SEMI E30.1-0200
INSPECTION AND REVIEW SPECIFIC EQUIPMENT MODEL (ISEM)

This standard was technically approved by the Global Information and Control Committee and is the direct responsibility of the North American Information and Control Committee. Current edition approved by the North American Regional Standards Committee on September 3, 1999. Initially available on SEMI OnLine November 1999; to be published February 2000. Originally published June 1998.

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1 Purpose

1.1 This standard establishes a Specific Equipment Model (SEM) for Inspection and Review Equipment (ISEM). The model consists of equipment characteristics and behavior that are to be implemented in addition to the SEMI E30 fundamental requirements and additional capabilities. The intent of this standard is to facilitate the integration of ISEM equipment into an automated (semiconductor fabrication) factory. This document accomplishes this by defining an operational model for ISEM equipment as viewed by a factory automation controller. This definition provides a standard host interface and equipment operational behavior (e.g., control, state models, data reports, and reporting levels). Several topics require additional activity that are within the scope of this standard: substrate pattern maps; defect classification code management; and review data management.

2 Scope

2.1 The scope of this standard is limited to the definition of Inspection, Review, and Inspection/Review equipment behavior as perceived by a SEMI Equipment Communications Standard II (SEMI E5/SECS-II) host that complies with SEMI E30. It defines the external view of the equipment through the SECS link; it does not define the internal operation of the equipment. This standard expands the SEMI E30 requirements and capabilities in the areas of the processing state model, remote commands, variable items, alarms, and data collection.

2.2 This standard is intended for ISEM equipment that generates data and information about anomalies and defects found on substrates. Inspection equipment finds anomalies. Anomalies are occurrences on a substrate that have been judged to be unexpected, abnormal, incongruous, or inconsistent. Anomalies may be examined using review equipment, at which time they may be classified as defects or non-defects. Some inspection equipment may generate, and some review equipment may use, coordinate data to locate anomalies on a substrate. The accuracy of the coordinate data generated or used is equipment-dependent.

2.3 This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3 Limitations

3.1 This document addresses three distinct types of equipment: inspection, review, and inspection/review. The term ISEM equipment refers to all three types of equipment. These three equipment types are differentiated by the basic functions they perform:

3.1.1 Inspection Equipment that looks for anomalies on a substrate and reports information regarding those anomalies. Inspection equipment may determine the location of anomalies relative to a coordinate system. Inspection equipment may also provide other types of data related to the anomaly.

3.1.2 Review Equipment that accepts information about anomalies on a substrate, gathers information on those anomalies, and reports that data.

3.1.3 Inspection/Review Equipment having the characteristics of both inspection and review equipment.

4 Referenced Standards

4.1 *SEMI Standards*

SEMI E5 — SEMI Equipment Communications Standard 2 Message Content (SECS-II)

SEMI E30 — Generic Model for Communications and Control of SEMI Equipment (GEM)

SEMI E37 — High-Speed SECS Message Services (HSMS) Generic Services

SEMI E37.1 — High-Speed SECS Message Services Single-Session Mode (HSMS-SS)

SEMI E58 — Automated Reliability, Availability, and Maintainability Standard (ARAMS): Concepts, Behavior, and Services

SEMI M20 — Specification for Establishing a Wafer Coordinate System

SEMI M21 — Specification for Assigning Addresses to Rectangular Elements in a Cartesian Array

4.2 *Other References*

Harel, D., "Statecharts: A Visual Formalism for Complex Systems," Science of Computer Programming 8, (1987), 231-274

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *GEM* — generic equipment model

5.1.2 *PE* — pattern element

5.1.3 *TCP/IP* — Transmission Communication Protocol/Internet Protocol

5.2 *Definitions*

5.2.1 *align* — to put into proper relative position or orientation.

5.2.2 *alignment* — a procedure in which a coordinate system is established on a substrate.

5.2.3 *alignment mark* — a feature on the substrate selectively used for alignment.

5.2.4 *anomaly* — an occurrence on a substrate that has been judged to be unexpected. Something abnormal, incongruous, or inconsistent.

NOTE 2: After an anomaly is reviewed, it may be classified as a defect.

5.2.5 *batch* — a group of substrates or lots intended for a process sequence versus single substrate processing.

5.2.6 *carrier* — a container with one or more fixed positions at which material can be held.

5.2.7 *carrier location* — a physical place within the equipment capable of holding a carrier.

5.2.8 *cassette* — a container with one or more substrate locations (see *slot*).

5.2.9 *defect* — 1) A physical, optical, chemical, or structural irregularity that degrades the ideal substrate structure or the thin films built over the substrate. 2) An undesirable classified anomaly.

5.2.10 *defect classification* — the categorization of defects according to some systematic division based on their physical, optical, chemical, or structural properties.

5.2.11 *die* — 1) A field sub-unit. 2) An area of substrate that contains the device being manufactured.

5.2.12 *ended* — the end of a state that may be when it is normally completed, or its early end due to an allowed or atypical condition (e.g., a STOP command, or an error or alarm condition).

5.2.13 *factory automation controller* — a computer system that provides integration of factory shop control and business systems with semiconductor equipment.

5.2.14 *feature* — 1) A line or a point (as a feature within a pattern). 2) A physical characteristic of the substrate (e.g., a substrate flat).

5.2.15 *field* — the printed pattern from a reticle.

5.2.16 *field of view* — the imaging area as seen at magnification of the inspection or review equipment.

5.2.17 *global alignment* — a procedure which establishes a coordinate system for the entire substrate (see *alignment*).

5.2.18 *group* — a logical collection of regions.

5.2.19 *group alignment* — a procedure which establishes a coordinate system for an area, which is a contiguous group (see *alignment*).

5.2.20 *inspect* — to detect anomalies and/or information about anomalies.

5.2.21 *inspection* — an examination to detect anomalies.

5.2.22 *inspection equipment* — equipment that looks for anomalies on a substrate and reports information regarding those anomalies. Inspection equipment may determine the location of anomalies relative to a coordinate system. Inspection equipment may also provide other types of data related to the anomaly.

5.2.23 *inspection/review equipment* — equipment having the characteristics of both inspection and review equipment.

5.2.24 *ISEM job* — the information required to specify an inspection or review that may include material identification and location and process program identifications as well as any other parameters required to obtain a desired result.

5.2.25 *layer* — one of a sequential series of overlaying photomasks that make up a device series.

5.2.26 *lot* — a group of one or more substrates of the same type (e.g., wafers, masks, CDs).

5.2.27 *major flat* — the flat of longest length that is commonly located with respect to a specific crystal plane (ASTM F 1241-89).

5.2.28 *mask* — a selective barrier to the passage of radiation. For example, a transparent plate containing an opaque pattern that is used to transfer that pattern to another substrate.

5.2.29 *material* — a piece or pieces of substrate, one or more substrates, a lot, a batch, or a run.

5.2.30 *metrology equipment* — any equipment that collects and reports information on specific predetermined locations or features on a substrate with consistent data structure or that reports general information about the entire substrate.

5.2.31 *notch* — a U-shaped cut on the edge of a substrate that is commonly located with respect to a specific crystal plane.

5.2.32 *overlay* — the actual distance between two features on different layers of a substrate, compared to the expected distance.

5.2.33 *pattern* — 1) The physical features on a substrate surface. 2) An ideal pattern is the arrangement of features expressed in a calculated or mathematical manner.

5.2.34 *pattern element* — 1) Any recognizable set of features. 2) A rectangular sub-unit of a pattern or a pattern element. There may be multiple levels of pattern elements.

5.2.35 *primary fiducial* — a key characteristic of a substrate used to align the substrate during processing (such as a *notch* or *major flat*).

5.2.36 *region* — a single field of view which may be a collection of sites.

5.2.37 *registration* — the actual distance between two features on the same layer of a substrate, compared to the expected distance.

5.2.38 *reticle* — a mask that contains the patterns to be reproduced on a substrate; the image may be equal to or larger than the final projected image.

5.2.39 *review* — the process of classification of anomalies which may result in the appending of additional data to inspection data. Used to create a field on a substrate.

5.2.40 *review equipment* — equipment that accepts information about anomalies on a substrate, gathers information on those anomalies, and reports that data.

5.2.41 *run (noun)* — the material processed during the EXECUTING state.

5.2.42 *run (verb)* — the actions of a process between the READY state and the STOPPING state.

5.2.43 *safe state* — a state in which the equipment presents no danger to the product or user. This implies that safety interlocks are in place such that the equipment can be serviced without harm to the operator and that the material being processed has been removed from the processing station into an accessible location.

5.2.44 *site* — a single x,y coordinate where an action can be performed (e.g., *alignment* or *review*). The area associated with a site is determined by the equipment accuracy (e.g., optics, stage algorithms).

5.2.45 *slot* — a physical location within a Carrier capable of containing a substrate. Also referred to as a carrier location.

5.2.46 *substrate* — the basic unit of material, processed by semiconductor equipment, such as wafers, CDs, flat panels, or masks.

6 Communication Requirements

6.1 It is required that any ISEM-compliant equipment follow the Communications State Model in SEMI E30. In addition, ISEM-compliant equipment shall support the High Speed Messaging Service Standard (SEMI E37/HSMS). It is a minimum requirement to support Single Session (SEMI E37.1/HSMS-SS) sending SECS-II messages over TCP/IP. The reason behind this requirement is the size of the process programs used by this class of equipment and the amount of data produced.

7 State Models

7.1 *Processing State Model Requirements*

7.1.1 The processing state model included in this standard is a requirement for ISEM equipment. This standard requires implementation of all SEMI E30 state models (such as control, communication, and on-line/off-line). A state model consists of state model diagrams, state definitions, and a state transition table. All state transitions in this standard, unless otherwise specified, shall correspond to collection events.

7.1.2 A state model is the host's view of the equipment and does not necessarily describe the internal equipment operation. All ISEM state model transitions shall be mapped sequentially into the appropriate internal equipment events that satisfy the requirements of those transitions. In certain implementations, the equipment may enter a state and have already satisfied all of the conditions required by the ISEM state model for transition to another state. The equipment makes the required transition without any additional actions in this situation.

7.1.3 Some equipment may need to include additional states other than those in this standard. Additional states may be added but shall not change the ISEM-defined state transitions. All expected transitions between ISEM states shall occur.

7.2 *Processing State Model Diagram* — Processing state models are detailed for ISEM equipment in Figure 1. This diagram contains all states and transitions that

are common to all three types of ISEM equipment. The WORKING state is different for each type of equipment. The same state names and transition identifiers are used to identify common states and transitions of the three types of equipment. The working states for the three types of equipment are presented in the following sections. All states and transitions are described in the section following the diagrams.

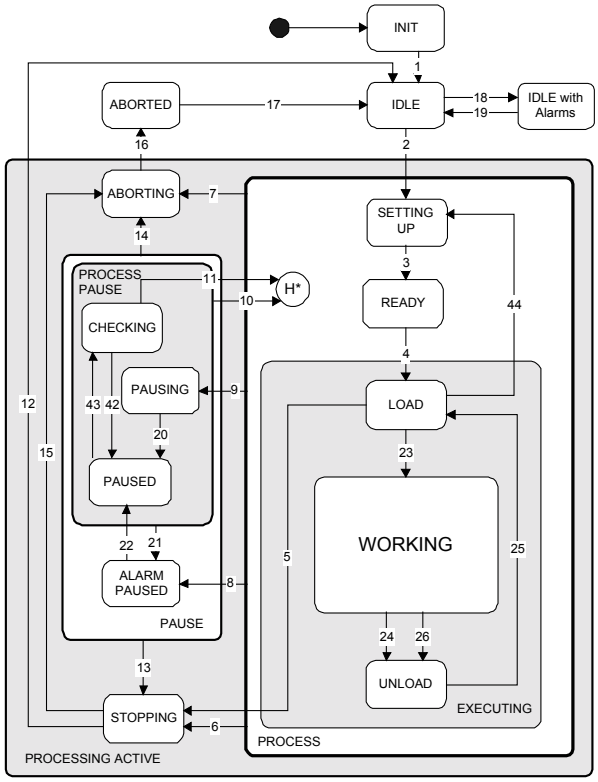

Figure 1
Generic ISEM Processing State Model Diagram

7.2.1 *Working State for Inspection Equipment Model* — The processing state model for inspection equipment is identical to the Generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the inspection equipment processing state model. This is shown in Figure 2.

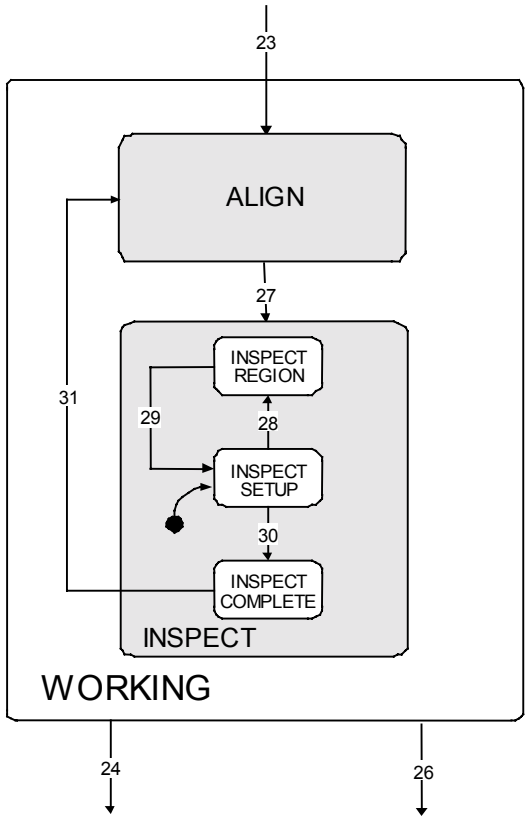

Figure 2
Working State for Inspection Equipment

7.2.2 *Working State for Review Equipment* — The processing state model for review equipment is identical to the generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the review equipment processing state model. This is shown in Figure 3.

