Trebor International, Inc.
DI Water Heater Series
Quantum NXT

May 10, 2019

Evaluated to:
SEMI S2-0715 Product Safety Assessment
SEMI S8-0915 Ergonomic Assessment
SEMI S14-0309 Fire Risk Assessment

Final Report

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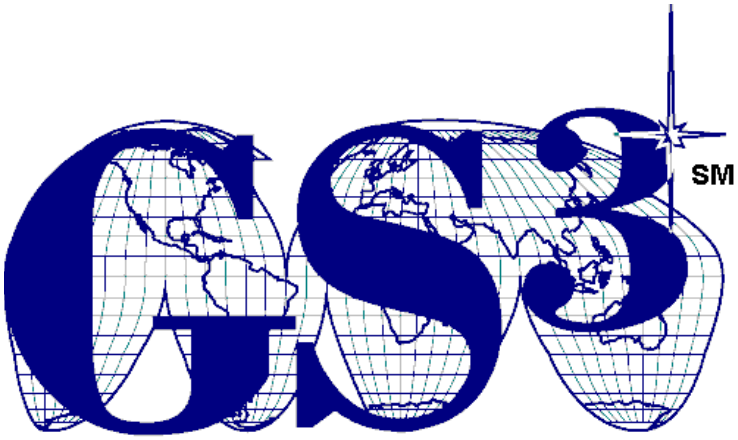

Prepared for:
Trebor International, Inc.
8100 S 1300 W
West Jordan, UT 84088
USA

Prepared by:
Intertek Testing Services NA
1365 Adams Court
Menlo Park, CA 94025
USA

Client - Confidential

The information used to prepare this report was based on interviews with the engineers of Trebor International, Inc. This report's significance is subject to the adequacy and representative characteristics of the system evaluated, and to the comprehensiveness of the tests, examinations, and / or surveys made. Trebor International, Inc. represents that all information supplied by it or its agents to Intertek is accurate and complete. In addition, Trebor International, Inc. acknowledges that Intertek is relying upon such information in the preparation of this report without further verification by Intertek as to the accuracy or completeness of such information. The service performed has been conducted in accordance with the standards currently accepted in the profession, and at the high level of skill and care exercised by the staff of Intertek.

This report has been prepared as a Client-Confidential document in accordance with all terms of the agreement between Trebor International, Inc. and Intertek pertaining to this report. This report is intended for the exclusive use of Trebor International, Inc. and for the purpose of documenting the conformance of the Trebor International, Inc. system to SEMI S2-0715. As the contents of this report may contain company confidential information, no outside distribution will occur unless written authorization is provided by Trebor International.

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SECTION 1.0 MANAGEMENT SUMMARY

Intertek Testing Services NA, Inc., (hereafter referred to as Intertek), a Nationally Recognized Testing Laboratory accredited by OSHA, was contracted by Trebor International, Inc. (hereafter referred to as Trebor or as Trebor International) to conduct a SEMI S2-0715 Product Safety Assessment of the Trebor DI Water Heater Series models Quantum NXT (hereafter referred to as Quantum NXT Series or QNXT) from October 10, 2016 through October 11, 2016.

The assessment was conducted in accordance with the applicable requirements of the most current version of SEMI Guidelines as referenced in SEMI S2-0715, Section 4. Any other SEMI Guidelines, codes or standards used during the evaluation are specifically noted in the applicable sections of this report.

Intertek (formerly Global Semiconductor Safety Services - GS^3) is a third party evaluator with extensive experience in evaluating semiconductor equipment. This experience is based upon having performed numerous third party evaluations for semiconductor equipment for all versions of SEMI S2 since its inception as SEMI S2-91 and all versions of SEMI S8, S14, and other related SEMI documents. These evaluations have addressed all aspects of the SEMI S2-0715 Guideline except as specifically excluded within the scope of the evaluation and have been performed for all phases of the semiconductor manufacturing process. Personnel involved in performing the S2-0715 evaluations for Intertek meet the qualifications identified in SEMI S7.

The original assessment was performed by Mr. Ronald Wellman of Intertek and reviewed by Mr. Steve Baldwin, also of Intertek. This evaluation was based on discussions with Mr. Cory Shorr of Trebor International, a physical inspection of a sample of the system and a review of system documentation including schematics, drawings, and operation and maintenance manuals. In addition, Intertek performed a “What If?” Hazard Assessment, SEMI S14 Fire Risk Assessment, and a SEMI S8/SESC ergonomic evaluation. During the evaluation, certain items were found to be missing from the supplied manuals and documentation. Those items were identified in Intertek Findings Letter, 102732084MPK-002, dated October 18, 2016.

On March 24, 2017, Trebor International provided revised manuals and documentation to address the issues identified in the previously referenced Findings Letter. The revised manuals and documentation provided were evaluated and integrated into this Report by Mr. Steve Baldwin of Intertek and reviewed by Mr. Lawrence Todd, also of Intertek.

On February 11-14, 2019, Intertek evaluated additional models in the Trebor International Quantum NXT, each with a 208VAC input rating. Trebor International provided additional manuals and documentation to address these additions. The additional models were represented by the QNXT080V208E1F model, which was the largest power model of the new additions. These models were evaluated and integrated into this Report by Mr. Allan Cose of Intertek and reviewed by Mr. Lawrence Todd, also of Intertek.

On April 25, 2019, Trebor International requested to add a booster pump to the output port of the Quantum NXT. Upon investigation limited testing was required to accept the integration of this pump into the system at large. Trebor International provided documentation to support this change. On May 9, 2019 Mr. Daron Bell of Intertek evaluated the Rev6 pump (Based on the Levitronix BPS-300 pump system) for abnormal temperature test and input test.

A complete description of the scope of this evaluation is provided in Section 2.0 of this report.

The results of the comprehensive safety assessment of the Quantum NXT identified that the equipment fully conforms to the requirements of the SEMI S2-0715 Guideline. This is described in the body of this report.

CONCLUSION

A sample of the Trebor International Quantum NXT has been evaluated in accordance with the applicable requirements of the *Environmental Health and Safety Guideline for Semiconductor Manufacturing Equipment,* SEMI S2-0715 Guideline.

The safety assessment revealed that the system is in full conformance to the applicable requirements in SEMI S2-0715.

Evaluation Leader:

Steve Baldwin
Staff Engineer

Reviewed by:

Lawrence E. Todd
Chief Engineer, Electrical

2019-05-10 Evaluation Leader:

Daron Bell
Project Engineer

Reviewed by:

Steve Baldwin
Staff Engineer

SECTION 2.0 SCOPE OF EVALUATION

The criteria for this evaluation were based upon the Semiconductor Equipment and Materials International SEMI S2-0715 Guideline. The Guideline is intended as a set of performance-based environmental, health, and safety (EHS) considerations for semiconductor manufacturing equipment. Note that it is not the philosophy of the SEMI S2-0715 Guideline to provide all of the detailed EHS design criteria that may be applied to semiconductor manufacturing equipment. The Guideline provides industry-specific criteria, and refers to some of the many international codes, regulations, standards, and specifications that should be considered when designing semiconductor manufacturing equipment. This evaluation report only addresses the conformance of the system design to the specific criteria in the SEMI S2-0715 Guideline and does not purport to document conformance to other standards, guidelines or criteria except where it is specifically indicated in the report.

As specified in the S2-0715 Guideline, this evaluation report only includes the manuals (Section 9.6) and the design-specific paragraphs (Sections 10 through 27) of the SEMI S2-0715 Guideline. The Appendices have been used in the evaluation, and referenced in the report, only as they pertain to the specific requirement.

For each numbered paragraph, an assessment to the requirement is provided, based on visual verification of the system and or documentation provided by the equipment supplier to demonstrate conformance. In addition, supporting engineering rationale is provided to explain each assessment. Each assessment is classified based on the categories defined below and which are specified and defined in SEMI S2-0715 Paragraphs 8.3.1 through 8.3.5.

CONFORMS TO THE STATED CRITERIA
The equipment aspects to which the paragraph pertains match the criteria stated in the text of the paragraph. The supporting rationale for “Conforms to the Stated Criteria” include a description of the equipment aspects, and the objective information demonstrating the conformance of each to the criteria (e.g., testing, measurements, observation).

CONFORMS TO THE PERFORMANCE GOAL
The equipment aspects to which the paragraph pertains do not match the stated criteria, but they do meet the performance goal of the paragraph and they present a Low or Very Low Risk according to the risk assessment method of SEMI S10. The supporting rationale for “Conforms to the Performance Goal” includes:

A description of the equipment aspects,
and, to support the conclusion of meeting the performance goal;

- a statement of the performance goal as it is understood by the evaluator,
- the logical argument which demonstrates the performance goal has been met,
- the objective evidence used to support the argument, and
- bibliographic information for references made in the argument (e.g., document title, website, reference number, author, publication date, revision).

and, to support the risk assessment;

- the specific hazards presented by the equipment aspects,

- the scenarios in which the hazards are foreseen to cause harm,
- the harm foreseen in each scenario, and
- the severity and likelihood analyses for each scenario.

If a standard is used in whole or in part to support the performance goal argument, the supporting rationale include information demonstrating why the standard is applicable, the section or sections used for the evaluation, and why the sections are relevant. For the purpose of this paragraph, a standard is applicable if the equipment aspect under consideration is properly within scope, and the sections are relevant if they contain criteria having demonstrable bearing to the equipment aspects (e.g., addressing similar design considerations).

However, those issues that result in a Low or Very Low overall risk, but have a Severity level of Catastrophic or Severe or if the issue is a code requirement and may impact field labeling conformance, the issue will be identified as Does Not Conform with the appropriate risk rank.

DOES NOT CONFORM
The system does not conform to the subsection to the stated criteria and does not conform to the performance goal; or there is insufficient information available to reach a conclusion for these or the "N/A" finding. The supporting rational for this finding include a description of the non-conforming equipment aspect(s), a description of the non-conforming characteristics, and a determination per SEMI S10 of the associated risk (as Very High, High, or Medium risks based on the example risk assessment matrix in SEMI S10); or a description of the information needed to reach a conclusion for one of the conformance findings or the "N/A" finding; as appropriate.

NOT APPLICABLE
Indicates the requirements to the paragraph are not applicable to the system.

INFORMATION REQUIRED
Indicates issues that adequate information to ensure conformance to the specified criteria was not provided during the evaluation. Additional information is required in order to adequately determine conformance.

RESPONDED
Indicates issues that were identified as *Does Not Conform* or *Information Required* as defined by SEMI S2-0715, Paragraph 8.3.1, at the time of the original investigation. The equipment manufacturer has proposed changes in the equipment, as required by SEMI S2-0715, Paragraph 9.2.1, that will adequately address the issues identified, and has committed to a date by which these changes will be fully implemented; however, these corrections have not been visually verified by Intertek.

ADDRESSED
Indicates the paragraph is more appropriately discussed in detail in another paragraph. The paragraph to which this issue is discussed is cited for reference.

REFERENCE ONLY
Those paragraphs of the Guideline that provide definitions, philosophy, or intent are indicated as *Reference Only*. There are no specific requirements designated by these paragraphs. All sections of this type are marked *Reference Only*.

SECTION 2.1 SYSTEM SCOPE

Intertek was contracted by Trebor to evaluate the Quantum NXT Series to the requirements of SEMI S2-0715. Intertek evaluated a sample of the Quantum NXT Series at the Trebor facility in West Jordan, Utah, from October 10, 2016 through October 11, 2016. The system is intended to be a stand-alone system to supply heated DI water to a host system. Note that issues related to the installation of the Quantum NXT Series in a specific facility are not covered by this report.

The following Quantum NXT Series models are covered by this report:

CHART 1: CIRCUIT BREAKER SIZE (400VAC-480VAC)						
	VOLTAGE	Power	CURRENT DRAW	MCB	# OF MODULES	POWER PER MODULE
QNXT030V400xxx	400VAC	30kW	44A	60A	2	15kW
QNXT036V480xxx	480VAC	36kW	44A	60A	2	18kW
QNXT060V480xxx	480VAC	60kW	73A	100A	4	18kW
QNXT060V400xxx	400VAC	60kW	87A	125A	4	15Kw
QNXT072V480xxx	480VAC	72kW	87A	125A	4	18kW
QNXT090V400xxx	400VAC	90kW	131A	175A	6	15kW
QNXT108V480xxx	480VAC	108kW	131A	175A	6	18kW
QNXT120V400xxx	400VAC	120kW	174A	225A	8	15kW
QNXT144V480xxx	480VAC	144kW	174A	225A	8	18kW

The sample that was provided for evaluation (QTM2144V480A00) was fully configured with the following assemblies:

- 8 x 18kW 480VAC heating modules, 144kW total, 2 modules per bank with 4 banks total

As part of Intertek's comprehensive evaluation of the Quantum NXT Series the following integration aspects were evaluated:

- Interlocks (evaluation of the interlock circuit and functional testing)
- EMO (evaluation of the EMO circuit and functional testing)
- Ergonomic access

On February 11-14, 2019, Intertek evaluated the following models in the Trebor International Quantum NXT, each with a 208VAC input rating. Trebor International provided additional manuals and documentation to address these additions. The additional models were represented by the QNXT080V208E1F model, which was the largest power (80kW) model of the new additions.

The following additional Quantum NXT Series models are covered by this report:

CHART 2: CIRCUIT BREAKER SIZE (208VAC)						
	VOLTAGE	Power	CURRENT DRAW	MCB	# OF MODULES	POWER PER MODULE
QNXT020V208xxx	208VAC	20kW	65A	100A	2	10kW
QNXT040V208xxx	208VAC	40kW	125A	175A	4	10kW
QNXT060V208xxx	208VAC	60kW	185A	225A	6	10kW
QNXT080V208xxx	208VAC	80kW	245A	400AF	8	10kW

The sample that was provided for evaluation (QNXT080V208E1F, S/N QNXT40009) was fully configured with the following assemblies:

- 8 x 10kW 208VAC heating modules, 80kW total, 2 modules per bank with 4 banks total

Model numbers in the QNXT series are determined using the following information.

The first four characters indicatge the model series: QNXT
The next three characters indicate the power level in kW
Available options in the 208V range are 020, 040, 060, and 080
The eighth character is always “V”
The next three characters indicate the voltage rating: 208, 400, or 480
The twelfth character is either “E”, “S”, “D”, “A”, or “C” and indicate the communication style
E: STD ENET;
S: Add SERIAL;
D: Add DIGITAL I/O;
A: Add Serial & Digital I/O;
C: custom
The thirteenth character indicates the number of DIW outlets: 1, 2, 3, 4, or C (for custom)
The final character indicates the option of feet/seismic characteristic
F: Std feet
L: Leveling casters
S: Seismic bracket (feet)
B: Seismic bracket (casters)
C: custom

On April 10, 2019, Trebor International requested to add a Rev6 Booster Pump to the output of the Quantum NXT to increase output pressure. The Rev6 is based off the Levitronix BPS-600 IEC Certified pump, with the exception of a modified upper interface. In order to ensure the addition of this component falls within compliance to SEMI S2, limited testing was performed at the Trebor site in West Jordan, Utah to evaluate the pump’s current draw on the system, as well as single fault testing to verify the pump does not fault to a non-compliant state.

A complete description of the system evaluated, including the assemblies configured as detailed above, is provided in Section 3.0 Equipment Description.

SECTION 2.2 DOCUMENTS REVIEWED

This SEMI S2-0715 assessment included a review of the following documents provided by Trebor International for the Quantum NXT. The documents listed were reviewed for content, and are identified by issue or revision date as noted below:

SECTION 2.2.1 MANUALS REVIEWED

- Trebor Quantum NXT DI Water Heater, Operation / Maintenance Manual, QUANTUMNXT, rev. March 2017.

- Trebor, QNXT Option 00, 120kW - 144kW 400-480V DI Water Heater, Appendix to Manual, revised October 2016.

On February 14, 2019, as part of the 208V models evaluation, Intertek reviewed the following manuals provided by Trebor International.

- Trebor Quantum NXT DI Water Heater, Operation / Maintenance Manual, MQNXT-A(B), rev. 08/18
- Trebor QNXT Option 00, 80kW 208V DI Water Heater, Appendix to Manual, MAQNXTB4-A, rev. 02/19

On May 9, 2019, as part of addressing previously found non-conformances, Intertek reviewed the following manuals provided by Trebor International.

- Trebor Quantum NXT DI Water Heater, Operation / Maintenance Manual, MQNXT-C, rev. 05/19

SECTION 2.2.2 REPORTS REVIEWED

- Trebor Test Report, Resulting Forces on QNXT Heater Cabinet from Seismic Event, TR0923, March 9, 2017.

- Trebor Test Report, QNXT144 Center of Gravity, TR0922, March 9, 2017.

On February 14, 2019, as part of the 208V models evaluation, Intertek reviewed the following reports provided by Trebor International.

- Trebor Test Report, Resulting Forces on QNXT Heater Cabinet from Seismic Event, TR0923b, dated 2/13/19
- Trebor Test Report, QNXT080 Center of Gravity, TR0922b, dated 2/13/19

SECTION 2.2.3 DRAWINGS AND DOCUMENTS REVIEWED

- ELEC SCHEMATIC, 144kW, Rev. 1

On February 14, 2019, as part of the 208V models evaluation, Intertek reviewed the following documents provided by Trebor International.

- Trebor PNS – QuantumNXT DI Water Heater, dated 1/22/15
- QuantumNXT Critical Component List, provided 2/11/2019

SECTION 2.3 ERGONOMIC ANALYSIS

The criteria for this evaluation were based upon the SEMI S8 Ergonomic Engineering Guidelines. SEMI S8 Guidelines are performance-based guidelines designed to promote compatibility between the user and the equipment in the manufacturing environment. These are accomplished by integrating three basic design principles into the equipment.

- Optimization of safety and equipment performance by distributing tasks among hardware, software, and the users to make the best use of each respective capability and to minimize limitations and hazards,
- System design to minimize potential errors and mishaps by conforming to user's expectations,
- System design to reduce fatigue and injury by fitting the equipment to the expected body size, strength, and range of motion characteristics of the user population.

In order to verify conformance with SEMI S8 Ergonomic Criteria, a Suppliers Ergonomic Success Criteria (SESC) checklist was completed for the system. It was determined that a Manual Material Handling (MMH) analysis was not necessary. All components in the system do not require lifting operations during normal operation, maintenance or service. The SESC Checklist results are provided in Attachment Five, Intertek SESC Checklist

During the evaluation, Intertek performed a review of operational, maintenance and service tasks for the system. This review was based upon discussions with personnel familiar with the tasks to be performed on the system. A review of the maintenance and service manuals for the system was performed as part of the ergonomic evaluation. The list of tasks evaluated is provided below.

The review of these tasks included the consideration that operators or maintenance personnel may perform tasks on multiple pieces of equipment under the control of one individual that may result in the task being repeated several times sequentially. The criteria Intertek used to perform this ergonomic evaluation, as based on information provided by Trebor, is that one system can be reasonably expected to be installed in a single area and may be operated or maintained by a single person.

The reference point for all of the vertical measurements taken during this evaluation was at the height of 2 in. as measured from the floor to the bottom of the frame. All measurements made during the evaluation were based upon the system mounted at this height. The system was mounted on adjustable feet and Trebor provides the installed heights in the installation manuals.

The tasks evaluated during this evaluation were the following:

<u>Operation Tasks</u>

- Operation of Main Breaker Power Switch by Rotation
- Turning On and Off Liquid Supply Lines
- Depressing Buttons on the Touch Screen
- No product loading is required by the system.

Maintenance / Service Tasks

- Remove/Test/Replace Heating Modules

SECTION 2.4 FIRE RISK ASSESSMENT

A fire protection risk assessment was performed by Intertek on the Trebor International Quantum NXT on October 11, 2016, at the Trebor International facility in West Jordan, UT. The system scope and description is provided in the Sections 2.0 and 3.0 of this SEMI S2-0715 report. The findings from the fire risk assessment / evaluation are presented in Attachment Three, Intertek Fire Risk Assessment Summary Report.

This fire risk assessment was performed using the criteria established by the Semiconductor Equipment and Materials International, *Safety Guidelines for Fire Risk and Mitigation for Semiconductor Manufacturing Equipment* (SEMI S14 Guidelines) and criteria in SEMI S2-0715, Section 14 Fire Protection.

As specified by SEMI S14, the fire risk assessment addressed design issues related to fires which originate inside of the system under normal conditions or reasonably foreseeable (abnormal) single point failure conditions. It did not address issues associated with fires which originate outside of the system, nor abnormal conditions that require more than one failure.

The assessment considered potential thermal and non-thermal hazards (e.g., smoke) resulting in property damage or loss of use of the equipment or of the facility. In addition, as specified by SEMI S2, the fire risk assessment also included the potential hazards to human exposure resulting from fire or smoke.

The evaluation was based upon information provided by Trebor International and a visual inspection of the system. The information provided by Trebor International included technical information regarding the fire ratings of the components and assemblies that may be potential fuel sources. The fuel sources considered include the materials of construction and the baseline process and maintenance materials established in Sections 2.0 and 3.0 of this report. Testing of the system or individual materials was not performed as part of the evaluation.

SECTION 2.5 STANDARDS USED

The assessment was conducted in accordance with the applicable requirements of the most current version of the following SEMI Guidelines as referenced in SEMI S2-0715, Section 4. Any other SEMI Guidelines, codes or standards used during the evaluation are specifically noted in the applicable sections of this report.

- SEMI S1, Safety Guideline for Equipment Safety Labels
- SEMI S2, Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment
- SEMI S7, Safety Guidelines for Environmental, Safety, and Health (ESH) Evaluation of Semiconductor Manufacturing Equipment
- SEMI S8, Safety Guidelines for Ergonomics Engineering of Semiconductor Manufacturing Equipment
- SEMI S10, Safety Guideline for Risk Assessment and Risk Evaluation Process
- SEMI S13, Environmental, Health and Safety Guideline for Documents Provided to the Equipment User for Use with Semiconductor Manufacturing Equipment
- SEMI S14, Safety Guidelines for Fire Risk Assessment and Mitigation for Semiconductor Manufacturing Equipment
- SEMI S22, Safety Guideline for the Electrical Design of Semiconductor Manufacturing Equipment

Note: Any other SEMI S2 Guidelines, codes or standards used during the evaluation are specifically noted in the applicable sections of this report.

SECTION 3.0 SYSTEM DESCRIPTION

Trebor's Quantum NXT Series Deionized (DI) water heater provides modular heating of DI water for a host system. The water heater is available in various power configurations to address water heating demand for the host system. The water heater uses a revolutionary heating technology to provide exceptional process purity and control. Heat is generated using resistive heating elements conducted to the fluid through quartz tubes using convective heat transfer. This conductive / convective heating method allows the heating element to operate at a much cooler temperature than IR heating systems and provides the basis for a responsive heating control system.

On February 11-14, 2019, Intertek added 208VAC input models in the Trebor International Quantum NXT. Trebor International provided additional manuals and documentation to address these additions. The additional models were represented by the QNXT080V208E1F model, S/N QNXT40009, which was the largest power model of the new additions and is documented below.

On May 10, 2019, Intertek added the Rev6 Booster Pump as a valid component for implantation in the Quantum NXT family of systems. Input and temperature testing was performed as a part of this evaluation, and included in Attachment Eleven, Input Test Data Sheet and Attachment Twelve, Temperature Test Data Sheet.

Reference Section 2.0 of this report for a discussion regarding the scope of this SEMI S2-0715 evaluation.

