<A PJ3>, CARRIERID="CID2" **. StartMethod = false, User start**
48	Equip. notifies host that CJ2 created. <no state> to QUEUED CEID (E94). Host acknowledges event	S6F11/S6F12	CJQueued	H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E94 Control Job State Model Transition #1 for CJ2
49	Equip. sends transition from QUEUED/ POOLED to SETTING UP CEID PJ1 (E40). Host acknowledges event	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	SETTING UP (Enumeration = 1)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E40 Process Job State Model Transition #2 Note the trigger for this is very dependent on tool structure and software

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
50	Equip. sends PJ Setting Up to WAITING FOR START PJ1 (E40). Host acknowledges event	S6F11/S6F12	PRJobProcessing	H ⇐ E	WAITING FOR START (Enumeration = 2)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E40 Process Job State Model Transition #3
51	Host. sends PRJOBCommand STARTPROCESS for PJ1 (E40). Equipment acknowledges PRJOBCommand for PJ1	S15F3/S15F4		H ⇒ E	WAITING FOR START (Enumeration = 2)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	
52	Equip. sends PJ WAITING FOR START to PROCESSING CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobProcessing	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E40 Process Job State Model Transition #5 for PJ1
53	E90 substrate tracking is performed for each wafer in PJ1 as processed, based upon the requirements of the standard and equipment configuration				PROCESSING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration =3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	This is a summary requirements statement, the related commands and messages are not reflected in this scenario
54	Equip. sends PRJOB Processing to PROCESS COMPLETE CEID for PJ2 (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
55	Equip. sends CJ (CJ2) QUEUED to SELECTED CEID (E94). Host acknowledges event	S6F11/S6F12	CJSelected	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	SELECTED (Enumeration = 1)	Refers to E94 Control Job State Model Transition #3 for CJ2
56	Equip. sends CJ Selected to WAITING FOR START (CJ2) CEID (E94). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	Refers to E94 Control Job State Model Transition #6 for CJ2
57	Host. sends CJStart for CJ2 (E94). Equipment acknowledges command.	S16F27/S16F28		H ⇒ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	WAITING FOR START (Enumeration = 2)	
58	Equip. sends CJ WAITING FOR START to EXECUTING (CJ2) CEID (E94). Host acknowledges event	S6F11/S6F12	CJExecuting	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #7 for CJ2
59	Equip. sends transition from QUEUED/ POOLED to SETTING UP CEID for PJ3 (E40). Host acknowledges event	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #2

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
60	Equip. sends PJ Setting Up to WAITING FOR START for PJ3 (E40). Host acknowledges event	S6F11/S6F12	PRJobWaitingFor Start	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #3
61	Host. sends PRJOBCommand STARTPROCESS for PJ3 (E40). Equipment acknowledges PRJOBCommand for PJ3	S16F5/S16F6		H ⇒ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	WAITING FOR START (Enumeration = 2)	EXECUTING (Enumeration = 3)	
62	Equip. sends PJ WAITING FOR START to PROCESSING CEID for PJ3 (E40). Host acknowledges event	S6F11/S6F12	PRJobProcessing	H ⇐ E	PROCESSING (Enumeration = 3)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #5
63	E90 substrate tracking is performed for each wafer in PJ3 as processed, based upon the requirements of the standard and equipment configuration				PROCESSING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration =3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	This is a summary requirements statement, the related commands and messages are not reflected in this scenario
64	Equip. sends PRJOB Processing to PROCESS COMPLETE CEID for PJ1 (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
65	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #10 for CJ1. Tool should send when all process jobs contained in control job are completed
66	Carrier closed CEID sent (E87). Host acknowledges event	S6F11/S6F12	Carrier closed	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, Refers to E87 "Additional Events"- not related to any state model transitions
67	Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier Complete	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, Refers to E87 Carrier state model transition #19. This event should be sent when last wafer is returned and carrier door closed
68	Equipment sends CarrierLocationChange event, from Docked to Placement (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
69	At this point the carrier is Undocked on LP1, Equip. sends Xfr Blocked to Ready to Unload CEID (E87). Host acknowledges event.	S6F11/S6F12	Ready to Unload	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, Refers to E87 Loadport transfer model transition #9. This event should be sent when carrier returned to unload position. **Should be unclamped at this point**
70	AMHS attempts material pickup (E84 trans. initiate) E84 Transactions				PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	
71	Carrier Unload begins, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges event	S6F11/S6F12	Transfer Blocked	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, Refers to E87 Loadport Transfer state model transition #7
72	Equipment sends CarrierLocationChange event from Placement at unload CEID (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	
73	AMHS completes material pickup (E84 trans. finish)				PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	
74	Carrier has been removed, equipment sends Xfr Blocked to Ready to Load CEID (E87). Host acknowledges event	S6F11/S6F12	Ready to Load	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, Refers to E87Loadport state model transition #8
75	Equipment notifies host that Material has departed CEID(E30). Host acknowledges event	S6F11/S6F12	Material Departed	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Material for CJ1, This event is required by E30(GEM)
76	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ2 (E40). Host acknowledges event	S6F11/S6F12	PRJobDeleted	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	<No State>	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #7 for PJ2.
77	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ1 (E40). Host acknowledges event	S6F11/S6F12	PRJobDeleted	H ⇐ E	<No State>	<No State>	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #7 for PJ1

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
78	Equip. sends CJ COMPLETED to <no State> CEID for CJ1 (E94). Host acknowledges event	S6F11/S6F12	CJDeleted	H ⇐ E	<No State>	<No State>	<No State>	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #13. Tool should send when all process jobs contained in control job are completed
79	Equip. sends PRJOB Processing to PROCESS COMPLETE CEID for PJ3 (E40). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
80	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Refers to E94 Control Job State Model Transition #10 for CJ2. Tool should send when all process jobs contained in control job are completed
81	Carrier closed CEID sent (E87). Host acknowledges event	S6F11/S6F12	Carrier closed	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, Refers to E87 "Additional Events"- not related to any state model transitions
82	Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier Complete	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, Refers to E87 Carrier state model transition #19. This event should be sent when last wafer is returned and carrier door closed
83	Equipment sends CarrierLocationChange event, from Docked to Placement (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2
84	At this point the carrier is Undocked on LP2, Equip. sends Xfr Blocked to Ready to Unload CEID (E87). Host acknowledges event.	S6F11/S6F12	Ready to Unload	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, Refers to E87 Loadport transfer model transition #9. This event should be sent when carrier returned to unload position. **Should be unclamped at this point**
85	AMHS attempts material pickup (E84 trans. initiate) E84 Transactions				<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
86	Carrier Unload begins, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges event	S6F11/S6F12	Transfer Blocked	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, Refers to E87 Loadport Transfer state model transition #7

Table 3 Concurrent Process and Control Job Execution (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	PJ3 Process Job State Model	CJ2 Control Job State Model	Notes
87	Equipment sends CarrierLocationChange event for unload (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2
88	AMHS completes material pickup (E84 trans. finish)				<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	
89	Carrier has been removed, equipment sends Xfr Blocked to Ready to Load CEID (E87). Host acknowledges event	S6F11/S6F12	Ready to Load	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, Refers to E87 Loadport state model transition #8
90	Equipment notifies host that Material has departed CEID(E30). Host acknowledges event	S6F11/S6F12	Material Departed	H ⇐ E	<No State>	<No State>	<No State>	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	Material for CJ2, This event is required by E30(GEM)
91	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ3 (E40). Host acknowledges event	S6F11/S6F12	PRJobDeleted	H ⇐ E	<No State>	<No State>	<No State>	<No State>	COMPLETED (Enumeration = 5)	Refers to E40 Process Job State Model Transition #7 for PJ3. At this stage all PJ's defined have been completed
92	Equip. sends CJ COMPLETED to <no State> CEID (E94). Host acknowledges event	S6F11/S6F12	CJDeleted	H ⇐ E	<No State>	<No State>	<No State>	<No State>	<No State>	Refers to E94 Control Job State Model Transition #13 for CJ2. Tool should send when all process jobs contained in control job are completed

4.2.2 Multiple Sequential PJ with the Same Wafers

ISMI's participating companies have identified a need to be able to execute multiple sequential processing passes on the same wafers within the same control job (i.e., without using CarrierRecreate or removing then returning the wafers to the equipment). The use case for such operations could take advantage of multiple configuration capabilities of the same processing hardware to realize a manufacturing efficiency or to allow for exception handling corrective action defined by the host.

Regardless of the reason for the need, the sample scenario in Table 4 illustrates the consensus-desired behavior of such operations.