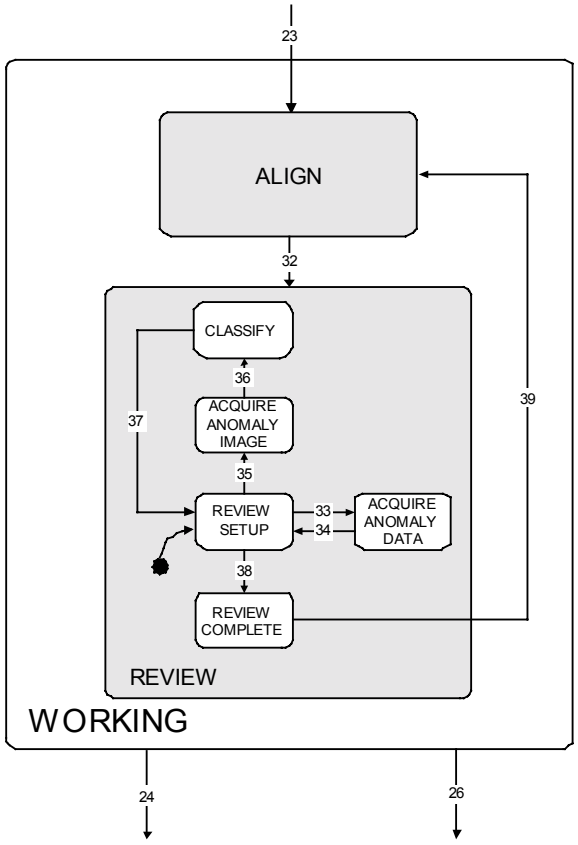

Figure 3
Working State for Review Equipment

7.2.3 *Working State for Inspection/Review Equipment* — The processing state model for inspection/review equipment is identical to the generic ISEM Processing State Model (Figure 1). Only the WORKING state is unique to the inspection/review equipment processing state model. This is shown in Figure 4.

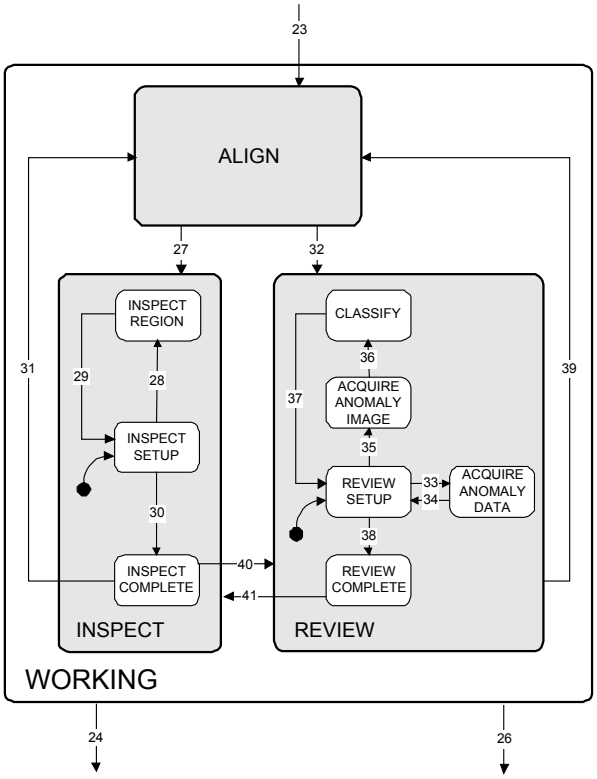

Figure 4
Working State for Inspection and Review Equipment

7.3 *Processing State Definitions*

7.3.1 *ABORTED* — All activity is suspended as a result of an ABORT command. Any alarm and abort conditions shall be cleared before exit from this state. The CLEANUP command is available to the operator or host to transition the equipment from the ABORTED state to IDLE state.

7.3.2 *ABORTING (PROCESSING ACTIVE Sub-State)* — The equipment has received an ABORT command. All normal activity is suspended. The equipment is taking appropriate action to put the equipment and material in a "safe state" where possible. Data may be invalid or not available.

7.3.3 *ACQUIRE ANOMALY DATA (REVIEW Sub-State)* — Data is being acquired about anomaly locations.

7.3.4 *ACQUIRE ANOMALY IMAGE (REVIEW Sub-State)* — The equipment is obtaining a view of the anomaly.

7.3.5 *ALARM PAUSED (PAUSE Sub-State)* — An alarm has occurred in the PROCESS or PROCESS PAUSE states, and the equipment is waiting for the alarm to be cleared or a command (STOP or ABORT).

7.3.6 *ALIGN (WORKING Sub-State*) — The equipment or operator is performing an alignment of the material to the equipment. If needed, within this state, the equipment shall refine or establish its SEMI M20 coordinate system and establish any secondary coordinate systems.

7.3.7 *CHECKING (PROCESS PAUSE Sub-State)* — The equipment verifies that the process program update request is valid. No process program parameters are changed unless "all" reported updates are valid. This is a similar procedure to that which is done in SETTING UP before the equipment is ready to transition to the READY state. Valid commands in this state are STOP, ABORT, and RESUME.

7.3.8 *CLASSIFY (REVIEW Sub-State)* — The operator or equipment is determining the classification of an anomaly.

7.3.9 *EXECUTING (PROCESS Sub-State)* — The equipment is processing material automatically and can continue to do so without external intervention but normally may include interaction with the host or operator.

7.3.10 *IDLE* — Checks for queued ISEM jobs or awaits a PP-SELECT, MAP-CARRIER, or PP-ASSIGN command. IDLE is free of alarm and error conditions. Any transition into this state shall deselect any selected Process program(s).

7.3.11 *IDLE with ALARMS* — An alarm has occurred in the IDLE state, and the equipment is waiting for all alarms to be cleared.

7.3.12 *INIT* — Equipment initialization is occurring. Equipment remains in this state unless initialization is successful.

7.3.13 *INSPECT (WORKING Sub-State)* — The current alignment area of the substrate is being inspected for anomalies.

7.3.14 *INSPECT COMPLETE (INSPECT Sub-State)* — The equipment has completed inspection of the current alignment area. Based on the recipe, the equipment determines if (a) additional alignment areas are required to do more inspections, (b) the recipe on this material is complete, or (c) a review of the current inspection area is required.

7.3.15 *INSPECT REGION* — A region on a substrate is being inspected for anomalies.

7.3.16 *INSPECT SETUP (INSPECT Sub-State)* — The equipment is in this sub-state immediately upon entering the INSPECT state. The equipment is determining if all conditions are satisfied to begin inspecting the regions in the current alignment as defined by the recipe and any commands.

7.3.17 *LOAD (EXECUTING Sub-State)* — The equipment is determining if the process program has completed. When additional processing is required, then the next unprocessed substrate shall be transferred to the equipment processing location, such as the stage. If equipment determines that there are more process programs in the "CARRIERBLD" ISEM job, the equipment makes the transition to setup for the next process program specified. Otherwise, the equipment transitions to IDLE through STOPPING.

7.3.18 *PAUSE (PROCESS ACTIVE Sub-State)* — PROCESS shall be suspended at the next opportunity. Actions to put the equipment in a "safe state" shall be performed. The equipment is awaiting a command (STOP or ABORT).

7.3.19 *PAUSED (PROCESS PAUSE Sub-State)* — PROCESS has been suspended, and the equipment is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT).

7.3.20 *PAUSING (PROCESS PAUSE Sub-State*) — PROCESS shall be suspended at the next opportunity, and the equipment shall be put in a "safe state." ABORT, STOP, and RESUME commands are valid in this state.

7.3.21 *PROCESS (PROCESSING ACTIVE Sub-State)* — This state is the parent of those sub-states which refer to the active preparation and execution of a process program.

7.3.22 *PROCESSING ACTIVE* — This state is the parent of all sub-states where the context of a process program execution exists.

7.3.23 *PROCESS PAUSE (PAUSE Sub-State)* — The equipment is free of alarm conditions in the PAUSE state. The equipment is awaiting for a command (ABORT, RESUME, or STOP).

7.3.24 *READY (PROCESS Sub-State)* — The equipment is ready to begin processing and is awaiting a START command from the operator or host.

7.3.25 *REVIEW (WORKING Sub-State)* — Classification is being done on anomalies previously found in the current alignment area of the substrate.

7.3.26 *REVIEW COMPLETE (REVIEW Sub-State)* — The equipment has completed review of the current alignment area. Based on the recipe, the equipment determines if (a) additional alignment areas are required to do more classifications, (b) the recipe on this material is complete, or (c) an inspection is required.

7.3.27 *REVIEW SETUP (REVIEW Sub-State)* — The equipment is in this sub-state immediately upon entering the REVIEW state. The equipment is determining if all conditions are satisfied to begin

reviewing the anomalies in the current alignment as defined by the recipe and any commands.

7.3.28 *SETTING UP (PROCESS Sub-State)* — The equipment is being setup so that external conditions are satisfied to start processing the material. This includes the receipt of any process programs and material to be processed and their validation. Any of these conditions may be satisfied on entry to SETTING UP. For example, the selected process program may have already been loaded (e.g., if it was the default process program), or the specified material may have already been placed on the equipment material port. Additional information may come from the host during the execution of this state.

7.3.29 *STOPPING (PROCESSING ACTIVE Sub-State)* — The equipment has completed all process programs within a "CARRIERBLD" ISEM job or has been instructed to stop processing and shall do so gracefully at the next opportunity. All cleanup necessary is being completed within this state with regard to material, data, control system, etc. Data is normally preserved. Any alarm or error condition in this state causes a transition to ABORTING.

7.3.30 *UNLOAD (EXECUTING Sub-State)* — The substrate is being removed from the processing location.

7.3.31 *WORKING (EXECUTING Sub-State)* — The equipment is processing a specific material.

7.4 *Processing State Transition Table*

Table 1 Processing State Transition Table

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
1	INIT	All equipment initialization is complete with no alarms or error conditions.	IDLE	Equipment awaits for a PP-SELECT, PP-ASSIGN, or MAP-CARRIER command.	All equipment requires INIT to be free of errors and alarms when exited. IDLE state entry requires that no process program is selected.
2	IDLE	A ISEM job has been or is queued (PP-ASSIGN) or selected (PP-SELECT).	SETTING UP	The setup procedure is equipment-dependent.	Commit has been made to setup. Material may have been placed on the equipment before SETUP is entered. When the job becomes active, the process program gets selected.
3	SETTING UP	All setup activity has completed, and the equipment is ready to receive a START command.	READY	The equipment is waiting for a START command. START may be initiated by an operator or may be included in the process program.	The selected process program is available for execution. When running multiple process programs within a ISEM job, the equipment makes the next process program available for execution.
4	READY	The equipment receives a START command from the user or from within the body of the process program selected for execution.	LOAD	The equipment determines if processing is completed. If not, it transfers the next substrate to the processing location.	Equipment transitions to STOPPING when all process programs in the selected ISEM job are executed. If a new process program within the ISEM job needs to be executed, the equipment transitions to SETTING UP.
5	LOAD	The processing job is complete, and there are no more substrates to load or process programs to run.	STOPPING	Equipment initiates a cleanup to remove the completed ISEM job and process program.	Normal completion of the run.
6	PROCESS	The equipment has received a STOP command.	STOPPING	The equipment unloads the material and brings the equipment to a "safe state."	Data is typically preserved and is valid.

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
7	PROCESS	The equipment has received an ABORT command.	ABORTING	The equipment is put in a "safe state" if necessary.	Data may be invalid or not available.
8	PROCESS	An alarm occurs.	ALARM PAUSED	PROCESS activity is suspended, and the equipment is waiting for all alarms to be cleared.	ALARM PAUSED is a PAUSE Sub-State.
9	PROCESS	The equipment has received a PAUSE command.	PAUSING	PROCESS shall be suspended at the next opportunity. Actions to put the equipment in a "safe state" will be performed.	This transition is required if the user wants to make changes to the current process program being executed.
10	PROCESS PAUSE	The equipment has received a RESUME command.	Previous PROCESS State	Proceed with the suspended process Sub-State.	If a RESUME command is received in the CHECKING state, then the PP-UPDATE command is canceled. Some equipment may only allow RESUME remote command from the PAUSE state.
11	CHECKING	The equipment has validated "all" requested updates to the current process program being executed; changes are done before entering into the next state.	Previous PROCESS State	Verification is appropriate in this state to check the changes made to the process program updated.	If an alarm occurs in the CHECKING state, then the PP-UPDATE command is canceled.
12	STOPPING	The equipment cleanup is complete, and the equipment is free of alarms.	IDLE	Equipment waits for a command/or determines if there is a ISEM job queued.	IDLE state entry requires that no process program is selected.
13	PAUSE	The equipment has received a STOP command.	STOPPING	The equipment proceeds with cleanup.	Normally, data is preserved and is valid.
14	PAUSE	The equipment has received an ABORT command.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or not available.
15	STOPPING	The equipment has received an ABORT command or an alarm was received while STOPPING.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or not available.
16	ABORTING	Unsafe conditions have been resolved where possible.	ABORTED	The equipment is waiting for alarm and ABORT conditions to be cleared.	The only state change allowed is to IDLE.
17	ABORTED	All alarms and abort conditions have been cleared.	IDLE	Equipment is waiting for a command (PP-SELECT, PP-ASSIGN, or MAP-CARRIER).	If needed, the CLEANUP command clears the abort conditions. IDLE state entry requires that no ISEM job or process program be selected.
18	IDLE	An alarm is set.	IDLE with ALARMS	The equipment waits for all alarms to be cleared.	None
19	IDLE with ALARMS	All alarms have been cleared.	IDLE	None	IDLE is free of alarms.

Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
20	PAUSING	The equipment has achieved a "safe state."	PAUSED	The equipment is waiting for a command (PP-UPDATE, RESUME, STOP, or ABORT).	None
21	PROCESS PAUSED	An alarm is set.	ALARM PAUSED	The equipment waits for all alarms to be cleared or for a STOP or ABORT command.	None
22	ALARM PAUSED	All alarms are cleared.	PAUSED	The equipment is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT).	None
23	LOAD	Material transfer to processing location is complete.	WORKING	The substrate is being processed.	None
24	WORKING	The processing of the specific material being processed successfully completed.	UNLOAD	This material is transferred from the processing location.	Normal completion of the substrate.
25	UNLOAD	The material unload is complete.	LOAD	The equipment returns to LOAD and determines if processing is complete, if not, transfers the next substrate to the processing location.	None
26	WORKING	The processing of the specific material being processed abnormally ended.	UNLOAD	This material is transferred from the processing location.	Error exit from WORKING. Data may be invalid.
27	ALIGN	The material alignment is complete, and inspection is required.	INSPECT	The equipment determines if another region needs to be inspected.	This transition is to the INSPECT SETUP Sub-State of INSPECT.
28	INSPECT SETUP	All inspect setup activity is complete, and the inspection is not complete.	INSPECT REGION	The equipment inspects the current alignment region.	None
29	INSPECT REGION	The region inspection has ended.	INSPECT SETUP	The equipment determines if another region needs to be inspected.	None
30	INSPECT SETUP	Inspection of this alignment group is complete.	INSPECT COMPLETE	The equipment determines if (a) additional alignment areas are required to do more inspections, (b) the recipe on this material is complete, or (c) a review of the current alignment area is required.	The next transition is conditional.
31	INSPECT COMPLETE	The inspection of this alignment area ended, and additional inspections may be required.	ALIGN	An inspection group is complete, and additional inspections may be required.	None
32	ALIGN	The material alignment is complete, and review is required.	REVIEW	The material is reviewed.	This transition is to the REVIEW SETUP Sub-State of REVIEW.
33	REVIEW SETUP	Anomaly data is needed to perform the review.	ACQUIRE ANOMALY DATA	Anomaly data is being acquired.	Anomaly data may come from the host or equipment.