Facilities Requirements 400-480 VAC models:

Floor Space: 800 mm (W) x 503 mm (D) x 1746 mm (H)

Electrical Power: 480 VAC; 225A; 50/60Hz; 3 Phase; 3 wires plus ground

Facility External Fluids and Gases:

Fluid/Gas	Pressure
Compressed Air	65-80 psig
N2	65-80 psig
Cold DI Water In	15-60 psig
Hot DI Water Out	15 psig

Facility Exhaust

Exhaust	Flow	Pressure
N/A	-	-

480V Nameplate

208V Nameplate

Facilities Requirements 208VAC models:

Floor Space: 711 mm (W) x 686 mm (D) with fittings x 1915 mm (H) with eye bolts, system on temporary casters [1887 mm (H) on feet per dwg]

Electrical Power: 208 VAC; 245A; 50/60Hz; 3 Phase; 3 wires plus ground

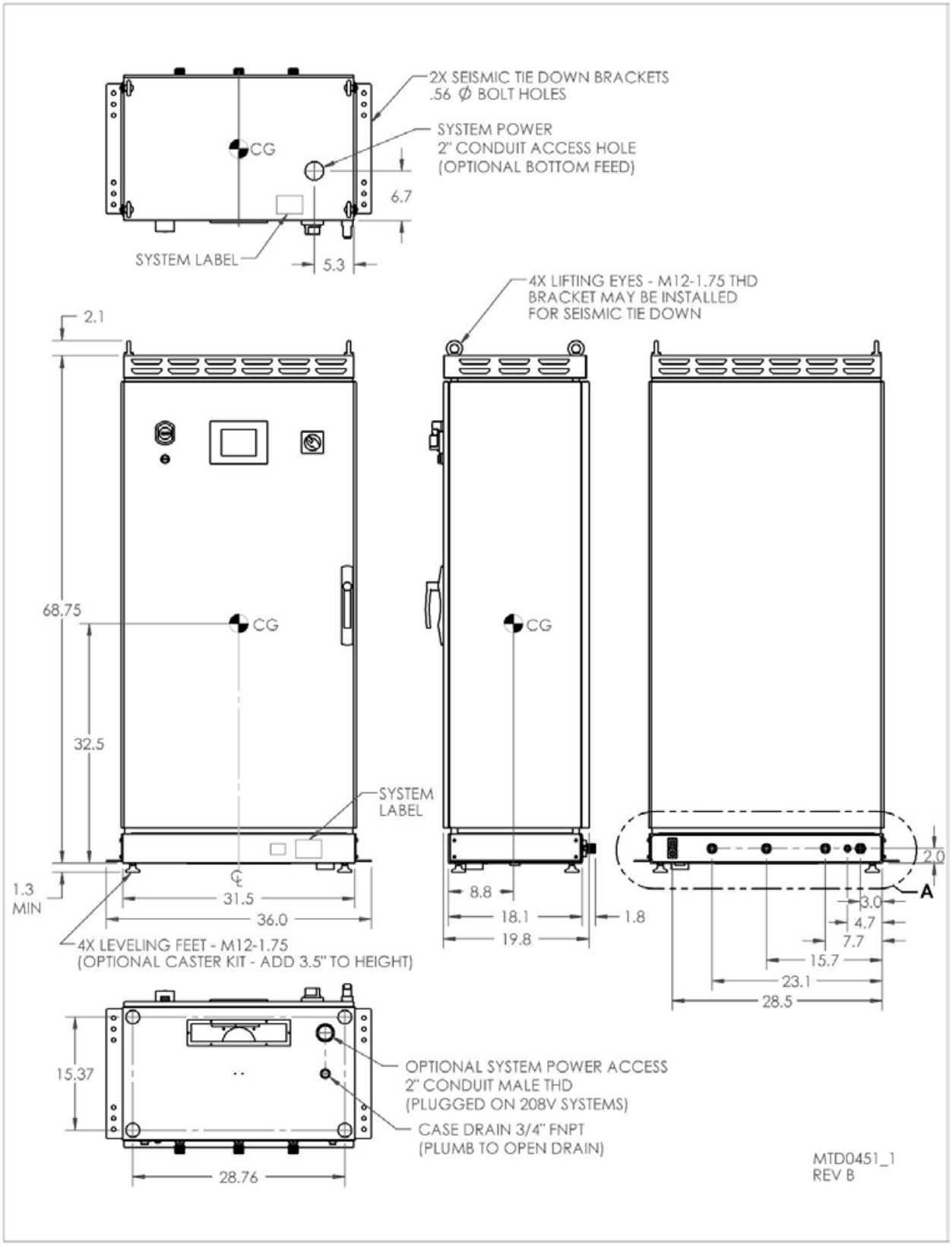
Weight: 188 kg dry; 192 kg filled

Facility External Fluids and Gases:

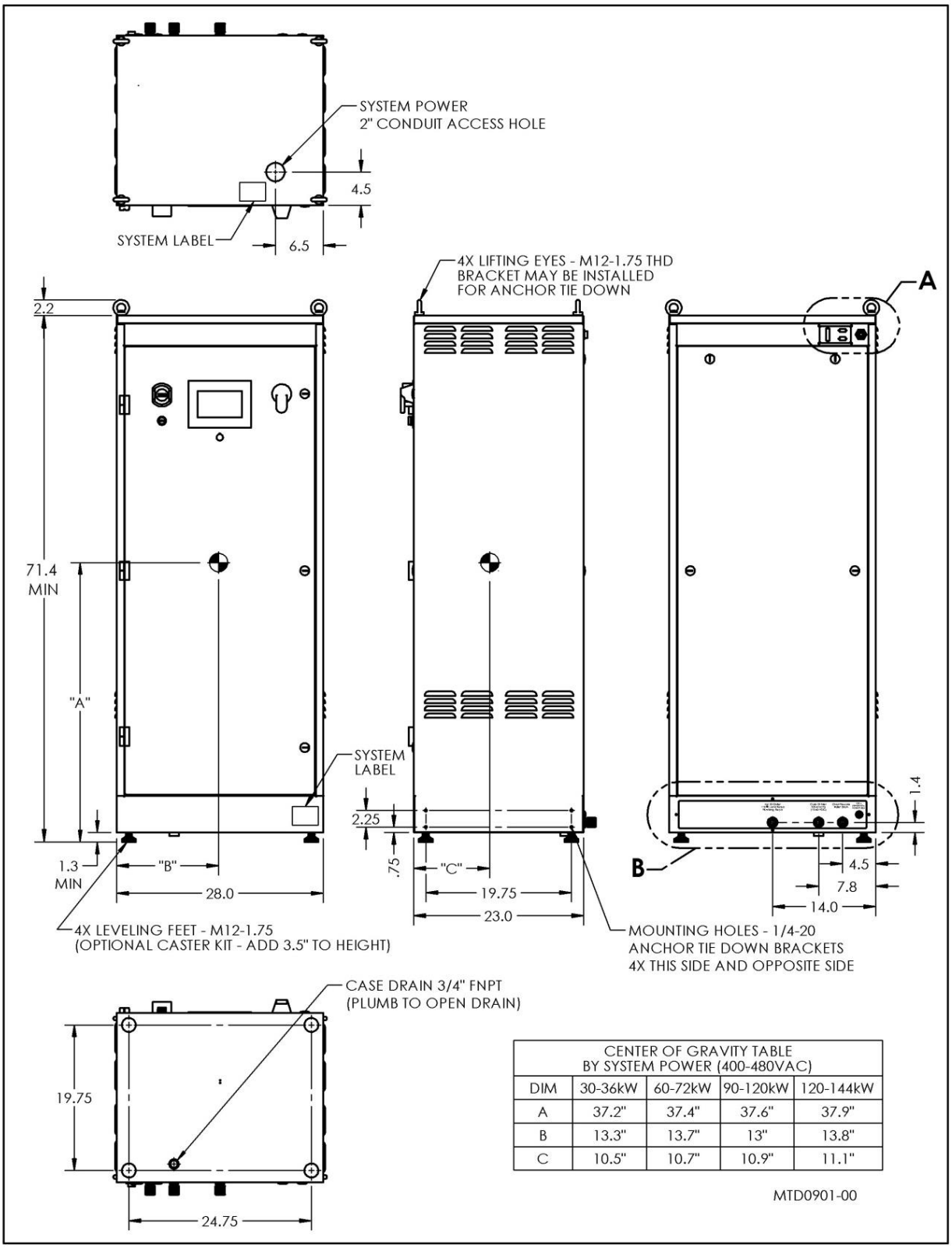
Fluid/Gas	Pressure
Compressed Air or N_2	300-500 kPa (45-80 psig)
Cold DI Water In	103-414 kPa (15-60 psig)
Hot DI Water Out	> 103 kPa (15 psig) backpressure; >170°C fittings

Facility Exhaust

Exhaust	Flow	Pressure
N/A	-	-



480V Cabinet



CENTER OF GRAVITY TABLE BY SYSTEM POWER (400-480VAC)				
DIM	30-36kW	60-72kW	90-120kW	120-144kW
A	37.2"	37.4"	37.6"	37.9"
B	13.3"	13.7"	13"	13.8"
C	10.5"	10.7"	10.9"	11.1"

208V Cabinet

SECTION 4.0 ANALYSIS AND TESTING METHODOLOGY

In order to verify conformance with SEMI S2-0715 Guideline and other applicable standards, a comprehensive series of analyses and tests were conducted using accepted industry practices and following the guidelines set forth in SEMI S22. The results of all analyses and tests are documented in analysis reports or test data sheets provided as attachments to this report. Included in each test data sheet is a description of the test method used and the discussion of the results or conclusion. In addition, a list of the test equipment used and its calibration data are provided. The following analyses or tests were performed:

- Hazard Analysis ("What-If?")
- Fire Risk Analysis
- Sound Pressure Level Survey
- Earthing Continuity and Continuity of the Protective Bonding Circuit Test
- Safety Circuit Function Test
- Input Test
- Temperature Test
- Dielectric Withstand Test

On February 11-14, 2019, Intertek evaluated additional models in the Trebor International Quantum NXT, each with a 208VAC input rating. The following additional tests were performed:

- Static Magnetic Field Survey
- Abnormal Test (Single Fault Temperatures)

Hazard Analysis (SEMI S2-0715 Paragraphs 6.5 and 6.8)

A Hazard Analysis was performed to determine the potential for deviations from system design intent that could pose increased hazard risk. The "What if?" method was used and is discussed by the American Institute of Chemical Engineers (AIChE) in their "Guidelines for Hazard Evaluation Procedures." In this analysis, the design or operating intent of the system is discussed, and questions (generally beginning with the phrase "What-If?") about possible deviations from design intent are asked. The potential consequences of each pertinent deviation were discussed and evaluated. If any single deviation was determined to potentially result in a release of a hazardous material, or other unsafe condition, then that deviation was deemed to be a single point failure and not compliant with the SEMI S2-0715 Guideline. In addition, a risk assessment was performed based on SEMI S10-0815^{E} guidelines on each deviation. Refer to Attachment One, Intertek "What if?" Hazard Analysis Summary Report.

Fire Risk Analysis (Section 14 of SEMI S2-0715 and SEMI S14)

Fire Risk Analysis was conducted to assess the system's risk to fire based on its design intent. This fire risk analysis was performed using the criteria established by the Semiconductor Equipment and Materials International, *Safety Guidelines for Fire Risk and Mitigation for Semiconductor Manufacturing Equipment* (SEMI S14 Guidelines) and the criteria in SEMI S2-0715 Section 14, Fire Protection. As specified by SEMI S14, the fire risk assessment addressed design issues related to fires which originate inside of the system under normal conditions or reasonably foreseeable (abnormal) single point failure conditions. It did not address issues associated with fires which originate outside of the system, nor abnormal conditions that require more than one failure. The assessment considered potential thermal and non-thermal hazards (e.g., smoke) resulting in property damage or loss of use of the equipment or

of the facility. In addition, as specified by SEMI S2, the fire risk assessment also included the potential hazards to human exposure resulting from fire or smoke. Refer to Attachment Three, Intertek Fire Risk Assessment Summary Report.

Sound Pressure Level Survey (Section 27 of SEMI S2-0715)
Sound pressure levels were measured using the method in ANSI S1.13-1971 (R1986), *Methods for the Measurement of Sound Pressure Levels*. Sound pressure levels were measured to determine the sound pressure emissions generated by the system when running at maximum normal load to verify conformance with the maximum acceptable noise level of 80 dB(A). Refer to Attachment Eight, Intertek Sound Pressure Level Survey Test Data Sheet.

Earthing Continuity and Continuity of the Protective Bonding Circuit Test (Section 22.3 of SEMI S22)
Grounding resistance measurements were made between all accessible metal parts and ground, to verify conformance with the maximum acceptable ground path resistance of 0.1 ohm. Refer to Attachment Nine, Intertek Earthing Continuity and Continuity of the Protective Bonding Circuit Test Data Sheet.

Safety Circuit Function Test (Section 22.10 of SEMI S22)
Functional tests of the EMO and interlock circuits were performed to verify proper operation. The tests were performed with the system running at maximum normal load, the emergency off buttons and interlocks were activated. Refer to Attachment Ten, Intertek Safety Circuit Function Test Data Sheet.

Input Test (Section 22.5 of SEMI S22)
The input current to the system was measured to ensure that it did not exceed 110% of the marked current rating. Refer to Attachment Eleven, Intertek Input Test Data Sheet.

Temperature Test (Section 22.13 of SEMI S22)
Temperatures of components throughout the system were monitored to ensure that temperature rises did not exceed acceptable levels. Refer to Attachment Twelve, Intertek Temperature Test Data Sheet.

Dielectric Withstand Test (Paragraph 6.7.1.5 of IEC 61010-1)
A 2210 VAC potential was applied for 60 seconds between live parts of the primary circuit and the grounding terminal. To ensure that the test potential was applied to all parts of the primary circuit, contactors were manually closed and circuit breakers and switches were set to their closed position. Refer to Attachment Thirteen, Dielectric Withstand Test Data Sheet.

Static Magnetic Field Survey (Section 25 of SEMI S2-0715)
Static magnetic field survey was performed using the method specified in SEMI S2-0715, Appendix 3 (calibrated Hall effect probe) around accessible locations to magnetic fields to measure the potential exposure to static magnetic field emissions during normal operation, and maintenance or service tasks. Refer to Attachment Fourteen, Intertek Static Magnetic Field Survey Test Data Sheet.

Abnormal Test
Abnormal tests of components were performed to verify the adequacy of protection to ensure that a hazardous condition (e.g. smoke, fire, or risk of electrical shock) will not occur. Refer to Attachment Fifteen, Abnormal Test Data Sheet.

SECTION 5.0 PRODUCT SAFETY ASSESSMENT

An assessment of the Quantum NXT Series was performed in accordance with the SEMI S2-0715 Guideline and other applicable standards as noted in Section 2.0 Scope.

Unless otherwise specified, all referenced sections below refer to *Environmental, Health, and Safety Guideline for Semiconductor Manufacturing Equipment* (SEMI S2-0715 Guideline). The report structure is modeled after the documentation requirements of SEMI S2-0715 Guideline.

Each reported paragraph of the SEMI S2-0715 Guideline is either presented verbatim or paraphrased in this section. The paragraphs from the SEMI S2-0715 Guideline are presented with their corresponding numbers from the Guideline. For example:

SEMI S2-0715 Paragraph No.
Statement of the requirement.

Below each "statement of the requirement" box, an assessment is given. For each numbered paragraph, an assessment to the requirement is provided based on visual verification of the system and or documentation provided by the equipment supplier to demonstrate conformance. In addition, supporting engineering rationale is provided to explain each assessment. Each assessment is classified based on the categories defined in Section 2.0, Scope of Evaluation of this report.

SEMI S2-0715 Section 9 – Documents Provided to User

SEMI S2-0715 Paragraph 9.6 Manuals
SEMI S2-0715 Paragraph 9.6.1
The supplier should provide the user with manuals based on the originally intended use of the equipment. The manuals should describe the scope and normal use of the equipment, and provide information to enable safe facilitization, operation, maintenance, and service of the equipment.

CONFORMS TO THE STATED CRITERIA
Manuals reviewed described the scope and normal use of the equipment, and provide information to enable safe facilitation, operation, maintenance, and service of the equipment.

SEMI S2-0715 Paragraph 9.6.2
The manuals should conform to SEMI S13.

NOTE 26: Fire suppression agents and chemicals used to test fire detection or suppression systems, fall under the MSDS provisions of SEMI S13 when they are provided with the equipment.

NOTE 27: Hazardous energies within fire detection or suppression systems fall under the hazardous energy control provisions of SEMI S13 when fire detection or suppression systems are provided with the equipment.

CONFORMS TO THE STATED CRITERIA
Quantum NXT manuals were reviewed for conformance to SEMI S13. The manuals reviewed provided the necessary information requested by SEMI S13 for conformance to this paragraph. Therefore, this paragraph conforms.

SEMI S2-0715 Paragraph 9.6.3
In addition to the provisions of SEMI S13, the manuals should include:

- *Specific written instructions on routine Type 4 tasks, excluding troubleshooting (refer to Paragraph 13.3);*
- *Instructions for energy isolation, ("lockout / tagout") (refer to Paragraph 17.2);*
- *Descriptions of the emergency off (EMO) and interlock functions;*
- *A list of hazardous materials (e.g., lubricants, cleaners, coolants) required for maintenance, ancillary equipment or peripheral operations, including anticipated change-out frequency, quantity, and potential for contamination from the process;*
- *A list of items that become solid waste as a result of the operation, maintenance, and servicing of the equipment, and that are constructed of or contain substances whose disposal might be regulated (e.g., beryllium-containing parts, vapor lamps, mercury switches, batteries, contaminated parts, maintenance wastes);*
- *Maintenance and troubleshooting procedures needed to maintain the effectiveness of safety design features or devices (i.e., engineering controls); and*
- *Instructions for proper use, maintenance and inspection of lifting equipment supplied by the SME supplier, including any guidance on specific inspection intervals. For lifting equipment specified or recommended, but not supplied, by the SME supplier, the documentations provided by the SME supplier should specify that such instructions be obtained by the user from its lifting equipment supplier*

CONFORMS TO THE STATED CRITERIA
System documentation was reviewed and provided the following information in conformance with the requirements:

- Maintenance and troubleshooting procedures needed to maintain the effectiveness of the safety design features.
- Descriptions of the emergency off (EMO) functions;
- Specific instructions for non-electrical hazardous energy isolation specifying that it is the responsibility of the End-User to provide and affix lockout/tagout devices for the water and Clean Dry Air and follow established End-User lockout/tagout procedures to meet the requirements of paragraph 17.2.2.

NOT APPLICABLE
The system does not:

- Use lifting equipment supplied by the SME supplier, including any guidance on specific inspection intervals.
- Create or contain solid waste
- Have type 4 electrical tasks.

SEMI S2-0715 Paragraph 9.6.4
Information should be provided regarding potential routes of unintended releases (see Paragraph 21.2.4).

NOT APPLICABLE
No materials are used that could result in unintended releases.

SEMI S2-0715 Paragraph 9.6.5
Recommended decontamination and decommissioning procedures should be provided in accordance with SEMI S12, and should include the following information:

- *Identity of components and materials of construction, in sufficient detail to support recycling, refurbishment, and reuse decisions (see Paragraph 8.5.3); and*
- *Residual hazardous materials, or parts likely to become contaminated with hazardous materials, that may be in the equipment prior to decommissioning.*

NOTE 28: It is recommended that the manual state that changes to the typical process chemistry or to the equipment could alter the anticipated environmental impact.

ADDRESSED
Refer to Paragraph 9.6.2.

SEMI S2-0715 Paragraph 9.6.6
Maintenance Procedures with Potential Environmental Impacts - The supplier's recommended maintenance procedures should:

- *Identify procedural steps during which releases might occur, and the nature of the releases; and*
- *Identify waste characteristics and methods to minimize the volume of effluents, wastes, or emissions generated during maintenance procedures.*

NOT APPLICABLE
There are no effluents, wastes or emissions generated. No materials are used that could result in unintended releases.

SEMI S2-0715 Section 10 - Hazard Alert Labels

SEMI S2-0715 Paragraph 10.1
Where it is impractical to eliminate hazards through design selection or to adequately reduce the associated risk with safety or warning devices, hazard alert labels should be provided to identify and warn against hazards.

CONFORMS TO THE STATED CRITERIA
A Hazardous Voltage Warning Label is affixed to the front of the enclosure. This label is visible to service personnel before opening the enclosure. The unit is also equipped with a hazardous temperature warning label located on the back side of the unit.

SEMI S2-0715 Paragraph 10.2
Labels should be durable and suitable for the environment of the intended use.

CONFORMS TO THE STATED CRITERIA
Labels were observed to be suitable for the environment in which they are located.

SEMI S2-0715 Paragraph 10.3
Labels should conform to SEMI S1.

EXCEPTION: Some hazard label formats and content are dictated by law (e.g., laser labeling and chemical hazard communication labeling in certain countries of use) and may not conform to SEMI S1.

CONFORMS TO THE STATED CRITERIA
Samples of existing labels were evaluated and determined to conform to SEMI S1.

SEMI S2-0715 Section 11 - Safety Interlock Systems

SEMI S2-0715 Paragraph 11.1
This section covers safety interlocks and safety interlock systems.

NOTE 29: If a fire detection or suppression system is provided with the equipment, see Paragraph 14 for additional information.

REFERENCE ONLY
This statement is provided for reference to define the subject of the section.

SEMI S2-0715 Paragraph 11.2
Where appropriate, equipment should use safety interlock systems that protect personnel, facilities, and the community from hazards inherent in the operation of the equipment.

NOTE 30: Safety critical parts whose primary function is to protect the equipment (e.g., circuit breakers, fuses) are typically not considered to be safety interlocks.

CONFORMS TO THE STATED CRITERIA
The system is provided with safety interlocks to protect personnel, facilities, and the community from hazards inherent in the operation of the equipment. The following interlocks are provided on the system.

The process fault interlocks are latched into the logic controller (PLC) memory. When a fault occurs, the user interface will display the alarm condition and the horn will sound. Pressing the RESET button will silence the audible horn. The system will retain the fault until it is cleared, disallowing reset or restart until the fault is cleared. Pressing the RESET button may restart the system, but not the heaters. Restart of the heaters requires selecting the ON button on the screen

The interlock circuit does not remove hazardous voltage from the circuit breakers, contactors, line filters, and the DC power supply. Interlock control contacts (contactors) are after the circuit breakers.

Leak Sensor – The Trebor QNXT heater is supplied with a 24Vdc conductive liquid (DIW) leak sensor in the bottom tray of the system fluid section. This sensor/interlock is designed to disable DIW supply and deenergize the heaters in the event of a leak. When the sensor, LKS1, is wetted, its internal transistor switch opens, removing 24 V signal from relay R3 coil. Relay R3 normally open (NO) contact in the interlock string opens, removing 24 V from relay CR2 coil. The NO CR2 contact in the contactor control string opens, removing operating power from all the heater contactors, which will open and deenergize all the heaters. The switch circuit also signals the PLC, which deenergizes its SSR output, opening all the heater SSR contacts. The PLC also deenergizes the air solenoid valve, which removes operator air from the DIW supply valve, which will then close. The circuit also creates a fault indication in the system and sounds the alarm horn. When the leak sensor fault is cleared and the Reset button is pressed, selecting the Enable button on the screen will restart water flow by opening the DIW supply valve.

Low Pressure Sensor – The Trebor QNXT heater is supplied with a 24Vdc low pressure sensor in the DIW supply line within the system fluid section. This sensor/interlock is designed to deenergize the heaters in the event of a leak, and the 10 second timer allows for pressure fluctuations without creating a hard alarm. When the sensor, PS1, detects pressure below the setpoint of 15 psig, its internal transistor

switch opens, removing 24 V signal from relay R2 coil. The transistor will automatically reclose when pressure is restored within 10 seconds, automatically restarting the heaters. When low pressure persists, relay R2 NO contact in the interlock string opens, removing 24 V from relay CR2 coil. The NO CR2 contact in the contactor control string opens, removing operating power from all the heater contactors, which will open and deenergize all the heaters. The switch circuit also signals the PLC, which deenergizes its SSR output, opening all the heater SSR contacts. The circuit also creates a fault indication in the system and sounds the alarm horn.

Low Liquid Level Sensor – The Trebor QNXT heater is supplied with a 24Vdc low liquid level sensor in the DIW output line at the top of the system fluid section. This sensor/interlock is designed to deenergize the heaters in the event of loss of fluid within the piping system. When the sensor, LL1, detects no liquid at it's location, its internal transistor switch opens, removing 24 V signal from relay R4 coil. Relay R4 NO contact in the interlock string opens, removing 24 V from relay CR2 coil. The NO CR2 contact in the contactor control string opens, removing operating power from all the heater contactors, which will open and deenergize all the heaters. The switch circuit also signals the PLC, which deenergizes its SSR output, opening all the heater SSR contacts. The circuit also creates a fault indication in the system and sounds the alarm horn.

Element Over-Temperature Protection - The Trebor QNXT heater is supplied with a temperature sensor(s) – thermocouple – located on each heater element. The temperature limit controller monitors a thermocouple attached to each heater element. In the event that the element temperature exceeds the maximum operating temperature, the system will immediately disengage power and alarm. Each element temperature thermocouples is read by the Temperature Limit Monitor (TLM) to ensure the element temperature does not exceed 270°C. When the TLM notices that an element thermocouple has exceeded the setpoint temperature, the TLM deenergizes its Alarm output, which removes 24 V signal from relay R4 coil. Relay R4 NO contact in the interlock string opens, removing 24 V from relay CR7 coil. The NO CR7 contact in the contactor control string opens, removing operating power from all the heater contactors, which will open and deenergize all the heaters. The TLM output circuit also signals the PLC, which deenergizes its SSR output, opening all the heater SSR contacts. The circuit also creates a fault indication in the system and sounds the alarm horn.

Over Pressure Relief Valve – The Trebor QNXT heater is supplied with a mechanical over pressure relief valve in the DIW supply line within the system fluid section. This valve is set at the factory to its maximum value of 90 ±3 psi. A lower pressure relief value may be set by turning the adjusting screw counter clockwise to decrease the relief pressure. When the relief valve opens, it dumps excess fluid into the drip pan. This action may trigger the leak sensor when sufficient fluid is dumped. The over pressure relief valve is auto reset and provides no alarm or indication to the operator.

Liquid Level Sensor Interlock - The Trebor QNXT heater requires a liquid level interlock with a sensor located at the heater outlet to prevent dry operation.

SEMI S2-0715 Paragraph 11.3
Safety interlock systems should be designed such that, upon activation of the interlock, the equipment, or relevant parts of the equipment, is automatically brought to a safe condition.

NOTE 31: Timing is relevant to risk; a safe condition includes bringing the equipment to a safe state before the hazard can be accessed by personnel.

CONFORMS TO THE STATED CRITERIA
The safety interlocks on the system were tested and found to bring the system to a safe condition when activated. The tests were performed by Trebor and were witnessed by Intertek.

SEMI S2-0715 Paragraph 11.4
Upon activation, the safety interlock should alert the operator immediately.

EXCEPTION: Alerting the operator is not expected if a safety interlock triggers the EMO circuit (see Paragraph 12) or otherwise removes power to the user interface.

NOTE 32: An explanation of the cause is preferred upon activation of a safety interlock.

CONFORMS TO THE STATED CRITERIA
The interlocks as described in Paragraph 11.2 are designed and configured such that upon activation, the operator is immediately alerted by an icon on the operator interface monitor, except as noted in Paragraph 11.2.