Table 4 Multiple Sequential PJ with Same Wafers

Scenario Operational Conditions:

- ***Multiple PJs referencing the same wafers***
- ***PJs created simultaneously***
- ***Assumption: wafers can transition back to "Needs Processing" state***

Color Code Glossary	E30 Related Interactions	
	E84 Related Interactions	
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
1	Host sends a Bind command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment acknowledges Bind	S3F17/S3F18	Bind	H ⇒ E	<No State>	<No State>	<No State>	<No State>	For this scenario info provided by Bind
2	Equipment notifies host of transition from Not Associated to Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Associated	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Association state model transition #2
3	AMHS attempts material delivery to LP2				<No State>	<No State>	<No State>	<No State>	
4	Equipment notifies Host that a carrier Xfer begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Loadport Xfer state model transition #6. For potential DVVALS attached, values: -PortID =2, -PortTransferState=1
5	Equipment sends CarrierLocationChange event, at Placement CEID for LP2 (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	
6	AMHS completes material transfer (E84 transactions finish)				<No State>	<No State>	<No State>	<No State>	
7	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges Event	S6F11/S6F12	Material Received	H ⇐ E	<No State>	<No State>	<No State>	<No State>	This event is required by E30 (GEM)
8	*Equipment determines value of internal equipment constant ByPassReadID and it equals FALSE*				<No State>	<No State>	<No State>	<No State	
9	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges Event	S6F11/S6F12	Waiting for Host	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete
10	Equipment sends CarrierLocationChange event, from Placement to Docked (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	
11	Carrier Opened CEID sent (E87). Host acknowledges Event	S6F11/S6F12	Carrier Opened	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 "Additional Events"- not related to any state model transitions

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
12	Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier In Access	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
13	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges Event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in Bind Carrier service
14	Equipment instantiates substrate objects using the ID's from the Content Map. Equipment sends event <no state> to NEEDS PROCESSING for each substrate object, including Substrate 3. Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	Refers to E90 Substrate Object State Model transition #10. **This scenario is initiated. The substrate object must use the ID from the Content Map rather than the default (CarrierID.SlotID).**
15	Equipment sends event <no state> to AT SOURCE for each substrate object. Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	Refers to E90 Substrate Object State Model transition #1.
16					<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	At this point all preliminary AMHS/E87 delivery transactions have been completed & carrier verification is complete
17	Host requests to send multi-block recipe to tool (E30). Equip. acknowledges req. to send multi-block recipe from host	S7F1/S7F2	PP Load Inquire	H ⇒ E	<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	
18	Host sends multi- block recipe to tool (E30). Equip. acknowledges receipt of multi- block recipe from host S7F3 Proc. Program Send	S7F3/S7F4	PP Send	H ⇒ E	<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	Potentially host could upload recipe at this point rather than download.

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
19	Host issues PRJobMultiCreate Command (E40) for 2 process jobs, Slot position 3 common across jobs. Equip. acknowledges PJ Multi Create command	S16F15/S16F16		H ⇒ E	<No State>	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	**Job1 Attributes**: PRJobID= "PJ1," CARRIERID="03459398", PRMtrlOrder=LIST, SlotIDList="<U2 1> <U2 3> <U2 5>", RCPSPEC="ThisRecipe" **Job2 Attributes:** PRJobID="PJ2," CARRIERID="03459398", PRMtrlOrder=LIST, SlotIDList="<U2 3> <U2 7> <U2 9>", RCPSPEC="ThatRecipe"
20	Equipment notifies host that PJ QUEUED/ POOLED for PJ1. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	<No State>	<No State>	NEEDS PROCESSING (Enumeration = 0)	Refers to E40 Process Job State Model Transition #1
21	Equipment notifies host that PJ QUEUED/ POOLED for PJ2. <no state> to PRJobQUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobQueued	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration =0)	<No State>	NEEDS PROCESSING (Enumeration = 0)	Refers to E40 Process Job State Model Transition #1
22	Host issues CJ Create Command (E94), specifying both PJs. PJ2 is first in list order. Equip. acknowledges CJ Create command S14F10 Create Obj. Ack	S14F9/S14F10		H ⇒ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration =0)	<No State>	NEEDS PROCESSING (Enumeration = 0)	**CJ1 Attributes:** ObjID="CJ1," ProcessingCtrlSpec="<A PJ2> <A PJ1>" **Note that because PJ2 is listed first in ProcessingCtrolSpec, it will be run before PJ1**
23	Equip. notifies host that CJ created. <no state> to QUEUED CEID (E94). Host acknowledges Event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration =0)	QUEUED (Enumeration =0)	NEEDS PROCESSING (Enumeration = 0)	Refers to E94 Control Job State Model Transition #1
24	Equip. sends CJ QUEUED to SELECTED CEID (E94). Host acknowledges Event	S6F11/S6F12	CJSelected	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration =0)	SELECTED (Enumeration =1)	NEEDS PROCESSING (Enumeration = 0)	Refers to E94 Control Job State Model Transition #3
25	Equip. sends CJ Selected to EXECUTING CEID (E94). Host acknowledges Event	S6F11/S6F12	CJExecuting	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	QUEUED/ POOLED (Enumeration =0)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to E94 Control Job State Model Transition #5
26	Equip. sends PJ QUEUED/ POOLED to SETTING UP transition for PJ2 CEID(E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	SETTING UP (Enumeration =1)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to E40 Process Job State Model Transition #2 for PJ2

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
27	Equip. sends PJ Setting Up to PROCESSING for PJ2 CEID (E40). Host acknowledges Event	S6F11/S6F12	PRJobProcessing	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to E40 Process Job State Model Transition #4
28	Equip. sends Substr. AT SOURCE to AT WORK CEID (E90). Host acknowledges Event	S6F11/S6F12	Substrate At Work	H ⇐ E	QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to transition #2 of Substrate State Model
29	Equip. sends Substrate NEEDS PROCESSING to IN PROCESS CEID (E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	IN PROCESS (Enumeration = 1)	Refers to transition #11 of Substrate State Model. Tool should send when processing/measurement has begun on wafer
30	Equip. sends Substrate IN PROCESS to PROCESSING COMPLETE(PROCESSED) CEID (E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to transition #12 of Substrate State Model. Tool should send when all processing/measuring of wafer has been completed
31	Equip sends Substr AT WORK to AT DESTINATION CEID(E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration =0)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to transition #5 of Substrate State Model. Tool should send when wafer returned to carrier
32	Equip. sends PJ QUEUED/ POOLED to SETTING UP transition for PJ1 CEID(E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	SETTING UP (Enumeration =1)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to E40 Process Job State Model Transition #2 for PJ1.
33	Equip. sends PRJOB Processing to PROCESS COMPLETE for PJ2 CEID (E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	SETTING UP (Enumeration =1)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete. **Note: Substrate state reverts back to NEEDS PROCESSING and AT SOURCE since subsequent process job defines subsequent work for this substrate. (Change to the standard to support this function, adding transition 15 is in progress)**

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
34	Equip. sends PJ Setting Up to PROCESSING for PJ1 CEID (E40). Host acknowledges Event	S6F11/S6F12	PRJobProcessing	H ⇐ E	PROCESSING (Enumeration =3)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to E40 Process Job State Model Transition #4
35	*Equip. sends Substr. AT SOURCE to AT WORK CEID (E90). Host acknowledges Event	S6F11/S6F12	Substrate At Work	H ⇐ E	PROCESSING (Enumeration =3)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	NEEDS PROCESSING (Enumeration = 0)	Refers to transition #2 of Substrate State Model
36	*Equip. sends Substrate NEEDS PROCESSING to IN PROCESS CEID (E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration =3)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	IN PROCESS (Enumeration = 1)	Refers to transition #11 of Substrate State Model. Tool should send when processing/measurement has begun on wafer
37	*Equip. sends Substrate IN PROCESS to PROCESSING COMPLETE(PROCESSED) CEID (E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration =3)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to transition #12 of Substrate State Model. Tool should send when all processing/measuring of wafer has been completed
38	*Equip sends Substr AT WORK to AT DESTINATION CEID(E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration =3)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to transition #5 of Substrate State Model. Tool should send when wafer returned to carrier
39	Equip. sends PRJOB Processing to PROCESS COMPLETE for PJ1 CEID (E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	EXECUTING (Enumeration =3)	PROCESSED (Enumeration = 2)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
40	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges Event	S6F11/S6F12	CJCompleted	H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed
41	Carrier closed, Carrier Closed CEID sent (E87) . Host acknowledges Event	S6F11/S6F12	Carrier Closed	H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87 "Additional Events"- not related to any state model transitions
42	Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87 Carrier state model transition #19. This event should be sent when last wafer is returned and carrier door closed

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
43	Equipment sends CarrierLocationChange event, from Docked to Placement (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	This event should be sent when carrier returned to unload position.
44	At this point the carrier is Undocked on LP2, Equip. sends Xfr Blocked to Ready to Unload CEID (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87 Loadport transfer model transition #9. **Should be unclamped at this point**
45	AMHS attempts material pickup (E84 trans. initiate) E84 Transactions				PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	
46	Carrier Unload begins, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87 Loadport Transfer state model transition #7
47	Equipment sends CarrierLocationChange event from Placement at unload CEID (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	
48	AMHS completes material pickup (E84 trans. finish)				PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	
49	Equipment notifies host that Material has departed CEID(E30). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	This event is required by E30(GEM)
50	Carrier has been removed, equipment sends Xfer Blocked to Ready to Load CEID (E87). Host acknowledges Event	S6F11/S6F12	Ready to Load	H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87Loadport state model transition #8
51	Equipment notifies host of transition from Associated to Not Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Not Associated	H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSED (Enumeration = 2)	Refers to E87 Association state model transition #3

Table 4 Multiple Sequential PJ with Same Wafers (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	PJ2 Process Job State Model	CJ1 Control Job State Model	Substrate 3 Processing State	Notes
52	*Equip. sends Substrate AT DESTINATION to <Extinction> CEID (E90). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	<Extinction>	Refers to transition #7 of Substrate State Model. Tool sends when material has been removed from equipment Table 1 E90 states that if transition #7 is sent, there is no need to send event for transition #9 (PROCESSED to <Extinction>)
53	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ2 (E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration =4)	<No State>	COMPLETED (Enumeration =5)	<Extinction>	Refers to E40 Process Job State Model Transition #7 for PJ2.
54	Equip. sends PRJOB PROCESS COMPLETE to <no State> (E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	COMPLETED (Enumeration =5)	<Extinction>	Refers to E40 Process Job State Model Transition #7 for PJ1. At this stage all PJs defined have been completed
55	Equip. sends CJ COMPLETED to <no State> CEID (E94). Host acknowledges Event	S6F11/S6F12	CJDeleted	H ⇐ E	<No State>	<No State>	<No State>	<Extinction>	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed

4.2.3 Control Job Stop/Pause/Abort Usage

The interdependency of the Control Job, Process Job(s), and recipe(s) can complicate the use of the CJ Stop/Pause/Abort commands. How to disposition the in-process material, managing the running process jobs and recipes, and determining safe stopping conditions are important factors in implementing these functions on the equipment.