Transi-tion #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
34	ACQUIRE ANOMALY DATA	Anomaly data has been acquired for the review, or no more anomaly data is available.	REVIEW SETUP	The equipment determines what to do.	
35	REVIEW SETUP	The equipment has anomaly data, and the review is not complete.	ACQUIRE ANOMALY IMAGE	The equipment acquires the anomaly image at the specified site.	The image may be a stored image or from an imaging device.
36	ACQUIRE ANOMALY IMAGE	The equipment has acquired the anomaly image for the specified site.	CLASSIFY	The operator or equipment classifies the anomaly.	None
37	CLASSIFY	All anomalies have been classified for the site.	REVIEW SETUP	The equipment determines what to do.	None
38	REVIEW SETUP	The review of the align area is complete.	REVIEW COMPLETE	Transition to next state is to be determined.	None
39	REVIEW COMPLETE	The review of this alignment area ended, and additional review is required.	ALIGN	A review group is complete, and additional alignment is required.	None
40	INSPECT	The alignment area inspection is complete, and review is required.	REVIEW	The material is reviewed.	This transition is to the REVIEW SETUP Sub-State of REVIEW.
41	REVIEW COMPLETE	The review is complete, and inspection is required.	INSPECT	The material is inspected.	This transition is to the INSPECT SETUP Sub-State of INSPECT.
42	CHECKING	Validation of requested process program changes failed.	PAUSED	The equipment is waiting for a new command.	No process program parameters have been changed.
43	PAUSED	The equipment receives a PP-UPDATE command.	CHECKING	The equipment begins validating requested changes to the process program.	No process program parameters are updated or changed before “all” requested changes are validated.
44	LOAD	Previous process program has completed, and there are additional process programs assigned to the “CARRIERBLD”. See Section 13.	SETTING UP	The equipment performs setup according to specifications of the next process program.	PROCESS-BLD-GROUP may include an AUTOSTART command within its body. Otherwise, the equipment waits for a START command.

8 Collection Event List

This section identifies data collection events and defines (Stream 6) reporting levels for variable items. The host can use the report definition scenario defined in SEMI E30 to define reports at ISEM-defined levels. The intent of this section is to ensure data is available at specific events and to optimize data reporting to the SECS-II host by allowing data to be grouped at reporting levels.

8.1 *Requirements*

8.1.1 This standard requires all collection events listed in the SEMI E30 standard. This standard requires the ISEM events in Table 2 for data collection (RunDataComplete, SubstrateDataComplete, GroupDataComplete, RegionDataComplete, and AnomalyDataComplete). These events are separate from the processing state transitions. These collection events shall occur before or on the processing state transition specified in Table 1. This was done to

ensure that the data and the material remain synchronous. As a result, in some cases material processing may be delayed due to extended data processing time.

8.1.2 The most fundamental level of data defined for ISEM equipment is the anomaly level for review equipment and region level for inspection equipment. For example, review equipment has data available for individual anomalies at the AnomalyDataComplete event. Anomaly data may be grouped for level reporting. For example, data for anomalies found within a region on a substrate would be available at the RegionDataComplete event. This data would be available as a list variable item for Region Anomalies. All anomalies found on a substrate would be available at the SubstrateDataComplete event. This could either be 1) a list of list variable items for Region Anomaly, or 2) a single list variable item of all Substrate Anomalies. In this way, data can be reported with less high-level event reports, rather than as more low-level event reports.

8.1.3 Data produced by ISEM equipment is customarily grouped for reporting by processing, material, and equipment constraints which are called reporting levels (i.e., run, substrate, group, site, and anomaly data). Level data is grouped by these constraints for a reporting level. Data shall be grouped within a reporting level according to other constraints by degree of processing (e.g., raw sensor, basic, or analyzed data), or statistically (e.g., summary, correlation, or comparison).

Table 2 Collection Events for ISEM Data Reporting

Reporting Level	*Data Collection Event*	*Inspection Equipment*	*Review Equipment*
Run	RunDataComplete	STOPPING → IDLE and LOAD → SETTING UP	STOPPING → IDLE and LOAD → SETTING UP
ProcessGroup	ProcessBuildGroup-Complete	LOAD → SETTING UP	LOAD → SETTING UP
Substrate	SubstrateDataComplete	UNLOAD → LOAD	UNLOAD → LOAD
Group	GroupDataComplete	INSPECT COMPLETE → ALIGN *or* WORKING → UNLOAD	REVIEW COMPLETE → ALIGN *or* WORKING → UNLOAD
Region	RegionDataComplete	INSPECT REGION → INSPECT SETUP	*Not Defined*
Anomaly	AnomalyDataComplete	*Not Defined*	CLASSIFY → REVIEW SETUP

NOTE 1: The data collection event shall occur before or on the processing state transition.

9 Variable Items

The purpose of this section is to define the list of variable item requirements for inspection and review equipment. Values of these variables shall be available to the host via collection event reports and host status queries. These variable items are separated into three categories: (a) common to all ISEM equipment; (b) specific to inspection equipment; (c) and specific to review equipment.

If equipment supports the data item functionality defined by ISEM, then it is required and shall be implemented as specified in Table 4 “Variable Item Dictionary”. That is, a variable item is only required if the equipment supports the functionality necessary to support it. For example, if an inspection instrument only has the hardware to count detected anomalies and lacks the hardware to determine their size, then the ISEM requires it to report anomaly count (e.g., as SubstrateAnomalyCount), but reporting anomaly size (as AnomalySize) is not required by the ISEM.

9.1 *Requirements*

- All variable items and data item restrictions defined in SEMI E30 are required on ISEM equipment.
- All variable items in the ISEM Variable Item Dictionary for specific equipment classifications are required for ISEM equipment. The data item restrictions are also required.

9.1.1 Variable items are categorized in the Variable Item Dictionary as follows:

- *Common Variables (CV)* — variables common to all ISEM equipment.
- *Inspection-Specific Variables (ISV)* — variables required only for inspection equipment.
- *Review-Specific Variables (RSV)* — variables required only for review equipment.

9.2 *Variable Items and Reporting Levels* — Table 3 defines reporting levels and associated Data Collection Events for which Variable Items are valid for.

Table 3 Variable Items and Reporting Levels

Level	*Reporting Level*	*Data Collection Event*
R	Run	RunDataComplete
P	ProcessGroup	ProcessGroupComplete
S	Substrate	SubstrateDataComplete
G	Group	GroupDataComplete
X	Region	RegionDataComplete
A	Anomaly	AnomalyDataComplete
ALL	Run, Substrate, Group, Region, and Anomaly	All of the above.

9.2.1 Variable items are documented in the ISEM Variable Item Dictionary using the following format:

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comments*

Where:

Variable Name: A unique name for the variable item (this name is for reference only).

Type: Defined as Common (CV), Inspection (ISV), Review (RSV), or Inspection/Review specific variables (IRSV).

Description: If class is DVVAL, then the description shall contain a statement of when data is valid in terms of ISEM events.

Level: The report level at which this variable is used <R|S|G|X|A|ALL> as defined in Table 3. It also indicates when the variable item is valid.

Class: The data type of the item.

Format: <SECS Message Language (SML) mnemonic> acceptable formats are SEMI E5 lists, ASCII, floating point, unsigned integer, or signed integer. A description of "ANY" indicates that only the above formats are acceptable and is left to the tool vendor to decide.

Comments: Any additional information pertinent to the variable name.

9.3 *Variable Item Types*

9.3.1 *Equipment Constants (ECV)* — The value can be changed by the host using S2,F15. The operator may have the ability to change some or all of the values. The value of an equipment constant may be queried at any time by the host using the S2,F13/14 transaction or Stream 6 reports.

9.3.2 *Status Variables (SV)* — The values are valid at all times. A SV may not be changed by the host or operator but may be changed by the equipment. A host or operator command may change an equipment status, thus changing an SV. The value of status variables may be queried by the host at any time using the S1,F3/4 or Stream 6 reports.

9.3.3 *Data Variables (DVVAL)* — These are variables which are valid upon the occurrence of a specific collection event and which may or may not be valid at other times, depending upon the equipment. An attempt to read a variable item when it is invalid will not result in an error, but the data reported may not have relevant meaning.

9.4 *Variable Item Dictionary*

9.4.1 *Data Validity* — The "Level" column in Table 4 defines when the variable item is valid. The entry in this column corresponds to a reporting level defined in Section 9.2 "Variable Items and Reporting Levels". For example, "RunAnomalyCount" is valid at the "RunDataComplete" event, and "AnomalySize" is valid at all reporting level data collection events.

Table 4 Variable Item Dictionary

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
ActiveLocation	CV	The current carrier location that has substrates in the executing state of the processing state model.	ALL	SV	U2	Valid in all data collection events as defined in Table 3.
AlignList	CV	A list of alignment sites information being used by the current active process program.	ALL	DVVAL	L,n 1. <AlignName> : n.	The order in which the alignment name appears in the list is important and is equipment-dependent.
AlignName	CV	Alignment name	ALL	DVVAL	A[1..16]	An item in the AlignList variable.
AnomalyArea	CV	The area within the bounds of an anomaly (in units of micron^2).	ALL	DVVAL	F4	
Anomaly-Attributes	CV	Miscellaneous anomaly information that is equipment-dependent and defined by the equipment supplier.	ALL	DVVAL	L,n 1. <attribute$_1$> : n. <attribute$_n$>	Mainly used as part of other anomaly-related data (list) (i.e., AnomalySize).
Anomaly-Comment	RSV	Operator-generated comment associated with the anomaly.	A	DVVAL	A[1..80]	
AnomalyData2D	CV	Coordinate data for an anomaly.	A	DVVAL	L,5 1. <AnomalyID> 2. <CoordSys> 3. <Coord2D> 4. <Anomaly-Attributes>	
AnomalyID	CV	A unique anomaly identifier.	A	DVVAL	A[1..16]	
AnomalySize	CV	The X,Y extent of the anomaly in microns. The dimensions of the smallest rectangle that contains the anomaly whose sides are parallel to the X and Y axis.	A	DVVAL	L,2 1. <XExtent> 2. <YExtent>	XExtent and YExtent are of Format F4.
AnomalyTable-Name	CV	Name identifier of anomaly table.	ALL	SV	A[1..80]	
AnomalyTable-Type	CV	Type of anomaly table. (See Section 11.)	ALL	SV	A[1..20]	"TABLE-AREA-DEF", "TABLE-ALIGN-DEF", "TABLE-ANOMALY-DEF", "TABLE-M21-ANOMALY-DEF"
BatchID	CV	The batch identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
CarrierBuild	CV	ID of the CARRIERBLD ISEM job that the inspection/review data is associated with.	ALL	SV	A[1..80]	See Section 14.
CarrierID	CV	Physical identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
CarrierNumber	CV	Used to identify carriers in	ALL	DVVAL	A[1..16]	

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
		multi-lot runs (batch).				
Classification	RSV	Classification code of an anomaly.	A	DVVAL	A[1..80]	
Coord2D	CV	The two-dimensional coordinate of an anomaly.	ALL	DVVAL	L,2 1. <CoordX> 2. <CoordY>	
CoordSys	CV	The identification for a coordinate system definition. SEMI M20, M20P, or SEMI M21.	ALL	DVVAL	A[1..16]	"M20" "M21" "M20P"
CoordX	CV	The coordinate in the X direction of a site (anomaly, alignment site, or the lower left-hand of an area or element).	ALL	DVVAL	F4	
CoordY	CV	The coordinate in the Y direction of a site (anomaly, alignment site, or the lower left-hand of an area or element).	ALL	DVVAL	F4	
DefaultPriority	CV	The default priority given a material location if none is assigned.	ALL	EC	U2	
DeltaX	CV	The X-axis translation of M20P coordinate system relative to the SEMI M20 coordinate system.	ALL	DVVAL	F4	
DeltaY	CV	The Y-axis translation of M20P coordinate system relative to the SEMI M20 coordinate system.	ALL	DVVAL	F4	
ElementID	CV	The SEMI M21 address for a specific rectangular element on a substrate.	ALL	DVVAL	I4[2]	May refer to a field or die.
ElementList	CV	A list of SEMI M21 elements where processing can be attempted.	ALL	DVVAL	L,n 1. <ElementID> : n.	
Fiducial	CV	The physical feature used to associate a fiducial line used for orientation (i.e., flat or notch on a substrate).	ALL	DVVAL	A[1..16]	"FLAT" "NOTCH"
GroupAnomaly-Count	CV	Anomaly count for the current or last group (i.e., field or die inspected).	G	DVVAL	U2	
GroupArea	CV	Square Area (microns^2) of the last group inspected.	G	DVVAL	F4	
GroupComment	RSV	Operator-generated comment associated with the group.	G	DVVAL	A[1..80]	
GroupID	CV	Inspection/review group identification for the current inspection/review.	ALL	DVVAL	U2	
InspectionPPID	CV	Process program used on the inspection/review tool	ALL	DVVAL	A[1..80]	