SEMI S2-0715 Paragraph 11.5
Safety interlock systems should be fault-tolerant and designed so that the functions or set points of the system components cannot be altered without disassembling, physically modifying, or damaging the device or component.

EXCEPTION: Components or circuits with adjustable set points or trip functions may be used in safety interlock systems if access is limited by requiring a deliberate action, such as using a tool or special keypad sequences, to access the adjustable devices or to adjust the devices. The justification for the adjustability of the interlock components or circuits should be included in the equipment evaluation report and equipment documentation.

NOTE 33: The intent is to limit access to the adjustable setpoints to properly trained maintenance and service personnel.

NOTE 34: This section does not address the defeatability of safety interlocks. See Paragraph 11.7 for additional information.

CONFORMS TO THE STATED CRITERIA
Intertek verified that each component of the interlock circuit, (as detailed in Paragraph 11.2), has been certified by an accredited testing laboratory and that each component has been subjected to an endurance cycling test (min. 10,000 cycles) under the load. Therefore, each component is considered to be a high integrity component. In addition, normally open relays and switches are used, so when any connector of the interlock circuit is disconnected, the interlock will be activated and the system will be placed in a safe state. Each component of the interlock safety circuit is used in accordance with the manufacturer's ratings and specifications. Therefore, the safety interlock circuit essentially meets the requirement of a fault tolerant circuit.

SEMI S2-0715 Paragraph 11.5.1

Interlock and EMO circuits should remove hazardous energies by de-energizing rather than energizing. Shunt trips are an example of components that do not operate by de-energizing.

EXCEPTION 1: This criterion is considered to be met if a) one part of a redundant circuit operates by de-energizing and the second part operates by energizing, or b) the monitoring circuit operates by energizing as long as the monitored circuit operates by de-energizing.

EXCEPTION 2: Earth Leakage (ground fault) sensing components (e.g., GFI, GFCI, RCD and ELB) often work by energizing within the components and are acceptable if a) the earth leakage sensing component(s) meets Paragraph 13.4.3 and b) the rest of the earth leakage interlock or EMO circuit operates by de-energizing.

CONFORMS TO THE STATED CRITERIA

Interlock and EMO circuits remove hazardous energies by de-energizing rather than by energizing.

SEMI S2-0715 Paragraph 11.6

Electromechanical devices and components are preferred. Solid-state devices and solid state components may be used, provided that the safety interlock system, or relevant parts of the system, are evaluated for suitability for use in accordance with appropriate standard(s). The evaluation for suitability should take into consideration abnormal conditions such as over voltage, under voltage, power supply interruption, transient over voltage, ramp voltage, electromagnetic susceptibility, electrostatic discharge, thermal cycling, humidity, dust, vibration, and jarring.

EXCEPTION: Where the severity of a reasonably foreseeable mishap is deemed to be Minor per SEMI S10, a software-based interlock may be considered suitable.

NOTE 35: Where a safety interlock is provided to safeguard personnel from severe or catastrophic harm as categorized by SEMI S10, consideration of positive-opening type switches is recommended.

NOTE 36: Evaluation for suitability for use may also include reliability, self-monitoring, and redundancy as addressed under standards such as NEMA ICS 1.1 and UL 991.

NOTE 37: Solid-state devices include operational amplifiers, transistors, and integrated circuits.

CONFORMS TO THE STATED CRITERIA

Intertek verified that each component of the interlock circuits as detailed in Paragraph 11.2 is electromechanical based.

SEMI S2-0715 Paragraph 11.6.1
FECS may be used in conjunction with electromechanical or solid state devices and components provided the programmable safety control system conforms to an appropriate standard for electronic safety systems. Components of the FECS should be tested and certified according to the requirements of the standard used. Examples of recognized electronic safety systems standards include IEC 61508, ISO 13849-1, ANSI/ISA S84.01 DIN V VDE-0801.

NOTE38: Paragraph 13.4.3 states additional assessment criteria for safety-related components and assemblies.

NOTE 39: A FECS is a subsystem of a PES. IEC 61508 is the preferred standard for complex PES.

NOTE 40: Related Information 13 provides additional information on applications of FECS design.

NOT APPLICABLE
There are no FECS used in the safety interlock circuits on the system.

SEMI S2-0715 Paragraph 11.7
The safety interlock system should be designed to minimize the need to override safety interlocks during maintenance activities.

CONFORMS TO THE STATED CRITERIA
There are no means provided or required for the defeating of any safety interlock as listed in Paragraph 11.2.

SEMI S2-0715 Paragraph 11.7.1
Safety interlocks that safeguard personnel during operator tasks should not be defeatable without the use of a tool.

NOT APPLICABLE
There are no interlocks that require operators to remove a barrier and bypass interlocks during normal process.

SEMI S2-0715 Paragraph 11.7.2
When maintenance access is necessary to areas protected by interlocks, defeatable safety interlocks may be used, provided that they require an intentional operation to bypass.

ADDRESSED
Refer to Paragraph 11.7.

SEMI S2-0715 Paragraph 11.7.2.1
Upon exiting or completing the maintenance mode, all safety interlocks should be automatically restored.

ADDRESSED
Refer to Paragraph 11.7.2.

SEMI S2-0715 Paragraph 11.7.2.2
If a safety interlock is defeated, the maintenance manual should identify administrative controls to safeguard personnel or to minimize the hazard.

ADDRESSED
Refer to Paragraph 11.7.

SEMI S2-0715 Paragraph 11.8
The restoration of a safety interlock should not initiate equipment operation or parts movement where this can give rise to a hazardous condition.

CONFORMS TO THE STATED CRITERIA
Restoration of the listed safety interlocks does not initiate equipment operation as the error must be cleared on the control screen before equipment function is restored.

SEMI S2-0715 Paragraph 11.9
Switches and other control device contacts should be connected to the ungrounded side of the circuit so that a short circuit to ground does not result in the interlocks being satisfied.

CONFORMS TO THE STATED CRITERIA
The interlock circuits switch the ungrounded side of the circuit to protect against failure of the interlock to operate in the event a wire becomes loose and shorts to ground.

SEMI S2-0715 Paragraph 11.10
Where a hazard to personnel is controlled through the use of an enclosure, the enclosure should either: require a tool to gain access and be labeled regarding the hazard against which it protects personnel; or be interlocked. In addition to enclosures, physical barriers at the point of hazard should be included where inadvertent contact is likely.

NOTE 41: Where the removal of a cover exposes a hazard, consider additional labels. See Paragraph 10 for guidance.

CONFORMS TO THE STATED CRITERIA
SEMI S1 labeled enclosure panels which require a tool to remove them are provided as protection against electrical and mechanical hazards. Safety interlocks are also used as described in Paragraph 11.2. In addition, components located within the electrical enclosures which have exposed contacts are equipped with polymeric guards to prevent accidental activation or are finger-safe by design.

SEMI S2-0715 Section 12 - Emergency Shutdown

SEMI S2-0715 Paragraph 12.1

The equipment should have an "emergency off" (EMO) circuit. The EMO actuator (e.g., button), when activated, should place the equipment into a safe shutdown condition, without generating any additional hazard to personnel or the facility.

EXCEPTION 1: An EMO circuit is not needed for equipment rated 2.4 kVA or less, where the hazards are only electrical in nature, provided that the main disconnect meets the accessibility provisions of Paragraph 12.5.2 and that the effect of disconnecting the main power supply is equivalent to activating an EMO circuit.

EXCEPTION 2: Assemblies that are not intended to be used as stand-alone equipment, but rather within an overall integrated system, and that receive their power from the user's system, are not required to have an emergency off circuit. The assembly's installation manual should provide clear instructions to the equipment installer to connect the assembly to the integrated system's emergency off circuit.

NOTE 42: It is recommended that the emergency off function not reduce the effectiveness of safety devices or of devices with safety-related functions (e.g., magnetic chucks or braking devices) necessary to bring the equipment to a safe shutdown condition effectively.

NOTE 43: If a fire detection or suppression system is provided with the equipment, see Section 14 for additional information.

CONFORMS TO THE STATED CRITERIA

The system is provided with a hardware based emergency off (EMO) circuit which, when activated, brings the system to a safe shutdown state without generating additional hazards.

SEMI S2-0715 Paragraph 12.1.1

If the supplier provides an external EMO interface on the equipment, the supplier should include instructions for connecting to the interface.

CONFORMS TO THE STATED CRITERIA

The system is optionally provided with an external EMO interface. The manual explains that connection instructions are available from the Factory.

SEMI S2-0715 Paragraph 12.2

Activation of the emergency off circuit should de-energize all hazardous voltage and all power greater than 240 volt-amps in the equipment beyond the main power enclosure.

EXCEPTION 1: A non-hazardous voltage EMO circuit (typically 24 volts) and its supply may remain energized.

EXCEPTION 2: Safety related devices (e.g., smoke detectors, gas / water leak detectors, pressure measurement devices, etc.) may remain energized from a non-hazardous power source.

EXCEPTION 3: A computer system performing data / alarm logging and error recovery functions may remain energized, provided that the energized breaker(s), receptacle(s), and each energized conductor termination are clearly labeled as remaining energized after EMO activation. Hazardous energized parts that remain energized after EMO activation should be insulated or guarded to prevent inadvertent contact by personnel.

EXCEPTION 4: Multiple units mounted separately with no shared hazards and without interconnecting circuits with hazardous voltages, energy levels or other hazardous conditions may have:

- *separate sources of power and separate supply circuit disconnect means if clearly identified, or*
- *separate EMO circuits, if they are clearly identified.*

CONFORMS TO THE STATED CRITERIA

The system was evaluated and activation of the EMO circuit deenergizes all hazardous voltage and all power greater than 240 volt-amps in the equipment beyond the main power enclosure.

SEMI S2-0715 Paragraph 12.2.1

The EMO circuit should not include features that are intended to allow it to be defeated or bypassed.

CONFORMS TO THE STATED CRITERIA

The system was evaluated and the EMO circuit does not include features which allow it to be defeated or bypassed.

SEMI S2-0715 Paragraph 12.2.2

The EMO circuit should consist of electromechanical components.

EXCEPTION 1: Solid-state devices and components may be used, provided the system or relevant parts of the system are evaluated and found suitable for use. The components should be evaluated and found suitable considering abnormal conditions such as over voltage, under voltage, power supply interruption, transient over voltage, ramp voltage, electromagnetic susceptibility, electrostatic discharge, thermal cycling, humidity, dust, vibration and jarring. The final removal of power should be accomplished by means of electromechanical components.

EXCEPTION 2: FECS may be used provided the FECS conforms to an appropriate standard for electronic safety systems. Components of the FECS should be tested and certified according to the requirements of the standard used. IEC 61508 and ISO 13849-1 are examples of internationally recognized electronic safety systems standards. The final removal of power should be accomplished by means of electromechanical components.

NOTE 1: Paragraph 13.4.3 states additional assessment criteria for safety-related components and assemblies.

NOTE 2: A FECS is a subsystem of a Programmable Electronic System (PES). IEC 61508 is the preferred standard for complex PES.

CONFORMS TO THE STATED CRITERIA
The system is provided with a circuit which places the equipment in a safe shutdown condition. Activation of the EMO button causes the heater contactors to drop out de-energizing the entire system. The EMO circuitry is comprised of electromechanical components.

SEMI S2-0715 Paragraph 12.2.3
All EMO Circuits should be fault-tolerant.

CONFORMS TO THE STATED CRITERIA
The system EMO circuit is hardware-based and fault-tolerant in design as the system will go to a safe shut down condition in the event of a loss of a connection.

SEMI S2-0715 Paragraph 12.2.4
Resetting the EMO switch should not re-energize circuits, equipment, or subassemblies.

CONFORMS TO THE STATED CRITERIA
Manual reset of the system is required following activation of the EMO circuit. Following EMO activation, the EMO button actuator must first be reset and the reset button must be pressed, then the ON button at the touch screen monitor must be pressed to restart system (energize heaters). Simply resetting the EMO button actuator does not re-energize any circuits or assemblies.

SEMI S2-0715 Paragraph 12.2.5
The EMO circuit should shut down the equipment by de-energizing rather than energizing control components.

CONFORMS TO THE STATED CRITERIA
The EMO circuit operates by de-energizing circuits such as the relay and contactor coils.

SEMI S2-0715 Paragraph 12.2.6
The EMO circuit should require manual resetting so that power cannot be restored automatically.

CONFORMS TO THE STATED CRITERIA
Once the EMO circuit has been activated and the EMO button has been reset, the system must be restarted using the reset button.

SEMI S2-0715 Paragraph 12.3
The emergency off button should be red, mushroom shaped, and self-latching. A yellow background for the EMO should be provided.

CONFORMS TO THE STATED CRITERIA
The EMO button is red, mushroom shaped and provided with a yellow background.

SEMI S2-0715 Paragraph 12.4
All emergency off buttons should be clearly labeled as "EMO," "Emergency Off," or the equivalent and should be clearly legible from the viewing location. The label may appear on the button or on the yellow background.

CONFORMS TO THE STATED CRITERIA
The EMO button is clearly labeled as EMO and clearly legible from the viewing location.

SEMI S2-0715 Paragraph 12.5
Emergency off buttons should be readily accessible from operating and regularly scheduled maintenance locations and appropriately sized to enable activation by the heel of the palm.

CONFORMS TO THE STATED CRITERIA
The system is provided with an EMO button that is readily accessible from operating and maintenance locations and allows for activation by the heel of the palm.

SEMI S2-0715 Paragraph 12.5.1
Emergency off buttons should be located or guarded to minimize accidental activation.

CONFORMS TO THE STATED CRITERIA
The system EMO button is guarded to minimize accidental activation.

SEMI S2-0715 Paragraph 12.5.2
No operation or regularly scheduled maintenance location should require more than 3 m (10 feet) travel to an EMO button.

CONFORMS TO THE STATED CRITERIA
The EMO button, located on the front door, is within a 3 meter reach from operating and maintenance locations.

SEMI S2-0715 Paragraph 12.5.3
The person actuating or inspecting the EMO switch assembly should not be exposed to hazards with a SEMI S10 risk of Medium or greater. Examples of hazards that could have such risk are:

- *contacting energized electrical parts,*
- *contacting moving machinery,*
- *contacting surfaces that are at excessively high or low temperatures, and*
- *limited or poor access causing impacts, tripping or falling during rapid movement during an emergency.*

CONFORMS TO THE STATED CRITERIA
Actuating an EMO switch assembly does not expose persons to hazards with a SEMI S10 risk of Medium or greater.

SEMI S2-0715 Paragraph 12.6
Refer to Paragraph 13.5 for additional EMO guidelines when EMOs are used with UPSs.

NOT APPLICABLE
No UPS is provided with the equipment.

SEMI S2-0715 Section 13 - Electrical Design

SEMI S2-0715 Paragraph 13.1
This section covers electrical and electronic equipment that use hazardous voltages.

REFERENCE ONLY
This paragraph is provided for reference only.

SEMI S2-0715 Paragraph 13.2
Types of Electrical Work - The following are the four types of electrical work defined by this guideline:

Type 1 – Equipment is fully de-energized.

Type 2 – Equipment is energized. Energized circuits are covered or insulated.

NOTE 46: Type 2 work includes tasks where the energized circuits are or can be measured by placing probes through suitable openings in the covers or insulators.

Type 3 - Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are no greater than 30 volts rms, 42.4 volts peak, 60 volts dc or 240 volt-amps in dry locations.

Type 4 - Equipment is energized. Energized circuits are exposed and inadvertent contact with uninsulated energized parts is possible. Potential exposures are greater than 30 volts rms, 42.4 volts peak, 60 volts dc, or 240 volt-amps in dry locations. Potential exposures to radio-frequency currents, whether induced or via contact, exceed the limits in Table A3-1 of Appendix 3.

REFERENCE ONLY
This Paragraph is used to define the types of electrical work. Refer to Paragraph 13.3 for issues that are applicable to this system.

SEMI S2-0715 Paragraph 13.3
Energized Electrical Work - The supplier should design the equipment to minimize the need to calibrate, modify, repair, test, adjust, or maintain equipment while it is energized, and to minimize work that must be performed on components near exposed energized circuits. The supplier should move as many tasks as practical from category Type 4 to Types 1, 2, or 3. Routine Type 4 tasks, excluding troubleshooting, should have specific written instructions in the maintenance manuals. General safety procedures (e.g., wearing Personal Protective Equipment and establishing barriers) for troubleshooting, including Type 4 work, should be provided.

CONFORMS TO THE STATED CRITERIA
The Installation Instructions identify Type 2 tasks for maintenance and service only. There are no tasks higher than type 2.

SEMI S2-0715 Paragraph 13.4
Electrical Design - Equipment should conform to the appropriate international, regional, national or industry product safety requirements.

CONFORMS TO THE STATED CRITERIA
The Quantum NXT Series complies with IEC 61010-1, Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General requirements..

SEMI S2-0715 Paragraph 13.4.1
Nonconductive or grounded conductive physical barriers should be provided:
- *Where it is necessary to reach over, under, or around, or in close proximity to hazards.*
- *Where dropped objects could cause shorts or arcing.*
- *Where failure of liquid fittings from any part of the equipment would result in the introduction of liquid into electrical parts.*
- *Over the line side of the main disconnect.*
- *Where maintenance or service tasks on equipment in dry locations are likely to allow inadvertent contact with uninsulated energized parts containing either: potentials greater than 30 volts rms, 42.4 volts peak, or 60 volts dc; or power greater than 240 volt-amps.*

NOTE 47: A dry location can be considered to be one that is not normally subject to dampness or wetness.

NOTE: 48: Removable nonconductive and noncombustible covers are preferred.

CONFORMS TO THE STATED CRITERIA
The equipment is provided with suitable internal barriers over parts which could be exposed during service, (terminals of the circuit breakers and terminal blocks are covered). During normal operation, all electrical assemblies are housed within tool secured grounded electrical assemblies. Areas which are likely to be wetted from leaking fittings do not expose live parts as they are enclosed within grounded metal enclosures.

SEMI S2-0715 Paragraph 13.4.2
Where test probe openings are provided in barriers, the barriers should be located, and the probe openings should be sized, to prevent inadvertent contact with adjacent energized parts, including the energized parts of the test probes.

NOT APPLICABLE
There are no test probe openings provided on the system.

SEMI S2-0715 Paragraph 13.4.3
Where failure of components and assemblies could result in a risk of electric shock, fire, or personal injury, those components and assemblies should be certified by an accredited testing laboratory and used in accordance with the manufacturer's specifications, or otherwise evaluated to the applicable standard(s).

CONFORMS TO THE STATED CRITERIA
Primary and critical components are either certified by an accredited testing laboratory, or are otherwise enclosed and protected by a protection device that is certified by an accredited testing laboratory and has been evaluated for use in the application according to the applicable component standard.

SEMI S2-0715 Paragraph 13.4.4
Electrical wiring for power circuits, control circuits, grounding (earthing) and grounded (neutral) conductors should be color coded according to appropriate standard(s) per Paragraph 13.4, or labeled for easy identification at both ends of the wire. Where color is used for identification, it is acceptable to wrap conductor ends with appropriate colored tape or sleeving; the tape or sleeving should be reliably secured to the conductor.

EXCEPTION 1: Internal wiring on individual components (e.g., motors, transformers, meters, solenoid valves, power supplies).

EXCEPTION 2: Flexible cords.

EXCEPTION 3: Non-hazardous voltage multi-conductor cables (e.g., ribbon cables).

EXCEPTION 4: When proper color is not available for conductors designed for special application (e.g., high-temperature conductors used for furnaces and ovens).

CONFORMS TO THE STATED CRITERIA
The electrical wiring is labeled at each termination or color coded for easy identification of the wiring connection points and for ease in assembly and troubleshooting. Additionally, identification tags are provided for each of the interconnecting and multi-conductor cables used on the system.

SEMI S2-0715 Paragraph 13.4.5
Grounding (earthing) conductors and connectors should be sized to be compatible in current rating with their associated ungrounded conductors according to appropriate standard(s) per Paragraph 13.4.

CONFORMS TO THE STATED CRITERIA
The ground conductor is the same size as the supply conductors provided for the equipment.

SEMI S2-0715 Paragraph 13.4.6
Electrical enclosures should be suitable for the environment in which they are intended to be used.

CONFORMS TO THE STATED CRITERIA
The electrical component enclosure is made of metal and is designed to protect internal components from damage, and to prevent dust and dirt from entering the enclosure. The electrical enclosure is suitable for use in a Semiconductor fab environment.

SEMI S2-0715 Paragraph 13.4.7
Enclosure openings should safeguard against personnel access to un-insulated parts energized to a hazardous voltage or hazardous electrical power. Compliance to this criteria should be demonstrated by compliance to enclosure opening criteria in SEMI S22.

CONFORMS TO THE STATED CRITERIA
The electrical enclosure for the equipment safeguards against personnel access to uninsulated energized parts.

SEMI S2-0715 Paragraph 13.4.8
Top covers of electrical enclosures should be designed and constructed to significantly reduce the risk of objects falling into the enclosure. Compliance to this criteria should be demonstrated by compliance to the enclosure opening criteria in SEMI S22.

CONFORMS TO THE STATED CRITERIA
The covers of the electrical enclosure for the equipment are designed and constructed to prevent objects from falling into the enclosure and causing a fire/shock hazard.

SEMI S2-0715 Paragraph 13.4.9
The short circuit current rating of the equipment or its industrial control panel, for each supply circuit from the facility to the equipment, should be identified in the equipment installation instructions.

CONFORMS TO THE STATED CRITERIA
The SCCR of the equipment is published in the documentation provided to the end user and is identified on the equipment nameplate. The SCCR is 6kA.

SEMI S2-0715 Paragraph 13.4.10
The equipment should be provided with main over current protection devices and main disconnect devices rated for at least 10,000 rms symmetrical amperes interrupting capacity (AIC).

NOTE 49: Some facilities may require higher AIC ratings due to electrical distribution system design.

EXCEPTION: Cord- and plug-connected single phase equipment, rated no greater than 240 volts line-to-line / 150 volts line-to-ground and no greater than 2.4 kVA, may have over current protection devices with interrupting capacity of at least 5,000 rms symmetrical AIC.

CONFORMS TO THE STATED CRITERIA
The equipment is fitted with a main over current protection device that is rated for at least 10,000 rms AIC.

SEMI S2-0715 Paragraph 13.4.11
Equipment should be designed to receive incoming electrical power from the facility to a single feed location that terminates at the main disconnect specified in Paragraph 13.4.10. This disconnect, when opened, should remove all incoming electrical power in the equipment from the load side of the disconnect. The disconnect should also have the energy isolation ("lockout") capabilities specified in Paragraph 17.

*EXCEPTION 1: Equipment with more than one feed should be provided with provisions for energy isolation (lockout) for each feed and be marked with the following text or the equivalent at each disconnect: "**WARNING**: Risk of Electric Shock or Burn. Disconnect all [number of feed locations] sources of supply prior to servicing." It is preferred that all of the disconnects for the equipment be grouped in one location.*

EXCEPTION 2: Multiple units mounted separately with no shared hazards and without interconnecting circuits with hazardous voltages, energy levels or other potentially hazardous conditions may have:
- *separate sources of power and separate supply circuit disconnect means, if they are clearly identified; or*
- *separate EMO circuits, if they are clearly identified.*

CONFORMS TO THE STATED CRITERIA
The Quantum NXT is fitted with a circuit breaker as the main over current protection device that receives the incoming electrical power from the facility. When opened, the circuit breaker removes all incoming electrical power in the equipment from the load side of the disconnect device. Lockout capabilities are specified in Section 17.

SEMI S2-0715 Paragraph 13.4.12
A permanent nameplate listing the manufacturer's name, machine serial number, supply voltage, number of phases, frequency, short circuit current rating of the equipment or its industrial control panel, and full-load current should be attached to the equipment where plainly visible after installation. Where more than one incoming supply circuit is to be provided, the nameplate(s) should state the above information for each circuit.

NOTE 50: Additional nameplate information may be required depending on the location of use.

CONFORMS TO THE STATED CRITERIA
A permanent nameplate is affixed that contains all of the above required information.

SEMI S2-0715 Paragraph 13.5
Uninterruptible Power Supplies (UPSs) - This section applies to UPSs with outputs greater than 30 volts rms, 42.4 volts peak, 60 volts dc, or 240 volt-amps.

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.5.1
Whenever a UPS is provided with the equipment, its location and wiring should be clearly described within the installation and maintenance manual.

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.5.2
Power from the UPS should be interrupted when any of the following events occur:
- *the emergency off actuator (button) is pushed; or*
- *the main equipment disconnect is opened; or*
- *the main circuit breaker is opened.*

EXCEPTION: Upon EMO activation, the UPS may supply power to the EMO circuit, safety related devices, and data / alarm logging computer systems as described in the exception Clauses of Paragraph 12.2.

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.5.3
The UPS may be physically located within the footprint of the equipment provided that the UPS is within its own enclosure and is clearly identified.

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.5.4
The UPS should be certified by an accredited testing laboratory and be suitable for its intended environment (e.g., damp location, exposure to corrosives).

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.5.5
The UPS wiring should be identified as "UPS Supply Output" or equivalent at each termination point where the UPS wiring can be disconnected.

NOT APPLICABLE
No UPS is provided for this equipment.

SEMI S2-0715 Paragraph 13.6 Electrical Safety Tests
SEMI S2-0715 Paragraph 13.6.1
Equipment connected to the facility branch circuit with a cord and plug should not exhibit surface leakage current greater than 3.5 milliampere (mA) as determined by testing completed in accordance with "Leakage Current Test for Cord-and-Plug Equipment" in SEMI S22, Testing section.