The three scenarios—CJ Abort (Table 5), CJ Pause (Table 6), and CJ Stop (Table 7)—are representative examples illustrating the consensus-desired behavior for these operations.

Table 5 CJ Abort Scenario

Scenario Operational Conditions:
- Usage of CJAbort command

Color Code Glossary	E30 Related Interactions	
	E84 Related Interactions	
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Process Job 3	Control Job	Notes
1	Host sends a 'Bind' command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment creates carrier, associates it to the loadport and material is delivered correctly (E87)			H ⇐ ⇒ E					This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
2	Material is reported as received. Host sends a multiblock recipe to the equipment correctly (E30)			H ⇐ ⇒ E					This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E30 behavior
3	Process Jobs and Control Jobs are created (3 PJ, 1 CJ), moved to QUEUED/ POOLED and SELECTED as appropriate. Processing begins: CJ moves to EXECUTING, PJ1 moves to PROCESSING correctly			H ⇐ ⇒ E	PROCESSING	QUEUED / POOLED	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E40/E94 behavior
4	Substrate tracking for each wafer processed			H ⇐ ⇒ E	PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E90 behavior
5	*At this point the equipment is processing normally. The scenario to define CJAbort behavior begins*				PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	
6	Host issues CJAbort to equipment (E94). Equipment acknowledges Host command	S16F27/S16F28	CJAbort	H ⇒ E	PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	
7	Internally equipment issues Abort command to current executing Process Job and all other PJs for this CJ (in the Queue/Pooled state)				PROCESSING	QUEUED / POOLED	QUEUED / POOLED	EXECUTING	
8	Equipment sends PRJOB PROCESSING to Aborting for (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobAborting	H ⇐ E	ABORTING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	Refers to E40 Process Job State Model Transition #13. Sent as soon as the job abort begins

Table 5 CJ Abort Scenario (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Process Job 3	Control Job	Notes
9	Equipment sends PRJOB ABORTING to (no state) (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJob No state	H ⇐ E	<No State>	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	Refers to E40 Process Job State Model Transition #16. The Abort command requires "immediate termination of the processing…as soon as having achieved a safe condition". This may require an error recovery procedure to return substrates to the destination.
10	Equipment sends PRJOB QUEUE/POOLED to no state for (Job2) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJob No state	H ⇐ E	<No State>	<No State>	QUEUED/ POOLED	EXECUTING	Refers to E40 Process Job State Model Transition #18
11	Equipment sends PRJOB QUEUE/POOLED to no state for (Job3) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJob No state	H ⇐ E	<No State>	<No State>	<No State>	EXECUTING	Refers to E40 Process Job State Model Transition #18
12	Equipment sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	Refers to E94 Control Job State Model Transition #12. Sent as soon as all process jobs contained in the control job are terminated
13	Carrier Accessing Status transitions to CARRIER STOPPED CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier Complete	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	Refers to E87 Carrier state model transition #20. This event should be sent when last wafer is returned and carrier door closed
14	Equipment may require a error recovery (a clean up procedure) to return all material left inside the equipment to the carrier.				<No State>	<No State>	<No State>	COMPLETED	See E40 paragraph 8.3.2.1
15	The carrier is closed and unloaded normally with all of the requisite messaging. Carrier object is deleted and the load port returned to Ready to Load			H ⇐ ⇒ E	<No State>	<No State>	<No State>	COMPLETED	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
16	Equipment sends CJ COMPLETED to (no state) CEID (E94). Host acknowledges event	S6F11/S6F12	CJ no state	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E94 Control Job State Model Transition #13.

Table 6 CJ Pause Scenario

Scenario Operational Conditions:
- Usage of CJPause command

Color Code Glossary	
E30 Related Interactions	
E84 Related Interactions	
E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
E40/94 Related Interactions	
E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Control Job	Notes
1	Host sends a Bind command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment creates carrier, associates it to the loadport and material is delivered correctly (E87)			H ⇐ ⇒ E				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
2	Material is reported as received. Host sends a multiblock recipe to the equipment correctly (E30)			H ⇐ ⇒ E				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E30 behavior
3	Process Jobs and Control Jobs are created (2 PJ, 1 CJ), moved to QUEUED/ POOLED and SELECTED as appropriate. Processing begins: CJ moves to EXECUTING, PJ1 moves to PROCESSING correctly			H ⇐ ⇒ E	PROCESSING	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E40/E94 behavior
4	Substrate tracking is initiated and performed for each wafer processed (E90)			H ⇐ ⇒ E	PROCESSING	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E90 behavior
5	*At this point the equipment is processing normally. The scenario to define CJPause behavior begins.* ***NOTE: CJPause does not affect executing PJs, only PJs in the QUEUED/POOLED state***				PROCESSING	QUEUED/ POOLED	EXECUTING	
6	Host issues CJPause (E94). Equipment acknowledges command	S16F27/S16F28		H ⇒ E	PROCESSING	QUEUED/ POOLED	EXECUTING	
7	Equip. sends PRJOB Processing to PROCESS COMPLETE (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESS COMPLETE	QUEUED/ POOLED	PAUSED	Refers to E40 Process Job State Model Transition #6.
8	Equip. sends CJ Executing to PAUSED CEID (E94). Host acknowledges event	S6F11/S6F12	CJPaused	H ⇐ E	PROCESS COMPLETE	QUEUED/ POOLED	PAUSED	Refers to E94 Control Job State Model Transition #8 **Note: Although PJ2 does not change state, the effect of the CJPause is to allow PJ1 to continue processing, but not allow PJ2 to start while the CJ is paused**
9	Equipment waits for host CJRESUME command to continue processing. Host can modify queued/pooled process job(s) while in the PAUSED state.				PROCESS COMPLETE	QUEUED/ POOLED	PAUSED	
10	Host issues CJResume command. Equipment acknowledges	S16F27/S16F28	CJResume	H ⇒ E	PROCESS COMPLETE	QUEUED/ POOLED	PAUSED	

Table 6 CJ Pause Scenario (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Control Job	Notes
11	Equip. sends PAUSED to EXECUTING event (E94). Host acknowledges event	S6F11/S6F12	PRJobExecuting	H ⇐ E	PROCESS COMPLETE	QUEUED/ POOLED	EXECUTING	Refers to E94 Control Job state model Transition #9
12	Equip. sends transition from QUEUED/ POOLED to SETTING UP (Job2) CEID(E40). Host acknowledges event	S6F11/S6F12	PRJobActive to Setup	H ⇐ E	PROCESS COMPLETE	SETTING UP	EXECUTING	Refers to E40 Process Job State Model Transition #2 (Job2)
13	Equip. sends PJ SETTING UP to PROCESSING (Job2) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobProcessing	H ⇐ E	PROCESS COMPLETE	PROCESSING	EXECUTING	Refers to E40 Process Job State Model Transition #4
14	Substrate tracking is initiated and performed for each wafer processed (E90)			H ⇐ ⇒ E	PROCESS COMPLETE	PROCESSING	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E90 behavior
15	Equip. sends PRJOB Processing to PROCESS COMPLETE (Job2)CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	PROCESS COMPLETE	PROCESS COMPLETE	EXECUTING	Refers to E40 Process Job State Model Transition #6.
16	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	PROCESS COMPLETE	PROCESS COMPLETE	COMPLETED	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed
17	The carrier is closed, Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier Complete	H ⇐ E	PROCESS COMPLETE	PROCESS COMPLETE	COMPLETED	Refers to E87 Carrier Object state model transition #19.
18	The Carrier is unloaded normally with all of the requisite messaging. Carrier object is deleted and the load port returned to Ready to Load			H ⇐ ⇒ E	PROCESS COMPLETE	PROCESS COMPLETE	COMPLETED	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
19	Material is removed from the equipment, and appropriately reported (E30)				PROCESS COMPLETE	PROCESS COMPLETE	COMPLETED	This event is required by E30(GEM)
20	Equip. sends PRJOB PROCESS COMPLETE to (no state) (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	<No State>	PROCESS COMPLETE	COMPLETED	Refers to E40 Process Job State Model Transition # 7
21	Equip. sends PRJOB PROCESS COMPLETE to (no state) (Job2) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobComplete	H ⇐ E	<No State>	<No State>	COMPLETED	Refers to E40 Process Job State Model Transition # 7
22	Equip. sends CJ COMPLETED to (no state) CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	<No State>	<No State>	<No State>	Refers to E94 Control Job State Model Transition #10.