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
		for the current inspection/review.				
InspectionRunID	CV	Run identification in the current inspection/review.	ALL	DVVAL	A[1..16]	
LotID	CV	Lot identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	
M20Data	CV	The silicon substrate size, fiducial type, and orientation to use.	ALL	DVVAL	L,3 1. <SubstrateSize 2. <Fiducial> 3. <Orientation>	
M21Data	CV	The data necessary to establish an ISEM SEMI M21 layout on a substrate.	ALL	DVVAL	L,2 1. L,3 1. <M21XSize> 2. <M21YSize> 3. <Tile> 2. L,n 1. L,3 1. <ElementID> 2. <CoordX> 3. <CoordY> : n.	
M21XSize	CV	The value of the SEMI M21 coordinate system in the X-direction.	ALL	DVVAL	F4	
M21YSize	CV	The value of the SEMI M21 coordinate system in the Y-direction.	ALL	DVVAL	F4	
Offset	CV	The distance of the actual or found location of a site relative to its defined or expected location.	ALL	DVVAL	L[2]	Refers to SiteDeltaX, SiteDeltaY which are of Format F4.
OperatorAction	CV	The action taken by the operator on the equipment's operator I/O.	ALL	DVVAL	A[1..80]	
OperatorComment	CV	Operator-generated comment, not associated with any reporting level.	ALL	DVVAL	A[1..80]	(See also Run-Comment, Substrate-Comment, Area-Comment, RegionComment, Site-Comment, and AnomalyComment.)
OperatorID	CV	Identification of the operator of the inspection/review equipment.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
Orientation	CV	How the wafer is loaded on the equipment.	ALL	EC	F4	"0" degrees indicates that the wafer has the primary fiducial towards the operator.
ProcessBuild-GroupID	CV	Name of the current or last process program executed.	ALL	SV	A[1..80]	See Section 14.
ProcessEquipmentID	CV	Identification of the process equipment used with the	ALL	DVVAL	A[1..16]	This information may be added by the host in

Variable Name	Type	Description	Level	Class	Format	Comment
		current material immediately prior to the inspection/review.				the ISEM Tables. (See Section 11.)
ProcessEquipmentLocation	CV	Location (code) of the process equipment used with the current material immediately prior to the inspection/review.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessEquipmentPPID	CV	Identification of the process program used with the process equipment used on the current material immediately prior to the inspection/review.	ALL	DVVAL	A[1..80]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessLevel	CV	Identification of the processing level of the current material.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProcessRunID	CV	Run identification for the process prior to current inspection/review.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
ProductID	CV	The product identification of the current material inspected/reviewed.	ALL	DVVAL	A[1..16]	This information may be added by the host in the ISEM Tables. (See Section 11.)
RegionComment	CV	Operator-generated comment associated with the region.	X	DVVAL	A[1..80]	
RunAnomaly-Count	ISV	Total number of all anomalies found on all substrates in the last run.	R	DVVAL	U2	
RunComment	CV	Operator-generated comment associated with the run.	ALL	DVVAL	A[1..80]	
RunInspected-AreasCount	ISV	The total number of inspected/reviewed areas on all substrates in the last run.	RS	DVVAL	U2	
RunInspection-PPCount	ISV	The total number of process programs used for the current or last run.	RS	DVVAL	U2	
RunSubstrate-Count	CV	The total number of substrates completed in the current inspection run, which remains valid until the next START command.	ALL	DVVAL	U2	
ScaleFactor	CV	A correction factor applied to the translation of one coordinate system to another.	ALL	DVVAL	F4	In most cases, a scaling of 1 (one) is expected.
SiteID	CV	Inspection/Review group identification for the current site inspection/review.	ALL	DVVAL	U2	
SlotID	CV	Carrier slot number from which the current substrate was taken.	ALL	DVVAL	U2	

Variable Name	*Type*	*Description*	*Level*	*Class*	*Format*	*Comment*
SlotList	CV	The list of carrier slots with substrates to be processed.	ALL	DVVAL	L,n 1. <SlotID> : n.	
SubstrateAnomalyCount	ISV	The total number of anomalies for the current substrate.	S	DVVAL	U2	For the most recent inspection.
Substrate-Comment	CV	Operator-generated comment associated with the substrate.	ALL	DVVAL	A[1..80]	
SubstrateID	CV	Substrate identification for the current inspection/review.	ALL	DVVAL	A[1..16]	
Substrate-InspectedAreas-Count	ISV	The total number of inspected areas on the current substrate.	S	DVVAL	U2	
SubstrateRegion-Count	CV	Total area count for the current or last substrate inspected.	ALL	DVVAL	U2	
SubstrateSize	CV	The nominal diameter (in mm) of the current or last substrate inspected/reviewed.	ALL	DVVAL	U2	
SubstrateTotal-AreaInspected	ISV	Total square area inspected/reviewed (micron^2) of the current substrate.	S	DVVAL	F4	
Theta	CV	The rotational difference in radians between a primary and secondary coordinate system.	ALL	DVVAL	F4	
Tile	CV	The layout of the pattern in the substrate.	ALL	DVVAL	A[1..16]	"NTILE" non-tiled, "CTILE" column-tiled, and "RTILE" row-tiled.
XLateData	CV	Variable for the equipment to report offset of the found or actual pattern-based coordinate system relative to the substrate-based coordinate system on the substrate being tested.	ALL	DVVAL	L,4 1. <DeltaX> 2. <DeltaY> 3. <Theta> 4. <ScaleFactor>	

10 Alarm List

Since each model of equipment differs in configuration, it is not practical to provide an exhaustive list of all possible alarms. Instead, the ISEM is requiring the two tables provided as described in SEMI E30 (document section). Alarm List Table, which is intended to provide for equipment configuration-specific alarms and Alarm ID, Alarm Set/Cleared Event Table.

10.1 *Alarm List Table*

10.1.1 The alarm list table contains examples of alarms that pertain to various configuration aspects of equipment. These examples are intended to illustrate that alarms pertain to situations in which there exists a potential for exceeding physical safety limits associated with people, equipment, and material being processed as per the SEMI E30 definition of an alarm. (See SEMI E30 for further reference.)

10.2 *Alarm ID, Alarm Set/Cleared Event Table*

10.2.1 The Alarm ID, Alarm Set/Cleared Event Table documents the association of each ALID to a set and cleared event as required by SEMI E30. (See SEMI E30 for further reference.)

11 ISEM Tables

A fundamental requirement of ISEM equipment is to transfer anomaly and review data between itself and the host. ISEM equipment may also be required to transfer "Area" and "Alignment Site" data needed for run setup. Anomaly and review data sets (as well as area and alignment site data sets) are commonly handled as lists and tables. ISEM equipment shall use tables when transferring this kind of data between itself and the host. List shall be used to refer to sub-sets of this table data.

11.1 *ISEM Table Data*

11.1.1 ISEM Tables are used to specify area, alignment site, and anomaly coordinate lists for ISEM equipment. ISEM Tables are transferred between the host and the equipment using SECS-II Stream 13 messages (Unformatted Data Set Transfers). For example, an ISEM Table may be used to transfer anomaly data (e.g., "M21" coordinates) generated by inspection equipment to the host, which in turn may then be transferred to review equipment from the host. ISEM Tables also include attributes items that are associated with the table, not with the table data. ISEM Table attributes are used to include information associated with table data, like the number of columns (NumCols), number of rows (NumRows), and table size (DataLength). (See SEMI E58 for additional information.) Product or process-related information may also be included on the attribute section of the ISEM Tables (e.g., LotID, ProductID, OperatorID, ProcessEquipmentID) (see Table 4). The ISEM does not specify additional table attribute variable items that may be associated with the table.

11.2 *TABLE-DEFs*

11.2.1 ISEM Tables are documented using TABLE-DEF structures (Figure 5). Each TABLE-DEF structure has a unique name (TableID) and type (TableType). Each column in the TABLE-DEF has a name (e.g., "AREANAME", "ALIGNNAME", OR "ANOMALYID"); row names are specific instances or values that correspond to the column headers in TABLE-DEF. A specific TABLE-DEF row is designated by referring to the TABLE-DEF name and the specific row name. ISEM Tables are transferred using standard (SECS-II message) Stream 13 messages (Figure 6), and each ISEM-defined TABLE-DEF item maps into a Stream 13 message item. Align and area data tables are host-defined, and anomaly tables are equipment-defined.

TableType = <*TableDef*> TableID = <*TableName*>

Row Name	*Column*$_1$	*Column*$_2$	*Column*$_3$	...	*Column*$_n$
Row$_1$ Name					
…					
Row$_m$ Name					

Figure 5
TABLE-DEF Structure

An example of usage of S13,F13 to transfer data sets is shown below:

```
L,7
   1. <DATAID>
   2. <OBJSPEC>
   3. “TableDef”                          <TBLTYP>
   4. “TableName”                         <TBLID>
   5. L,n                                 # of table attributes
       1. L,2
              1. “NumRows”                <ATTRID1>
              2. <m>                      <ATTRDATA1>
       2. L,2
              1. “NumCols”                <ATTRID2>
              2. <n>                      <ATTRDATA2>
       3. L,2
              1. “DataLength”             <ATTRID3>
              2. <table length>           <ATTRDATA3>
       4. L,2
              1. “LotID”                  <ATTRID4>
              2. “ABC123”                 <ATTRDATA4>
          n. L,2
              1. “ProductID”              <ATTRIDn>
              2. “CPUTYPE”                <ATTRDATAn>
       6. L,n                             # of columns
            1. “AREANAME”                 <COLHDR1>(1st column description)
            .
            n. “ATTRIBUTE5”               <COLHDRn>(nth column description)
       7. L,m                             # of rows
            1. L,n                        # of columns
               1. <Item 1,1>              table item in row 1, column 1
               .
               n. <Item 1,n>              table item in row 1, column n
               .
            m. L,n                        # of columns
               1. <Item m,1>              table item in row m, column 1
               .
               n. <Item m,n>              table item in row m, column n
```

Figure 6
S13,F13 with ISEM TABLE-DEF Data

11.3 *Required ISEM Tables* — ISEM equipment shall support all three table types: area, align, and anomaly. SEMI M21 anomaly table type may be supported, but it is optional. The ISEM equipment shall be able to store simultaneously at least 3 (three) defined tables of each type supported to guarantee the validity of any table while that table is being transferred (a table transfer transaction is in process).

ISEM align and area tables are stored by the equipment during the current inspection or review run (i.e., until a new remote command PP-SELECT or PP-ASSIGN is sent, or until they are modified with PP-UPDATE).

Table 5 ISEM Table Types (TABLE-DEFs)

Table Type	*Req/Opt*	*Description*
“TABLE-AREA-DEF”	R	*Area Definition* — A set of areas and their attributes, typically the list of areas to be inspected.
“TABLE-ALIGN-DEF”	R	*Alignment Site Definition* — A set of alignment sites and their attributes.
“TABLE-ANOMALY-DEF”	R	*Anomaly Coordinate Data Definition* — A set of anomalies and their attributes, with coordinates given in the SEMI M20 or M20P coordinate system.
“TABLE-M21-ANOMALY-DEF”	O	*Anomaly SEMI M21 Coordinate Data Definition* — A set of anomalies and their attributes, with coordinates given in the SEMI M21 coordinate system.

As indicated in Table 5, the SEMI M21 anomaly definition table "TABLE-M21-ANOMALY-DEF" is optional. The others are required.

ISEM requires that the following columns be included in the TABLE-DEFs. Table 6 defines the column headers and the allowed formats. Anomaly attributes and attribute headings are defined by the supplier, based on equipment capability.

11.3.1 "TABLE-AREA-DEF"

TableType: "TableAreaDef" TableID: <*AreaTableName*>

Area Name	*Coordx*	*Coordy*	*Coordsys*	*Xtentx*	*Xtenty*	*Attribute (1)*	*...*	*Attribute*

11.3.2 "TABLE-ALIGN-DEF"

TableType: "TableAlignDef" TableID: <*AlignTableName*>

AlignName	*Coordx*	*Coordy*	*Coordsys*	*Attribute (1)*	*...*	*Attribute(N)*

11.3.3 "TABLE-ANOMALY-DEF"

TableType: "TableAnomalyDef" TableID: <*AnomalyTableName*>

Anomalyid	*Coordx*	*Coordy*	*Coordsys*	*AnomalyAttribute*	*...*	*AnomalyAttribute*

11.3.4 "TABLE-M21-ANOMALY-DEF"

TableType = "TableM21AnomalyDef" TableID = <*M21AnomalyTableName*>

Anomalyid	*Coordx*	*Coordy*	*Elementid*	*AnomalyAttribute*	*...*	*AnomalyAttribute*

Defect data shall be transferred between the host and inspection/review/analysis equipment using SEMI E5, S13,F13. Columns in the table are defined by Table 11.3.5 below.

11.3.5 TABLE-STANDARD-DEFECT-DATA-SET-DEF

NOTE 1: Data for each substrate should be reported in column order shown below. Inspection tools should support relevant columns (see NOTE 6). Review and analysis tools should support all columns. Multiple data entries (list format data items) are allowed for a given attribute on a single defect.

NOTE 2: The inspection equipment must add a table attribute called "Substrate Header" (ATTRID). It must be a list that includes the following items in the given order: LotID (A[1..16]), SubstrateID (A[1..16]), ProcessEquipmentID (A[1..16]), substrate center[1] (L[2], CoordX (F4), CoordY (F4)) and centering method[2] (A[1..16]). Refer to Table 4, Variable Item Dictionary for descriptions of these items.

NOTE 3: See SEMI M21 for (0,0) die location methodology.

1 Vector from the origin of the substrate coordinate system to nominal substrate center location.

2 CoordSys (e.g., "SEMI M20", "SEMI M21", "M21P", etc).

NOTE 4: Die origin is located at lower left-hand corner (LLHC).

NOTE 5: Data format must comply with the ISEM standard.

NOTE 6: In order to signify tool context, anomaly attributes are labeled as follows:

Column name starts with "insp*_" for inspection data, "rev*_" for defect review data, "and "anal*_" for analysis data, where "*" is a numeric string that ensures each set of columns added is uniquely named (e.g., "rev1_" and "rev2_").

NOTE 7: Inspection, review and analysis tools must add a table attribute called "insp*_ Header," "rev*_Header" and "anal*_Header" respectively (ATTRID) each time they add data to the table.[3] It must be a list that includes the following items in the given order: EquipmentID (A[1..16]), EquipmentType (A[1..16]), OperatorID (A[1..16]), and CLOCK[4] (A[16]).