EXCEPTION: Equipment with leakage current exceeding 3.5 mA is acceptable if documentation is provided to substantiate that the equipment is fully compliant with an applicable product safety standard that explicitly permits a higher leakage current.

NOT APPLICABLE
The system is permanently connected to the facility branch circuit and not powered from a cord and plug.

SEMI S2-0715 Paragraph 13.6.2
Equipment protective grounding circuits should have a measured resistance of one-tenth (0.1) ohm or less as determined by testing in accordance with "Earthing Continuity and Continuity of the Protective Bonding Circuit Test" in SEMI S22.

CONFORMS TO THE STATED CRITERIA
Testing was performed on the equipment in accordance with SEMI S22, section 22.3. The results indicated that the grounding resistance did not exceed 0.1 Ohm. The complete results of the bonding circuit test are provided in Attachment Nine, Intertek Earthing Continuity and Continuity of the Protective Bonding Circuit Test Data Sheet.

SEMI S2-0715 Paragraph 13.7
Equipment in which flammable liquids or gases are used should be assessed to determine if additional precautions (e.g., purging) in the electrical design are necessary.

NOTE 51: NFPA 497 and EN 1127-1 provide methods for making this assessment.

NOT APPLICABLE
The system does not use flammable materials. Therefore, this paragraph is not applicable.

SEMI S2-0715 Section 14 - Fire Protection

SEMI S2-0715 Paragraph 14.1
Overview - This section applies to fire hazards that are internal to the equipment.

REFERENCE ONLY
General Information only.

SEMI S2-0715 Paragraph 14.1.1
This section provides minimum safety considerations for fire protection designs and controls on the equipment.

REFERENCE ONLY
General Information only.

SEMI S2-0715 Paragraph 14.1.2
This section also provides minimum considerations for fire detection and suppression systems when provided with the equipment.

NOTE 52: Detailed guidance on fire risk assessment and mitigation for semiconductor manufacturing equipment is provided in SEMI S14.

REFERENCE ONLY
This statement is provided for reference to define the subject of the section.

SEMI S2-0715 Paragraph 14.2 Risk Assessment
SEMI S2-0715 Paragraph 14.2.1
A documented risk assessment should be performed or accepted by a party qualified to determine and evaluate fire hazards and the potential need for controls. The risk assessment should consider normal operations and reasonably foreseeable single-point failures within the equipment. It should not consider exposure to fire or external ignition sources not within the specified use environment.

NOTE 53: This risk assessment can be combined with the overall hazard analysis performed for this guideline, provided the risk assessor has the required professional expertise to perform risk assessments for fire hazards. SEMI S7 describes qualifications for such an assessor.

CONFORMS TO THE STATED CRITERIA
A Fire Risk Assessment was performed by Intertek on the system as described in Section 2.1 System Scope of this report. This was based on the criteria established in SEMI S14 and the paragraphs in this section to identify potential thermal and non-thermal property and non-property Fire Risk issues during normal operations and during reasonably foreseeable single fault failures (abnormal conditions). This report is included as Attachment Three. All issues identified as a result of this Fire Risk Assessment are documented. Note: As specified in SEMI S2, Paragraphs 6.5 and 14.3.1, issues resulting in significant fire risks based on single failure conditions are also addressed in the appropriate paragraphs of this S2 report.

SEMI S2-0715 Paragraph 14.2.2
If an accurate risk assessment depends on the user's adherence to specified procedures or conditions of use, the supplier should describe such procedures or conditions and state their importance.

ADDRESSED
Issues where hazards have been mitigated by administrative controls (i.e. manuals) have been addressed in applicable sections of this report (not limited to Paragraphs 9.6 and 9.7).

SEMI S2-0715 Paragraph 14.2.3
SEMI S14 should be used to assess and report risks to property and the environment.

CONFORMS TO THE STATED CRITERIA
A Fire Risk Assessment was performed by Intertek on the system as described in Section 2.1 system Scope of this report. This was based on the criteria established in SEMI S14 and the paragraphs in this section to identify potential thermal and non-thermal property and non-property Fire Risk issues during normal operations and during reasonably foreseeable single fault failures (abnormal conditions). This report is included as Attachment Three. All issues identified as a result of this Fire Risk Assessment are documented. Note: As specified in SEMI S2, Paragraphs 6.5 and 14.3.1, issues resulting in significant fire risks based on single failure conditions are also addressed in the appropriate paragraphs of this S2 report.

SEMI S2-0715 Paragraph 14.3 Reporting
SEMI S2-0715 Paragraph 14.3.1
A summary report should be provided to the user. The summary should include the following characterizations, per SEMI S10, for each residual fire hazard identified:

- *the assigned Severity;*
- *the assigned Likelihood; and*
- *the resulting Risk Category.*

CONFORMS TO THE STATED CRITERIA
Intertek prepared a fire risk summary report and the results from it are included in Attachment Three. In addition, the fire risk summary report includes the assigned Severity, Likelihood, and the resulting Risk Category. Note: As specified in SEMI S2, Paragraphs 6.5 and 14.3.1, issues resulting in significant fire risks (i.e., Critical/Very High, High, and Medium Risks) based on single failure conditions are also addressed in the appropriate paragraphs of this S2 report.

Additional assessment was performed during the February 2019 evaluation of the 208V models, which determined that these systems also conform to the stated criteria and that descriptions of the fire risk of the 480V systems also apply to the 208V systems.

SEMI S2-0715 Paragraph 14.3.2
Optional fire risk reduction features should be described in the pre-purchase information provided to the user.

NOT APPLICABLE
There were no optional fire risk reduction features provided for the equipment at the time of the evaluation. Therefore, this requirement is not applicable.

SEMI S2-0715 Paragraph 14.3.3
The scope and effectiveness of the means of fire risk reduction should also be identified and reported, including the expected risk reduction (as described in Paragraph 14.3.1).

ADDRESSED
The scope and effectiveness of the means of the fire risk reduction is addressed in the Final Fire Risk Assessment Report. Refer to Attachment Three.

SEMI S2-0715 Paragraph 14.3.4
If, due to fire hazards within the equipment, thermal or non-thermal (e.g., smoke) damage is possible outside of the equipment, then this possibility should be reported to the user. This report should include a qualitative description of the foreseen scenario.

ADDRESSED
This requirement is addressed in Paragraph 14.3.1.

SEMI S2-0715 Paragraph 14.4 Fire Risk Reduction
SEMI S2-0715 Paragraph 14.4.1
Materials of Construction - Equipment should be constructed of noncombustible materials wherever reasonable. If process chemicals do not permit the use of noncombustible construction, then the equipment should be constructed of materials, suitable for the uses and compatible with the process chemicals used that contributes least to the fire risk.

NOTE 54: Some regional codes (e.g., Uniform Fire Code) may require construction with noncombustible materials.

CONFORMS TO THE STATED CRITERIA
The system is constructed primarily of metal. The polymeric materials used within the enclosures for barriers, wireways and in the construction of internal assemblies have a suitable flame rating for the application.

SEMI S2-0715 Paragraph 14.4.1.1
The flowchart in Appendix 4 may be used for the selection of materials of construction for equipment.

REFERENCE ONLY
This statement is provided for reference only.

SEMI S2-0715 Paragraph 14.4.1.2
Any portion of equipment that falls within the scope of SEMI F14 (Guide for the Design of Gas Source Equipment Enclosures) should be designed in accordance with that guide.

NOT APPLICABLE
The system does not use or contain a gas cylinder enclosure that falls within the scope of SEMI F14. Therefore, this paragraph is not applicable.

SEMI S2-0715 Paragraph 14.4.2
Elimination of Process Chemical Hazards - The option of substituting non-flammable process chemicals for flammable process chemicals should be considered.

NOT APPLICABLE
The equipment does not use any flammable process chemicals; therefore this requirement is not applicable.

SEMI S2-0715 Paragraph 14.4.3 Engineering Controls
SEMI S2-0715 Paragraph 14.4.3.1
Fire risks resulting from process chemicals may be reduced using engineering controls (e.g., preventing improper chemical mixing, preventing temperatures from reaching the flash point).

CONFORMS TO THE STATED CRITERIA
A fire risk assessment was prepared for the Quantum NXT Series, as described in Section 2.1, System Scope of this report. See Attachment Three, Intertek Fire Risk Assessment Summary Report.

SEMI S2-0715 Paragraph 14.4.3.2
Fire risks resulting from materials of construction may be reduced using engineering controls (e.g., non-combustible barriers that separate combustible materials of construction from ignition sources, installing a fire suppression system that extinguishes ignited materials).

ADDRESSED
The use of engineering controls to reduce fire risks resulting from the materials of construction is included in the Final Fire Risk Assessment Report addressed in Paragraph 14.2.1.

SEMI S2-0715 Paragraph 14.4.3.3
Equipment power and chemical sources that present unacceptable fire risks should be interlocked with the fire detection and suppression systems to prevent start-up of the equipment or delivery of chemicals when the fire detection or suppression is inactive.

NOTE 55: Some jurisdictions require interlocking.

NOTE 56: Refer to Paragraph 6.5 for criteria for acceptability.

NOT APPLICABLE
No fire detection/suppression system is provided or is required on the system.

SEMI S2-0715 Paragraph 14.4.3.4
*Shutdown or failure of a fire detection or suppression system need **not** interrupt the processing of product within the equipment by immediately shutting down the equipment, but should prevent additional processing until the fire detection or suppression is restored. Software or hardware may be used for this function.*

NOT APPLICABLE
No fire detection/suppression system is provided or is required on the system.

SEMI S2-0715 Paragraph 14.4.3.5
Controlling smoke by exhausting it (using the supplier-specified equipment exhaust) from the cleanroom may be used to reduce fire risks from the generation of products of combustion. When used, this reduction method should be combined with detection or suppression when flames can be propagated.

NOTE 57: Controlling smoke may be sufficient when smoke is the only consequence (e.g., smoldering components that generate smoke).

NOTE 58: For controlling smoke to be effective, the smoke must be removed not only from the equipment, but also from the cleanroom. This is typically accomplished by using ducted exhaust.

NOTE 59: The use of exhaust to remove smoke may be subject to regulations such as building and fire codes.

NOTE 60: The use of exhaust to remove smoke may create hazards within the exhaust system. Therefore, a description of the expected discharge (i.e., anticipated air flow rate, temperature, and rate of smoke generation) into the exhaust system may be important information for installation of equipment.

ADDRESSED
Thermal and non-thermal fire risk issues are reported in the Fire Risk Assessment Report addressed in Paragraph 14.2.1.

SEMI S2-0715 Paragraph 14.4.4
Fire Detection - The following criteria apply to any fire detection system determined to be appropriate for fire protection by the fire risk assessment.

NOTE 61: Heat detectors, smoke sensing devices, and other devices used solely for monitoring equipment status may not need to meet these requirements. Some local jurisdictions, however, may require that all smoke detectors be connected to building systems and be compliant with all applicable fire alarm codes.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.1
The fire detection system, which includes detectors, alarms and their associated controls, should be certified by an accredited testing laboratory and suitable for the application and for the environment in which it is to be used.

NOTE 62: Such certifications typically require that the components of fire detection systems are readily identifiable and distinguishable from other components in the equipment.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.2
The fire detection, alarm and control system should be installed in accordance with the requirements of the certification in Paragraph 14.4.4.1 and in accordance with requirements of the appropriate international or national codes or standards (e.g., NFPA 72).

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.3
The fire detection system should be capable of interfacing with the facility's alarm system. It may be preferable for the equipment supplier to specify the location and performance of detectors, but not provide them, so that the user may better integrate the detection in the equipment with that in the facility. This alternative should be negotiated explicitly with the user.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.4
The fire detection system should activate alarms audibly and visually at the equipment.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.5
Manual activation capability for the fire detection system should be considered, for the purpose of providing notification to a constantly attended location.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.6
Activation of trouble or supervisory conditions should result in all of the following:
- *notification of the operator;*
- *allowing the completion of processing of substrates in the equipment;*
- *prevention of processing of additional substrates until the trouble or supervisory condition is cleared; and*
- *providing, through an external interface, a signal to the facility monitoring system or a constantly attended location.*

NOTE 63: Some local jurisdictions require that such alarms signal the building/facility fire alarm system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.7
The fire detection system should be capable of operating at all times, including when the equipment is inoperable (e.g., equipment controller problems) or in maintenance modes (e.g., some or all of the equipment's hazardous energies are isolated ("locked out"). For the purposes of this section, "inoperable" includes the equipment state after an EMO is activated, and after the equipment has had its hazardous energies isolated (i.e., has been "locked out"). Therefore, the detection system should not require hazardous voltages (e.g., line alternating current) to operate anything other than the equipment within the detection system's control enclosure. Sensors and other devices outside the detection system's control enclosure should not require hazardous voltage.

EXCEPTION: Operability is not required during maintenance of the fire detection system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.7.1
Power at a hazardous voltage may be supplied to the detection system controller enclosure after the equipment EMO is activated or after the equipment has had its hazardous energies isolated only if the wiring providing the hazardous voltage is separated from other wiring and is suitably labeled.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.7.2
If the hazardous voltage supply to the detection system controller is not disconnected by the energy isolation method that removes the other hazardous voltages from the equipment, there must also be separate hazardous energy isolation capability for the hazardous voltage supplies to the detection system controller enclosure.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.8
A battery or other regulatory agency acceptable emergency power alternative capable of sustaining the detection system for 24 hours, should be provided.

NOTE 64: Back-up power must be provided in accordance with local regulations. The requirements for back-up power vary among jurisdictions.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.9
The fire detection system should remain active following EMO activation.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.10
There may be cases where the internal power supply for a detection system cannot supply power for the full length of extended maintenance procedures (i.e., procedures longer than the expected duration of the back-up power supply). In such cases, the supplier should provide written procedures for either removing the fire hazard or safely supplying power to the fire detection system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.11
Activation of the fire detection system should shut down the equipment within the shortest time period that allows for safe equipment shutdown. This includes shutdown of any fire-related hazard source that could create additional fire risks for the affected module or component.

NOTE 65: See Paragraphs 14.4.3.3 and 14.4.3.4 for related provisions.

EXCEPTION 1: A non-recycling, deadman abort switch is acceptable on detection systems that are used for equipment shutdown, but not on those used for activation of a suppression system.

EXCEPTION 2: Activation of the fire detection system should not remove power from fire and safety systems.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.4.12
The equipment design and configuration should not prevent licensed parties from certifying the design and installation of fire detection systems.

NOTE 66: This is not meant to suggest installation by licensed parties; however, some jurisdictions require fire detection and suppression system installers to be licensed as specified by the jurisdiction.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5
Fire Suppression - The following criteria apply to any fire suppression system determined to be appropriate by the fire risk assessment.

NOTE 67: As a fire detection system is generally required to provide the initiating sequence for the suppression system, it is the intention of this guideline that this be the same fire detection system described in Paragraph 14.4.4.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.1
The fire suppression system, which includes nozzles, actuators, and their associated controls, should be certified by an accredited testing laboratory and suitable for the application and for the environment in which it is to be used.

NOTE 68: Such certifications typically require that the components of fire suppression systems are readily identifiable and distinguishable from other components in the equipment. This includes adequate labeling of piping.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.2
The fire suppression agent should be accepted for the application by an accredited testing laboratory. The suppression agent selection process should include an evaluation of the amount and storage location of the suppression agent and of potential damage to a cleanroom and the environment. The least damaging effective agent should be selected. If more than one agent is effective, the options should be specified to the user so that the user may specify which agent should be provided with the equipment. The supplier should also specify if the user may provide the agent.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.3
The fire suppression agent and delivery system should be designed and installed in accordance with the appropriate international or national standard (e.g., NFPA 12, NFPA 13, NFPA 2001). It may be preferable for the equipment supplier to specify the location and performance of suppression system components, but not provide them, so that the user may better integrate the suppression in the equipment with that in the facility. This alternative should be negotiated explicitly with the user.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.4
The assessment of the equipment to SEMI S2 should include the risks associated with the suppression systems.

NOTE 69: This includes the risks (e.g., chemical exposure, noise, and asphyxiation) introduced by the incorporation of the suppression system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.5
Activation of the fire suppression system should alarm audibly and visually at the equipment. This may be done by the same system that initiates activation.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.6
If the discharge is likely to present a risk to personnel, the alarm should provide adequate time to allow personnel to avoid the hazard of the agent discharge.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.6.1
If there is a confined space in the equipment, the asphyxiation hazard posed by the suppression system should be assessed.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.7
The fire suppression system should be capable of operating at all times, including when equipment is inoperable and during equipment maintenance.

NOTE 70: For the purpose of this section, "inoperable" includes the equipment state after the EMO is activated.

EXCEPTION: Most suppression systems contain sources of hazardous energy. These sources should be capable of being isolated (i.e., "locked out") to protect personnel.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.8
The fire suppression system should remain active following EMO activation.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.9
There may be cases where the internal power supply for a suppression system cannot supply power for the full length of extended maintenance procedures (i.e., procedures longer than the expected duration of the back-up power supply). In such cases, the supplier should provide written procedures for either removing the fire hazard or safely supplying power to the fire suppression system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.10
Allowances can be made to provide for the deactivation of an automatic discharge of the suppression system when in the maintenance mode. Such deactivation switches should be supervised (i.e., if the suppression system is deactivated, there should be an indication to the user and the resumption of production in the equipment should be prevented.)

NOTE 71: Hazardous energies associated with the fire suppression system may be isolated (i.e., "locked out") using an energy isolation procedure (see Paragraph 17) during equipment maintenance.

NOTE 72: The permissibility of deactivation of suppression systems varies among jurisdictions.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.11
A back-up power supply, capable of sustaining the suppression system for 24 hours, should be included where the suppression system requires independent power from the detection system used to activate the suppression.

NOTE 73: The requirements for back-up power vary among jurisdictions.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.12
The fire suppression system should be capable of interfacing with the facility's alarm system. This may be done via the fire detection system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.13
Activation of the fire suppression system should shut down the equipment within the shortest time period that allows for safe equipment shutdown.

NOTE 74: Refer to Paragraphs 14.4.3.3 and 14.4.3.4 for related provisions.

EXCEPTION: Activation of the fire suppression system should not remove power from fire and safety systems.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.14
The fire suppression system should be capable of manual activation, which should shut down the equipment and activate an alarm signal locally and at a constantly attended location.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.15
The fire suppression system should be tested on a representative sample of the equipment. The test procedure should include a suppression agent discharge test, unless precluded for health or environmental reasons. This test may be performed at the equipment supplier's or other similar facility, but should be performed under conditions that adequately duplicate any factors (e.g., equipment exhaust) that may reduce the effectiveness of the suppression. This representative sample need not be fully operational, but should duplicate those factors (e.g., exhaust, air flow) that could negatively affect the performance of the system.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.16
Procedures for controlling access to the suppression agent source (e.g., protecting agent cylinders from disconnection by unauthorized personnel) should be provided.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.17
The equipment design and configuration should not prevent licensed parties from certifying the design and installation of fire suppression systems.

NOTE 75: This is not meant to suggest installation by licensed parties; however, some jurisdictions require fire detection and suppression system installers to be licensed as specified by the jurisdiction.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.18
Installation of Piping for Fire Suppression Agent - The fire suppression piping system should be:
- *made from corrosion-resistant components,*
- *designed to minimize water accumulation around components and control other conditions that promote corrosion, and*
- *designed so mechanical inspections are easily performed.*

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.19
Piping should be designed, installed, and tested to ensure that it is capable of containing the high pressures generated by the discharge of the suppression agent.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.4.5.20
The supplier should provide information necessary for proper field installation of piping.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.5
Warnings and Safe Work Practices - Warnings and safe work practices related to fire detection and suppression features of the equipment (e.g., restrictions on using open flames within range of active fire detection systems, hazardous stored energy in pressurized suppression systems) should be part of the documentation provided by the supplier.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6
Maintenance and Testing of Fire Detection and Suppression Systems - The equipment supplier should provide detailed maintenance and testing procedures for the fire systems provided with each piece of equipment. These procedures should include testing frequency, as well as details of special equipment required for testing.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.1
Chemical generating test apparatus (e.g., canned smoke) should be avoided for cleanroom applications.

NOTE: Information about UV / IR generating sources used for testing fire detection systems may require consideration of Paragraph 25 (Non-Ionizing Radiation).

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.2
The maintenance testing procedure should include testing of the facility interface and verify that all the equipment fire detection and suppression systems are functional.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.3
The detection and suppression systems should be designed so that preventative maintenance of components does not degrade their performance (e.g. by resulting in displacement or destruction of sensors).

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.4
The supplier should document the sound pressure level generated during suppression agent discharge, if the test is performed.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.5
Materials or procedures used for testing and maintenance of the fire detection and suppression system should not degrade the equipment's ability to perform its intended function.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.6.6
Suppliers should describe hazardous energies present in fire detection and suppression systems, and provide instructions for their proper isolation (see Paragraph 17.2).

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Paragraph 14.7
Environmental - Suppliers should provide guidance to users regarding the impact on emissions of any fire suppression agents used in the equipment.

NOT APPLICABLE
No fire detection or suppression systems are provided or required on the system. Therefore, this section is not applicable.

SEMI S2-0715 Section 15 - Process Liquid Heating Systems

NOT APPLICABLE

The system does not contain or use a process liquid heating system (PLHS) as defined in SEMI S3-0306. Therefore, this entire section is not applicable.

SEMI S2-0715 Section 16 - Ergonomics and Human Factors

SEMI S2-0715 Paragraph 16.1
General - Ergonomics and human factors design principles should be incorporated into the development of equipment to identify and eliminate or mitigate ergonomics- and human factors-related hazards.

ADDRESSED
SEMI S8 Safety Guideline for *Ergonomics Engineering of Semiconductor Manufacturing Equipment*, the *SEMATECH Application Guide to SEMI S8-95 (used as a reference for psychophysical data).* and other standard ergonomics guidelines were used to provide reference data for this evaluation. This evaluation was performed using the latest SEMI S8 SESC checklist as a guide.

A complete description of the scope of the ergonomic evaluation is provided in Section 2.3 of this report.

Issues identified as a result of this evaluation are provided below in Paragraph 16.2.

SEMI S2-0715 Paragraph 16.2 Provisions for Conformance
Equipment should be assessed to the guidelines set forth in SEMI S8. The Supplier Ergonomic Success Criteria (SESC; see SEMI S8), or the equivalent, should be used to document the assessment.

REFERENCE ONLY
Intertek performed an ergonomic evaluation based on the SEMI S8/SESC checklist. The complete results of the ergonomic evaluation are provided in Attachment Five, Intertek SESC Checklist, and Attachment Six, Intertek, Ergonomic Data Worksheet. All issues identified are provided below.

CONFORMS TO THE PERFORMANCE GOAL
The system is provided with the following handles with the following locations, features and dimensions:

- All edges are radiused.
- Pistol grip handle located at CB1:
  - Diameter = 1.4 cm (0.5 in.) x 4 cm (1.5 in.)
  - Length = 4 cm (1.5 in.)

The handle does not meet the SEMI S8/SESC, Section 6.6 criteria for Pistol grip handles. Trebor should provide the system with handles that meet the minimum length criteria of 127mm (5.0 in).

This item has been assigned a Risk Rank of 3D - LOW. This is based on a Severity Level of 3 - MODERATE as handles that do not meet the SEMI S8/SESC criteria for handle design may result in hand fatigue and require medical attention, especially in smaller operators when used frequently or for prolonged periods of time. The Likelihood Level is determined to be D - RARE as this handle is not used frequently or for prolonged periods of time. It is also a device actuator and not a weight handling/lifting type handle. An overall Risk Rank of 3D - LOW indicates that this item Conforms to the Performance Goal.

CONFORMS TO THE PERFORMANCE GOAL

The system requires standing posture working space during maintenance and service. The system does not require sitting-on-floor, squatting, kneeling crawl, supine posture, working in prone or crawl space during system maintenance and service. Standing working space clearance specified in the Manual (24" at the rear of the cabinet) is less than the minimum required 27" per SESC Section 7.2.2.

This item has been assigned a Risk Rank of 3D - LOW. This is based on a Severity Level of 3 - MODERATE as insufficient working clearance may lead to muscle strain and loss of work. The Likelihood Level is determined to be D - RARE as this space is used very infrequently, and once the rear panel is removed the clearance increases to within the limits. An overall Risk Rank of 3D - LOW indicates that this item Conforms to the Performance Goal.

SEMI S2-0715 Section 17 - Hazardous Energy Isolation

SEMI S2-0715 Paragraph 17.1 General
SEMI S2-0715 Paragraph 17.1.1
Lockable energy isolation capabilities should be provided for tasks that may result in contact with hazardous energy sources.

ADDRESSED
Electrical lock out and tag out is addressed in Paragraph 17.3 and non-electrical tag out is addressed in Paragraph 17.4.

SEMI S2-0715 Paragraph 17.1.2
Where service tasks may be safely performed on subassemblies, energy isolation devices (e.g. circuit breakers, disconnect switches, manual valves) may be provided for the subassemblies for use as an alternative to shutting down the entire equipment system. The isolation devices should isolate all hazardous energy to the subassemblies and be capable of being locked in the position in which the hazardous energy is isolated.

NOT APPLICABLE
The system is not provided with energy isolation devices at the subassembly level.

SEMI S2-0715 Paragraph 17.1.3
The person actuating or inspecting an energy isolating device should not be exposed to serious risks of tripping or falling or of coming in contact with energized electrical parts, moving machinery, surfaces or objects operating at high temperatures, or other hazardous equipment.