Table 7 CJ Stop Scenario

Scenario Operational Conditions:
- Usage of CJStop command

Color Code Glossary	
	E30 Related Interactions
	E84 Related Interactions
	E87 Related Interactions
	E40/94 Related Interactions
	E90 Related Interactions
	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Process Job 3	Control Job	Notes
1	Host sends a Bind command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment creates carrier, associates it to the loadport and material is delivered correctly (E87)			H ⇐ ⇒ E					This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
2	Material is reported as received. Host sends a multiblock recipe to the equipment correctly (E30)			H ⇐ ⇒ E					This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E30 behavior
3	Process Jobs and Control Jobs are created (3 PJ, 1 CJ), moved to QUEUED/ POOLED and selected as appropriate. Processing begins: CJ moves to EXECUTING, PJ1 moves to PROCESSING correctly			H ⇐ ⇒ E	PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E40/E94 behavior
4	Substrate tracking for each wafer processed			H ⇐ ⇒ E	PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E90 behavior
5	*At this point the equipment is processing normally. The scenario to define CJStop behavior begins*				PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	
6	Host issues CJStop to equipment (E94). Equipment acknowledges Host command	S16F27/S16F28	CJStop	H ⇒ E	PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	Command Parameter: Action = 1 (Remove Jobs)
7	*A CJStop command requires that the equipment internally issues Stop commands to currently executing PRJob and all PRJobs for this CJ in the Queue/Pooled state.*				PROCESSING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	
8	Equip. sends PRJOB PROCESSING to STOPPING for (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobStopping	H ⇐ E	STOPPING	QUEUED/ POOLED	QUEUED/ POOLED	EXECUTING	Refers to E40 Process Job State Model Transition #11. Sent as soon as the PJ enters the STOPPING state **Current job completes the substrates that are in active processing, but does not start the processing of any additional unprocessed substrates**

Table 7 CJ Stop Scenario (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Process Job 1	Process Job 2	Process Job 3	Control Job	Notes
9	Equip. sends PRJOB QUEUE/POOLED to no state for (Job2) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobNoState	H ⇐ E	STOPPING	<No State>	QUEUED/ POOLED	EXECUTING	Refers to E40 Process Job State Model Transition #18
10	Equip. sends PRJOB QUEUE/POOLED to no state for (Job3) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobNoState	H ⇐ E	STOPPING	<No State>	<No State>	EXECUTING	Refers to E40 Process Job State Model Transition #18
11	Equip. sends PRJOB STOPPING to (no state) (Job1) CEID (E40). Host acknowledges event	S6F11/S6F12	PRJobNoState	H ⇐ E	<No State>	<No State>	<No State>	EXECUTING	Refers to E40 Process Job State Model Transition #17. Sent when the substrates in active processing have completed and returned to the destination
12	Equip. sends CJ Executing to COMPLETED CEID (E94). Host acknowledges event	S6F11/S6F12	CJCompleted	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	Refers to E94 Control Job State Model Transition #11. Sent when all process jobs contained in control job have been stopped
13	Carrier Accessing Status transitions to CARRIER STOPPED CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier Complete	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	Refers to E87 Carrier state model transition #20. This event should be sent when the carrier has been stopped abnormally and the carrier should be moved out
14	The carrier is closed and unloaded normally with all of the requisite messaging. Carrier object is deleted and the load port returned to Ready to Load	S6F11/S6F12	Ready to Load	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
15	Equipment notifies host that Material has departed CEID(E30). Host acknowledges event	S6F11/S6F12	Material Departed	H ⇐ E	<No State>	<No State>	<No State>	COMPLETED	This event is required by E30(GEM)
16	Equip. sends CJ COMPLETED to (no state) CEID (E94). Host acknowledges event	S6F11/S6F12	CJNoState	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E94 Control Job State Model Transition #13. Tool should send when all material departs the tool

4.2.4 Recipe Download (without effect on in-process job) and PRMtlType = Substrate

In the HVM environment, the consensus intent is for the process recipes for all equipment, processes, and products to be maintained and controlled by a central Recipe Management System. The recipe(s) will then be downloaded to the equipment as required for the material and process to be executed, with the appropriate inputs from the APC and other factory systems. Often, a recipe will be downloaded for a process job even if the recipe already exists on the equipment, with a process parameter set that is optimized for the specific material and process step. As a result, the same named source recipe may be downloaded multiple times with different parameter sets, overwriting the existing copy of the recipe.

HVM-capable equipment must be able to manage the pool of recipes to ensure that the integrity of each recipe is maintained without conflict and that the correct recipe is applied to each wafer. Further, downloading another iteration of the same named source recipe cannot interact with in-process material or its executing job/recipe. When an executing recipe, from the host point of view, has been processed, the same named recipe with a different parameter set can be downloaded while that job is still executing. In this case, the equipment *must* continue to execute the original recipe and parameters for the remaining material in that job, without being influenced by the newly downloaded instance of the recipe.

There is no defined requirement for the equipment to maintain or manage the recipe pool to allow for multiple instances (versions) of the same named recipe to support a stored queue of process jobs. The burden of ensuring the proper timing and availability of recipe updates and downloads related to the process job pool must be managed by the host.

The Material Type = “substrate” mode of operation is highly desirable in advanced wafer fabs. Combined with E90 Substrate Tracking, this operational mode can significantly benefit factory operations, data management and storage, engineering investigation, and other high leverage activities. Substrate mode materially impacts the activity sequencing of an operational scenario.

The sample scenario in Table 8 illustrates the consensus-desired behavior for recipe downloads that do not affect the in-process job, combined with PRMtlType = substrate.

Table 8 Recipe Download Effects and PRMtlType = Substrate

Scenario Operational Conditions:
- Recipe download during processing
- Material Type - substrate

Color Code Glossary	E30 Related Interactions	
	E84 Related Interactions	
	E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
	E40/94 Related Interactions	
	E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
1	Host sends a Bind command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment acknowledges Bind	S3F17/S3F18	Bind	H ⇒ E	<No State>	<No State>	<No State>	<No State>	For this scenario info provided by Bind
2	Equipment notifies host of transition from Not Associated to Associated CEID (E87). Host acknowledges Event	S6F11/S6F12	Associated	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Association state model transition #2
3	AMHS attempts material delivery to LP1				<No State>	<No State>	<No State>	<No State>	
4	Equipment notifies Host that a carrier Xfer begins with Ready to Load to Xfer State Blocked CEID (E87). Host acknowledges Event	S6F11/S6F12	Transfer Blocked	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Loadport Xfer state model transition #6. For potential DVVALS attached, values: PortID =1, PortTransferState=1
5	Equipment sends CarrierLocationChange event, at Placement CEID for LP2 (E87). Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	
6	AMHS completes material transfer (E84 transactions finish)				<No State>	<No State>	<No State>	<No State>	
7	Equipment notifies host that Material has arrived : Material Received CEID (E30). Host acknowledges Event	S6F11/S6F12	Material Received	H ⇐ E	<No State>	<No State>	<No State>	<No State>	This event is required by E30 (GEM)
8	*Equipment determines value of internal equipment constant ByPassReadID and it equals FALSE*				<No State>	<No State>	<No State>	<No State	
9	Equipment sends ID Not Read to ID Verification Ok CEID (E87). Host acknowledges Event	S6F11/S6F12	Waiting for Host	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #6. Equipment based ID verification is complete
10	Equipment sends CarrierLocationChange event, from Placement to Docked (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	
11	Carrier Opened CEID sent (E87). Host acknowledges Event	S6F11/S6F12	Carrier Opened	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 "Additional Events"- not related to any state model transitions

Table 8 Recipe Download Effects and PRMtlType = Substrate (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
12	Carrier Accessing Status transitions from Not Accessed to IN ACCESS CEID (E87). Host acknowledges event	S6F11/S6F12	Carrier In Access	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier state model transition #18. This event should be sent when the equipment is accessing the carrier and it should not be moved out
13	Slot Map is verified by Equipment, sends Slot Map not Read to SlotMapVerif OK CEID (E87). Host acknowledges Event	S6F11/S6F12	SlotMapVerif OK	H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E87 Carrier State Model transition #13. Equipment determines # of wafers present = # in Bind Carrier service
14	Equipment instantiates substrate objects using the ID's from the Content Map. Equipment sends event <no state> to NEEDS PROCESSING for each substrate object, including Substrate 3. Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E90 Substrate Object State Model transition #10. **This scenario is initiated by a Bind with a Content Map. The substrate object must use the ID from the Content Map rather than the default (CarrierID.SlotID).**
15	Equipment sends event <no state> to AT SOURCE for each substrate object. Host acknowledges event.	S6F11/S6F12		H ⇐ E	<No State>	<No State>	<No State>	<No State>	Refers to E90 Substrate Object State Model transition #1.
16					<No State>	<No State>	<No State>	<No State>	At this point all preliminary AMHS/E87 delivery transactions have been completed & carrier verification is complete
17	Host issues request to send multi-block recipe to equipment. Equipment acknowledges request to send multi-block recipe from host	S7F1/S7F2		H ⇒ E	<No State>	<No State>	<No State>	<No State>	
18	Host sends multi-block recipe to equipment. Equipment acknowledges receipt of multi-block recipe from host	S7F3/S7F4	Process Program Send	H ⇒ E	<No State>	<No State>	<No State>	<No State>	Download Recipe= "ThisRecipe" for PJ1
19	Host issues (E40) PRJobMultiCreate for 1 process job. Equipment acknowledges PJ Multi Create command	S16F15/S16F16		H ⇒ E	<No State>	<No State>	<No State>	<No State>	**Job1 Attributes**: PRJobID= "PJ1" Substrate List="<A "Wafer1"> <A "Wafer2"> <A "Wafer3">", PRMtlType = Substrate (MF 14), RCPSPEC="ThisRecipe" **Note: This is the first instance of this recipe on the equipment**
20	Equipment notifies host of transition PJ1, <no state> to QUEUED/ POOLED CEID (E40). Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	<No State>	Refers to E40 Process Job State Model Transition #1