Column #	*Column Name*	*Description*
1	Insp_Anomaly ID	ID # for the defect
2	Insp_Table specifier	Specifies table with other relevant information
3	Insp_Coordinate X	Intra die X Coordinate wrt LLHC of die in um
4	Insp_Coordinate Y	Intra die Y Coordinate wrt LLHC of die in um
5	Insp_X index	X axis die index wrt center of wafer (COW)
6	Insp_Y index	Y axis die index wrt center of wafer (COW)
7	Insp_X size	Defect size along X axis in microns
8	Insp_Y size	Defect size along Y axis in microns
9	Insp_Defect area	Defect area in square microns
10	Insp_Defect size	Linear measure of defect size in microns
11	Insp_Scatter intensity	Anomaly scattering intensity
12	Insp_Defect class number	Previously defined class number assigned to the defect
13	Insp_Test number	Inspection test in which defect was found
14	Insp_# Optical image count	Number of optical images stored for a given defect
15	Insp_Optical image data	Optical image data specifier
16	Insp_Cluster	= 1 if defect is part of a systematic defect cluster
17	Insp_Cluster class	Systematic defect class name
18	Sampled for SEM	= 1 if defect chosen for SEM review
19	Rev_SEM image data	SEM image data specifier
20	Rev_SEM class	SEM defect class name
21	Rev_Defect height	Defect height in microns
22	Sampled for analysis	= 1 if defect chosen for EDX, = 2 if defect chosen for FIB or other analysis
23	Anal_EDX data	EDX data specifier
24	Anal_FIB data	FIB data specifier

3 Where "*" is a numeric string that corresponds to the one in the column names the header refers to.

4 Date and time of the start of inspection, review, or analysis per SEMI E5 CLOCK data item variable.

11.4 TABLE-DEF Column Header Descriptions and Formats

Table 6 Description and Formats for ISEM Table Data

Column Header	*Description*	*Format*	*Comments*
"ALIGNNAME"	The identifier given to an alignment site.	A[1..16]	
ANOMALYATTRIBUTE (n) NOTE: String defined by equipment supplier.	Tool-specific information associated with an ANOMALY for which no specific ISEM data item has been defined.	U2, F4, F8, A[1..16]	Examples: Include information such as magnification, voltage, current, wavelength, brightness, color, height, or chemical spectra. The equipment supplier shall document all attributes that are supported.
"ANOMALYID"	A unique identifier for an anomaly.	A[1..16]	
"AREANAME"	A unique identifier given to an inspection area.	A[1..16]	
ATTRIBUTE(n) NOTE: String defined by equipment supplier.	Tool-specific information associated with an alignment or measurement site for which no specific ISEM data item has been defined.	U2, F4, F8, A[1..16]	Examples: Include information such as magnification, voltage, current, wavelength, number of scans, integration time, or film stack. The equipment supplier shall document all attributes that are supported.
"COORDSYS"	The identification for applicable coordinate system.	A[1..16]	Options are "M20", "M20P", and "M21".
"COORDX"	The x-coordinate for a site.	F4	Units are in microns.
"COORDY"	The y-coordinate for a site.	F4	Units are in microns.
"ELEMENTID"	The SEMI M21 address for a specific rectangular element on a substrate.	I4[2]	
"XTENTX"	The extent in the X-direction of an area to inspect as measured from the lower left-hand corner of the area given by CoordX.	F4	Units in microns.
"XTENTY"	The extent in the Y-direction of an area to inspect measured from the lower left-hand corner of the area given by CoordY.	F4	Units in microns.

12 Process Program Management

12.1 *Definition and Rules for ISEM Process Programs*

12.1.1 A process program contains information and/or instructions required for the Inspection/Review equipment to process a given run of material. The process program shall supply all of the information required for a remotely executed run to be processed without operator intervention.

12.2 *Requirements*

12.2.1 The ISEM requires that the SEMI E30 capability of Process Program Management be fully supported for this class of equipment. ISEM requires that the process program have a structure that enables the user to build process programs with default conditions that can be overridden for a run. ISEM requires the ability to vary the quantity of substrates processed, the alignment information used, and the number and/or location of the areas/anomalies to be inspected/reviewed through the uses of process program variable parameters. The concepts of process program structure and process program variable parameters are discussed in the following sections.

12.3 *Process Program Structure*

12.3.1 The purpose of this process program structure and the related concepts is to provide flexibility in using process programs to reduce the number of process programs needed. This structure enables the user or host to vary certain parameters of a given process program as needed for any particular run.

12.3.2 Often a process program may be very similar from one run to another and may differ only in a few parameters such as: which substrate slots to run, which areas to inspect, which parameters to run on each substrate, etc. Previously this small variation from run to run would require a large number of process programs to be created and maintained. The flexibility

of the method described in this section will reduce the number of process programs.

12.4 *Process Program Variable Parameters* — A process program parameter specifies a value that temporarily modifies the value of a process program variable parameter. A process program variable parameter is formally defined within a process program body and contains (1) a variable parameter name that is unique in the body (CPNAME), and (2) a parameter default value for use when the process program is selected for execution without specification of an override value for this variable parameter (CPVAL/CPEVAL).

12.4.1 *Overriding Process Program Variable Parameters Default Values*

12.4.1.1 Any process-related information that is normally requested from the operator console in manual operation shall have a process program variable parameter identified in the process program and default values assigned in the body of the process program. An equipment would run the process program using the default values unless those values were overridden.

12.4.1.2 These process program variable parameters allow a host to tailor a process program for a specific run of material by temporarily modifying (replacing) the process program default values using a remote command of PP-UPDATE. The modification does not permanently change the process program; the modifications remain in effect only until the next run or until the next PP-UPDATE remote command is received.

12.4.2 *Requirements and Rules*

12.4.2.1 ISEM equipment is required to support variable process program parameters. Additionally, ISEM process programs are required to contain variable process program parameters that specify a name for each of the four previously defined ISEM table types. Specifically, parameters for "TABLE-AREA-DEF", "TABLE-ALIGN-DEF", "TABLE-ANOMALY-DEF", and "TABLE-M21-ANOMALY-DEF" table names are required. Only the names that refer to these TABLE-DEFs are required to be included in the process program body. The actual TABLE-DEF data is external to the process program body. The host may always assume that there are variable process program parameters for these four ISEM tables.

12.4.2.2 Before execution of a CARRIERBLD can begin, the presence of all the ISEM Tables that it references shall be verified by the equipment. If they are not all present, an error shall be reported. The equipment shall support data items that may be linked to the event report that specifies the name of missing ISEM Tables. S7,F27 is used for reporting this error condition.

12.4.2.3 The following table summarizes the variable process program parameters that ISEM equipment shall support and the remote command parameters that the host may use to override their values (as defined in Section 13 and Table 9).

Table 7 Required Variable Process Program Parameters

Variable Process Program Parameter and Host Command Parameter Name (CPNAME)	*Description*
"ALIGNLIST"	A list of location identifiers to be reviewed.
"ANOMALYLIST"	A list of location identifiers to be reviewed.
"AREALIST"	A list of area identifiers to be inspected or reviewed.
"ELEMENTLIST"	A list of array element identifiers to be inspected.
"SLOTLIST"	A list of carrier slot numbers with material to be inspected or to be reviewed.
"SUBSTRATELIST"	A list of substrate IDs with material to be inspected or to be reviewed.
"TABLE-ALIGN-DEF"	A set of alignment site definitions.
"TABLE-ANOMALY-DEF"	A set of (SEMI M20) anomaly location and attribute definitions.
"TABLE-AREA-DEF"	A set of area definitions.
"TABLE-M21-ANOMALY-DEF"	A set of SEMI M21 anomaly location and attribute definitions.

12.4.3 *Modifying Process Program Variable Parameters* — The remote commands of PP-SELECT, PP-ASSIGN, or PP-UPDATE are used to modify any of the identified process program variable parameters within the process program. The modification is done by including CPNAME/CPVAL pairs within the "PROCESS-BLD-GROUP", which is part of the remote commands of PP-SELECT or PP-ASSIGN, or by including a different list name in the PP-UPDATE remote command. A CPNAME in a process program shall be identical to the process program variable parameter name as specified in the "PROCESS-BLD-GROUP". See next section for details of these parameters.

12.5 *Use of Process Programs, Remote Commands, and "PROCESS-BLD-GROUP"* — This is a brief description of the steps involved in using the process program structure, the process program variable parameters, the TABLE-DEFs, and the modification of process program variable parameters through the use of "PROCESS-BLD-GROUP" and CPNAME/CEPVAL pairs in the enhanced remote command (S2,F49).

- A process program is created with certain items in the body identified as process program variable parameters, along with their default values.
- The host sends to equipment one or more TABLE-DEFs: such as "TABLE-AREA-DEF" and "TABLE-ALIGN-DEF", along with the names of those tables using Stream 13 commands (See SEMI E5). These tables are now resident on the equipment.
- The host sends an enhanced remote command (S2,F49) to the equipment (either PP-SELECT or PP-ASSIGN) that contains the information needed for processing ("CARRIERBLD"). The "CARRIERBLD" contains a "PROCESS-BLD-GROUP" for each different set of run parameters that are needed during the inspection or review process.
- "PROCESS-BLD-GROUP" shall contain the ProcessBuildGroupID to identify which program is selected.
- If the default list of slots in the process program needs to be changed for this run, then "PROCESS-BLD-GROUP" contains a "MATERIALLIST" and the list of selected slots or substrates, designated by SlotIDs or SubstrateIDs.
- If the default set of inspection areas in the process program needs to be changed for this run, then "PROCESS-BLD-GROUP" contains the name of a specific "TABLE-AREA-DEF" (in AreaTable Name). If not all of the inspection areas given in that "TABLE-AREA-DEF" are needed for this run, then "AREALIST" is used and includes a list of the names of the specific inspection areas which are needed. Those names refer to inspection areas defined in the "TABLE-AREA-DEF".
- If the default set of alignment sites in the process program needs to be changed for this run, then "PROCESS-BLD-GROUP" contains the name of a specific "TABLE-ALIGN-DEF" (in AlignTable Name). If not all of the alignment sites given in that "TABLE-ALIGN-DEF" are needed for this run, then "ALIGNLIST" is used and includes a list of the names of the specific alignment sites which are needed. Those names refer to alignment sites defined in the "TABLE-ALIGN-DEF".
- If the SEMI M21 coordinate system is being used and a pattern has been defined with pattern element names and if only certain of those elements need to be inspected for this run, then "PROCESS-BLD-GROUP" contains an "ELEMENTLIST" and the list of selected elements, designated by ElementIDs.
- If certain equipment-specific process program variable parameters need to have different values for this run, then for each needed parameter, "PROCESS-BLD-GROUP" contains a CPNAME (unique name of a specific process program variable parameter) and the new CEPVAL (new value for that parameter).
- The equipment executes the process program with the new values.
- If indicated in the process program, the equipment generates the list of anomalies found and sends it to the host in the format of a "TABLE-ANOMALY-DEF" using the ISEM table definition and Stream 13 transfer messages (see SEMI E5 for format specification).
- The host would send the "TABLE-ANOMALY-DEF" to a review equipment. The host might need to modify part of the table if required by the review equipment. This anomaly table is now resident on the review equipment. (NOTE: The host might choose to not send all of the table of anomalies, but rather a desired selection of them.)
- The host sends the equipment the enhanced remote command (PP-SELECT or PP-ASSIGN) that contains a "CARRIERBLD". The "CARRIERBLD" has a "PROCESS-BLD-GROUP" for each different set of run parameters that is needed by the review equipment. It is required for the host to use the Enhanced Remote Command S2,F49 for transferring the information

to the equipment. "PROCESS-BLD-GROUP" includes the name of a specific "TABLE-ANOMALY-DEF" in the parameter AnomalyTableName. If not all of the anomalies given in that "TABLE-ANOMALY-DEF" are needed for this run, then either "ANOMALYLIST" or "M21-ANOMALYLIST" is used and includes a list of the names of the specific anomalies which are desired. Those names refer to anomalies defined in the named "TABLE-ANOMALY-DEF".

- The equipment runs the process program using the selected values and reviewing the specific anomalies indicated.
- The equipment adds review information to the ANOMALYATTRIBUTE list. Then the review equipment sends this modified "TABLE-ANOMALY-DEF" to the host.

13 Remote Commands

The purpose of this section is to identify remote commands, command parameters, and valid commands versus states pertinent to the SEM.

13.1 *Requirements*

- The equipment shall support the SEMI E30 required remote commands.
- All the remote commands defined by ISEM are required unless they have been qualified by the statement "if the equipment supports this functionality, it shall use this command." In this case, they are only required if the equipment supports the functionality necessary to support the command. A good example of this is the MAP-CARRIER command. If the equipment does not have the hardware necessary to scan a carrier for the presence of substrates in slots, then the command is not required by the ISEM.
- The alphanumeric strings defined by ISEM for RCMD and CPNAME are required.

Host Command Parameter (CPNAME/CPVAL) — A parameter name/value associated with a particular host command when using stream function (S2,F41) and a (CPNAME/CEPVAL) parameter name/value when using the enhanced remote command (S2,F49). This document specifies unique names (CPNAMEs) and values (CPVALs and CEPVALs) for many command parameters. Note that if there are no associated parameters, a zero length list is sent.

The purpose of the remote commands is to allow host control over the following capabilities:

- Start processing
- Stop processing
- Temporarily suspend processing
- Resume processing
- Abort processing
- Select process programs, material, and/or sites to measure
- Report location of material found

The following remote commands (RCMDs) shall be supported as described below:

NOTE 3: The terms "current cycle" and "safe point" used below are to be defined by the supplier.

13.2 *Remote Commands Description*

1. *ABORT* — Terminate the current cycle prior to its completion. ABORT has the intent of immediately stopping the process and is used because of abnormal conditions. ABORT makes no guarantee about the subsequent condition of material except as noted in the "ABORTLEVEL" description.
2. *CLEANUP* — De-selection of the current ISEM job ("CARRIERBLD") and process program ("PROCESS-BLD-GROUP"), including the removal of all material to output locations and any equipment-specific activities needed to transition into the IDLE state. Completion of this command should generate a collection event report. If the equipment supports this functionality, it will use this command.
3. *MAP-CARRIER* — Requests the equipment to provide a list of carrier slots that contain material. MAP-CARRIER has the intent of providing the host with enough information about the location and/or ID of material so it may select material for processing accordingly. Completion of this command shall generate a collection event report. If the equipment supports this functionality, it must use this command.
4. *NEXT-MATERIAL* — Processing of the current substrate is halted at the first safe point and unloaded to the target carrier location. NEXT-MATERIAL has the intent of allowing the host to skip measurement of the current substrate. This is a trigger for processing state transition from WORKING to UNLOAD. If the equipment supports this functionality, it will use this command.
5. *PAUSE* — Suspend processing temporarily at the next safe point. PAUSE has the intent of resuming the process at the same point where it was paused.

RESUME or PP-UPDATE may be used to resume the process.