NOTE 1: Hazardous energies include electrical, stored electrical (e.g., capacitors, batteries), chemical, thermal / cryogenic, stored pressure (e.g., pressurized containers), suspended weight, stored mechanical (e.g., springs), generated pressure (e.g., hydraulics and pneumatics), and other sources that may lead to the risk of injury.

NOTE 2: In order to minimize down-time and provide ease of use, it is preferred to have energy isolation devices located in the areas where maintenance or service is performed.

NOTE 3: Energy isolation devices for incompatible hazardous energy sources (e.g., electrical and water, incompatible gases) are recommended to be separated.

NOTE 4: Isolation of hazardous energy may include: deenergizing of hazardous voltage; stopping flow of hazardous production material (HPM); containing HPM reservoirs; depressurizing or containing HPM and pneumatic lines; deenergizing or totally containing hazardous radiation; discharging of residual energy in capacitors; stopping of hazardous moving parts; and shutting off hazardous temperature sources.

NOTE 5: Energy isolation devices with integral locking capabilities are preferred, but may not be feasible or commercially available, in which case detachable lockout adapters may be used.

NOTE 6: See Section 14 for information on fire protection hazardous energies.

ADDRESSED
Refer to paragraph 17.2.2

SEMI S2-0715 Paragraph 17.2 Installation and Maintenance Manuals
SEMI S2-0715 Paragraph 17.2.1
Installation and maintenance manuals should identify the types of hazardous energies within the equipment.

CONFORMS TO THE STATED CRITERIA
The Instruction Manual identifies the types of hazardous energies within the equipment.

SEMI S2-0715 Paragraph 17.2.2
Installation and maintenance manuals should provide specific instructions for the equipment on how to:
- *shut down the equipment in an orderly manner,*
- *locate and operate all the equipment's energy isolating devices,*
- *affix energy isolating ("lockout / tagout") devices,*
- *relieve any stored energies,*
- *verify that the equipment has actually been isolated and deenergized, and*
- *properly release the equipment from its isolated state.*

CONFORMS TO THE STATED CRITERIA
The End User documentation provides specific instructions on how to shut down the system and electrically lock-out and tag-out the system. The End User documentation also provides specific instructions on how to shut down the water and Clean Dry Air.

SEMI S2-0715 Paragraph 17.2.3
Where the manufacturer provides written maintenance procedures for tasks within subassemblies, and intends that these tasks be performed without controlling hazardous energies at the entire equipment level, the installation and maintenance manuals should provide appropriate energy isolation procedures at the subassembly level.

NOT APPLICABLE
The system is intended to be locked out at the entire system level so that lockout of individual assemblies is not required.

SEMI S2-0715 Paragraph 17.3 Electrical Energy Isolation
SEMI S2-0715 Paragraph 17.3.1
The main energy isolation capabilities (equipment supply disconnects) should be in a location that is readily accessible and should be lockable only in the deenergized position.

NOTE: For equipment with multiple incoming supply sources, it is recommended that all of the energy isolation devices be located in one area.

CONFORMS TO THE STATED CRITERIA
The main energy isolation device is in a location, on the front panel, that is readily accessible and the device is lockable only in the deenergized position.

SEMI S2-0715 Paragraph 17.4 Non-Electrical Energy Isolation
SEMI S2-0715 Paragraph 17.4.1
The equipment should include provisions and procedures so that hazardous energy sources, such as pressurized systems and stored energy, can be isolated or reduced to a zero energy state prior to maintenance or service work.

ADDRESSED
Refer to paragraph 17.2.2

SEMI S2-0715 Paragraph 17.4.2
The hazardous energy isolation devices should be in a location that is readily accessible.

ADDRESSED
Refer to paragraph 17.2.2

SEMI S2-0715 Paragraph 17.4.3
The hazardous energy isolation devices should be capable of being locked in the position in which the hazardous energy is isolated.

ADDRESSED
Refer to paragraph 17.2.2

SEMI S2-0715 Section 18 - Mechanical Design

SEMI S2-0715 Paragraph 18.1
This section covers hazards due to the mechanical aspects of the equipment.

NOTE 86: This is similar to the essential requirements of European Union directives. The supplier has the option of demonstrating compliance by choosing standards that are appropriate to the machine and application.

NOTE 87: Pressurized vessels must meet applicable codes and regulations.

REFERENCE ONLY
This statement is provided for reference only

SEMI S2-0715 Paragraph 18.2
All exposed surfaces that personnel are reasonably foreseen to contact should be free of sharp edges and burrs.

CONFORMS TO THE STATED CRITERIA
Reasonably foreseeable, exposed contact surfaces are free of sharp edges and burrs.

SEMI S2-0715 Paragraph 18.3
Machine Stability - Equipment, components and fittings should be designed and constructed so that they are stable under reasonably foreseeable shipping, installation, and operating conditions. The need for special handling devices and anchors should be indicated in the instructions. Unanchored equipment in its installed condition should not overbalance when tilted in any direction to an angle of 10° from its normal position.

NOTE 88: See IEC 61010-1 for an example of stability tests.

CONFORMS TO THE STATED CRITERIA
The documentation specifies a seismic anchoring system to secure the system to the floor. Secured in this way, the system cannot be tilted or become unstable. Unanchored, the tilt over angle of the 208V model is 15.9° when filled with water.

SEMI S2-0715 Paragraph 18.4
Break-up during Operation – The various parts of the equipment and its linkages should be able to withstand the stresses to which they are subjected when used as designed. Precautions should be taken to control risks from falling or flying objects.

CONFORMS TO THE STATED CRITERIA
Moving parts are limited to cooling fans and hazards from flying/falling objects are enclosed within the metal enclosure panels.

SEMI S2-0715 Paragraph 18.4.1
The potential effects of fatigue, aging, corrosion and abrasion for the intended operating environment should be considered as part of the mechanical hazards risk assessment.

CONFORMS TO THE STATED CRITERIA
The equipment is constructed of materials and parts compatible with the stresses to which they will be exposed. Fatigue, aging, corrosion and abrasion have been considered as part of the design of the system.

SEMI S2-0715 Paragraph 18.4.2
Where a risk of rupture or disintegration remains despite the measures taken (e.g., a substrate chuck that loses its vacuum), the moving parts should be mounted and positioned in such a way that, in case of rupture, their fragments will be contained.

CONFORMS TO THE STATED CRITERIA
The moving parts of the system (fans) and those which are subject to pressure (DIW lines) are rated for the application and designed so that they are not likely to degrade or break during normal operation. The system is provided with an overall outer enclosure so that even if one of the assemblies were to break, it would be contained within the overall frame of the system.

SEMI S2-0715 Paragraph 18.4.3
*Both rigid and flexible pipes carrying liquids or gases should be able to withstand the foreseen internal and external stresses and should be **firmly** attached or protected against external stresses and strains. Based on the application, an appropriate factor of safety should be included.*

CONFORMS TO THE STATED CRITERIA
Suitably rated lines are provided for the DIW flowing within the unit. Internal regulators are provided to ensure that the pressure rating of the system components are not exceeded. The lines and hoses are protected from access to moving parts within the system.

SEMI S2-0715 Paragraph 18.5
Moving Parts – The moving parts of equipment should be designed, built and positioned to avoid hazards. Where hazards persist, equipment should be fitted with guards or protective devices that reduce the likelihood of contact that could lead to injury.

CONFORMS TO THE STATED CRITERIA
The moving parts on the system are enclosed within panels which require a tool to remove.

SEMI S2-0715 Paragraph 18.5.1
Where the machine is designed to perform operations under different conditions of use (e.g., different speeds or energy supplies), it should be designed and constructed in such a way that selection and adjustment of these conditions can be performed safely.

CONFORMS TO THE STATED CRITERIA
The equipment is designed to safely operate under any programmable speeds or rated electrical supply.

SEMI S2-0715 Paragraph 18.5.2
Selection of Protection against Hazards Related to Moving Parts – Guards or protective devices used to protect against hazards related to moving parts should be selected on the basis of a risk assessment that includes the:

- *hazards that are being guarded against,*
- *probability of occurrence and severity of injury of each hazard scenario, and*
- *frequency of removal of guards.*

ADDRESSED
Refer to Paragraph 18.5.

SEMI S2-0715 Paragraph 18.5.3
Guards and protection devices. Guards should:

- *reduce the risk that personnel will contact the mechanical hazard to an acceptable level, and*
- *not give rise to additional risk.*

CONFORMS TO THE STATED CRITERIA
The system components that contain moving parts are adequate to contain the moving parts of the system, provide protection against the moving parts and do not give rise to additional risks.

SEMI S2-0715 Paragraph 18.6
Lifting Equipment – Lifting equipment used for maintenance and service of semiconductor manufacturing equipment (SME) should conform to each applicable criterion of Paragraph 18.6 and its subordinate paragraphs.

NOTE 89: The purpose of this section is to encourage that the hazards and potential consequences related to lifting operations (e.g., falling loads, collisions, tipping) be given appropriate consideration during design and development of SME.

EXCEPTION: Lifting equipment that has documentation indicating conformance with an applicable standard, code or regulation need conform to only Paragraph 18.6.3, Paragraph 18.6.4 and their subordinate paragraphs, in addition to the applicable standard, code or regulation.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.1 Lifting Equipment Design Criteria
SEMI S2-0715 Paragraph 18.6.1.1
Mechanical Strength – Lifting equipment should be designed such that it has a minimum factor of safety of 3, with the factor of safety determined as the ratio of yield strength to stress on each component, in the least favorable condition. For the purposes of Paragraph 18.6, "least favorable condition" is the position and orientation of fixed or moveable elements that places the greatest stress on the components of the lifting equipment. It may be necessary to test more than one condition so that each element is tested in its "least favorable" condition. These elements include:

- *Fixed or removable booms,*
- *End effectors or grippers used in conjunction with fixed or removable booms, and*
- *Fixtures designed to provide interconnection between the load and the lifting device, excluding slings.*

NOTE 90: A minimum factor of safety of 3 appears in several standards (e.g., ASME B30.20 Below-the-hook Lifting Device subparagraph 20-1.2.2 General Constructions).

NOTE 91: Other factors of safety are required by codes, laws and regulations, as they pertain to other types of lifting equipment, these must be met as well (e.g., EN 1492 requires a safety factor (SF) of 7 for webbing slings, MIL-STD-1365 B requires a SF of 5 for hoist rings and ASME B18.15M requires a SF of 5 for lifting eyes). Conformance with these criteria for things other than the lifting device is typically evaluated separately from lifting equipment used in support of SME.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.1.2
Materials should be appropriate for their intended use. Materials should be chosen with particular consideration to the effects of corrosion, abrasion, impact and ageing.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.2
Design Verification – The conformance to these criteria should be demonstrated for the particular lifting equipment under consideration or a representative sample thereof.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.2.1
Lifting equipment should undergo testing and verification that includes the following:

- *Classical engineering calculations;*
- *Risk Assessment, such as Failure Modes and Effects Analysis (FMEA) and*
- *Physical Testing, as described below for subsequently produced lifting equipment.*

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.2.2
A written report, including photographs or drawings of how the testing was conducted along with written test specifications and results of all tests should be prepared.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.2.3
Documentation, including the elements in Paragraphs 18.6.1-18.6.2.2 and Paragraph 9.6.3 (user documentation) should be prepared and kept for sufficient time period to support the equipment while in service and for a sufficient period of time (typically a minimum of ten years) after the equipment is placed on the market. Conformance with this criterion may be demonstrated by making the documentation from design verification available to the assessor and providing the assessor evidence that the equipment supplier has a program that will retain the records for an appropriate period.

NOTE 92: Several standards and directives (e.g., ISO 2415 (forged shackles), and 98/37/EC (Machinery Directive)) require keeping records for 10 years or beyond the time the last unit was produced, tested and shipped.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3
Subsequently Produced Lifting Equipment – Each individual piece of lifting equipment should have testing and record keeping specifications in accordance with the criteria for static and dynamic load testing. Test certificates should accompany each unit upon delivery. The supplier should retain a copy of test records for at least 10 years from the date of shipment.

EXCEPTION: Lifting accessories permanently affixed to and tested as a part of a lifting fixture do not need individual testing.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.1 Static Load Testing
SEMI S2-0715 Paragraph 18.6.3.1.1
Static load testing should be conducted on each lifting device at 150% of the rated load and with the mechanical elements of the structure in their least favorable conditions (see Paragraph 18.6.1.1 for guidance as to determining the "least favorable condition")

NOTE 93: Static load test (proof load testing) of a new design is part of the process of validation the design's maximum working load.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.1.2
The static test should be conducted for a minimum of 2 minutes beyond the time that the test load has stabilized (stopping moving).

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.1.3
A static test should be considered acceptable if no permanent deformation or other physical damage is found once the test load has been removed and equipment examined. A static test resulting in damage or abnormality should be considered to be a failed test.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2 Dynamic Load Testing
SEMI S2-0715 Paragraph 18.6.3.2.1
Dynamic load testing should be performed on each lifting device, as this term is defined within this document.

NOTE 94: Dynamic load testing is conducted to confirm that the lifting equipment has been properly assembled, operated with account taken of the dynamic behavior of the lifting equipment and that all operational features, including mechanical stops, limit switches, brakes (if lifted) and all safety related features are fully adjusted and operational.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.2
Dynamic load testing should be performed on lifting fixtures or lifting accessories, only if the number of load cycles to which they are foreseen to be subjected is sufficient to make such testing appropriate.

NOTE 95: The American Welding Society (AWS) Standard D14.1 table 3 considers cyclic loading of 20,000 cycles and below to be equivalent to static loading. Thus, there is no need to consider dynamic testing of welded metal lifting fixtures or lifting accessories if the foreseen number of cycles in the fixture's or accessory's life is less than 20,000.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.3
Dynamic load testing should be conducted;

- *Using 110% of the working (rated) load,*
- *And with the mechanical elements of the structure in their least favorable conditions,*
- *For a minimum of two complete cycles at maximum operational speed of each axis of motion and*
- *If the control circuit allows for a number of simultaneous movements (e.g., rotation and displacement of the load), by combining the movements concerned.*

NOTE 96: for manual actuation of lifting equipment using a crank, it is recommended that the cranking speed be agreed upon by the supplier and evaluator based on the lifting device and the cranking mechanism. Manual cranks are not normally designed to a maximum cranking speed. The intent of this test is to verify that the cranking force is not sufficient to damage the lifting device when the device is exercised throughout its full operational range of motion. It is recommended that an agreed typical person be used to perform the cranking for this evaluation.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4 Acceptance Criteria
SEMI S2-0715 Paragraph 18.6.3.2.4.1
There should be no noticeable signs of improper assembly.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4.2
There should be no noticeable signs of excessive wear

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4.3
There should be no noticeable signs improper operations or incorrect adjustment of operational features, including mechanical stops, limit switches and brakes (if fitted)

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4.4
There should be no noises that indicate a problem other than that a simple adjustment is required.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4.5
All safety features should be operational and perform their intended function

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.3.2.4.6
There should be no permanent set (yielding) of any mechanical or structural member.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.4 Marking Criteria
SEMI S2-0715 Paragraph 18.6.4.1
Lifting equipment should be clearly marked in a lasting and legible manner on a portion of the equipment that cannot be removed.

EXCEPTION: Lifting accessories permanently affixed to and tested as a part of a lifting fixture do not need individual marking

NOTE 97: Components of fixture (e.g., individual components that make-up a larger lifting fixture) that could be used independently of their parent fixtures should be marked.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.4.1.1
There should not be conflicting marks on any piece of lifting equipment. The working (rated) load should be visible and readable from the floor or working position.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.4.1.2
The following minimum information should be included:

- *Name and address of the manufacturer, or registered trade mark,*
- *Working (rated) load,*
- *Date of construction and initial testing of that unit, and*
- *Serial number, if any.*

NOTE 98: There are additional marking requirements, imposed by various standards and regulations, depending on equipment type (e.g., hoist, slings and accessories). The supplier must ensure that such additional information be considered and provided as required. This includes any marking required by directives or regional requirements (e.g., the CE mark for the EU).

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.5 Ergonomic Considerations
SEMI S2-0715 Paragraph 18.6.5.1
Lifting equipment is subject to the ergonomic design and assessment criteria, described elsewhere in this Safety Guideline, that are applicable to the SME. Therefore, ergonomic factors should be considered in the design of lifting equipment.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.5.2
Handles or coupling points should be provided for use on lifting equipment that are to be positioned manually. Handles or coupling points should be positioned such that their use does not promote awkward postures. Postures and space requirements during movement of the lifting equipment should be evaluated as part of the overall ergonomic evaluation of the SME.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.6.5.3
It is recommended that handles or coupling points be provided or identified for manually driven axes in an effort to discourage the user from grabbing the load itself or the hoisting rope to maneuver the load in the horizontal plane. However, there are conditions where the controlling of a load in order to place the load into a specific location or orientation will require the user to grab the load itself and provide guidance. This is acceptable, but it is recommended that moving a load, more than 5cm (2 inches), be done using handles or specific coupling points identified on the lifting device for that purpose.

NOT APPLICABLE
The system is not provided with a lifting device that meets the scope and definition of lifting equipment in SEMI S2 and this Section. Therefore, this entire section is not applicable.

SEMI S2-0715 Paragraph 18.7 Mechanisms Supporting and Moving Hinged Loads
SEMI S2-0715 Paragraph 18.7.1
Applicability of Paragraph 18.7

REFERENCE ONLY
General Information only.

SEMI S2-0715 Paragraph 18.7.1.1
Hinges and mechanisms that are constructed as part of the SME and are intended to support and lift nothing other than their associated hinged loads should conform to each applicable criterion of Paragraph 18.7.

EXCEPTIONS: Hinged loads having a total mass not more than 5kg (11lb).

NOT APPLICABLE
The system is not provided with hinged loads. Therefore, this entire Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.1.2
Other lifting equipment used for maintenance and service of SME and used to lift hinged loads should conform to each applicable criterion of Paragraph 18.6.

NOT APPLICABLE
The system is not provided with hinged loads. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2
There are multiple ways by which the energy for movement of a hinged load can be provided:

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2.1
Direct Human power – Energy for lifting is supplied by a human and at a rate no greater than that at which it is provided by the human. This type includes simple machines (e.g., a handle mounted opposite a hinge) and complex machines (e.g., a winch driven by a human turning a crank handle which drives, through a series of gears, a drum which retracts a cable which, through a series of pulleys, lifts a load).

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2.2
Stored Energy – At least some of the energy for lifting is supplied from a part of the mechanism in which it was stored, such as a spring (including a "gas spring") or a counterweight.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2.3
External Power – Energy for lifting is supplied by an external source, such as an electric motor or pneumatic drive cylinder.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2.4
Combination of direct human power and stored energy.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.2.5
Combination of external power and stored energy.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.3 Design Criteria for Mechanisms Supporting and Moving Hinged Loads
SEMI S2-0715 Paragraph 18.7.3.1
Mechanical Strength – Mechanisms supporting hinged loads (including hinges) should be designed such that they have a minimum factor of safety of 3, where the factor of safety is the ratio of yield strength to stress on each component in the least favorable condition. For the purpose of Paragraph 18.7, "least favorable condition" is the position and orientation of fixed or movable elements that places the greatest stress on the components of the support mechanism.

NOTE 99: Mechanisms supporting hinged loads include hinges; support hardware such as springs, gas-filled shocks, and spring dampeners; mounting hardware; and counterbalance mechanisms. This does not mean for example, a gas-filled shock must be "sized" to hold 3 times the mass of the hinged component if it is used only as an ergonomic assist.

NOTE 100: The "least favorable condition" may differ from component to component. Therefore, more than one position may need to be considered in designing and testing to meet this criterion.

NOTE 101: Failure to follow procedural controls (e.g. not venting chamber or removing hardware) may have a significant affect on these structures. It is recommended that such conditions be fully explored using analysis methods listed in Paragraph 18.7.4.2 or other similar methods designed to identify critical deficiencies within a design or process.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.3.2
Materials should be appropriate for their intended use. Materials should be chosen with particular consideration to the effects of corrosion, abrasion, impact and aging.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4
Design Verification – The conformance to these criteria should be demonstrated for each mechanism supporting a hinged load or a representative sample of each such design.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.1
Ergonomic Considerations – Means of moving hinged loads that use "direct human power" (with or without "stored energy") should be assessed to the applicable sections of Appendix 1 (SESC) of SEMI S8.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.2
Mechanisms supporting and moving hinged loads should undergo verification and testing that includes:

- *Classical engineering calculations;*
- *Risk assessment, such as failure modes and effects analysis (FMEA), and*
- *Physical testing under static and dynamic load*

NOTE 102: "Classical engineering calculations" are calculations based on: dimensions and masses of the components of the mechanism, dimensions and mass of the load, and typical characteristics of the materials of which they are constructed.

NOTE 103: Several standards and directives (e.g., ISO 2415 (forged shackles) and 98/37/EC (Machinery Directive)) require keeping records for 10 years or more beyond the time the last unit was produced, tested and shipped.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.3 Static Load Testing
SEMI S2-0715 Paragraph 18.7.4.3.1
Static load testing should be conducted on mechanisms supporting and moving hinged loads at 150% of the manufacturer's intended configured load and with the mechanical elements of the structure in their least favorable conditions. This may be done prior to full integration, such as by using a test fixture or after full integration.

NOTE 104: The term "full integration" refers to the level of assembly where the moveable part of the hinge is attached to its static hinge portion as required to complete the SME assembly.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.3.2
See Paragraph 18.7.3.1 for guidance as to determining the "least favorable condition."

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.3.3
The static test should be conducted for a minimum of 2 minutes beyond the time that the test load has stabilized (stopped moving).

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.3.4
A static test should be considered acceptable if no permanent deformation or other physical damage is found once the test load has been removed and equipment examined. A static test resulting in damage or abnormality should be considered to be a failed test.

NOTE 105: Static load test (proof load testing) of a new design is part of the process of validating the design's maximum working load.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4 Dynamic Load Testing
SEMI S2-0715 Paragraph 18.7.4.4.1
Dynamic load testing should be conducted on hinged loads at 100 percent of the manufacturer's intended configured load.

NOTE 106: Dynamic load testing is conducted to confirm that equipment has been properly assembled and that all operational features, including mechanical stops, limit switches, brakes (if fitted) and all safety related features are fully adjusted and operational.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.2
Dynamic load testing should be conducted for a minimum of five complete cycles at a maximum operational speed of each axis of motion.

NOTE 107: Dynamic testing of hinged load at 100 percent of the manufacturer's intended configured load is a different test than that specified in section 18.6 for lifting equipment. The latter has a more sever load condition than that stated for hinged loads and as such, may likely highlight areas of concern within two cycles of operation. For testing of hinged loads, it was felt that additional operational cycles should be performed, allowing more opportunity for the mechanism to be exercised and areas of concern amply reviewed.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.3
Dynamic testing using human power should be performed at speeds that do not put the human at unacceptable risk.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4 Acceptance Criteria
SEMI S2-0715 Paragraph 18.7.4.4.4.1
There should be no noticeable signs of improper assembly.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4.2
There should be no noticeable signs of excessive wear.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4.3
There should be no noticeable signs of improper operation or incorrect adjustment of operational features, including mechanical stops, limit switches and brakes (if lifted).

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4.4
There should be no noises that indicate a problem other than that a simple adjustment is required.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4.5
All safety features should be operational and perform their intended function.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.4.4.6
There should be no permanent set (yielding) of any mechanical or structural member.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.5 Documentation of Testing
SEMI S2-0715 Paragraph 18.7.4.5.1
A written report should be prepared and should include:

- *written test specifications,*
- *photographs or drawings of how the testing was conducted, and*
- *results of all tests*

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.4.5.2
Documentation, including the elements in sections Paragraphs 18.7.3 - 18.7.4.5.1 and Paragraph 9.6.3 (user documentation), should be prepared and kept for sufficient time to support the equipment while in service and for sufficient time (typically a minimum of ten years) after the equipment is placed on the market. Conformance with this criterion may be demonstrated by making the documentation from design verification available to the assessor and providing the assessor evidence that the equipment supplier has a program that will retain the records for an appropriate period.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.7.5 Subsequently Produced Lifting Equipment
Each hinged load assembly supporting and moving a hinged load should be tested in accordance with Paragraph 18.7.4.4 and have records kept in accordance with Paragraph 18.7.4.5. Test certificates should accompany each unit upon delivery. The supplier should retain a copy of test records for at least 10 years from the date of shipment.

NOT APPLICABLE
The system is not provided with a moving hinged load. Therefore, this Paragraph is not applicable.

SEMI S2-0715 Paragraph 18.8 Extreme Temperatures
Surfaces that are accessible to personnel and that are at high (per temperature limits in Table 1) or very cold temperatures (below -10°C [14°F]), should be fitted with guards or designed out.

NOT APPLICABLE
Surfaces accessible to personnel were measured and the measured temperatures did not exceed the limits of Table 1 of SEMI S2. Therefore, the test results are acceptable, and the criteria of this paragraph are not applicable. The complete results of the temperature evaluation are provided in Attachment Twelve, Intertek Temperature Test Data Sheet.

SEMI S2-0715 Paragraph 18.8.1

Where it is not feasible to protect or design out the exposures to extreme temperature, temperatures exceeding the limits are permitted, provided that either of the following conditions is met:

- *unintentional contact with such a surface is unlikely, or*
- *the part has a warning indicating that the surface is at a hazardous temperature.*

Table 1 Potentially Hazardous Surface Temperatures

Accessible Parts	*Maximum Surface Temperature, in ˚C*		
	Metal	*Glass, Porcelain, Vitreous Material*	*Plastic, Rubber*
Handles, knobs, grips, etc., held or touched for short periods (5 seconds or less) in normal use	*60*	*70*	*85*
Handles, knobs, grips, etc., held continuously in normal use	*51*	*56*	*60*
External surfaces of equipment, or parts inside the equipment, that may be touched	*65*	*80*	*95*

NOT APPLICABLE

Surfaces accessible to personnel did not exceed the limits of Table 1 of SEMI S2, nor are they very cold. Therefore, the criteria of this paragraph are not applicable.