Table 8 Recipe Download Effects and PRMtlType = Substrate (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
21	Host issues CJ Create command (E94, E39) specifying PJ1. Equipment acknowledges CJ Create command	S14F9/S14F10		H ⇒ E	QUEUED/ POOLED (Enumeration = 0)	<No State>	<No State>	<No State>	**CJ1 Attributes:** ObjID="CJ1," ProcessingCtrlSpec="<A PJ1>"
22	Equipment notifies host that CJ created. <no state> to QUEUED CEID (E94). Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #1
23	Equipment sends CJ QUEUED to SELECTED CEID (E94). Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	SELECTED (Enumeration = 1)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #3
24	Equipment sends CJ SELECTED to EXECUTING CEID (E94). Host acknowledges event	S6F11/S6F12		H ⇐ E	QUEUED/ POOLED (Enumeration = 0)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E94 Control Job State Model Transition #5
25	Equipment sends PRJob transition from QUEUED/ POOLED to SETTING UP CEID(E40). Host acknowledges event	S6F11/S6F12		H ⇐ E	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #2
26	Equipment sends PJ1 SETTING UP to PROCESSING CEID (E40). Host acknowledges event	S6F11/S6F12		H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Refers to E40 Process Job State Model Transition #4
27	Substrate tracking for each wafer processed			H ⇐ ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E90 behavior
28	Host issues request to send multi-block recipe to equipment. Equipment acknowledges request to send multi-block recipe from host	S7F1/S7F2		H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	The host is requesting to download a recipe of the same name as that used in a currently executing job, but with different parameters applicable to the material planned for PJ2
29	Host sends multi-block recipe to equipment. Equipment acknowledges receipt of multi-block recipe from host	S7F3/S7F4	Process Program Send	H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	Download Recipe= "ThisRecipe" for use by PJ2. ***Downloading a recipe with the same name as the recipe currently being used in an executing process job should have no effect on the processing of the executing process***

Table 8 Recipe Download Effects and PRMtlType = Substrate (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
30	Host issues PRMultiCreate Command (E40) 1 process job. Equipment acknowledges PRMultiCreate command	S16F15/S16F16		H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	<No State>	<No State>	**Job2 Attributes**: PRJobID= "PJ2", Substrate List="<A "WaferA"> <A "WaferB"> <A "WaferC">", PRMtlType = Substrate (MF 14), RCPSPEC="ThisRecipe" **NOTE: This is the second instance of the same recipe name on the equipment, and each must be seperately maintained to support processing of the related material without any interaction between the iterations of the recipe. The instance of the recipe in use by PJ1 is being executed, and not available to be overwritten.**
31	Equipment notifies host <no state> to PRJobQUEUED/ POOLED CEID (E40) for PJ2. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	<No State>	Refers to E40 Process Job State Model Transition #1
32	Host issues CJ Create Command (E94, E39) Create Obj. Request, specifying PJ2. Equipment acknowledges	S14F9/S14F10		H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	No State	**CJ2 Attributes:** ObjID="CJ2," ProcessingCtrlSpec="<A PJ2>"
33	Equipment notifies host that CJ created. <no state> to QUEUED CEID (E94) for CJ2. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	Refers to E94 Control Job State Model Transition #1
34	AMHS attempts material delivery on 2nd LP				PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	QUEUED/ POOLED (Enumeration =0)	QUEUED (Enumeration = 0)	
35	Host sends a 'Bind' command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment creates carrier, associates it to the loadport and material is delivered correctly (E87)				PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	QUEUED (Enumeration = 0)	This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
36									The equipment has instantiated substrate objects using the ID's from the content map.
37	AMHS completes material transfer (E84 transactions finish)				PROCESSING (Enumeration =3)	EXECUTING (Enumeration =3)	QUEUED/ POOLED (Enumeration =0)	QUEUED (Enumeration = 0)	

Table 8 Recipe Download Effects and PRMtlType = Substrate (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
38	Equipment sends CJ QUEUED to SELECTED CEID (E94) for CJ2. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	SELECTED (Enumeration = 1)	Refers to E94 Control Job State Model Transition #3
39	Equipment sends CJ SELECTED to EXECUTING CEID (E94) for CJ2. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	QUEUED/ POOLED (Enumeration = 0)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #5
40	Equipment sends transition from QUEUED/ POOLED to SETTING UP CEID(E40) for PJ2. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	SETTING UP (Enumeration = 1)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #2
41	Equipment sends PJ SETTING UP to PROCESSING CEID (E40) for PJ2. Host acknowledges event	S6F11/S6F12		H ⇒ E	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #4 **NOTE: PJ2 begins processing to meet the requirements of cascade processing before PJ1 is complete. PJ2 will use the recipe and parameter set from the recipe pool, which has been maintained independent of the instance that is in use by PJ1.**
42	Equipment sends PRJOB PROCESSING to PROCESS COMPLETE CEID (E40) for PJ1. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	EXECUTING (Enumeration = 3)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #6. Sent when all wafers pertaining to a process job are complete
43	Equipment sends CJ EXECUTING to COMPLETED CEID (E94) for CJ1. Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #10. Tool should send when all process jobs contained in control job are completed
44	Carrier closed, Carrier Closed CEID sent (E87) . Host acknowledges Event	S6F11/S6F12	Carrier Closed	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 "Additional Events"- not related to any state model transitions for LP1
45	Carrier Accessing Status transitions to CARRIER COMPLETE CEID (E87). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 Carrier state model transition #19 for LP1. This event should be sent when last wafer is returned and carrier door closed
46	Equipment sends CarrierLocationChange event, from Docked to Placement (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	This event should be sent when carrier returned to unload position on LP1.

Table 8 Recipe Download Effects and PRMtlType = Substrate (continued)

Item #	Action	SECSMsg	SECSDesc	Primary Direction	PJ1 Process Job State Model	CJ1 Control Job State Model	PJ2 Process Job State Model	CJ2 Control Job State Model	Notes
47	Carrier is Undocked on LP1, Equipment sends Xfer Blocked to Ready to Unload CEID (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 Loadport transfer model transition #9 for LP1. **Should be unclamped at this point**
48	AMHS attempts material pickup from LP1 (E84 trans. initiate) E84 Transactions				PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration = 3)	
49	Carrier Unload begins on LP1, equipment sends a Ready to Unload to Transfer Blocked CEID (E87). Host acknowledges event	S6F11/S6F12	Transfer Blocked	H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 Loadport Transfer state model transition #7
50	AMHS completes material pickup on LP1 (E84 trans. finish)				PROCESS COMPLETE (Enumeration =4)	COMPLETED (Enumeration =5)	PROCESSING (Enumeration =3)	EXECUTING (Enumeration = 3)	
51	Equipment notifies host that Material has departed CEID(E30). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	This event is required by E30(GEM)
52	Equipment notifies host of transition from Associated to Not Associated CEID (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 Association state model transition #3
53	Carrier Unload has completed, equipment sends a Transfer Blocked to Ready to Load CEID (E87). Host acknowledges event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E87 Loadport Transfer state model transition #8. After this event, the tool is ready to accept another carrier transfer
54	Equip. sends PRJOB PROCESS COMPLETE to <no State> for PJ1 (E40). Host acknowledges Event	S6F11/S6F12		H ⇐ E	PROCESS COMPLETE (Enumeration = 4)	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E40 Process Job State Model Transition #7 for PJ1. At this stage all PJs defined have been completed
55	Equip. sends CJ COMPLETED to <no State> CEID for CJ1 (E94). Host acknowledges Event	S6F11/S6F12	CJDeleted	H ⇐ E	<No State>	COMPLETED (Enumeration = 5)	PROCESSING (Enumeration = 3)	EXECUTING (Enumeration = 3)	Refers to E94 Control Job State Model Transition #10 for CJ1. Tool should send when all process jobs contained in control job are completed
56	Normal processing continues for CJ2/PJ2, with all of the normal events and material handling required.				<No State>	<No State>	PROCESSING (Enumeration =3)	EXECUTING (Enumeration = 3)	This is a summary task statement, indicating that all steps were completed as needed for integrated operations

4.2.5 Recipe Tuning

Recipe tuning can be used to update recipe parameters after the recipe has been downloaded to the equipment. Long-term, the consensus is that it would be desirable to be able to update the recipe at any time before completion: while it is in the pool before starting, during a PJ Pause, or on the fly between or even during wafer processing. However, a significant number of issues would need to be resolved to enable and safeguard the material and operation for update once a PJ has started. Thus, these cases remain future considerations.

The sample scenario in Table 9 illustrates the consensus-desired behavior for recipe tuning in the basic case where the recipe is in the pooled/queued state before start.