6. *PP-ASSIGN* — Instructs the equipment that supports queuing to create a new ISEM job ("CARRIERBLD") for the specified port ("LOCATIONID") when more than one port is available for processing. If only one port is available, "LOCATIONID" is not required. Priority may optionally be specified with this command. The "PRIORITY" specifies the priority of the newly created job in the ISEM job queue (a value of 0 (zero) assigns the highest priority to the job). Without specifying a priority, the job is queued with the default priority. Jobs with equal priority are queued in the order the PP-ASSIGN commands are received. This command is valid in all PROCESSING states.

7. *PP-SELECT* — Instructs the equipment to make the requested ISEM job(s) ("CARRIERBLD") available in the execution area. This is a trigger for the processing state transition from IDLE to SETTING UP. The first process program ("PROCESS-BLD-GROUP") specified in the "CARRIERBLD" is also validated during SETTING UP.

8. *PP-UNASSIGN* — Removes the ISEM job assignment ("CARRIERBLD") for a carrier or port. The carrier or port is removed from the process queue.

9. *PP-UPDATE* — Provides the ability to alter the current process program being executed during the PAUSED state. The process program variables specified in the PP-UPDATE command will replace previous definitions in the "PROCESS-BLD-GROUP". This command will trigger transition to CHECKING for process program parameter verification. A RESUME command is implied with the validation of "all" replaced values to resume the process. If the PP-UPDATE fails, the process program variables present prior to the PP-UPDATE are retained. If no parameters values are specified, the defaults are used.

10. *RESUME* — Resume processing from the point where the process was paused. This is the trigger for processing state transition from PROCESS PAUSE to the previous PROCESS state.

11. *START* — Instructs the equipment to initiate processing. This is the trigger for the processing state transition from READY to LOAD. An "AUTOSTART" command parameter may be included to allow for continuous processing.

12. *STOP* — Complete the current cycle, stop in a safe condition, and return to the IDLE processing state. Stop has the intent of stopping the process entirely. This command can be used to both: stop the current ISEM job or to stop all queued jobs. The equipment is not required to support the continuation of processing.

13.2.1 *Remote Commands and Associated Host Command Parameters* — This table describes the allowable command parameters (CPNAME) for each remote command (RCMD). Equipment shall support all parameters. The column marked Req/Opt specifies which parameters are required to be sent by the host and which parameters may be optionally sent by the host.

Table 8 Allowable Command Parameters

Remote Command	*Parameters*		
	CPName	*Req/Opt*	*Comments*
ABORT	"ABORTLEVEL"	R	
CLEANUP	"CARRIERID" "LOCATIONID" "SLOTID"	O O O	PORT and SLOT may be used to define a different carrier/slot destination for the substrates.
MAP-CARRIER	"CARRIERID" "LOCATIONID"	R* R*	* One is required.
NEXT-MATERIAL	"CARRIERID" "LOCATIONID" "SLOTID"	O O O	PORT and SLOT may be used to define a different carrier/slot destination for the substrates.
PAUSE	None	NA	None
PP-ASSIGN	"PRIORITY" "CARRIERBLD"*	O R	* More than one "CARRIERBLD" may be specified.
PP-SELECT	"CARRIERBLD"*	R	* More than one "CARRIERBLD" may be specified.
PP-UNASSIGN	"CARRIERBLD"	R	None

PP-UPDATE	"PPBUILDID" "ALIGNLIST" "ANOMALYLIST" "AREALIST" "ELEMENTLIST" "SLOTLIST" "SUBSTRATELIST" "TABLE-ALIGN-DEF" "TABLE-AREA-DEF" "TABLE-ANOMALY-DEF" "TABLE-M21-ANOMALY-DEF"	R R* R* R* R* R* R* R* R* R* R*	* At least one is required.
RESUME	None	N/A	None
START	"CARRIERBLD"	0	None
STOP	"CARRIERBLD"	0	None

13.2.2 *Host Command Parameter Names and Values*

Table 9 Host Command Parameters CPNAMES

CPName	*Parameter Value*		
	Description	*Range*	*Format*
"ABORTLEVEL"	ISEM-defined abort levels: HALT — Process halts, and the ABORTING process state is entered. CLEANUP — Process halts, material cleanup is performed, and the ABORTING process state is entered.	"1= HALT" "2 = CLEANUP"	U2
"ALIGNLIST"	L,n 1. $AlignName_1$: n. For the SEMI M20 or M20P coordinate system.		List of A[1..16] data items
"ALIGNNAME"	Alignment name See the "TABLE-ALIGN-DEF" definition for further explanation.		A[1..16]
"ANOMALYLIST"	L,n 1. $AnomalyID_1$: n. For the SEMI M20 or M20P coordinate system.		List of A[1..16] data items
"ANOMALYID"	Anomaly identifier See the "TABLE-ANOMALY-DEF" or the "TABLE-M21-ANOMALY-DEF" definition for further explanation.		A[1..16]
"AREALIST"	L,n 1. $AreaName_1$: n.		List of A[1..16] data items
"AREANAME"	Unique identifier for an area to be inspected. See the "TABLE-AREA-DEF" definition for further explanation.		A[1..16]
"AUTOSTART"	Specifies whether a START command is required from an external source (operator or host) to exit the READY state. 0 = NoAutoStart (A START command required.) 1 = AutoStart (No external START command required to begin execution.)	0–1	U2
"CARRIERID"	Identifier of the carrier that the inspection/review data is associated with.		A[1..16]

CPName	*Parameter Value*		
	Description	*Range*	*Format*
"ELEMENTLIST"	L,n 1. ElementID$_1$: n. For the SEMI M21 coordinate system.		List of A[1..16] data items
"LOCATIONID"	Unique identifier of the location to be used for the "CARRIERBLD" assignment.		U2
"PPBUILDID"	ProcessProgramBuildID		A[1..80]
"PPNAME"	ProcessProgramName		A[1..80]
"PRIORITY"	Assignment priority	0–9 Highest priority corresponds to 0.	U2
"SLOTLIST"	Specifies carrier slots containing substrate for the ISEM job. L,n 1. SlotID$_1$: n. SlotIDn	Zero length list specifies all slots.	List of U2 data items
"STOPLEVEL"	Stop levels defined by the ISEM.	"1 = LOCATIONID" "2 = CARRIERID"	Use defined CPVALs
"SUBSTRATELIST"	Specifies identifiers of substrate for the ISEM job. L,n 1. SubstrateID$_1$: n. SubstrateID$_n$	Zero length list specifies all substrate (independent of substrate identifier).	List of A[0..16] data items
"CARRIERBLD" E5 Format	L, 3 Three ISEM required parameters 1. L, 2 ❖ 1. "CARRIERID" **A[9]** -- CPName 2. CarrierID **A[1..16]** -- CPValue 2. L, 2 ❖ 1. "LOCATIONID" **A[10]** -- CPName 2. LocationID **U2** -- CPValue 3. L, 2 1. "PROCESS-BLD-LIST" 2. L, n ❖ List of n jobs 1. L, 2 1. "PROCESS-BLD-GROUP" 2. L, m First ISEM job 2. L, 2 1. "PROCESS-BLD-GROUP" 2. L, m Next ISEM job . . . n. L, 2 1. "PROCESS-BLD-GROUP" 2. L, m Last ISEM job	m = 3	List
"PROCESS-BLD-GROUP" (for Inspection)	L,m 1. L,2 1. "PPBUILDID" 2. ProcessBuildGroupID	*m* ≥ 2	List of *m* data items

CPName	*Parameter Value*		
	Description	*Range*	*Format*
	2. L,2 1. "PPNAME" 2. ProcessProgramID 3. L,2 1. "SLOTLIST" 2. L,n 1. $SlotID_1$: n. ***Or*** 1. "SUBSTRATELIST" 2. L,n 1. $SubstrateID_1$: n. 4. L,2 1. "AUTOSTART" 2. AutoStart 5. L,2 1. "TABLE-AREA-DEF" 2. AreaTableName 6. L,2 1. "AREANAME" 2. L,n 1. $AreaName_1$: n. 7. L,2 1. "TABLE-ALIGN-DEF" 2. AlignTableName 8. L,2 1. "ALIGNNAME" 2. L,n 1. $AlignName_1$: n. 9. L,2 1. "ELEMENTLIST" ** 2. L,n 1. $ElementID_1$: n. 10. L,2 1. CPNAME* 2. CEPVAL* m. L,2 1. CPNAME* 2. CEPVAL* **NOTES:** "PPBUILDID" and "PPNAME" are required. "SLOTLIST", "SUBSTRATELIST", "AREALIST", and "ALIGNLIST" are optional. * Supplier shall define as many of these CPNAME, CEPVAL		

CPName	*Parameter Value*		
	Description	*Range*	*Format*
	pairs as are supported by the equipment. ** "ELEMENTLIST" is required when using the SEMI M21 coordinate system in the definition of an AlignName or AreaName.		
"PROCESS-BLD-GROUP" (for Review Equipment)	L,m 1. L,2 1. "PPBUILDID" 2. ProcessBuildGroupID 2. L,2 1. "PPNAME" 2. ProcessProgramID 3. L,2 1. "SLOTLIST" 2. L,n 1. $SlotID_1$: 2. $SlotID_n$ ***Or*** 1. "SUBSTRATELIST" 2. L,n 1. $SubstrateID_1$: n. $SubstrateID_n$ 4. L,2 1. "AUTOSTART" 2. AutoStart 5. L,2 1. "TABLE-ANOMALY-DEF" 2. AnomalyTableName 6. L,2 1. "ANOMALYNAME" or "M21-ANOMALYNAME" 2. L,n 1. $AnomalyID_1$ or $M21AnomalyID_1$: n. 7. L,2 1. "ALIGN-TABLE-DEF" 2. AlignTableName 8. L,2 1. "ALIGNNAME" 2. L,n 1. $AlignName_1$: n. 9. L,2 1. "ELEMENTLIST"** 2. L,n 1. $ElementID_1$: n. 10. L,2	$m \geq 2$	List of *m* data items

CPName	*Parameter Value*		
	Description	*Range*	*Format*
	1. CPNAME* 2. CEPVAL* m. L,2 1. CPNAME* 2. CEPVAL* **NOTES:** "PPBUILDID" and "PPNAME" are required. "SLOTLIST", "SUBSTRATELIST", "AREALIST", and "ALIGNLIST" are optional. * Supplier shall define as many of these CPNAME, CEPVAL pairs as are supported by the equipment. ** "ELEMENTLIST" is required when using the SEMI M21 coordinate system in the definition of an AlignName or AreaName.		

NOTE 1: ❖ Required ISEM parameters: "CARRIERID", "LOCATIONID", "PROCESS-BLD-GROUP"

13.2.3 *Remote Commands vs. Processing States* — The following table indicates states where the remote commands are allowed. This is indicated with a "X" mark.

Table 10 Remote Commands vs. Processing States

	COMMAND											
PROCESSING STATE	*STOP*	*START*	*RESUME*	*PP-UPDATE*	*PP-SELECT*	*PAUSE*	*NEXT-MATERIAL*	*MAP-CARRIER*	*PP-ASSIGN*	*CLEANUP*	*ABORT*	*PP-UNASSIGN*
IDLE					X			X	X			X
ABORTED									X	X		X
PROCESSING ACTIVE												
STOPPING									X		X	
ABORTING												
PAUSE												
ALARM PAUSED	X								X		X	
PROCESS PAUSE												
PAUSING	X								X		X	
PAUSED	X		X	X					X		X	
CHECKING	X								X		X	
PROCESS												
SETTING UP	X					X		X	X		X	X
READY	X	X				X			X		X	X
EXECUTING												
LOAD	X					X			X		X	
UNLOAD	X					X			X		X	
WORKING												
INSPECT	X					X	X		X		X	
ALIGN	X					X	X		X		X	
REVIEW	X					X	X		X		X	

14 Scenarios

14.1 *Run Level Reporting Scenario* — This scenario only has expected events (i.e., no alarms or errors).

COMMENT	HOST	EQUIPMENT	COMMENT
			The equipment is in the IDLE processing state and in The ONLINE REMOTE control state. The host has defined, linked, and enabled RUN level report for CEIDs 2, 3, and 5.
Host sends a PP-SELECT command specifying a ″CARRIERBLD″	S2,F49-->		
		<--S2,F50	Command Acknowledge
			The equipment transitions from IDLE to SETTING UP, and material arrives at input port.
		<--S6,F11	SETTING UP -> READY (CEID 3)
Event Report Acknowledge	S6,F12-->		
START	S2,F41-->		
		<--S2,F42	Host Command Acknowledge
			READY -> LOAD. [WHILE] Note End of Run LOAD -> WORKING WORKING -> UNLOAD UNLOAD -> LOAD [END WHILE]
		<--S6,F11	LOAD -> STOPPING (CEID 5)
Event Report Acknowledge	S6,F12-->		
		<--S6,F11	Run Processed Data Valid event.
Event Report Acknowledge	S6,F12-->		
			The equipment transitions from STOPPING to IDLE.

14.2 *PP-UPDATE Remote Command Scenario* — Host issues the PP-UPDATE remote command.

COMMENT	HOST	EQUIPMENT	COMMENT
START	S2,F41-->		
		<--S2,F42	Positive Acknowledge.
		<--S6,F11	READY -> LOAD
Positive Acknowledge.	S6,F12-->		
			[WHILE] Not End of Run 1) LOAD -> WORKING 2) WORKING -> UNLOAD 3) UNLOAD -> LOAD [END WHILE]
Sometime during the [WHILE]:			
PAUSE	S2,F41-->		
		<--S2,F42	Positive Acknowledge.
		<--S6,F11	Transition to PAUSING
Positive Acknowledge.	S6,F12-->		
		<--S6,F11	PAUSING -> PAUSED
Positive Acknowledge.	S6,F12-->		
PP-UPDATE	S2,F49-->		
		<--S2,F50	Positive Acknowledge.
		<--S6,F11	PAUSED -> CHECKING
Positive Acknowledge.	S6,F12-->		
		<--S6,F11	CEID is posted. [IF] the updates are valid: Return to the previous process state through history. [ELSE] Return to the PAUSED state. The Process program remains unchanged. [ENDIF]
Positive Acknowledge.	S6,F12-->		

COMMENT	HOST	EQUIPMENT	COMMENT
			The equipment is in the IDLE processing state and in the ONLINE REMOTE control state.
Host sends a TABLE-DEF to the equipment.(See Section 11.)	S13,F13-->		
		<--S13,F14	Table Data Acknowledge
Host sends more tables if needed.	S13,F13-->		
		<--S13,F14	Table Data Acknowledge
Host prepares the remote command to initiate an inspection run, including the “TABLE-AREA-DEF”, ”TABLE-ALIGN-DEF”, and ”ELEMENTLIST”, if required.			
Host sends a PP-SELECT command specifying a ”CARRIERBLD”.	S2,F49-->		
		<--S2,F50	Command Acknowledge
			The equipment transitions from IDLE to SETTING UP to READY.
START	S2,F41-->		
		<--S2,F42	Host Command Acknowledge
			READY -> LOAD. [WHILE] Not End of Run LOAD -> WORKING WORKING -> UNLOAD UNLOAD -> LOAD [END WHILE]
			LOAD -> STOPPING
		<--S13,F13	Equipment sends anomaly table with additional data, including the table name using Table Data Send command.
Table Data Acknowledge	S13,F14-->		
			The equipment transitions from STOPPING to IDLE.