SEMI S2-0715 Section 19 - Seismic Protection

NOTE: Users have facilities located in areas that are susceptible to seismic activity. The end-user may require more stringent design criteria because of increased site vulnerability (e.g., local soil conditions and building design may produce significantly higher accelerations) and local regulatory requirements. Certified drawings and calculations may be required in some jurisdictions.

SEMI S2-0715 Paragraph 19.1 General

The equipment should be designed to control the risk of injury to personnel, adverse environmental impact, equipment and facility damage due to movement, overturning, or leakage of chemicals (including liquid splashing), during a seismic event. The design should also control equipment damage due to failure of fragile parts (e.g., quartzware, ceramics) during a seismic event.

NOTE 109: These criteria are intended to accomplish two things:
(1) allow equipment suppliers to design correctly the internal frame and components to withstand seismic forces, and (2) allow equipment designers to provide end-users with the information needed to appropriately secure the equipment within their facility.

CONFORMS TO THE STATED CRITERIA

The system has been designed to prevent movement and control risk of injury during a seismic event. Seismic documentation has been provided by Trebor to demonstrate the system is designed to control the risk of injury to personnel, adverse environmental impact, equipment and facility damage due to movement, or overturning during a seismic event. Seismic documentation and analysis of the structural design and the seismic restraints have been provided by Trebor for review. These have been reviewed and were found to conform to the requirements of this paragraph.

SEMI S2-0715 Paragraph 19.1.1

Because preventing all damage to equipment may be impractical, the design should control the failure of parts that may result in increased hazard (e.g., hazardous materials release, fire, projectile).

NOTE 110: It is recommended that the hazard analysis described in section 6.8 be used to evaluate both the risk of part failure and the effectiveness of control measures.

ADDRESSED

This is addressed in Paragraph 19.1.

SEMI S2-0715 Paragraph 19.1.1.1

These parts should be accessible for evaluation of damage.

NOTE 111: SEMI S8 contains guidelines for maintainability and serviceability; these may be used to determine accessibility.

ADDRESSED

This is addressed in Paragraph 19.1.

SEMI S2-0715 Paragraph 19.2 Design Loads
The equipment, subassemblies, and all devices used for anchoring the equipment should be designed as follows:

REFERENCE ONLY
This paragraph provides only reference to the criteria provided in Paragraphs 19.2.1 through 19.2.4.

SEMI S2-0715 Paragraph 19.2.1
For equipment containing hazardous production materials (HPMs), the equipment should be designed to withstand a horizontal loading of 94% of the weight of the equipment, acting at the equipment's center of mass.

NOT APPLICABLE
This equipment does not contain hazardous production materials.

SEMI S2-0715 Paragraph 19.2.2
For equipment not containing HPMs, the equipment should be designed to withstand a horizontal loading of 63% of the weight of the equipment, acting at the equipment's center of mass.

NOTE 112: Subassemblies may include transformers, vessels, power supplies, vacuum pumps, monitors, fire suppression components, or other items of substantial mass that are attached to the equipment.

CONFORMS TO THE STATED CRITERIA
Refer to paragraph 19.1.

SEMI S2-0715 Paragraph 19.2.3
Horizontal loads should be calculated independently on each of the X and Y axes, or on the axis that produces the largest loads on the anchorage points.

CONFORMS TO THE STATED CRITERIA
Seismic restraint calculations been provided to Intertek for review. Horizontal loads were calculated independently on each of the X and Y axes.

SEMI S2-0715 Paragraph 19.2.4

When calculating for overturning, a maximum value of 85% of the weight of the equipment should be used to resist the overturning moment.

NOTE 113: Because equipment may be placed into service anywhere in the world, it is recommended that the seismic protection design of the equipment be based upon requirements that allow the equipment, as designed, to be installed in most sites worldwide. The above loads are based on 1997 Uniform Building Code (UBC) requirements for rigid equipment in Seismic Zone 4, and are assumed to satisfy most design situations worldwide.

NOTE 114: If the equipment or internal component is flexible as defined by the UBC, is located above the mid-height of the building, or is within 5 km of a major active fault, the horizontal design loadings in Paragraphs 19.2.1 and 19.2.2 may not be conservative. Likewise, there are several conditions for which the horizontal design loadings are overly conservative (e.g., rigid equipment with rigid internal components located at grade or sites with favorable soils conditions). For these conditions, designing based on the more detailed approach in the UBC may result in a more economical design. It is recommended that the user engage a professional mechanical, civil, or structural engineer to make these determinations.

CONFORMS TO THE STATED CRITERIA

Seismic restraint calculations were provided to Intertek for review and were found to comply with the requirements of this paragraph.

SEMI S2-0715 Paragraph 19.3

The supplier should provide the following data and procedures to the user. This information should be included in the installation instructions as part of the documentation covered in Section 9:

- *A drawing of the equipment, its support equipment, its connections (e.g., ventilation, water, vacuum, gases) and the anchorage locations identified in Paragraph 19.4.*
- *The type of feet used and their location on a base frame plan drawing.*
- *The weight distribution on each foot.*
- *Physical dimensions, including width, length, and height of each structurally independent module.*
- *Weight and location of the center of mass for each structurally independent module.*
- *Acceptable locations on the equipment frame for anchorage.*

NOTE 115: A "structurally independent module" reacts to seismic loads by transferring substantially all of the loads to its own anchorages, as opposed to transferring the loads to adjacent modules.

CONFORMS TO THE STATED CRITERIA

The information required by this paragraph is provided in the user documentation

SEMI S2-0715 Paragraph 19.4

The locations of the tie-ins, attachments, or seismic anchorage points should be clearly identified.

NOTE 116: It is not the intent of SEMI S2-0715 that the supplier provides the seismic attachment point hardware. Such hardware may be provided as agreed upon between supplier and user.

NOTE 117: It is the responsibility of the user to verify that the vibration isolation, leveling, seismic reinforcing, and load distribution is adequate.

CONFORMS TO THE STATED CRITERIA

The seismic anchorage tie-down points are identified in the documentation. The locations of seismic anchorage points are clearly identified in the installation instructions as part of the documentation covered in Section 9.

SEMI S2-0715 Section 20 - Automated Material Handlers

NOT APPLICABLE

There is no automated material handler associated with the evaluated equipment. This section is not applicable.

SEMI S2-0715 Section 21 - Environmental Considerations

SEMI S2-0715 Paragraph 21.1
This section covers environmental impacts throughout the life of the equipment.

NOTE 1: It is recommended that environmental impacts be balanced against other factors, including safety and health, legal, and regulatory requirements.

NOTE 2: It is recommended that the manufacturer maintain awareness of relevant environmental regulations, either internally or through the user.

NOTE 3: The user is responsible for providing the manufacturer with information regarding any environmental restrictions that are specific to a given site and that may impact equipment design (e.g., cumulative emissions limits, permit requirements, site-specific programs).

NOTE 4: See Section 14 for fire suppression emission issues.

NOTE 5: References to "process" in this section are meant to refer to the baseline process.

REFERENCE ONLY
This paragraph is provided for reference only.

SEMI S2-0715 Paragraph 21.2 Design
SEMI S2-0715 Paragraph 21.2.1
The following design guidelines apply to all phases of equipment life, from concept to decommissioning and disposal.

NOTE: The documentation described in subsections 8.5.3 and 9.4 provide information that can be used for evaluating conformance to this section.

REFERENCE ONLY
This paragraph is provided for reference only.

SEMI S2-0715 Paragraph 21.2.2 Resource Conservation
SEMI S2-0715 Paragraph 21.2.2.1
The manufacturer should consider resource conservation (i.e., reduction, reuse, recycling) during equipment design, for example:

- *water reuse or water recycling within the equipment,*
- *reduced chemical consumption, energy use, and water use (e.g., reducing resource use when no process is occurring),*
- *reduced use of resources during maintenance procedures (e.g., parts cleaning procedures could include minimum rinse rates and rinse times),*
- *recycling or reusing chemicals in the equipment, rather than consuming only new materials,*
- *reducing volume of packaging, increasing recycled content of packaging, and / or designing reusable packaging.*

CONFORMS TO THE STATED CRITERIA
The system is well designed to conserve resources.

SEMI S2-0715 Paragraph 21.2.3 Chemical Selection
SEMI S2-0715 Paragraph 21.2.3.1
Chemical selection for process, maintenance, and utility uses (e.g., gases, enchants, strippers, cleaners, lubricants, and coolants) should take into account effectiveness, environmental impacts, volume, toxicity, by-products, decommissioning, disposal, and recyclability; use of the least hazardous chemical is preferred. To the extent practicable, the utilities, maintenance, and process should be designed so that the equipment operates without the use of:

- *ozone depleting substances (ODSs) as identified by the Montreal Protocol, such as chlorofluorocarbons (CFCs), methyl chloroform, hydro chlorofluorocarbons (HCFCs), and carbon tetrachloride, or*
- *perfluoro compounds (PFCs), including CF_4, C_2F_6, NF_3, C_3F_8, and SF_6, and CHF_3 due to their global warming potential.*

CONFORMS TO THE STATED CRITERIA
The system does not utilize any ODSs, CFCs, HCFCs, or PFCs.

SEMI S2-0715 Paragraph 21.2.4 Prevention and Control of Unintended Releases
SEMI S2-0715 Paragraph 21.2.4.1
Equipment design, including feed, storage, and waste collection systems, should prevent potential unintended releases. At a minimum.

REFERENCE ONLY
This section is provided for reference only, to establish the basic scope for the following criteria.

SEMI S2-0715 Paragraph 21.2.4.2
Secondary containment for liquids should be capable of holding at least 110% (see first row of Table A1-1 of Appendix 1) of the volume of the single largest container, or the largest expected volume for any single point failure.

NOTE: In some circumstances secondary containment may be specified by the equipment supplier, but provided by the user.

NOT APPLICABLE
The system does not store water. A drip pan, approximately ½ inch deep, is located at the bottom of the cabinet with a sensor to detect water leaks. The Leak Sensor will disable heater power immediately and close the water supply valve when water is detected in the leak tray. The drip pan is also fitted with a drain hole and documentation recommends that end users connect this to a facility drain.

SEMI S2-0715 Paragraph 21.2.4.3
Chemical storage containers and secondary containment should be designed for accessibility and easy removal of collected material.

CONFORMS TO THE STATED CRITERIA
There are no storage containers or secondary containment on the system other than the integrated drip pan, which has a drain fitting.

SEMI S2-0715 Paragraph 21.2.4.4
Secondary containment should have alarms and gas detection or liquid sensing, as appropriate, or have recommended sensing points identified in the equipment installation instructions.

CONFORMS TO THE STATED CRITERIA
The drip pan is fitted with a leak sensor that provides an alarm to the operator.

SEMI S2-0715 Paragraph 21.2.4.5
Equipment design should allow personnel to determine all in-equipment container levels conveniently without having to open the containers, where ignorance of the level could result in an inadvertent release.

NOT APPLICABLE
There are no storage containers on the system.

SEMI S2-0715 Paragraph 21.2.4.6
Overfill level detectors and alarms should be provided for in-equipment containers.

NOT APPLICABLE
There are no storage containers on the system. The system is designed to operate at pressure, full, in a closed system.

SEMI S2-0715 Paragraph 21.2.4.7
Secondary containment and other control systems should be designed to ensure that chemicals cannot be combined, where the combination could result in an inadvertent release.

NOT APPLICABLE
Incompatible chemicals were not used.

SEMI S2-0715 Paragraph 21.2.4.8
Equipment components should be compatible with chemicals used in the manufacturing process. Chemical systems should be designed for the specified operating conditions, and have sufficient mechanical strength and corrosion resistance for the intended use.

CONFORMS TO THE STATED CRITERIA
Gas and liquid lines are compatible with the materials used.

SEMI S2-0715 Paragraph 21.2.4.9
Equipment should be able to accept a signal from a monitoring device and stop the supply of chemical, at the first non-manual valve within the affected system.

CONFORMS TO THE STATED CRITERIA
The leak sensor device provides a signal to close the supply valve of the water to the system.

SEMI S2-0715 Paragraph 21.2.4.10
Chemical distribution systems should be capable of automatic shutoff and remote shutdown.

NOT APPLICABLE
The system is not a chemical distribution system.

SEMI S2-0715 Paragraph 21.2.5
Effluents, Wastes, and Emissions

NOTE 1: It is recommended that the manufacturer document its efforts to minimize the equipment's generation of hazardous wastes, solid wastes, wastewater, and air emissions.

NOTE 2: It is recommended that SEMI F5 be used for guidance in gaseous effluent handling.

REFERENCE ONLY
This paragraph is provided for reference only.

SEMI S2-0715 Paragraph 21.2.5.1
Equipment design that allows connection to a central waste collection system is preferred, except where collection at the equipment may facilitate recycling or reuse opportunities or otherwise reduce environmental impacts.

NOTE: It is recommended that individual drains and exhausts be kept separate (e.g., separate outlets for acid drain, solvent drain, deionized (DI) water drain; acid exhaust, solvent exhaust).

NOT APPLICABLE
The system does not generate waste products.

SEMI S2-0715 Paragraph 21.2.5.1.1
Point-of-use collection containers should be designed for accessibility as well as the possible reuse and recycling of the collected materials.

NOT APPLICABLE
No point of use collection containers are used on the tool.

SEMI S2-0715 Paragraph 21.2.5.2
Equipment should use partitions, double-contained lines, or other similar design features to prevent the mixing of incompatible waste streams.

NOT APPLICABLE
The system does not generate waste products.

SEMI S2-0715 Paragraph 21.2.5.3
The manufacturer should evaluate the feasibility of including integrated controls for effluent and emission treatment.

NOT APPLICABLE
The system does not generate waste products.

SEMI S2-0715 Paragraph 21.2.5.4
Dilution in excess of process or safety requirements should not be used to reduce contaminant discharge concentrations.

CONFORMS TO THE STATED CRITERIA
The system does not use any dilution.

SEMI S2-0715 Paragraph 21.2.5.5
Segregation of effluents, wastes, and emissions should be provided in the following cases:

- *where chemically incompatible,*
- *where segregation facilitates recycling or reuse, or*
- *where separate abatement or treatment methods are required.*

NOTE: It is recommended that the equipment design documentation show evidence of consideration of by-products generated during equipment operation, clean-up, maintenance, and repair. By-products can include deposits in drains or ducts, and replaceable parts (e.g., batteries, vapor lamps, contaminated parts).

NOT APPLICABLE
The system does not generate waste products.

SEMI S2-0715 Paragraph 21.2.6 Decommissioning and Disposal
SEMI S2-0715 Paragraph 21.2.6.1
Equipment design should address (see subsection 8.5.3 for documentation provisions) construction material and component reuse, refurbishment, and recycling.

CONFORMS TO THE STATED CRITERIA

The system is constructed of aluminum, steel, and minimal poly components. The system processes only de-ionized water and therefore does not require decontamination prior to recycling or reuse.

SEMI S2-0715 Paragraph 21.2.6.2
The equipment should be designed to facilitate equipment decontamination and disposal, e.g., by use of removable liners or replaceable modules. This includes minimizing the number of parts that become contaminated with hazardous materials.

NOTE: It is recommended that SEMI S12 "Guidelines for Equipment Decontamination" be used for guidance during equipment decontamination.

CONFORMS TO THE STATED CRITERIA
The current process is not expected to produce or deposit films so no removable liners or replaceable modules are needed.

SEMI S2-0715 Section 22 - Exhaust Ventilation

NOT APPLICABLE

The system is not provided with any exhaust ventilation. Therefore, this entire section is not applicable.

SEMI S2-0715 Section 23 - Chemicals

NOT APPLICABLE

The system does not use or generate chemical materials. Therefore, this entire section is not applicable.

SEMI S2-0715 Section 24 - Ionizing Radiation

NOT APPLICABLE

The system does not use, contain, or generate sources of ionizing radiation. Therefore, this entire section is not applicable.

SEMI S2-0715 Section 25 - Non-Ionizing Radiation and Fields

NOT APPLICABLE
The system does not use, contain, or generate emissions of non-ionizing radiation. Therefore, this entire section is not applicable.

Static magnetic fields were measured on the 208V system and found to be within specified limits. Refer to Attachment Fourteen, Static Magnetic Field Survey Test Data Sheet for details.

SEMI S2-0715 Section 26 - Lasers

NOT APPLICABLE

The system does not use or contain laser devices or systems. Therefore, this entire section is not applicable.

SEMI S2-0715 Section 27 - Sound Pressure Level

SEMI S2-0715 Paragraph 27.1
Equipment should be designed to control exposures to sound pressure levels equal to or greater than 80 dB(A) continuous or intermittent sound pressure level, and 120 dB instantaneous (impulse) sound pressure level.

NOTE 155: It is recommended that efforts be made to decrease sound pressure levels as they approach 80 dB(A) (i.e., 77 to 80 dB(A)), due to the additive sound pressure level effects of multiple pieces of equipment in the same vicinity.

CONFORMS TO THE STATED CRITERIA
Intertek performed a sound pressure level survey for the system in accordance with the criteria established in SEMI S2-0715, Paragraph 27.3.1.2 and ANSI S1.13-1995. Measurements were taken one meter from the system and 1.5 meters from floor to represent a standing operator position. During this test, the system was configured as described in Section 2.0 - Scope of Evaluation, in this report. The system was located near reflective or noise generating surfaces such as: walls, other equipment; therefore readings have been corrected for background noise level.

The results of the survey indicated that during normal operation the highest average sound pressure level was measured to be 69.2 dB(A) at the rear of the system. The background noise level was measured to be 63.2 dB(A) and contributed to the resulting sound pressure level for the system.

Based on the sound pressure level survey results, there is no requirement for additional noise control. All corrected readings are clearly below 70 dBA.

The results of the February 2019 survey of the 208V system indicated that during normal operation the highest average sound pressure level was measured to be 78.7 dB(A) at the rear of the system. The background noise level was measured to be 73.7 dB(A) and contributed to the resulting sound pressure level for the system.

Based on the sound pressure level survey results, there is no requirement for additional noise control. All corrected readings are below 80 dBA. Operators are expected to spend less than an hour per shift in the vicinity of the system.

SEMI S2-0715 Paragraph 27.2
The order of preference for controlling exposures is as follows:

27.2.1 Engineering controls (e.g., source sound pressure level reduction, absorption, enclosures, barriers, acoustic dampening) - At a minimum, the design of the engineering controls should consider the sound pressure levels and type, the frequency, and the appropriate control technologies.

27.2.2 Administrative controls - Acceptable administrative controls should be limited to supplemental hazard warning labels and operating procedures.

NOTE 156: Noise labeling is typically implemented as signs located in the users facility.

CONFORMS TO THE STATED CRITERIA
Intertek performed a sound pressure level survey that demonstrated that the engineering controls have controlled exposure to sound pressure levels to below the specified limits.

SEMI S2-0715 Paragraph 27.3
Sound level surveys should be conducted by the manufacturer during equipment development for equipment that may emit hazardous sound pressure levels.

CONFORMS TO THE STATED CRITERIA
Intertek performed a sound pressure level survey that demonstrated that the engineering controls have controlled exposure to sound pressure levels to below the specified limits.

SEMI S2-0715 Paragraph 27.3.1
The survey should be conducted in accordance with a recognized standard. In addition, the following test criteria should be applied:

ADDRESSED
Refer to Paragraph 27.1.

SEMI S2-0715 Paragraph 27.3.1.1
The equipment mode of operation during the sound pressure level tests should simulate as closely as possible the actual modes and operating positions that may be experienced by the equipment user.

ADDRESSED
Refer to Paragraph 27.1.

SEMI S2-0715 Paragraph 27.3.1.2
Measurements should be taken in locations that best simulate actual positions of operators relative to the equipment. As a general guideline, the microphone should be traversed 1 meter from the equipment, 1.2 meters above the ground to simulate seated operators, 1.5 meters above the ground to simulate standing operators and 3.5 meters (or as far as possible) away from the nearest walls or sound-reflecting objects. Measurements are taken 360° around the equipment wherever possible.

NOTE 157: Background level may be subtracted using an accepted method. If the sound pressure level difference is less than 3 dBA, the contribution of the source from the background cannot be adequately distinguished and the survey results would not be valid for values over 80 dBA.

ADDRESSED
Refer to Paragraph 27.1.

Table 2 Sound Pressure Level Test Criteria

Difference between sound pressure level measured with noise source operating and background sound pressure level (dBA)	*Correction to be subtracted from the sound pressure level measured with the noise source operating to obtain the sound pressure level due to noise source alone (dBA)*
3	*3*
4	*2.5*
5	*1.7*
6	*1.3*
7	*1*
8	*0.8*
9	*0.6*
10	*0.4*

SEMI S2-0715 Paragraph 27.3.2
If the measured sound pressure level is less than 70 dB(A), the manufacturer should provide to the evaluator test data documenting sound pressure levels, survey equipment, equipment calibration, test conditions and results.

ADDRESSED
Refer to Paragraph 27.1.

SEMI S2-0715 Paragraph 27.3.3
If the measured sound pressure level is greater than 70 dB(A), the test data should include all of the information in Paragraph 27.3.2 and should also include the expected duration of personnel exposure.

NOT APPLICABLE
Refer to Paragraph 27.1. Measured sound pressure levels, corrected for background noise levels, were less than 70 dB(A) for the 480V system.

SEMI S2-0715 Paragraph 27.3.4
If measured sound pressure level is greater than 75 dB(A), information should be provided in the equipment maintenance manual describing the sound pressure level(s) and location(s).

CONFORMS TO THE STATED CRITERIA
User Manual includes a warning that audio levels can reach 77.0dB(A) at the right side of the heater. Therefore, this paragraph conforms.

Attachment One
Intertek "What-If?" Hazard Analysis Summary Report

Trebor International
Quantum NXT

Intertek "WHAT-IF?" Hazard Analysis Summary Report

Introduction

On October 11, 2017, Intertek performed a "What-If?" Hazard Analysis on the Trebor Quantum NXT Series to determine the potential for deviations from system design intent that could pose increased hazard risk. This method of hazard analysis is discussed by the American Institute of Chemical Engineers (AIChE) in their *Guidelines for Hazard Evaluation Procedures*. In this analysis, the design or operating intent of the system is discussed, and questions (generally beginning with the phrase "What-If?") about possible deviations from design intent are asked. The potential consequences of each pertinent deviation were discussed and evaluated.

On February 14, 2019, Intertek performed a "What-If?" Hazard Analysis on the 208V models of the Trebor Quantum NXT Series to determine the potential for deviations from system design intent that could pose increased hazard risk. This method of hazard analysis is discussed by the American Institute of Chemical Engineers (AIChE) in their *Guidelines for Hazard Evaluation Procedures*. In this analysis, the design or operating intent of the system is discussed, and questions (generally beginning with the phrase "What-If?") about possible deviations from design intent are asked. The potential consequences of each pertinent deviation were discussed and evaluated.

If any single deviation was determined to potentially result in a release of a hazardous material, or other unsafe condition, then that deviation was deemed to be a single point failure and not conformant with the SEMI S2-0715 Guideline.

Scope of the "What-If?" Hazard Analysis

The "What-If?" Hazard Analysis was performed to determine system conformance with the requirement of SEMI S2-0715 that, "no single point failure or operational error should allow immediate exposure of personnel, facilities or community to hazards or directly result in injury, death or equipment loss"; therefore, the analysis focused only on single point failures, and should not be considered a comprehensive process hazard analysis. Hazards which were identified as requiring more than one failure to occur were not studied further (i.e., to determine consequence or actions required).

The documented results are intended to represent the consensus of the "What-If?" team. Intertek did not investigate the veracity or thoroughness of all statements made by Trebor representatives during the "What-If?" session, and accepts no liability for issues which were not identified during the session and which are later found to pose hazardous consequences.