Table 9 Recipe Tuning Scenario

Scenario Operational Conditions: ***- Usage Recipe parameter update*** ***- PJ in queued/pooled state*** ***- PJ = manual start***	***Color Code Glossary***	E30 Related Interactions	
		E84 Related Interactions	
		E87 Related Interactions	Denotes an editorial comment about the scenario and/or a summary preparation or condition statement
		E40/94 Related Interactions	
		E90 Related Interactions	

Item #	Action	SECSMsg	SECSDesc	Primary Direction	Notes
1	Host sends a 'Bind' command containing Carrier ID, Port ID, Slot Map, Content Map (E87). Equipment creates carrier, associates it to the loadport and material is delivered correctly (E87)				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
2	Material is reported as received. Host sends a multiblock recipe to the equipment correctly (E30)				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E30 behavior
3	Process Job and Control Job are created (PJ1, CJ1), moved to queued/pooled and selected as appropriate. Control Job has started, but Process Job is still in Queued/Pooled state				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E40/E94 behavior
4	Recipe parameter update to a queued/pooled Process Job is shown below				
5	Host sends Recipe Parameter Update service. Equipment replies to the Recipe Parameter Update service	S16F23/S16F24	PRJobSetRecipeVariable	H ⇒ E	Equipment verifies the value(s) sent by the host and applies them to the specified recipe
6	The Recipe has been updated with the parameters sent from Host				
7	Host sends a STARTPROCESS command to the PJ. Equipment replies to the host request	S16F27/S16F28	"STARTPROCESS"	H ⇒ E	
8	Equip. sends PJ WAITING FOR START to PROCESSING CEID (E40). Host acknowledges event	S6F11/S6F12		H ⇐ E	Refers to E40 Process Job State Model Transition #5 for PJ1
9	*At this point the equipment continues to process normally*				
10	Substrate tracking for each wafer processed				This is a summary task statement, indicating that all steps were completed as indicated in oter scenarios defining E90 behavior
11	Process Jobs and Control Jobs are executed, completed, and closed in a normal manner				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E40/E94 behavior
12	Material handling is completed normally				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E87 behavior
13	Event reporting of material removal is completed normally				This is a summary task statement, indicating that all steps were completed as indicated in other scenarios defining E30 behavior

4.3 Exception Handling

Any complex system is subject to failures, unplanned events, and unexpected interruptions. The responses, management, disposition, and corrective actions taken for software systems are defined as Exception Handling. For this guidance, two aspects of exception handling will be addressed: the command granularity required to provide the capability and documentation of some commonly occurring exceptions and the consensus-desired representative action.

This section is not meant to be comprehensive or exhaustive. Possible symptoms and sources of exception are almost infinite. The intent is to use representative examples and cases to begin the process of developing and documenting a robust exception handling solution space.

4.3.1 Exception Handling Capabilities

To take action once an exception has occurred, access to commands at high granularity must be available at the local level and to the host. Many of these individual commands are not intended to be used during normal program execution and have significant levels of risk for the material and the equipment if they are used without adequate care and protections. ISMI's member company consensus is that access to these commands is a requirement to allow adequate exception handling within the factory.

Table 10 is the consensus listing of the commands required for exception handling. In recognition of the risk and care associated with the use of these commands, a set of boundary conditions and deployment factors have been identified:

- The commands shown in the Host and Operator Command Table (Table 10) shall be made available to the operator by the equipment user interface.
- Only host commands that are not already specified in other SEMI standards should be implemented using S2F41 or S2F49. Host commands that are already specified in other SEMI standards using defined stream/function codes do not need to be replicated as Remote Commands using S2F41 or S2F49.
- Operator commands identified with a "Yes" in the "Requires Privilege" column shall be enabled for use at other user levels by the "Equipment Engineer" and "Process Engineer" user levels without requiring the equipment software to be rebooted.
- Some commands may cause a personnel or material risk if used out of context or out of sequence. The equipment supplier shall apply the "Requires Privilege" access control to any commands that it determines may cause a personnel or material risk if used out of context or out of sequence.
- "Normal" commands shall be executable during normal wafer processing when the equipment is in the E30 LOCAL or REMOTE modes. "Maint" Commands shall be executable only in LOCAL mode during maintenance operations.
- The E30 PAUSE, RESUME, STOP, and ABORT commands are required to enable control at the "whole tool" level for use in emergency situations: e.g., fab evacuation, loss of cooling water supply, etc.
- RETURN-ALL-WAFERS and RETURN-ALL-WAFERS-TO-PORT commands are required to simplify wafer recovery operations at a macro level to clear a tool as quickly as possible in abnormal scenarios, instead of forcing an operator to retrieve wafers individually using low level commands.

- All commands shall be interpreted as “request action be initiated” rather than “do action” according to Section 4.4.3 of SEMI E30.
- Execution of operator commands shall cause collection events to be sent to the host, thereby enabling the host to keep track of operator data entry.

Table 10 Host and Operator Commands

Remote Command	Description	Requires Privilege	Operator Command	Host Command	Mode	Related Standard
GO-ON-LINE	Request the equipment to attempt to go ON-LINE	No	Yes	Yes	Normal	E30
GO-OFF-LINE	Request the equipment to go OFF-LINE	No	Yes	Yes	Normal	E30
PAUSE	PAUSE all processes	No	Yes	Yes	Normal	E30
RESUME	RESUME all processes	No	Yes	Yes	Normal	E30
STOP	STOP all processes	No	Yes	Yes	Normal	E30
ABORT	ABORT all processes	No	Yes	Yes	Normal	E30
GO-LOCAL	Enter LOCAL control mode	No	Yes	Yes	Normal	E30
GO-REMOTE	Enter REMOTE control mode	No	Yes	No	Normal	E30
SHOW-RUN-JOBS	Display all Control and Process jobs currently executing on the tool on the equipment user interface	No	Yes	No	Normal	E94/E40
SHOW-QUEUE-JOBS	Display all Control and Process jobs currently queued for execution on the equipment user interface	No	Yes	No	Normal	E94/E40
SHOW-PAST-JOBS	Display all Control and Process jobs that have been completed and are still tracked on the equipment	No	Yes	No	Normal	E94/E40
CJ-CREATE	Create a Control Job	Yes	Yes	Yes	Normal	E94
CJ-START	START specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-PAUSE	PAUSE specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-RESUME	RESUME specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-CANCEL	CANCEL specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-STOP	STOP specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-ABORT	ABORT specified Control Job	Yes	Yes	Yes	Normal	E94
CJ-SELECT	SELECT a Control Job from the queue and make it available for processing	Yes	Yes	Yes	Normal	E94
CJ-DESELECT	DESELECT the selected Control Job	Yes	Yes	Yes	Normal	E94
CJ-HOQ	Move specified Control Job to the head of the queue	Yes	Yes	Yes	Normal	E94
CJ-DETAIL	Show detail of specified Control Job, including carriers and Process Jobs	Yes	Yes	Yes	Normal	E94
PR-JOB-CREATE	Create a Process Job (see SEMI E40 PRJobCreate service)	Yes	Yes	Yes	Normal	E40
PR-JOB-CREATE-ENH	Create a unique Process Job with a user-supplied JobID (see SEMI E40 PRJobCreateEnh service)	Yes	Yes	Yes	Normal	E40
PR-JOB-MULTI-CREATE	Create Process Jobs (see SEMI E40 PRJobMultiCreate service)	Yes	Yes	Yes	Normal	E40
PJ-START	START specified Process Job	Yes	Yes	Yes	Normal	E40
PJ-PAUSE	PAUSE specified Process Job	Yes	Yes	Yes	Normal	E40
PJ-RESUME	RESUME specified Process Job	Yes	Yes	Yes	Normal	E40
PJ-CANCEL	CANCEL specified Process Job	Yes	Yes	Yes	Normal	E40

