SEMI E30.1-0217 (Reapproved 0423)
SPECIFICATION FOR INSPECTION AND REVIEW SPECIFIC EQUIPMENT MODEL (ISEM)

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NOTICE: Paragraphs entitled 'NOTE:' are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

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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.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other 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 and Documents

4.1 *SEMI Standards and Safety Guidelines*

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 Selected-Session Mode (HSMS-SS)

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

SEMI M20 — Practice for Establishing a Wafer Coordinate System

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

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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 1: 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 subunit. (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.

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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 F1241-89]

5.2.28 *mask* — a selective barrier to the passage of radiation.

5.2.28.1 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 (n.)* — the material processed during the EXECUTING state.

5.2.42 *run (v.)* — 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.

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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.

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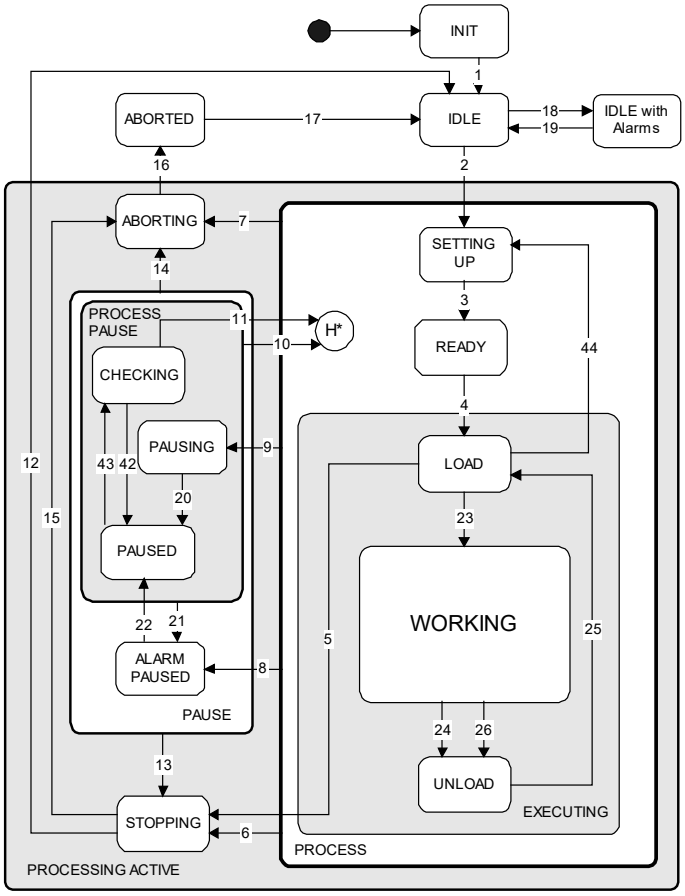

Figure 1
Generic ISEM Processing State Model Diagram

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.

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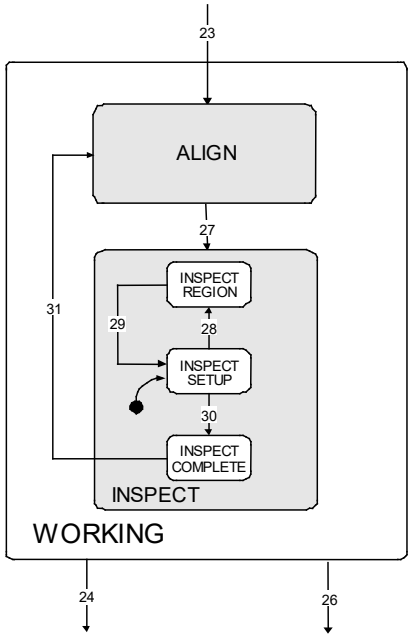

Figure 2
Working State for Inspection Equipment

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.