"What-If?"…	Consequence	Protection	Severity	Likelihood	Comments / Actions / Overall Risk
Loss of power	Loss of process control	Valves are NC (normally closed) and heater contactors are normally open (NO) so removal of power shuts off air control pressure to DIW valve to stop flow of DIW and opens heater contactors to deenergize heaters.			None
Power restored to system after power loss	Unexpected start up Electric shock Water leak	No valves are opened nor heaters started until deliberately Reset at button and Enabled (if faults existed) from the control screen and select ON at the screen to energize heaters. LOTO required for system maintenance – personnel access Electrical circuits enclosed – require tool to open hazard labeled door			None
EMO the system	Loss of control Loss of product	Solenoid control valves are NC so EMO activation shuts off operating air to DIW supply valve, closing it, and removes power from heaters via NO contactors. Monitor and PLC power remains.			None

"What-If?"…	Consequence	Protection	Severity	Likelihood	Comments / Actions / Overall Risk
System EMO reset	Unexpected startup	No valves are opened nor heaters started until deliberately Reset at button and Enabled (if faults existed) from the control screen and select ON at the screen to energize heaters. LOTO required for system maintenance – personnel access Electrical circuits enclosed – require tool to open hazard labeled door			None
DIW line seal is compromised	DI Water leaks from the line Slip / trip hazard created System overheats	Leaking water collects in a drip tray where a leak sensor triggers a shutdown command, closing valves and turning off heaters Drip tray to be connected to facility drain by end user IF leak is at supply fittings outside the enclosure, limited control or sensing is provided.			Manual should specify secondary containment for external fittings. Refer to Paragraph 9.6.2.
Loss of or insufficient facility DIW pressure	System overheats Equipment damage Personnel burn	Low pressure switch (15psi) immediately drops heaters, after 10 sec delay if still faulted, creates hard fault (turns off system power) and alarms. Manual restart of system required after low pressure is resolved.			None

"What-If?"…	Consequence	Protection	Severity	Likelihood	Comments / Actions / Overall Risk
Loss of fluid level within system	System overheats Local boiling Equipment damage Personnel burn	Low level switch at top of fluid system outlet manifold immediately drops heaters, after 10 sec delay if still faulted, creates hard fault (turns off system power) and alarms. Manual restart of system required after low level is resolved.			None
High fluid pressure	System overheats Equipment damage Personnel burn	Pressure relief valve opens momentarily (90 psi setting – is adjustable to 100 psi using two tools). Relieves to drain line (to be connected to facility drain system). Continually relieves if needed. No indication or alarm. System tested to hold 120 psi.			None
Low or loss of fluid flow	System overheats Local boiling Equipment damage Personnel burn	Low Flow sensor limits heater output power/duty cycle via software This is a user selectable option			None
Loss of control – PLC fails ON for heater output	System overheats Equipment damage Personnel burn	Overtemperature TCs at heater elements, Overtemperature TCs at SSR heat sinks and back panel. Each of these trip via hardware interlock to protect components. Testing indicated that system shuts down within 2 minutes and surface temperatures do not exceed 70°C.	Severe	Unlikely	Output temperature exceeds 188°C / Specify high temperature (>200°C) parts in facility outlet line / See Paragraph 9.6.2 – Risk: LOW
Loss of control – PLC fails OFF for heater output	Loss of process control	Process does not reach set point temperature No hazard created			None

"What-If?"…	Consequence	Protection	Severity	Likelihood	Comments / Actions / Overall Risk
Loss of cooling fans	System overheats Equipment damage Personnel burn	Overtemperature TCs at SSR heat sinks and back panel. Each of these trip via hardware interlock to protect components. Testing indicated that system shuts down within 10 minutes and surface temperatures do not exceed 65°C.			None
User sets heater output to >95°C	System overheats Equipment damage Personnel burn	Overtemperature control reduced power at 105°C, then 110°C hard fault deenergizes heaters, alarms, and user must manually reset after system cooled to within settings. Accessible temperatures <65°C			None
Heater element fails open	Process control instability Reduced total power	Temperature comparison software alerts user to out of average condition per element			None
Heater element fails short	Electrical components overheat Electric shock	TC overtemperature on each element, protects at 270°C Multiple elements in system and controls maintain average set temperature,			None
Contactor fails closed	Component damage Electric shock Fire	Controls reduce total heater outputs to maintain set temperature 105.3°C overtemperature reduces total output, 110°C hard fault in control system Contactor is NRTL recognized			None

"What-If?"…	Consequence	Protection	Severity	Likelihood	Comments / Actions / Overall Risk
SSR fails shorted	Component damage Electric shock Fire Process instability	Controls reduce total heater outputs to maintain set temperature 105.3°C overtemperature reduces total output, 110°C hard fault in control system SSR is NRTL recognized			None
Contactor fails open	Process instability Reduces other heater element lifetime	Controls increase total heater outputs on other elements to maintain set temperature			None
SSR fails open	Process instability Reduces other heater element lifetime	Controls increase total heater outputs on other elements to maintain set temperature			None
Electrical short to ground	Electric shock	GFCI at main breaker Sub-system circuit breakers provide overcurrent protection Grounded enclosure			None
Electrical short between phases	Equipment damage Overcurrent – arc flash	Sub-system circuit breakers provide overcurrent and short circuit protection Grounded enclosure			None
Main circuit breaker handle is too small	Ergonomic stress related injury	Very infrequently used – for LOTO and system startup, not for control	Moderate	Rare	No action required. Risk Rank = LOW Refer to Paragraph 16.2.
Person opens rear panel while operating	Burn hazard Electric shock	Hot surface shields labeled Energized conductors insulated and not accessible			Rear panel should be hazard alert labeled for hot surfaces within. Refer to Paragraph 10.1.

Attachment Two
SEMI S10
Risk Assessment Methodology

Trebor International
Quantum NXT

Product Safety Risk Assessment Methodology

Introduction

Each issue identified by the product safety evaluation was subjected to a Risk Assessment to assign an Overall Risk Assessment Category to the Issue. The approach used to determine the Risk Assessment Category for each issue was based upon SEMI S10, *Safety Guideline for Risk Assessment*. Using this methodology, two components are assessed, Severity and Likelihood. Severity levels are summarized in Table 1. Table 4 provides some expanded examples of hazards and severity affecting both humans and equipment.

Each issue was also assigned a Likelihood level based upon the five levels in Table 2.

The Overall Risk Assessment Category was determined by using the Combined Severity and Frequency Assessment Matrix presented in Table 3. Using this matrix and the Severity and Likelihood levels, an overall risk category was assigned to each issue.

Table 1
Hazard Severity Groups

Numerical Value	Severity Level	People*	Equipment/ Facility*	Property*
1	Catastrophic	One or more Fatalities	System or Facility Loss	Chemical release with acute, lasting environment or public health impact
2	Severe	Disabling Injury/ Illness	Major subsystem loss or facility damage	Chemical release with temporary environment or public health impact
3	Moderate	Medical Treatment or Restricted Work (OSHA Recordable)	Minor Subsystem loss or facility damage	Chemical release triggering external reporting requirements
4	Minor	First aid Only	Non-serious equipment or facility damage	Chemical release requiring only routine cleanup without reporting

*These descriptions are provided for example only. Other descriptions may be used that are appropriate for each specific application.

Table 2
Hazard Likelihood Groups

Alphabetical Value	Likelihood Level	Expected Rate of Occurrence (% of Units / Year)*
A	Frequent	More than 1%
B	Likely	More than 0.2%, but not more than 1%
C	Possible	More than 0.04%, but not more than 0.2%
D	Rare	More than 0.02%, but not more than 0.04%
E	Unlikely	More than 0.002%, but not more than 0.02%
F	Not Reasonably Foreseeable	Not more than 0.002%

Note: The frequency (in percent) is calculated by dividing the number of (observed or expected) occurrences by the number of unit-years that the hazard has existed or is anticipated to exist, then multiplying the quotient by 100.

If data are available, they should be used. If data are not available, the frequencies should be estimated.

Example Calculations:

1. If an incident has occurred or is expected to occur 1 time in 5 units over 6 years:
   (1 time/ (5 units x 6 years)) x 100% = 3.3% = A – Frequent

2. If an incident has occurred or is expected to occur 2 times on 50 units with 30 operated for 6 years and 20 have operated for 7 years:
   (2 times/ (30 units x 6 years + 20 units x 7 years)) x 100% = 0.625% = B – Likely.

Table 3
Overall Risk Assessment Category
Combined Severity and Frequency Assessment Matrix

The overall ranking was based upon the two components using a matrix from SEMI S10.

Risk Assessment Matrix	Likelihood					
Severity	**A Frequent**	**B Likely**	**C Possible**	**D Rare**	**E Unlikely**	**F Not Reasonably Foreseeable**
1. Catastrophic	**Very High**	**Very High**	**High**	**Medium**	**Low**	**Very Low**
2. Severe	**Very High**	**High**	**Medium**	**Low**	**Low**	**Very Low**
3. Moderate	**High**	**Medium**	**Low**	**Low**	**Very Low**	**Very Low**
4. Minor	**Low**	**Low**	**Low**	**Very Low**	**Very Low**	**Very Low**

	Very High	=	1A, 2A, 1B
	High	=	3A, 2B, 1C
	Medium	=	3B, 2C, 1D
	Low	=	4A, 4B, 4C, 3C, 3D, 2D, 2E, 1E
	Very Low	=	4D, 4E, 3E, F1, F2, F3, F4

RISK RANKING MATRIX		***LIKELIHOOD***					
		FREQUENT A	***LIKELY B***	***POSSIBLE C***	***RARE D***	***UNLIKELY E***	***NOT REASONABLY FORESEEABLE F***
SEVERITY	Catastrophic 1	Very High	Very High	High	Medium	Low	Very Low[#1]
	SEVERE 2	Very High	High	Medium	Low	Low	Very Low[#1]
	MODERATE 3	High	Medium	Low	Low	Very Low	Very Low[#1]
	MINOR 4	Low	Low	Low	Very Low	Very Low	Very Low[#1]

#1 The Severity group does not need to be determined for outcomes of Likelihood group F, because the Risk is Very Low for all of the Severity Groups.

Table 4
Expanded Hazard and Severity Examples

Hazard Severity		Hazard Type			
		Electrical	**Mechanical**	**Chemical**	**Radiation**
Catastrophic	H:	Electrocution	Paralysis / death	Arsine fatality	Radiation fatality
	E:	Mainframe fire	Structural failure of monolith	Toxic / flammable release into fab	EMI fails exhaust switching system
Severe	H:	Cutaneous burn	Eye / limb loss	HF bone damage	Cataracts
	E:	Heat exchanger frame fire	Structural failure of remote frame	Chamber / pump reaction & damage	Magnetron failure due to no plasma
Moderate	H:	Shock	Strain / sprain	Acid spill with burn	Sunburn symptom
	E:	Major PCB, transformer or connector fire	RF generator bracket falls	Gas contamination of line	EMI causes Robot movement and broken susceptor
Minor	H:	Startle	Minor cut on extremity	Solvent exposure to skin	Sunburn exposure > TLV
	E:	Burnt PCB or connector	Susceptor blade breaks in slit valve	Contained TEOS spill within hotbox	EMI causes door to move

H = Human
E = Equipment

Attachment Three
Fire Risk Assessment
Summary Report

Trebor International
Quantum NXT

Introduction

On October 11, 2016, Intertek performed a fire risk analysis on the Quantum NXT DI Water Heater Series. The system scope and description is provided in Sections 2.0 and 3.0 of this SEMI S2-0715 report. The evaluation was based upon information provided by Trebor International and a visual inspection of the system. The information provided by Trebor International included technical information regarding the fire ratings of the components and assemblies that may be potential fuel sources. The fuel sources considered include the materials of construction and the baseline process and maintenance materials used as defined in the system scope and description. Testing of the system or individual materials was not performed as part of the evaluation. The findings from the fire risk assessment / evaluation are presented in the following tables.

This fire risk assessment was performed using the criteria established by the Semiconductor Equipment and Materials International, *Safety Guidelines for Fire Risk and Mitigation for Semiconductor Manufacturing Equipment* (SEMI S14 Guidelines) and the criteria in SEMI S2-0715 Section 14, Fire Protection.

As specified by SEMI S14, the fire risk assessment addressed design issues related to fires which originate inside of the system under normal conditions or reasonably foreseeable (abnormal) single point failure conditions. It did not address issues associated with fires which originate outside of the system, nor abnormal conditions that require more than one failure.

The assessment considered potential thermal and non-thermal hazards (e.g., smoke) resulting in property damage or loss of use of the equipment or of the facility. In addition, as specified by SEMI S2, the fire risk assessment also included the potential hazards to human exposure resulting from fire or smoke.

Intertek Fire Risk Assessment Report
Property Damage and Personnel Exposure

Item No.: 1
Location:

Fuel Sources	Controls / Mitigating Factors
• Electrical Components	• All are approved by an Accredited Testing Laboratory
• Electrical Conductors	• Insulation is flame rated, VW-1

Intertek Fire Risk Assessment Report
Property Damage and Personnel Exposure

Normal Condition Equipment operating under normal parameters	
Ignition Source	Normal Power
Fire Severity - most severe group marked by asterisk (*)	
Equipment Damage	None
Equipment Loss of Use	None
Facility Loss of Use	None
Env. / Prop. Contamination	None
Fire Likelihood	N/A
Smoke Severity - most severe group marked by asterisk (*)	
Equipment Damage	None
Equipment Loss of Use	None
Facility Loss of Use	None
Env. / Property Contamination	None
Smoke Likelihood	N/A
Overall Residual Risk Rank	
Fire Risk	No Fire Risk is likely
Smoke Risk	No Smoke Risk is likely

Abnormal Condition Equipment failure	
Ignition Source	Electrical spark Short circuit
Fire Severity – most severe group marked by asterisk (*)	
Equipment Damage	2* - Severe – Electrical compartment is considered to be a major component of the system
Equipment Loss of Use	3 - Moderate – component replacements would require no more than one week
Facility Loss of Use	4 - Minor
Env. / Property Contamination	4 – Minor
Fire Likelihood	E – UNLIKELY
Smoke Severity – most Severe Group marked by asterisk (*)	
Equipment Damage	2* - Severe – Electrical compartment is considered to be a major component of the system
Equipment Loss of Use	3 - Moderate – component replacements would require no more than one week
Facility Loss of Use	4 - Minor
Env. / Property Contamination	4 – Minor
Smoke Likelihood	E – UNLIKELY
Overall Residual Risk Rank	
Fire Risk **2E – Low**	The Electrical compartment contains electrical assemblies which may result in a fire in the event of a short circuit or overload. Based on the fire risk analysis performed by Intertek, the resulting residual fire risk is determined to be: 2E - LOW. This is based on a severity level of 2 - SEVERE based on the fact the Electrical compartment would be damaged after the fire occurs due to the components failure. The fire could cause severe equipment damage. The Likelihood is determined to be E – UNLIKELY as all components are approved and used within their ratings.
Smoke Risk **2E –Low**	The Electrical compartment contains electrical assemblies which may result in smoke in the event of a short circuit or overload. Based on the fire risk analysis performed by Intertek, the resulting residual smoke risk is determined to be: 2E - LOW This is based on a severity level of 2 - SEVERE based on the fact the Electrical compartment would be damaged after the smoke occurs due to the components failure. The smoke could cause severe equipment damage. The Likelihood is determined to be E – UNLIKELY as all components are approved and used within their ratings

Intertek Fire Risk Assessment Report
Property Damage and Personnel Exposure

Personnel Exposure Normal & Abnormal condition	
Ignition Source	Electrical spark Short circuit
Fire Severity	
Normal Operation	None
Abnormal* Condition	None – any fire will be contained within the metal enclosure of the unit
Fire Likelihood	N/A
Smoke Severity	
Normal Operation	None
Abnormal* Condition	4 – Minor; Smoke may cause minor irritation.
Smoke Likelihood	E – UNLIKELY as all components are approved and used within their ratings
Overall Residual Risk Rank	
Fire Risk **None**	N/A
Smoke Risk **4E – SLIGHT**	The Electrical compartment contains electrical assemblies which may result in smoke in the event of a short circuit or overload. Based on the fire risk analysis performed by Intertek, the resulting residual smoke risk is determined to be: 4E - SLIGHT. This is based on a severity level of 4 – MINOR based on the potential for smoke exiting the enclosure through the openings and causing minor irritation to personnel in the area. The Likelihood is determined E – UNLIKELY as all components are approved and used within their ratings

Attachment Four
Fire Risk Assessment Methodology

Trebor International
Quantum NXT

Fire Risk Assessment Methodology

Introduction

Each Issue identified by the Fire Risk Assessment evaluation was subjected to a Risk Assessment to assign an Overall Risk Assessment Category to the Issue. The approach used to determine the Risk Assessment Category for each issue was based upon SEMI S14, *Safety Guidelines for Fire Risk Assessment and Mitigation for Semiconductor Manufacturing Equipment*. Using this methodology, two components are assessed; Severity and Likelihood. Severity levels are summarized in Table 1. Likelihood Levels are summarized in Table 2. Table 3 summarizes the combined Fire Risk ranking.

Each issue was assigned a Severity Level using the four categories in Table 1 based on the most reasonable and foreseeable single-point failure that may result in fire or smoke. The Likelihood Level using the five categories in Table 2 is based on information provided by the equipment supplier during the fire risk assessment. The Overall Fire Risk Rank is based on the combining the Severity and Likelihood Levels in matrix form in Table 3.

Table 1
Fire Hazard Severity Groups

Severity Group	(S1) Equipment Physical Damage	(S2) Equipment Loss of Use	(S3) Facility Loss of Use (minimum times)	(S4) Environmental and Real Property Contamination
1. Catastrophic	loss of entire piece of equipment	one year	one week	Lasting facility or environmental impact
2. Severe	loss of major subsystem	one month	one day	Temporary facility or environmental impact
3. Moderate	loss of minor subsystem	one week	one shift	Limited to the equipment, but requiring more than routine cleanup
4. Minor	non-serious equipment loss	one day	less than one shift	Requiring routine cleanup but not external reporting

The severity should be assigned for each category:

1. Equipment Physical Damage
2. Equipment Loss of Use
3. Facility Loss of Use (minimum times)
4. Environmental and Real Property Contamination

Only the most SEVERE Group should be used in determining the risk. However, each of the Severity Groups should be reported.

Table 2
Fire Hazard Likelihood Groups

Likelihood Group	Expected Frequency (% of system per Year)
A. Frequent	More than 1%
B. Likely	More than 0.2% but no more than 1%
C. Possible	More than 0.04% but no more than 0.2%
D. Rare	More than 0.02% but no more than 0.04%
E. Unlikely	Not more than 0.02%

Table 3
Overall Fire Risk Ranking

The overall ranking was based upon the two components using a matrix from SEMI S14.

Severity	Likelihood				
	A. Frequent	B. Likely	C. Possible	D. Rare	E. Unlikely
1. Catastrophic	Critical	Critical	High	Medium	Low
2. Severe	Critical	High	Medium	Low	Low
3. Moderate	High	Medium	Low	Low	Slight
4. Minor	Medium	Low	Low	Slight	Slight

Attachment Five
SEMI S8 SESC Checklist

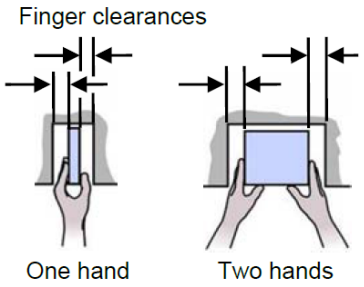
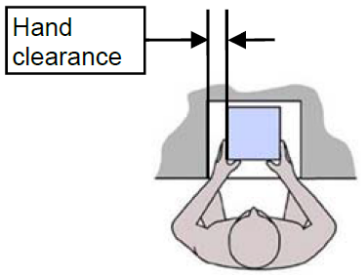
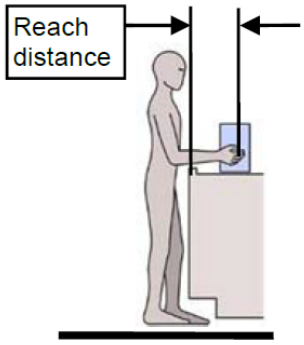
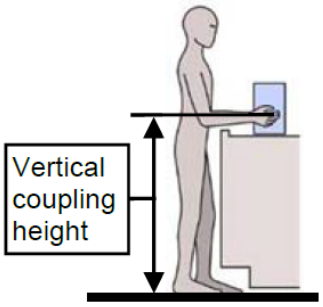
Trebor International
Quantum NXT

Supplier Ergonomic Success Criteria (SESC)
SEMI S8-0915

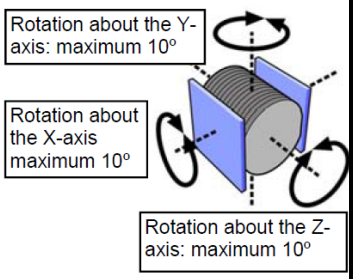
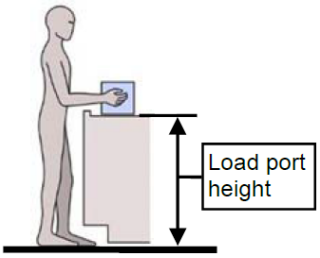
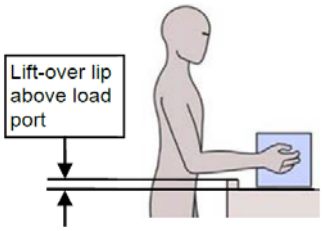
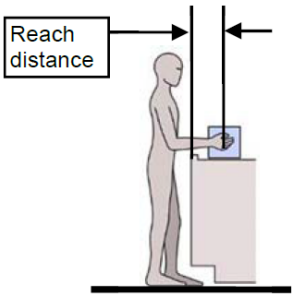
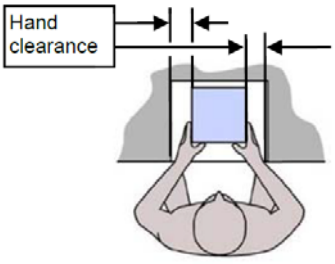
Equipment: Quantum NXT
Serial Number: Pilot Run
Analyst: Ronald R. Wellman
Date: October 11, 2016
Frame Reference: 2.0" from the floor
4 cm (1.6 inches) from the floor for 208V unit, evaluated February 12-13, 2019

Section 1: Manual Material Handling			
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**
1.1	Potentially hazardous manual material handling tasks performed as part of operations, maintenance, or service is analyzed utilizing appropriate procedures. NOTE: Two hand lifting or lowering tasks should be analyzed: if the object being handled weighs more than 44.5 N (10 lbf); OR, if the object weighs more than 22.2 N (5 lbf) and the anticipated frequency is greater than 1 lift every 5 minutes. See Appendix 2 for further information.	Analysis and results documentation. SEMI S8-0915, Table A2-2, Appendix 2, or the equivalent, should be used to document two-hand lift/lower analysis.	

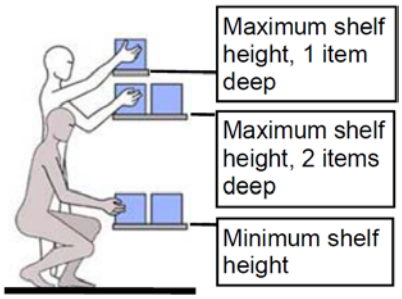
NOT APPLICABLE
There are no manual handling tasks associated with this system that meet the criteria in Section 1 above.

Section 2: Product Loading in a Standing Posture **(Applicable to all media other than wafer cassettes including JEDEC trays, magazines, and reticle cassettes.)**				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
2.1	Clearance provided for finger thickness	Minimum 38 mm (1.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
2.2	Clearance provided for hand thickness.	Minimum 76 mm (3.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
2.3	Reach distance measured from the leading edge of the tool or obstruction to the hand / product coupling point(s).	Maximum 330 mm (13 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
2.4	Vertical coupling point of hand to product in load position	Maximum 1010 mm (40 in) Minimum 890 mm (35 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

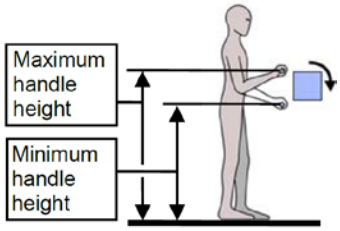
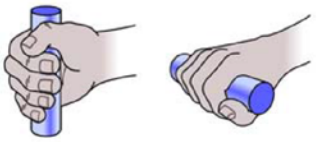
NOT APPLICABLE
The system does not require product loading in a standing position.

Section 3: Wafer Cassette Loading				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
3.1	Wafer cassette loading should not require greater than 10° cassette rotation in any axis. *Note: Unless otherwise specified, you should assume that 200 mm or smaller wafers are transported in the vertical orientation and that 300 mm wafers are transported in the horizontal orientation.*	Less than 10° rotation in any axis.	**Wafer cassette shown in the manual carrying orientation** 	Measurement: Conforms? ☐Yes ☐No ☒N/A
3.2	Load port height, vertical distance from standing surface (150 - 200 mm wafers).	maximum 960 mm (38 in) minimum 890 mm (35 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
3.3	Maximum lip height in front of cassette load port over which cassette is lifted (150 - 200 mm wafer cassettes only). Measure lip height from the load surface.	maximum 30 mm (1.2 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
3.4	Reach distance from the leading edge of the tool or obstruction to the coupling point(s) on rotation device or the product grasp point.	maximum 330 mm (13 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
3.5	Minimum hand clearance on either side of the cassette, measured from the side of the cassette to the nearest adjacent object.	minimum 76 mm (3.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE
The system does not use wafer cassettes.

Section 4: Work in Process Storage (specific to wafer cassettes)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
4.1	Integral wafer cassette / lot box storage shelf height (150 and 200 mm [6 and 8 in.] wafer cassette / lot boxes only).	Maximum (1 item deep) 1520 mm (60 in) Maximum (2 items deep) 1220 mm (48 in) Minimum 460 mm (18 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE
The system has no work in process storage.

Section 5: Manual Wafer Cassette Rotation Device Design				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
5.1	Handle height, couple point for hand(s) from standing surface.	Maximum 1206 mm (47.5 in) Minimum 838 mm (33 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
5.2	Hand grip(s) shall allow for a full "power grip" similar to grabbing a rung on a ladder or holding a pistol.	Allows for a full power grip in either pronated (palm facing down) or neutral (handshake position) posture.	Power grip examples 	Measurement: Conforms? ☐Yes ☐No ☒N/A
5.3	Single hand lift force	Maximum 37.8 N (8.5 lbf.) This value includes a 15% capacity reduction due to clean room glove use. Wrist deviation reduces further strength capacity by 15%	-	Measurement: Conforms? ☐Yes ☐No ☒N/A
5.4	Two hand lift force	Maximum 64.5 N (14.5 lbf.) This value includes a 15% capacity reduction due to clean room glove use. Wrist deviation reduces further strength capacity by 15%	-	Measurement: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE
The system has no manual wafer cassette rotation devices.