14.4 *Event Report and ISEM Table Transfer Command Scenario*

COMMENT	HOST	EQUIPMENT	COMMENT
			The equipment is in the IDLE processing state and in the ONLINE REMOTE control state.
Host defines report with AnomalyTableName and AnomalyTableType	S2,F33-->		
		<--S2,F34	Define Report Acknowledge
Link report to RunDataComplete event	S2,F35-->		
		<--S2,F36	Link Event Report Acknowledge
Enable event	S2,F37-->		
		<--S2,F38	Enable Event Acknowledge
Host sends an ISEM table to the equipment.	S13,F13-->		
		<--S13,F14	Table Data Acknowledge
Host sends more tables if needed.	S13,F13-->		
		<--S13,F14	Table Data Acknowledge
Host sends a PP-SELECT command specifying a ″CARRIERBLD″	S2,F49-->		
		<--S2,F50	Remote Command Acknowledge The equipment transitions from IDLE -> SETTING UP -> READY.
START	S2,F41-->		
		<--S2,F42	Host Command Acknowledge READY -> LOAD. [WHILE] Not End of Run LOAD -> WORKING WORKING -> UNLOAD UNLOAD -> LOAD [END WHILE] LOAD -> STOPPING STOPPING -> IDLE
		<--S6,F11	RunDataComplete event with AnomalyTableName and AnomalyTableType.
Event Report Acknowledge	S6,F12-->		
Host sends Table DataRequest	S13,F15-->		
		<--S13,F16	Equipment sends requested table TBLACK = 0 if no errors.

15 GEM Capabilities

The purpose of this section is to specify any SEMI E30 additional capabilities that are required to be supported by this class of equipment.

15.1 *Requirements*

15.1.1 This standard requires that the SEMI E30 fundamental requirements and additional capabilities have been implemented on the ISEM equipment with the exception of limits monitoring and trace reporting. If these capabilities are implemented, they shall be implemented as required by the SEMI E30 document. The following SEMI E30 additional capabilities required by ISEM are:

- Dynamic Event Report Configuration
- Variable Data Collection
- Status Data Collection
- Alarm Management
- Remote Control
- Equipment Constants
- Process Program Management
- Spooling
- Trace Data Collection (optional)
- Control (Host-Initiated)

RELATED INFORMATION 1

NOTE: This related information is not an official part of SEMI E30.1 and was approved for publication by full letter ballot procedures on September 3, 1999.

R1-1 Defect Classification Code Management

The purpose of this section is to provide a method and specific formats to define, identify, and communicate coordinate systems and site locations on substrates for alignment sites, anomaly locations, and other sites used by the ISEM equipment.

R1-1.1 *Classification Codes and Defect Classification* — One function of review equipment is to view previously identified anomalies and to associate a defect classification code with each anomaly. A classification code is an identifier for a classification description.

Typically, the review equipment has a set of defect classification codes and their descriptions available to the operator. Then, for each anomaly, the operator selects a particular code to be associated with that anomaly. This action is defect classification.

The set of valid classification codes and their descriptions may change from one run to another. For example, the same main process program could be used with different substrate levels, and each level may use a different set of classification codes. The purpose of this section is to provide the requirements so that a user can both define several sets of classification codes and their descriptions and can also manage these sets on ISEM equipment.

R1-1.2 *Requirements*

- Each set of classification codes and their descriptions shall have an identifier, known as a classification code set ID.
- Review equipment shall provide a means for the user (the host or the operator) to define a classification code set, consisting of (a) the classification code set ID and (b) the list of classification codes and their descriptions.
- Equipment shall provide a means to manage the various classification code sets.
- A main process program shall include a process program variable that specifies the particular classification code set ID to be used.
- Equipment vendor shall provide documentation to the user regarding how to define and manage classification code sets.

Comment: In one implementation, the equipment considers a classification code set to be a sub-process program or an ISEM table. This would allow the user to identify a classification code set by name (using a PPID) or a table name and thereby managing this sub-process program with the SEMI E30 Process Program Capability or with SEMI E58 ARAMS tables.

R1-2 Reporting Coordinates and Coordinate Systems

The purpose of this section is to provide a method and specific formats to define, identify, and communicate coordinate systems and site locations on substrates for alignment sites, anomaly locations, and other sites used by ISEM equipment.

The ISEM-required formats are intended to minimize the number and type of site location format transformations needing to be supported by both equipment suppliers and users.

All ISEM-required site location formats involve the use of an ISEM-defined right-handed Cartesian coordinate system, established on substrates in an ISEM-defined manner. The scope of the detailed methods in this section are specific to unpatterned and patterned wafers in this release, but the section is intended to be general enough in methodology so that it can be extended to other substrate types in future revisions of ISEM, if required.

The purpose of inspection and review equipment is to locate, evaluate, classify, and report anomalies on substrates. ISEM equipment may deal with either unpatterned or patterned substrates or both. In most cases, the anomaly location is part of the information reported and/or used by ISEM equipment. An anomaly location is reported at a particular site with x,y coordinates in a particular coordinate system. Site coordinates are also used by ISEM equipment for the alignment sites for defining a coordinate system on a substrate. A standard method is needed to define a coordinate system and to report site coordinates for both alignment sites, anomaly locations, and any other reference sites needed by ISEM equipment. A standard method is essential in order to transfer the anomaly site information from one equipment to another.

R1-2.1 *Site Location Accuracy* — Each equipment has an accuracy with which it can define or locate a site as being within a certain area. This area associated with a site is determined by the equipment accuracy, based on the accuracy of its motion and imaging systems to locate a site, as well as on the accuracy with which it can define the coordinate system on the substrate.

When equipment shall locate a particular site on a substrate based on the expected or design-based location, then the location of a site or feature on an actual substrate is further affected by the accuracy of the equipment which placed the pattern on the substrate.

R1-2.2 *Expected or Designed Locations vs. Actual Locations* — The placement of patterns, sites, and coordinate systems is designed to be at certain mathematically described locations relative to one another and to an ideal substrate. These are the expected or designed locations. When a pattern is written by equipment onto a specific substrate, the actual placement of the pattern, the pattern-elements, and their features may differ from the expected locations, due to variations in equipment performance and variations in substrate shape and dimensions.

R1-2.3 *Substrate Coordinate Systems (Unpatterned)* — A substrate coordinate system is a coordinate system which has both origin and axes defined by the shape and dimensions of the substrate and which does not depend on whether there is a pattern on the substrate or whether it is unpatterned. This coordinate system is used to locate or define sites relative to the substrate.

R1-2.4 *Substrate Pattern Coordinate System* — A substrate pattern coordinate system is a coordinate system which has its origin and axes defined by the pattern as a whole on the substrate. This coordinate system is used to locate or to define sites relative to the pattern on the substrate. The expected or designed location of the pattern on the substrate can be defined in terms of the placement of the origin and axes of the substrate pattern coordinate system relative to those of the substrate coordinate system. The actual location of a pattern on a substrate may differ from the expected location. The actual location is determined by locating two or more alignment sites on the patterned substrate. The alignment sites are specific points of certain features in the pattern. The coordinates of the alignment sites are given in the substrate pattern coordinate system. In many cases, equipment does not align to the specific pattern elements but instead uses the defined locations of the pattern elements within the substrate pattern coordinate system.

R1-2.5 *Pattern Element Coordinate System* — A pattern-element coordinate system is a coordinate system which has its origin and axes defined by the pattern of one specific rectangular element in a pattern (a defined arrangement) of equal-sized rectangular elements. This coordinate system is used to locate or to define sites relative to that specific pattern-element. The expected or designed location of the pattern-element within a pattern can be defined in terms of the placement of the origin and axes of the pattern-element coordinate system relative to those of the pattern coordinate system. The actual location of a pattern-element within a pattern on a substrate may differ from the expected location. The actual location is determined by locating two or more alignment sites within the pattern-element. The coordinates of the alignment sites are given in the pattern-element coordinate system.

R1-2.6 *Parallel Coordinate Systems* — A second coordinate system is considered to be parallel to a first coordinate system if the origin of the second can be defined as a translation from the origin of the first and if the axes of the second are parallel and in the same direction as those of the first.

R1-2.7 *Requirements* — The following is a list of requirements for ISEM equipment regarding coordinate systems and reporting site locations:

- ISEM equipment shall document whether it deals with coordinate systems based on (a) a substrate, (b) a substrate pattern, or (c) a pattern-element or whether it deals with several of these coordinate systems.

- ISEM equipment shall establish a substrate coordinate system using a standard, documented method. This coordinate system is not based on any pattern on the substrate. This coordinate system shall be a right-hand Cartesian coordinate system and shall be identified by a name.

  NOTE: For wafers, this method is defined in SEMI M20 (Specification for Establishing a Wafer Coordinate System), and the coordinate system is named “M20.”

- For equipment dealing with substrate pattern coordinates, the substrate pattern coordinate system shall be established in a standard, documented method relative to the substrate coordinate system (the “unpatterned” coordinate system). This substrate pattern coordinate system shall be a right-hand Cartesian coordinate system and shall be designed to be parallel to the substrate coordinate system. The substrate pattern coordinate system shall be identified by a name. The location of its origin and axes relative to the substrate coordinate system shall be communicated in terms of the substrate coordinate system.

  NOTE: For wafers, this method is the one described below, and the substrate pattern coordinate system is named “M20P”, and its origin and axis relative to the SEMI M20 coordinate system are given in terms of “M20” coordinates and are communicated using XlateData.

- For equipment dealing with pattern-element coordinates, the pattern-element coordinate system shall be established in a standard, documented

method relative either to the substrate pattern coordinate system or to another pattern-element coordinate system. The pattern-element coordinate system shall be a right-hand Cartesian coordinate system which is designed to be parallel to the substrate pattern coordinate system. The pattern-element coordinate system shall be identified by a name. The location of its origin and axis relative to the substrate pattern coordinate system shall be communicated in terms of the substrate pattern coordinate system.

NOTE: For wafers, this method is based on SEMI M21, and the coordinate system is named "M21" and its origin and axis relative to the "M20P" coordinate system are given in terms of the M20P coordinates.

- ISEM requires that equipment have the capability to use site location information that is based on the user's product designs, which the user shall provide in the appropriate ISEM-required format.
- ISEM-compliant equipment shall have the capability to define, locate, and report site information using only the ISEM-defined right-handed Cartesian coordinate system formats. This requirement does not preclude equipment from having additional capability for defining or reporting site location information using other formats.
- Coordinate system name and placement relative to the "higher" coordinate system shall be defined and communicated using the following ISEM data items, in terms of either expected or actual placement: CoordSys, XlateData, and their included data items.
- Alignment site information shall be defined and communicated using the following ISEM items: the variable item AlignList, the "ALIGNLIST", the Process program class of "TABLE-ALIGN-DEF", and their included information.
- Areas to be inspected shall be reported using the specific coordinate system defined by the user. The following ISEM items are used to define and communicate area locations: the variable item "AREALIST", the "AREALIST", and the Process program class of "TABLE-AREA-DEF", and their included information.
- The displacement of an actual coordinate system relative to its expected location shall be communicated using the ISEM data item: XlateData and its included data items.
- The displacement of an actual site location relative to its expected site location shall be communicated using the ISEM data item: Offset and its included data items.
- The equipment vendor shall document the requirements for the ISEM data items used in alignment of a coordinate system.
- The equipment vendor shall provide and document a means for the user to define and communicate a pattern map using SEMI M21 data. A pattern map defines the layout of equal-sized rectangular pattern-elements which make up a pattern. Each pattern-element shall have a name, using the SEMI M21 naming convention.

  NOTE: For patterned wafers, the naming method shall be that described in SEMI M21, and the pattern-element information shall be communicated using the ISEM data item of SEMI M21Data.

- For ISEM compliance, inspection equipment shall report various anomaly data; AnomalyID, coordinates, and attributes. Review equipment shall receive this data for anomalies and be able to locate them and perhaps modify the coordinates. Anomaly coordinates shall be reported using ISEM table named "TABLE-ANOMALY-DEF" and its included data.

R1-3 Coordinate System for a Substrate

R1-3.1 *SEMI M20 Coordinate System* — The SEMI M20 standard (Specification for Establishing a Wafer Coordinate System) describes how to map a right-handed Cartesian coordinate system to a substrate so that its origin is at the center of the substrate, and its negative *y*-axis bisects the substrate's primary fiducial. This coordinate system is defined by ISEM to be the "M20" coordinate system. The only information required by equipment in order to establish an "M20" coordinate system is the substrate size and the type of fiducial, which are communicated using the ISEM data items named **SubstrateSize** and **Fiducial**. Another ISEM data item named **Orientation** identifies how the substrate is loaded on the equipment. Note that the SEMI M20 standard requires that the "M20" coordinate system is fixed on the substrate and is not affected by how the substrate is loaded on equipment. Also, as stated in the SEMI M20 standard, an orientation of "0" degrees designates a substrate loaded on equipment, with the primary fiducial towards the operator or "down."

R1-3.2 *M20P Coordinate System* — ISEM defines the M20P coordinate system to be one which is aligned to the pattern on the substrate. The M20P coordinate system is useful because in many cases, it is more significant to the user to know the location of an anomaly relative to the pattern on the substrate rather

than relative to the substrate shape and dimensions. ISEM also defines the M20P coordinate system to be one which is designed to be "parallel" to the SEMI M20 coordinate system. In practice, because of experimental errors, both the origins and the axes may differ slightly from their intended values of a simple translation and no rotation. Equipment should be designed to be able to locate the alignment sites, given the various possible experimental errors.

R1-3.3 *Establishing an M20P Coordinate System* — A minimum of two alignment sites is necessary to establish an M20P coordinate system on a substrate. Additional sites are often used to determine a scaling ratio of the dimensions of the actual coordinate system relative to the dimensions of the expected coordinate system and are reported using the ISEM data item of **ScaleFactor**.