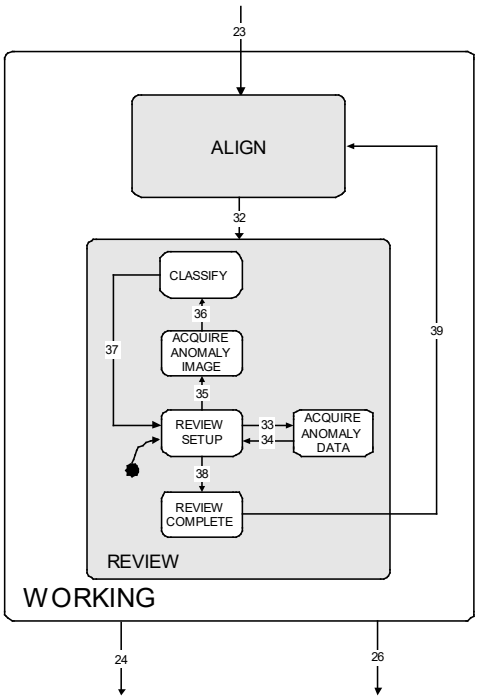

Figure 3
Working State for Review Equipment

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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.

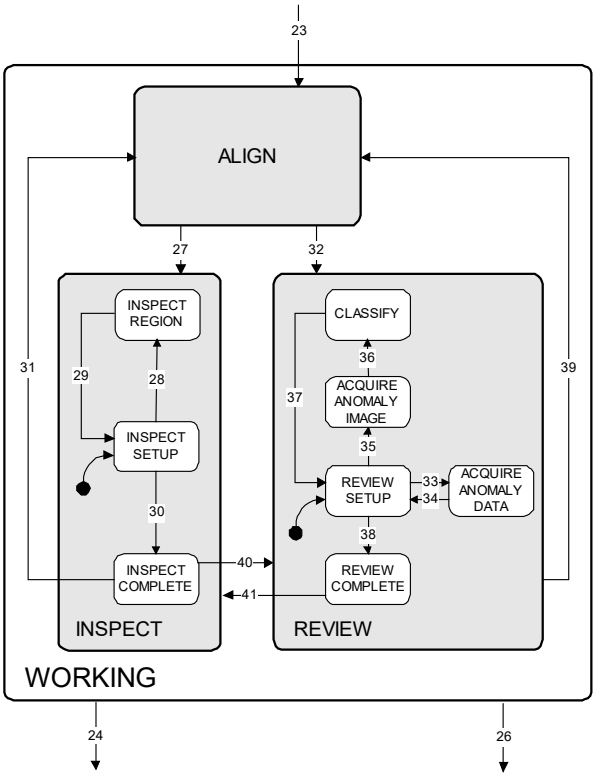

Figure 4
Working State for Inspection and Review Equipment

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 Substate)* — 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 Substate)* — Data is being acquired about anomaly locations.

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

7.3.5 *ALARM PAUSED (PAUSE Substate)* — 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 Substate)* — 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 Substate)* — 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.

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

7.3.9 *EXECUTING (PROCESS Substate)* — 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 Substate)* — The current alignment area of the substrate is being inspected for anomalies.

7.3.14 *INSPECT COMPLETE (INSPECT Substate)* — 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 Substate)* — The equipment is in this substate 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 Substate)* — 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 Substate)* — 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 Substate)* — PROCESS has been suspended, and the equipment is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT).

7.3.20 *PAUSING (PROCESS PAUSE Substate)* — 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 Substate)* — This state is the parent of those substates which refer to the active preparation and execution of a process program.

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

7.3.23 *PROCESS PAUSE (PAUSE Substate)* — 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 Substate)* — The equipment is ready to begin processing and is awaiting a START command from the operator or host.

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

7.3.26 *REVIEW COMPLETE (REVIEW Substate)* — 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 Substate)* — The equipment is in this substate 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.

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7.3.28 *SETTING UP (PROCESS Substate)* — 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 Substate)* — 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 Substate)* — The substrate is being removed from the processing location.

7.3.31 *WORKING (EXECUTING Substate)* — 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 an 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.

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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 Substate.
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 Substate.	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 an 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.

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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 Substate 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 Substate of REVIEW.

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Transition #	*Previous State*	*Trigger*	*New State*	*Actions*	*Comments*
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.
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 Substate 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 Substate 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'. Refer to § 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

8.1 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.

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8.2 *Requirements*

8.2.1 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.

8.2.2 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.

8.2.3 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

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

9 Variable Items

9.1 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.

9.1.1 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.

9.2 *Requirements*

- All variable items and data item restrictions defined in SEMI E30 are required on ISEM equipment.

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- 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.

9.2.1 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.

9.3 *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.

9.3.1 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.

9.4 *Variable Item Types*

9.4.1 *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.

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9.4.2 *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.

9.4.3 *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.

9.5 Variable Item Dictionary

9.5.1 *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 § 9.3, 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]	

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