Remote Command	Description	Requires Privilege	Operator Command	Host Command	Mode	Related Standard
PJ-STOP	STOP specified Process Job	Yes	Yes	Yes	Normal	E40
PJ-ABORT	ABORT specified Process Job	Yes	Yes	Yes	Normal	E40
PJ-DETAIL	Show detail of specified Process Job, including recipe, recipe parameters and substrate material list.	Yes	Yes	Yes	Normal	E40
PJ-SetRecipeVariable	Set the specified recipe variable	Yes	Yes	Yes	Normal	E40
PLACE-PORT-IN-SERVICE	Place the loadport in service. (E-87 ChangeServiceStatus)	Yes	Yes	Yes	Normal	E87
PLACE-PORT-OUT-OF-SERVICE	Place the loadport out of service. (E-87 ChangeServiceStatus)	Yes	Yes	Yes	Normal	E87
ACCESS-MODE-MANUAL	Change the access mode to manual. (E-87 ChangeAccess)	Yes	Yes	Yes	Normal	E87
ACCESS-MODE-AUTO	Change the E87 access mode to auto. (E-87 ChangeAccess)	Yes	Yes	Yes	Normal	E87
Bind	Associate the specified CarrierID to the specified loadport and transition the loadport to the RESERVED state	Yes	Yes	Yes	Normal	E87
CancelAllCarrierOut	Remove ALL CarrierOut services from the queue	Yes	Yes	Yes	Normal	E87
CancelReservationAtPort	Unreserve the specified loadport and transition it to the NOT RESERVED state	Yes	Yes	Yes	Normal	E87
CancelBind	Cancel the BIND for the specified carrier and loadport and transition it to the NOT RESERVED state	Yes	Yes	Yes	Normal	E87
CancelCarrier	Cancel the current carrier related action at the specified loadport and return the carrier to the unload position of the loadport, or an internal buffer position, depending on the carriers position in the equipment	Yes	Yes	Yes	Normal	E87
CancelCarrierAtPort	Cancel the current carrier related action at the specified loadport and return the carrier to the unload position of the loadport	Yes	Yes	Yes	Normal	E87
CancelCarrierNotification	Cancel the Carrier Notification for the specified carrier	Yes	Yes	Yes	Normal	E87
CancelCarrierOut	Remove the specified CarrierOut service from the queue	Yes	Yes	Yes	Normal	E87
CarrierIn	Move the specified carrier into the internal buffer.	Yes	Yes	Yes	Normal	E87
CarrierNotification	Instantiate a carrier object with the specified CarrierID	Yes	Yes	Yes	Normal	E87
CarrierOut	Move the specified carrier from the internal buffer to the specified loadport or any available loadport if no loadport is specified	Yes	Yes	Yes	Normal	E87
CarrierReCreate	Recreate the specified carrier object (this command shall only be accepted if the carrier accessing state is “Carrier Complete” or “Carrier Stopped” and the loadport is in the “Ready to Unload” state)	Yes	Yes	Yes	Normal	E87
CarrierRelease	Release the specified carrier from Carrier Hold	Yes	Yes	Yes	Normal	E87
ProceedWithCarrier	Execute a Proceed With Carrier command	Yes	Yes	Yes	Normal	E87

Remote Command	Description	Requires Privilege	Operator Command	Host Command	Mode	Related Standard
ReserveAtPort	Reserve the specified loadport and transition it to the RESERVED state	Yes	Yes	Yes	Normal	E87
SHOW-PORT-ASSOCIATIONS	Show all BIND related CarrierID/port associations, all CarrierNotification related CarrierIDs and all port related states on the equipment user interface	No	Yes	No	Maint	E87
RETURN-ALL-WAFERS	Return all wafers currently out of the FOUP to their source FOUP at their original slot locations	Yes	Yes	No	Maint	N/A
RETURN-ALL-WAFERS-TO-PORT	Clear all wafers currently out of the FOUP, out of the equipment, and place them in a FOUP at a specified port.	Yes	Yes	No	Maint	N/A
OPEN-FOUP	Open the FOUP door	Yes	Yes	No	Maint	E87
CLOSE-FOUP	Close the FOUP door	Yes	Yes	No	Maint	E87
FIMS-PORT-DOCK	Move the FOUP to the FIMS port and clamp	Yes	Yes	No	Maint	E87
FIMS-PORT-UNDOCK	Unclamp the FOUP at the FIMS port and move it to the load position	Yes	Yes	No	Maint	E87
LOAD-PORT-CLAMP	Clamp the FOUP at the loadport	Yes	Yes	No	Maint	E87
LOAD-PORT-UNCLAMP	Unclamp the FOUP at the loadport	Yes	Yes	No	Maint	E87
OPEN-DOOR	Open the equipment load lock door	Yes	Yes	No	Maint	E87
CLOSE-DOOR	Close the equipment load lock door	Yes	Yes	No	Maint	E87
READ-CARRIER-ID	Read the carrier ID and display it on the equipment user interface	Yes	Yes	No	Maint	E99
READ-PAGE	Read a whole page from the RFID tag and display it on the equipment user interface	Yes	Yes	No	Maint	E99
WRITE-PAGE	Write a whole page to the RFID tag (assumes equipment user interface provides tag page edit functionality for Operator Command)	Yes	Yes	No	Maint	E99
READ-SLOT-MAP	Read the Slot Map for the specified carrier and display on the equipment user interface	No	Yes	No	Maint	E87
CLEAR-ALL-JOBS	Terminate and/or clear any and all Control and Process Jobs from the equipment.	Yes	Yes	Yes	Maint	E94/E40
CLEAR-JOB	Terminate and/or clear a specific Control and Process job or jobs from the equipment.	Yes	Yes	Yes	Maint	E94/E40
RESET-PIO	Reset the PIO unit for the specified loadport	Yes	Yes	Yes	Maint	E84

4.3.2 Exception Handling for Commonly Occurring Discrepancies

This section contains guidance on handling some commonly occurring exceptions. The solution defined for an exception is the consensus for the general handling of the exception, understanding that even slight variations in the exception may require a different solution.

This exception handling guidance implies that the desire is for some level of automated error handling and recovery. However, such automated error handling and recovery capabilities must be able to be enabled or disabled at the equipment configuration level. That is, the end user is

able to choose (perhaps by using an EC) whether the automated error handling and recovery is turned on or off.

4.3.2.1 Unexpected Events E84/E87

4.3.2.1.1 Guidance for Abnormal FOUP Delivery Scenarios

- **Background:**

  This section outlines IC maker expectations for tool behavior when loadport delivery errors occur.

  Note: only a subset of the required collection events is detailed below to aid clarity.

1. **Exception: Operator manually places FOUP when loadport is in AUTO mode (correct equipment)**
   a) Configuration and Setup:
      – Fixed buffer equipment.
      – Loadport set to AUTO access mode.
      – BypassReadID set to FALSE (CarrierID reader enabled).
      – Operator places FOUP on loadport.

        **Note: the following equipment response assumes that the host performs CarrierID and slotmap verification
   b) Equipment response:
      – Equipment sets HO_AVBL signal to OFF (preventing AMHS deliveries).
      – Equipment sends E30 Material Received event to host.
      – Equipment determines that FOUP was not delivered by AMHS and sends “Access Mode Violation” alarm to host and displays error message on tool GUI. **Displays GUI Message “Do You Wish To Process This FOUP?” With Yes/No Operator Choice Options**.
      – **Choice = “Yes”**
        - Equipment clears “Access Mode Violation” alarm.
        - Equipment transitions AMSM to MANUAL and sends AMSM SCT-3 to host.
        - Equipment sends E30 Material Received event to host.
        - Equipment reads the CarrierID of the placed FOUP, instantiates a new carrier object and sends CarrierID to host for verification.
        - Equipment transitions CSM to WAITING FOR HOST, SLOT MAP NOT READ and NOT ACCESSED and sends CSM SCT-7, 12, and 17, respectively, to host.
        - Equipment transitions the LPCASM for loadport where the carrier was placed to ASSOCIATED and sends LPCASM SCT-2 for this loadport to the host (i.e., equipment automatically associates carrier with loadport).
        - Host determines that placed FOUP should be processed on this tool and sends ProceedWithCarrier #1 to tool.
        - Equipment transitions the CSM for the received carrier to ID VERIFICATION OK and sends CSM SCT-8 to the host.

- Equipment reads SlotMap and sends to host. Equipment transitions CSM to WAITING FOR HOST and sends CSM SCT-14 to host.
- Host validates SlotMap and sends ProceedWithCarrier #2 to equipment.
- Equipment transitions CSM to SLOT MAP VERIFICATION OK and sends CSM SCT-15 to host.
- Host sets up the required CJ(s) and PJ(s) on the equipment.
- Equipment processes FOUP.

– **Choice = "No"**

- Equipment transitions AMSM to MANUAL and sends AMSM SCT-3 to host.
- Operator removes FOUP.
- Equipment sends E30 Material Removed event to host.
- Equipment clears "Access Mode Violation" alarm.
- Operator can change load port to Auto access mode. Equipment will then transition AMSM to AUTO and send AMSM SCT-2 to host.
- As soon as port transitions to Auto access mode, equipment sets HO_AVBL signal to ON (enabling AMHS deliveries).

2. Exception: FOUP delivery to OUT OF SERVICE loadport (MANUAL or AUTO delivery)

a) Configuration and Setup:
- Fixed buffer equipment.
- Loadport set to OUT OF SERVICE state (LPTSM).
- Equipment has set E84 HO_AVBL signal to OFF for OUT OF SERVICE loadport (preventing AMHS delivery).
- Operator places FOUP on OUT OF SERVICE loadport.

b) Equipment Response:
- Equipment checks LPTSM for loadport where the FOUP was delivery and finds that it is in the OUT OF SERVICE state.
- Equipment sends "Attempt To Use Out Of Service Loadport" alarm to host and displays error message on tool GUI.
- Operator removes FOUP.
- Equipment clears "Attempt To Use Out Of Service Loadport" alarm.

3. Exception: AMHS delivers FOUP to wrong (unreserved) loadport

c) Configuration and Setup:
- Fixed buffer equipment with two or more loadports.
- All loadports set to AUTO access mode.
- BypassReadID set to FALSE on all loadports (CarrierID readers enabled).
- Bind command accepted for a specified CarrierID on loadport #1, which is RESERVED and ASSOCIATED.
- Loadport #2 (and other loadports) are UNRESERVED and NOT ASSOCIATED.

d) Equipment Response:
- AMHS delivers FOUP to loadport #2.
- Equipment sends E30 Material Received event to host.
- Equipment reads the CarrierID and determines that carrier was not expected on loadport #2.
- Equipment checks whether carrier is associated with loadport #1 and determines that it is.
- Equipment transitions the LPCASM for loadport #1 (where the carrier was *expected*) to NOT ASSOCIATED and sends LPCASM SCT-3 for loadport #1 to the host.
- Equipment checks whether loadport #2 (where the carrier was *delivered*) is associated with another carrier and finds that it is not.
- Equipment performs a self-initiated CancelBind for the carrier that was received on loadport #2 and sends CSM SCT-21 *for loadport #1* to the host.
- Equipment associates the *delivered* carrier with loadport #2, transitions the LPCASM for loadport #2 to ASSOCIATED and sends LPCASM SCT-2 for loadport #2 to the host.
- Equipment transitions the CSM for the received carrier to ID VERIFICATION OK and sends CSM SCT-6 to the host.