XlateData is used to report actual coordinate system location. Most equipment cannot distinguish whether patterned substrate site location errors are due to the substrate, the layout on the substrate, or the equipment's ability to locate the sites. However, information that is available through the use of patterned-substrate alignment sites can provide a means for identifying potential equipment problems. For instance, assume that the only pattern-layout location error on a substrate is that due to the establishment of the location of the substrate center and fiducial. For many users and equipment systems, this is a good assumption. If this is the case, then the ISEM data item named **XlateData** can be used to track this error. Although the error may result from multiple sources, being able to track it on various equipment will enable users to apply statistical process control techniques to identify the specific sources.

Offset sites may be found by equipment at actual locations which deviate from their expected locations through either pattern layout errors or equipment "stage" or imaging errors. Again, in a controlled manufacturing process, these combined errors should be normally distributed, and non-normal deviations may indicate possible equipment problems. The actual position of a site relative to its expected position shall be reported through the use of the ISEM data item named **Offset**.

R1-4 Layout of Rectangular Pattern Elements on a Substrate Using SEMI M20 Coordinate System

Equipment shall be capable of routine, automated operation without needing substrate layout information (e.g., field or die maps). However, having the capability to provide substrate layout information to equipment from the host can be desirable. ISEM defines a means to do this in this section for substrates, based on SEMI M21 (Specification for Assigning Addresses to Rectangular Elements in a Cartesian Array.) The SEMI M21 standard is limited to defining how to assign "addresses" to elements and how to find the "array center" element. It does not specify how the rectangular pattern-elements are located on the substrate. In this section, ISEM defines how these pattern-elements are located on a substrate, using the data item named M21Data, and how to establish within-element coordinate systems. Any additional layout information, such as within-element structure details or element attribute information, is beyond the scope of ISEM.

R1-4.1 *ISEM "M21" Layouts*

- An "M21" layout consists of an array of equal-sized rectangular pattern-elements with no space between the pattern elements.
- ISEM defines the "M21" layout on a substrate to include all pattern-elements which are either wholly or partially within the circumference of the substrate.
- The ISEM approach is to define the pattern map by specifying the M20P coordinate for the lower left corner of the minimum number of pattern-elements needed to define the layout, along with the pattern-element addresses (names). For a non-tiled layout, the location and name of a single pattern-element is sufficient to establish the "M21" layout. For tiled layouts, the location and name of one pattern-element in each row or column are required. Note that the location of the lower left corner of some pattern-elements may be outside the circumference of the substrate.
- The "M21" pattern-element coordinate system shall have its x and y axes parallel to the respective M20P coordinate system axes and shall have their origins at the lower left corner of each element. The pattern-element coordinate system shall have a name and a specific pattern-element address identifier per SEMI M21.
- Layout definition is supported only for host-to-equipment communications. The user is responsible for ensuring that the pattern-element addresses provided to the equipment agree with the SEMI M21 specification. The equipment need not check this, other than to ensure that there are not conflicts within the provided layout, and shall report results with pattern-element addresses as provided by the user.

- "M21" layouts are established within the M20P coordinate system and need not require any additional alignment site data than is needed to establish the M20P coordinate system. However, as with M20P, additional alignment may be necessary because of errors in either the pattern layout or the equipment's ability to locate features. Offset shall be used to report the location corrections that result from any within-element alignments.

R1-5 How an M20P Coordinate System Is Established on a Substrate

The following example is fairly basic. For this example, the M20P coordinate system has a zero translation from the SEMI M20 coordinate system. Also, the equipment documentation states that 4 alignment sites are required. The equipment does M20P alignment on two alignment sites and does a low resolution and then a high resolution alignment at each site. Note that the specific alignment point is different at the two resolutions, so the coordinates are slightly different. The alignment sites are defined to the equipment via the process program class named "TABLE-ALIGN-DEF", as detailed below. The order of the sites in "TABLE-ALIGN-DEF" is not important. The sites are then selected via the CPNAME named "ALIGNLIST", which is included in the PP-SELECT command. The order of the sites listed in "ALIGNLIST" is important and is as-specified in the equipment's documentation. The first item is the alignment site for the first low resolution site, the second item is for the first high resolution site, the third item is the second low resolution site, and the fourth is the second high resolution site.

"TABLE-ALIGN-DEF"

AlignName	*Coordx*	*Coordy*	*Coordsys*	*Attribute (1)*
Coarse1	-60000	-200	"M20P"	
Fine1	-60020	-205	"M20P"	
Coarse2	+60000	+200	"M20P"	
Fine2	+59980	+195	"M20P"	

"ALIGNNAME"

L,4

1. <Coarse1>
2. <Fine1>
3. <Coarse2>
4. <Fine2>

Using this information, the equipment will go to the nominal "M20" location for Coarse1, then "find" where it actually is. The offset between the nominal "M20" location and the actual "M20" location is then used to "find" Fine1. The actual M20 location of Fine1 is saved. The process is then repeated for Coarse2 and Fine2. The equipment can now determine the "M20" to M20P offset from the nominal and actual coordinates. First, a summary of the data:

xN1 = -60020	yN1 = -205	Nominal *x* and *y* data for the first fine site
xA1 = -59800	yA1 = -150	Actual *x* and y data for the first fine site
xN2 = +59980	yN2 = +195	Nominal *x* and *y* data for the second fine site
xA2 = +60060	yA2 = +175	Actual *x* and *y* data for the second fine site

The equipment first calculates Theta, using, for example, the formula:

$$\Theta = tan^{-1}\ \frac{MA - MN}{1 + MA\ \ MN}$$

where *MA* and *MN* are, respectively, the slopes of the lines connecting the two actual fine sites and the line connecting the two nominal sites, in "M20" coordinates, calculated as follows:

$$MA = \left| \frac{yA_2 - yA_1}{xA_2 - xA_1} \right| \quad MN = \left\lceil \frac{yN_2 - yN_1}{xN_2 - xN_1} \right\rceil$$

The equipment then calculates *DeltaX* and *DeltaY*, using, for example, the formulas:

$$DeltaX = \left| \frac{C\sin(\Theta) + D\cos(\Theta)}{(\sin(\Theta))^2 + (\cos(\Theta))^2} \right|$$

$$DeltaY = \left\lceil \frac{C\sin(\Theta) - D\cos(\Theta)}{(\sin(\Theta))^2 + (\cos(\Theta))^2} \right\rceil$$

where *C* and *D*, the adjusted site 1 coordinates in a rotation-adjusted coordinate system, are calculated, for example, using the formulas:

$$C = yA1 - ((xN1\ \sin\Theta) + ((yN1\ \cos\Theta)$$

$$D = xA1 - ((xN1\ \cos\Theta) - ((yN1\ \sin\Theta)$$

The equipment can also calculate a ScaleFactor term to indicate the relative ratio between the length of the vector connecting the nominal alignment sites and the length of the vector connecting the actual alignment sites. This can be used, for example, to judge whether there is a problem with the alignment process, since the difference between these two vectors should be small.

$$ScaleFactor = \frac{VA}{VN}$$

where *VA* and *VN* are the length of the vectors connecting the actual and nominal alignment sites, calculated using the formulas:

$$VN = \sqrt{(yN_2 - yN_1)^2 + (xN_2 - xN_1)^2}$$

$$VA = \sqrt{(yA_2 - yA_1)^2 + (xA_2 - xA_1)^2}$$

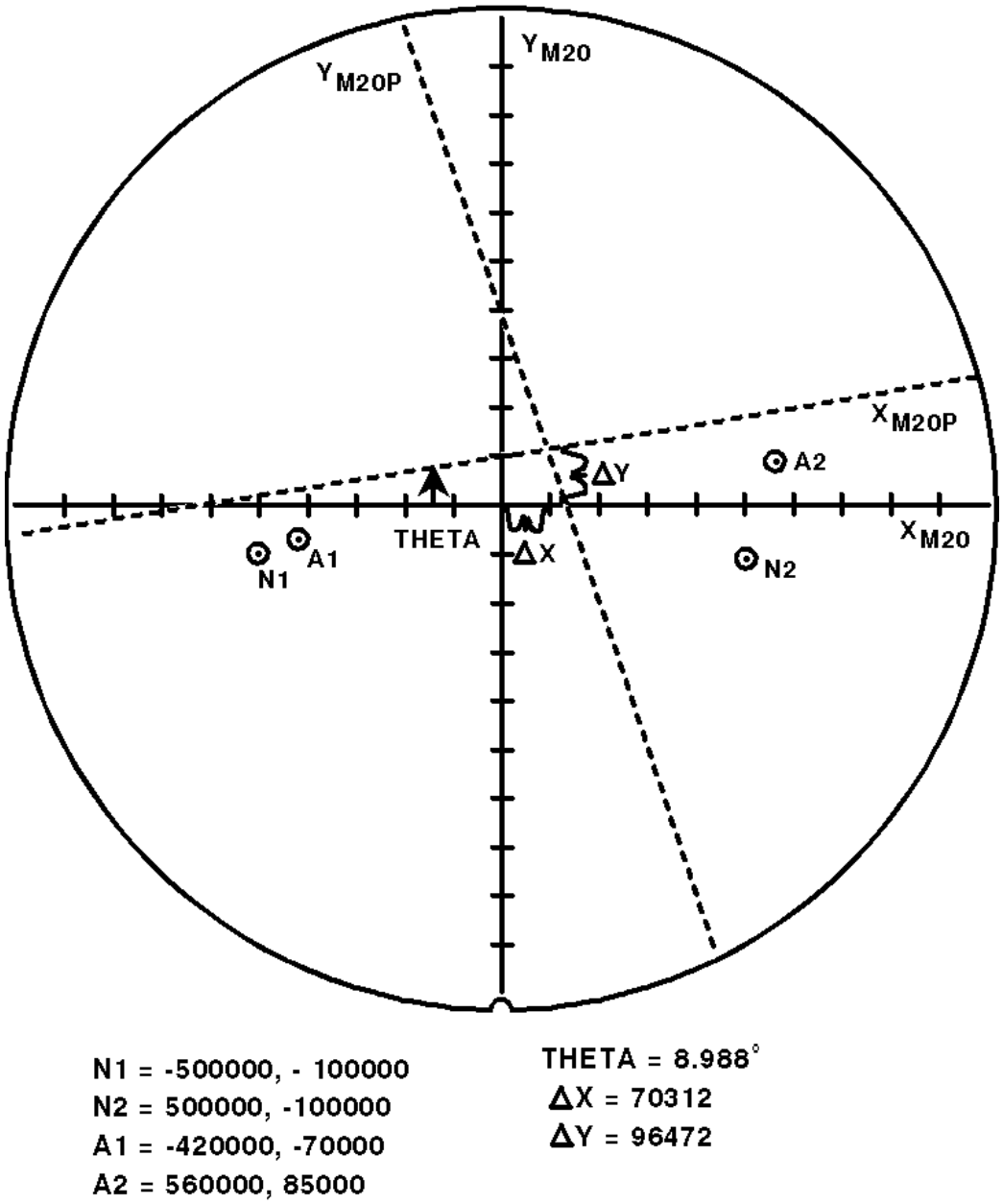

Figure 7
Review Data Management

RELATED INFORMATION 2
APPLICATION NOTES

NOTE: The material contained in these Application Notes is not an official part of SEMI E30.1 and is not intended to modify or supersede the official standard. Rather, these notes describe possible methods for implementing certain ISEM requirements described by the standard and are included as reference material.

R2-1 Using ISEM Table Attributes to Specify Process Related Data Item Variable Values

R2-1.1 Section 11.1 (ISEM Table Data) allows the host to use ISEM Table attributes to specify product and process related information related to the table data. The ISEM Variable Item Dictionary (Table 4) includes seven data items intended to be used for this purpose. They are identified with the comment "This information may be added by the host in the ISEM Tables." Identifying the value of variable data items in Table attributes is not covered in use of ISEM Tables. One method to accomplish this is to use attribute identifiers (ATTRID*n*) that are the same identifiers that are used for the equipment variable data items (Table R2-1). (This is very similar to the method specified in Section 12.5 to identify values to override the default values of variable process program parameters using the "PP-SELECT" remote commands).

Table R2-1 ISEM Variable Items and Their Equivalent ISEM Table Attribute Identifiers

Variable Item (Table 4)		*ISEM Table Attribute Identifier*	*Description*
Name	*Type*		
OperatorID	DV	OperatorID	Identification of the operator of the inspection/review equipment.
ProcessEquipmentID	DV	ProcessEquipmentID	Identification of the process equipment used with the current material immediately prior to the inspection/review.
ProcessEquipmentLocation	DV	ProcessEquipmentLocation	Location (code) of the process equipment used with the current material immediately prior to the inspection/review.
ProcessProgramID	DV	ProcessProgramID	Identification of the process program used with the process equipment used on the current material immediately prior to the inspection/review.
ProcessLevel	DV	ProcessLevel	Identification of the processing level of the current material.
ProductID	DV	ProductID	The product identification of the current material inspected/reviewed.
ProcessRunID	DV	ProcessRunID	Run identification for the process prior to current inspection/review.

NOTE 1: The variable item may be identified using any appropriate SECS II data item format.

R2-2 Example ISEM Table with Item Attributes That Specify ISEM Variable Values Using S13,F13 Table Data Send

R2-2.1 Typical values for Data Items are indicated.

L, 8

1. <DATAID>
2. <OBJSPEC=null>
3. <TBLTYP=DefectData>
4. <TBLID=null>
5. <TBLCMD=1>

6. L, 2
    1. L, 2
        1. <ATTRID= “ProcessProgramID”>
        2. <ATTRDATA= “My Recipe”>
    2. L, 2
        1. <ATTRID= “ProcessLevel”>
        2. <ATTRDATA= “My Level”>
7. L, c
    1. <COLHDR1= “Insp_Anomaly ID”>
    2. <COLHDR2= “Insp_Table specifier”>
    3. <COLHDR3= “Insp_Coordinate X”
    4. <COLHDR4= “Insp_Coordinate Y”
    : // etc…as defined by Table 11.3.5
    c. <COLHDRc>
8. L, r
    1. L, c
        1. <TBLELT11> // A[1..16]
        2. <TBLELT12> // I4
        3. <TBLELT13> // I4
        4. ETC…
        :
        c. <TBLELT1c> // A
    :
    r. L, c
        1. <TBLELTr1>
        :
        c. <TBLELTrc>