At this point, the equipment has automatically corrected the FOUP placement error. It is assumed that the host takes care of the scheduling and dispatch implications of any carrier that was *expected* on the loadport where the FOUP was erroneously placed.

4. Exception: AMHS delivers FOUP to wrong (reserved) loadport

e) Configuration and Setup:
- Fixed buffer equipment with two or more loadports.
- All loadports set to AUTO access mode.
- BypassReadID set to FALSE on all loadports (CarrierID readers enabled).
- Bind command accepted for a specified CarrierID on loadport #1, which is RESERVED and ASSOCIATED.
- Bind command accepted for a specified CarrierID on loadport #2, which is also RESERVED and ASSOCIATED.

f) Equipment response:
- AMHS delivers FOUP that is ASSOCIATED with loadport #1 to loadport #2.
- Equipment sends E30 Material Received event to host.
- Equipment reads the CarrierID and determines that carrier was not expected on loadport #2.
- Equipment checks whether carrier is associated with loadport #1 and determines that it is.
- Equipment transitions the LPCASM for loadport #1 (where the carrier was *expected*) to NOT ASSOCIATED and sends LPCASM SCT-3 for loadport #1 to the host.

- Equipment checks whether loadport #2 (where the carrier was *delivered*) is associated with another carrier and finds that it is. Equipment transitions the LPCASM for loadport #2 to NOT ASSOCIATED and sends LPCASM SCT for loadport #2 to the host.
  - Equipment performs a self-initiated CancelBind for the carrier that was received on loadport #2 and sends CSM SCT-21 *for loadport #1* to the host.
  - Equipment associates the *delivered* carrier with loadport #2, transitions the LPCASM for loadport #2 to ASSOCIATED and sends LPCASM SCT-2 for loadport #2 to the host.
  - Equipment transitions the CSM for the received carrier to ID VERIFICATION OK and sends CSM SCT-6 to the host.

At this point, the equipment has automatically corrected the FOUP placement error. It is assumed that the host takes care of the scheduling and dispatch implications of the carrier that was *expected* on the loadport where the FOUP was erroneously placed.

4.3.2.1.2 Guidance for E84/E87 Relationships and Exception Handling Recommendations

- **Background:**

  This section outlines IC maker expectations for tool behavior when material handling errors occur. It specifically clarifies some of the E84 and E87 relationships. For this document, the reference to overhead hoist transport (OHT) could be replaced by any other automated form of transport that uses SEMI E84 handoffs (e.g., automated guided vehicle [AGV]).

- **Normal FOUP Unload Operation**
  1. **Exception: None**
     - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
     - **Scenario**: Upon return of final wafer specified for processing by existing PJ/CJs, the equipment closes the FOUP door and immediately undocks and unclamps the carrier while transitioning to the E87 Ready to Unload state. The E84 state for that loadport should signal Handoff Available simultaneously with the E87 Ready to Unload collection event.

- **Abnormal FOUP Load/Unload Operations**
  1. **Exception: AMHS request to unload FOUP before completion of processing.**
     - **E87 configuration**: Loadport-auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
     - **Scenario**: While the equipment is in the process of accessing a FOUP, the E84 Handoff Available should NOT be asserted. Under no conditions should the tool accept an Unload request from the OHT while the FOUP is docked to the tool and not in a E87 Ready to Unload state.
  2. **Exception: Failure in FOUP door closing mechanism**
     - **E87 configuration**: Loadport-auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
     - **Scenario**: Upon return of the final wafer specified for processing by existing PJ/CJs, the equipment attempts to close the FOUP door unsuccessfully, so an E87

alarm is sent (Carrier Open/Close Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the FOUP door has been successfully attached, it should under no condition transition to E87 Ready to Unload and likewise should under no condition signal E84 Handoff Available for the affected loadport.

- Operator intervention will likely be required in this scenario.

3. **Exception: Failure in FOUP door opening mechanism**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: The equipment attempts to open the FOUP door unsuccessfully, so an E87 alarm is sent (Carrier Open/Close Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the FOUP door has been successfully opened, it should under no condition transition to any other E87 state (other than Transfer Blocked, which it should already be in) until either the cause of the problem has been identified and removed or a CancelCarrier command has been received from the host or through the equipment UI.
   - Operator intervention will likely be required in this scenario.
4. **Exception: Failure of loadport clamping mechanism (unclamped to clamped)**
   - **E87 configuration**: Loadport-auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: The equipment attempts to clamp the FOUP unsuccessfully, so an E87 alarm is sent (Carrier Dock/Undock Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the clamp mechanism has successfully engaged, it should under no conditions transition to any other E87 state (other than Transfer Blocked which it should already be in) until either the cause of the problem has been identified and removed or a CancelCarrier command has been received from the host or through the equipment UI.
   - Operator intervention will likely be required in this scenario.
5. **Exception: Failure of loadport clamping mechanism (clamped to unclamped)**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: Upon return of the final wafer specified for processing by existing PJ/CJs, the equipment closes the FOUP door and attempts to undock and unclamp the FOUP. The equipment is unsuccessful in unclamping the FOUP, so an E87 alarm is sent (Carrier Dock/Undock Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the clamping mechanism has successfully disengaged from the FOUP, it should under no condition transition to E87 Ready to Unload and likewise should under no condition signal E84 Handoff Available for the affected loadport.
   - Operator intervention will likely be required in this scenario.

6. **Exception: Failure of loadport docking mechanism (undocked to docked)**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: The equipment attempts to dock the FOUP unsuccessfully, so an E87 alarm is sent (Carrier Dock/Undock Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the FOUP has been successfully docked, it should under no conditions transition to any other E87 state until either the cause of the problem has been identified and removed or a CancelCarrier command has been received from the host or through the equipment UI.
   - Operator intervention will likely be required in this scenario.
7. **Exception: Failure of loadport docking mechanism (docked to undocked)**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: Upon return of the final wafer specified for processing by existing PJ/CJs, the equipment closes the FOUP door and attempts to undock the FOUP. The equipment is unsuccessful in undocking the FOUP, so an E87 alarm is sent (Carrier Dock/Undock Failure). Even if the operator clears the alarm condition on the tool UI (or uses another method), unless the equipment is able to verify that the FOUP has been successfully undocked, it should under no condition transition to E87 Ready to Unload and likewise should under no condition signal E84 Handoff Available for the affected loadport.
   - Operator intervention will likely be required in this scenario.
8. **Exception: Errors/Failures isolated to one port/carrier and effects on other parts of tools**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed buffer equipment, no ID tag write.
   - **Scenario**: If errors occur on a loadport or while processing a carrier already located on that loadport, then those errors shall not affect the operations of other ports on the tool and the ability to use those other loadports for delivery or pick-up of FOUPs. For instance, if any of the error conditions previously cited occur on a loadport (i.e., failed loadport clamp mechanism on loadport X), the E84/E87 signals on all other loadports should be maintained in valid states without restricting normal pickup/delivery operations to those unaffected loadports.
   - **Note**: The one exception to this guideline would be when an equipment E-Stop (EMO) on the equipment occurs, it would affect operations on all loadports concurrently.
9. **Exception: Error during initial portion of E84 handoff.**
   - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed or internal buffer equipment.
   - **Scenario:** Any handoff error before E84 BUSY ON signal should result in an error code sent to the host and a non-human involved recovery on the active and passive equipment. Following such an automated correction, there should be no impact to future delivery or removal on this or any other loadport.

- **Note**: Also, refer to E84 Application notes located for E84, Appendix 1, section entitled Errors and Automated Recovery, for related information.

10. **Exception: Error during FOUP delivery to the loadport**
    - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed or internal buffer equipment.
    - **Scenario:** Delivery of FOUP from Active AMHS has begun to the loadport (E84 BUSY ON signal), and then an E84 Active/Passive equipment error occurs. E84 L_REQ signal should remain ON (high), and under no circumstances should the passive equipment drop the E84 L_REQ signal until manual recovery is initiated. The E87 Loadport state should remain in Transfer Blocked during this period.
    - **Note:** Also, refer to E84 Application notes located for E84, Appendix 1, section entitled Errors and Automated Recovery, for related information.
11. **Exception: Error during FOUP unload from the loadport**
    - **E87 configuration**: Loadport auto access mode, AMHS triggered unclamp is OFF, Fixed or internal buffer equipment.
    - **Scenario:** Removal of FOUP from equipment has begun from the loadport (E84 BUSY ON signal), and then an E84 Active/Passive equipment error occurs. E84 BUSY signal should remain ON (high), and under no circumstances should the active equipment drop the E84 BUSY signal until manual recovery is initiated. The E87 Loadport state should remain in Transfer Blocked until the E84 COMPT signal is received (ON).
    - **Note**: Also, refer to E84 Application notes Appendix 1, section entitled Errors and Automated Recovery, for related information.

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