Section 6: Handle Design

Dimensions of handles and knobs to which one needs to apply less than:

- Linear force: 13 N (3 lbf)
- Torque: 0.43 N-m (3.8 lbf-in.)
-

do not need to be assessed to the criteria in this section.

Sections 5.1 and 9 should be used to assess the location of all handles and knobs regardless of the force required. Unless otherwise noted, the provided dimensions are acceptable for use with or without gloves.
If a handle is used for both machine operation and maintenance/service tasks then apply the operational criteria.
Forces provided in §§ 6.7.1, 6.8.1, and 6.9.1 are for hand-handle and hand-knob interface only and might exceed the maximum recommended forces for performing a task based on the appropriate analysis tool. See Appendix 2 for a list of lifting, strength, and material handling analysis tools.

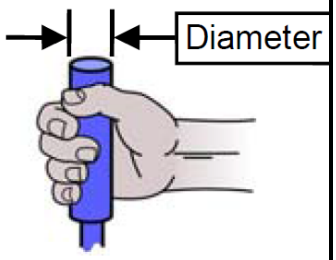
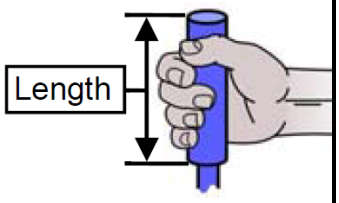
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
6.1	Handle surface finish	All edges radiused	-	Measurement: Conforms? ☒Yes ☐No ☐N/A

CONFORMS TO THE STATED CRITERIA

All system handle edges are radiused.

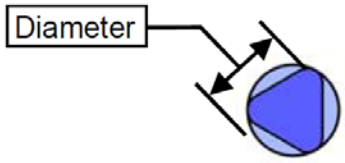
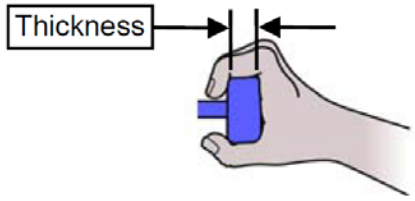
Section 6.2: Cylindrical Handle

(Handle dimensions are correct for use of bare hand or use of typical clean room gloves)

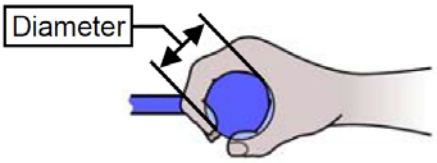
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
6.2.1	Cylindrical handle diameter (D)	Maximum 38 mm (1.5 in) Minimum 25 mm (1.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
6.2.2	Cylindrical handle length (L)	Minimum 127 mm (5.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE

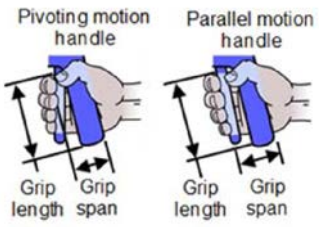
The system does not have cylindrical handles.

Section 6.3: Circular or Triangular Handle (Handle dimensions are correct for use of bare hand or use of typical clean room gloves)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
6.3.1	Circular or triangular handle diameter (D)	Maximum 90 mm (3.5 in) Minimum 50 mm (2.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
6.3.2	Circular or triangular handle height (thickness) (H)	Maximum 25 mm (1.0 in) Minimum 19 mm (0.75 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

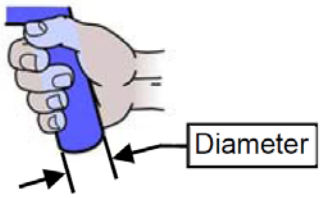
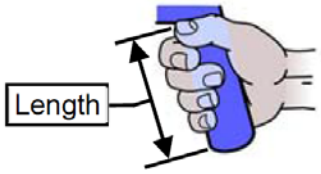
NOT APPLICABLE
The system does not have circular or triangular handles.

Section 6.4: Ball Handle (Handle dimensions are correct for use of bare hand or use of typical clean room gloves)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
6.4.1	Ball handle diameter (D)	Maximum 63 mm (2.5 in) Minimum 38 mm (1.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE
The system does not have ball handles.

Section 6.5: Squeeze Grip Handle (Handle dimensions are correct for use of bare hand or use of typical clean room gloves)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
6.5.1	Squeeze Grip handle grip span (S) Handle sections need not be cylindrical. Measurement taken at the maximum grip span of handle measured at the user's middle finger.	Maximum 89 mm (3.5 in) open Minimum 38 mm (1.5 in) closed		Measurement: Conforms? ☐Yes ☐No ☒N/A
6.5.2	Squeeze Grip handle length (L)	Minimum 127 mm (5.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

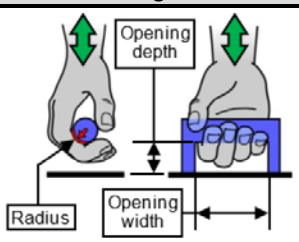
NOT APPLICABLE
The system does not have squeeze grip handles.

Section 6.6 Pistol Grip Handle (Handle dimensions are correct for use of bare hand or use of typical clean room gloves)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
6.6.1	Pistol grip handle diameter (D)	Maximum 63 mm (2.5 in) Minimum 38 mm (1.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
6.6.2	Pistol grip handle length (L)	Minimum 127 mm (5.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

ADDRESSED
Issues related to this criterion are addressed in Paragraph 16.2.

Section 6.7: Enclosed Handle

Guidelines for the design of optimum enclosed handles with a round section are provided in section 6.7.1. Use of cleanroom gloves with knit liners is assumed. Enclosed handles that do not meet the design criteria in section 6.7.1 should be assessed using the instructions and data provided in Appendix 3, Enclosed Handle Assessment Criteria.

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
6.7.1	Enclosed handle, full hand power grip (Suitcase Handle).	Opening width, minimum 122 mm (4.8 in.) Opening depth, minimum 41 mm (1.6 in.) Maximum push/pull force		Force: Opening depth: Opening width: Radius: Conforms? ☐Yes ☐No ☒N/A

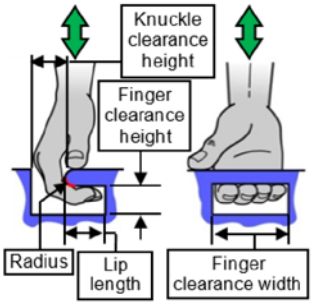
Operational tasks	
Radius, min.	Force, max.
3.1 mm (0.12 in.)	33 N (7.4 lbf)
6.5 mm (0.25 in.)	72 N (16.1 lbf)
10 mm (0.39 in.)	110 N (24.8 lbf)
Maintenance/service tasks	
3.1 mm (0.12 in.)	88 N (19.8 lbf)
6.5 mm (0.25 in.)	191 N (42.9 lbf)
10 mm (0.39 in.)	294 N (66.1 lbf)

NOT APPLICABLE

The system does not have full hand power grip handles.

Section 6.8: Hook Grasp Handle

Hook grasp handles that do not meet the design criteria in section 6.8.1 should be assessed using the instructions and data provided in Appendix 3, Enclosed Handle Assessment Criteria.

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
6.8.1	Hook Grasp Handle (four fingers)	Finger clearance width, minimum 97 mm (3.8 in.) Finger clearance height, minimum 28 mm (1.1 in.) Knuckle clearance height, minimum 48 mm (1.9 in.) Lip length, minimum 49 mm (1.9 in.) Maximum push/pull force		Force: Finger clearance height: Finger clearance width: Radius: Lip: Knuckle clearance height: Conforms? ☐Yes ☐No ☒N/A

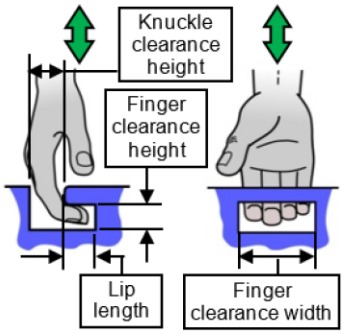
Operational tasks	
Radius, min.	Force, max.
6.3 mm (0.25 in.)	15 N (3.5 lbf)
13 mm (0.5 in.)	33 N (7.5 lbf)
19 mm (0.75 in.)	51 N (11.5 lbf)
Maintenance/service tasks	
6.3 mm (0.25 in.)	41 N (9.3 lbf)
13 mm (0.5 in.)	89 N (20.1 lbf)
19 mm (0.75 in.)	137 N (30.9) lbf)

NOT APPLICABLE

The system is not provided with four fingers, hook grasp handles.

Section 6.9: Finger Pull Handle

Finger pull handles that do not meet the design criteria in section 6.9.1 should be assessed using the instructions and data provided in Appendix 3, Enclosed Handle Assessment Criteria.

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
6.9.1	Finger pull handles (four fingers)	Finger clearance width, minimum 91 mm (3.6 in.) Finger clearance height, minimum 22 mm (0.8 in.) Knuckle clearance height, minimum 28 mm (1.1 in.) Lip length, minimum 18 mm (0.7 in.) Maximum push/pull force Operational tasks: 36 N (8.1 lbf) all radii Maintenance/service tasks: 97 N (21.7 lbf) all radii		Force: Finger clearance height: Finger clearance width: Lip Length: Knuckle clearance height: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE

The system is not provided with four fingers, pull handles.

Section 7: Clearance Criteria

Equipment may extend into the recommended clearance envelopes provided that the assessor captures in the assessment report a rationale demonstrating that the impinging object(s) will not interfere with the task or tasks for which clearance is being evaluated. The rationale should give consideration to at least the following points:

- 95th percentile North American male body dimensions,
- Line-of-sight vision required throughout the task(s),
- Anticipated body motions (e.g., turning, reaching) during the task(s).

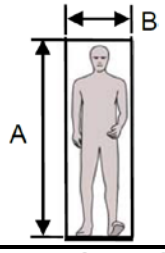
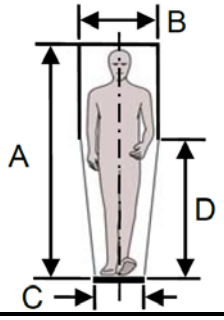
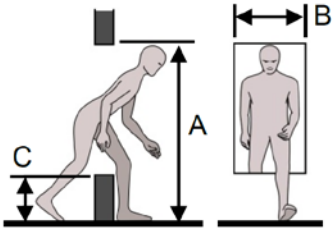
The following clearance criteria for design and assessment do not include consideration of the tools, materials, and devices identified by the supplier to be moved and used in the course of the task, and personal protective equipment recommended by the supplier to be worn by workers during the task(s). Additional clearance should be provided for these considerations.

These criteria are limited to the equipment structure as provided, and installed per supplier instructions. If a horizontal dimension extends outside the envelope of the equipment, as provided, then the excursion should be included in the equipment ergonomics clearances (see for example SEMI S8, paragraph 7.3). Clearance around the equipment (ergonomic clearance), per the supplier's specifications, may be considered in determining conformance as applicable.

Clearances should be approached from a task analysis point of view. Clearances should be provided based on the nature of the tasks performed in the designated area.

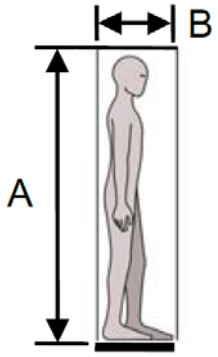
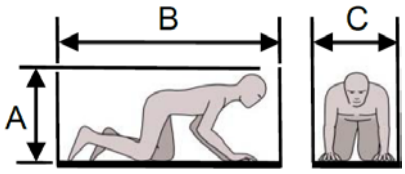
Section 7.1: Whole Body Clearance for Walking and Crawling

(point-to-point access only and not work activities)

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
7.1.1	Clearance for walking (operator tasks)	A. Vertical clearance, minimum 1980 mm (78 in.) B. Passage width, minimum 610 mm (24 in.)		Measurements A: B: Conforms? ☐Yes ☐No ☒N/A
7.1.2	Clearance for walking (maintenance and service activity only)	A. Vertical clearance, minimum 1900 mm (74.8 in.) B. Upper body passage width, minimum 610 mm (24 in.) C. Walking surface width minimum 457 mm (18 in.) D. Elbow/hip clearance height, maximum height of sloped area 1002 mm (39.8 in.)		Measurements A: B: C: D: Conforms? ☐Yes ☐No ☒N/A
7.1.3	Clearance for walking through vertical hatchways (maintenance and service activity only)	A. Overhead clearance, minimum 1524 mm (60 in.) B. Upper body passage width, minimum 610 mm (24 in.) C. Height of threshold, maximum 406 mm (16 in.)		Measurements: A: B: C: Conforms? ☐Yes ☐No ☒N/A

NOT APPLICABLE

The system does not require provisions for walking and crawling clearances.

Section 7.1: Whole Body Clearance for Walking and Crawling (point-to-point access only and not work activities)				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
7.1.4	Clearance for moving sideways (maintenance and service activity only)	A. Overhead clearance, minimum 1900 mm (74.8 in.) B. Forward horizontal clearance, minimum 477 mm (18.8 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A
7.1.5	Kneeling crawl	A. Overhead clearance measured from floor, minimum 740 mm (29 in.) B. Forward horizontal clearance, minimum 1520 mm (60 in.) C. Elbow clearance, minimum 635 mm (25 in.)		Measurements: A: B: C: Conforms? ☐Yes ☐No ☒N/A

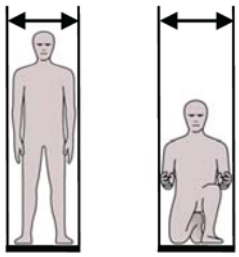
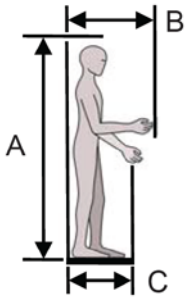
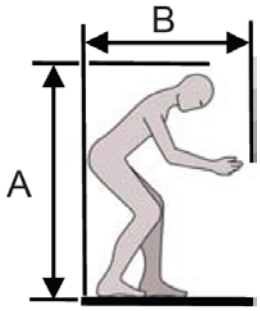
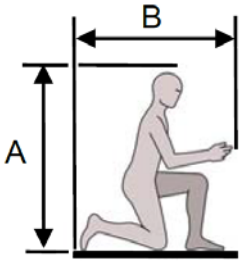
NOT APPLICABLE
The system does not require provisions for walking and crawling clearances.

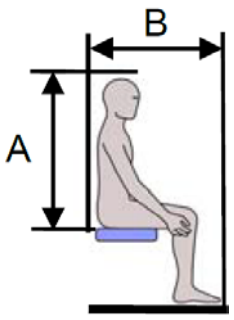
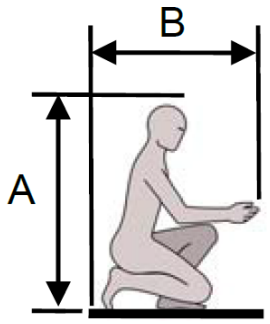
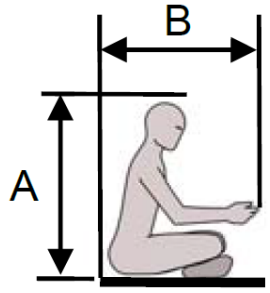
Section 7.2: Whole Body Clearance for Work Activities

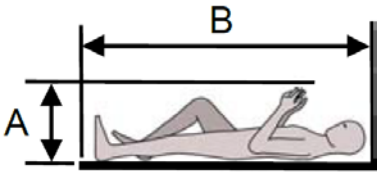
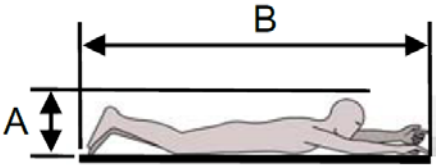
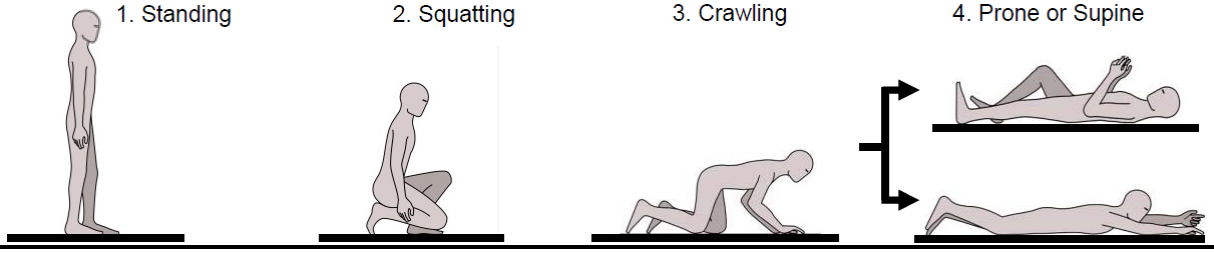
These criteria apply to tasks that are anticipated by the supplier to involve manual and visual activity lasting longer than 5 minutes, or having multiple occurrences with a total duration of greater than 1 hour per 8-hour shift.

Clearances should be provided based on the nature of the tasks performed in the designated area. When determining the working space required for a given task, first estimate where the hands, tools and equipment will be, the line-of sight needed, and if the body will be supported (for example, sitting on a stool) for the envisioned task. Also consider space needed for movement such as squatting to lift an item or applying push/pull forces. Once this is done, estimate the posture(s) that will be associated with the task and use ¶¶ 7.2.1–7.2.9 to determine the various minimum clearance dimensions required for that posture.

Clearances required for displays and controls in sections 8 and 9 should also be considered.

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
7.2.1	Horizontal clearance for upper body (all postures)	Minimum 610 mm (24 in.)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.2.2	Standing	A. Overhead clearance, minimum 1980 mm (78 in.) B. Forward horizontal clearance[#1], minimum 690 mm (27 in.) C. Lower body clearance[#1], minimum 508 mm (20 in.)		Measurements: A: 80 in B: 30 / **24** in – Front / Back C: 30 / 24 in – Front / Back Work space clearance per Manual Conforms? ☐Yes ☒No ☐N/A
7.2.3	Stooping	A. Overhead clearance, minimum 1450 mm (57 in.) B. B. Forward horizontal clearance[#1], minimum 1020 mm (40 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A
7.2.4	Kneeling	A. Overhead clearance (from floor), minimum 1450 mm (57 in.) B. Forward horizontal clearance[#1], minimum 1220 mm (48 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A

Section 7.2: Whole Body Clearance for Work Activities				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
7.2.5	Sitting The given clearance dimensions do not provide room for movement of seating devices. Thickness of chair backrest is not included. Room for movement of the seating device is not included.	A. Overhead clearance measured from sitting surface, minimum 1010 mm (39.8 in.) B1. Forward horizontal clearance (as measured from any obstruction, or front [user] side of backrest, if present)[#1] B2. Clearance for operation tasks (relaxed posture), minimum 1034 mm (40.7 in.) B3. Clearance for maintenance tasks (upright posture), minimum 867 mm (34.1 in.)		Measurements: A: B1: B2: B3: Conforms? ☐Yes ☐No ☒N/A
7.2.6	Squatting	A. Overhead clearance, minimum 1220 mm (48 in.) B. Forward horizontal clearance[#1], minimum 790 mm (31 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A
7.2.7	Sitting-on-floor	A. Overhead clearance, minimum 1000 mm (39 in.) B. Forward horizontal clearance[#1], minimum 690 mm (27 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A

Section 7.2: Whole Body Clearance for Work Activities				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
7.2.8	Supine (lying on back)	A. Vertical clearance (overhead), minimum 430 mm (17 in.) If the supplier specifies the use of a mechanic's-type creeper for a task, measure from the top surface of the creeper to the overhead obstruction. B. Length (forward), minimum 1980 mm (78 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A
7.2.9	Prone (lying on stomach)	A. Vertical clearance (overhead), minimum 510 mm (20 in.) If the supplier specifies the use of a mechanic's-type creeper for a task, measure from the top surface of the creeper to the overhead obstruction. B. Length (forward), minimum 2440 mm (96 in.)		Measurements: A: B: Conforms? ☐Yes ☐No ☒N/A
7.2.10	To determine space needed to assume prone or supupine positions from a standing posture, use the clearance recommendations for standing, squatting, and crawling sequentially. 			

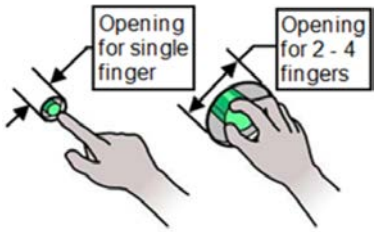
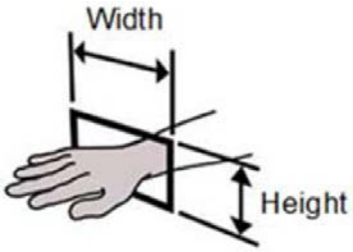
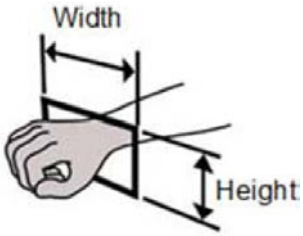
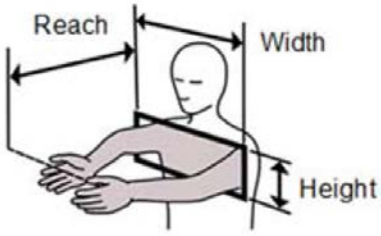
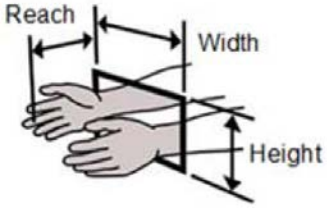
[#1] Distance measured away from the equipment or obstruction for body clearance in the given posture.

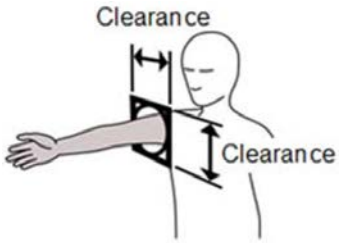
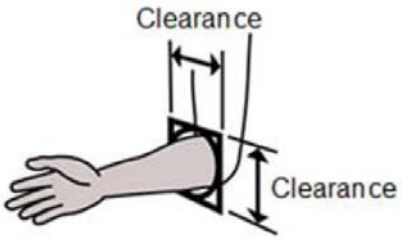
ADDRESSED

Issues related to this criterion are addressed in Paragraph 16.2.

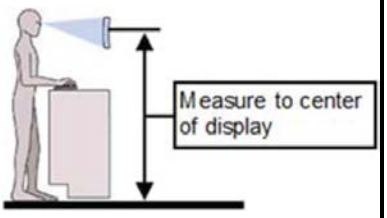
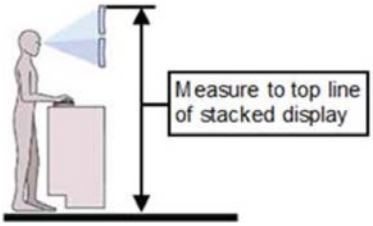
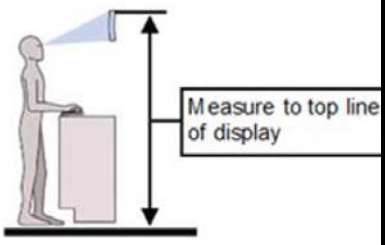
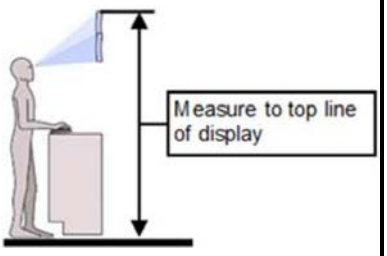
Section 7.3: Hand / Arm Clearance

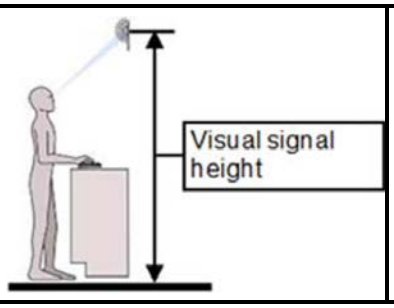
Note: Where appropriate to do so, dimensions have been adjusted for the use of cleanroom gloves.

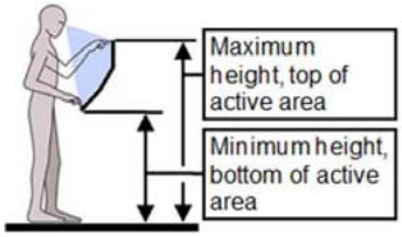
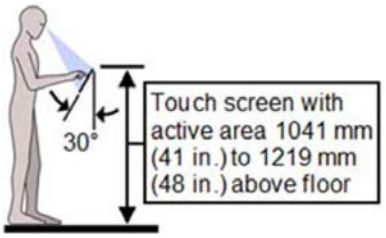
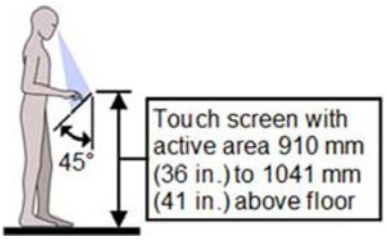
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
7.3.1	Clearance provided for finger access, round (diameter) or square.	One finger access, minimum 32 mm (1.25 in) 2, 3, 4 finger twist of small knob, minimum object diameter + 58 mm (2.3 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.3.2	Clearance provided for flat hand wrist access.	Height, palm thickness, minimum 89 mm (3.5 in) Width, palm width, minimum 114 mm (4.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.3.3	Clearance provided for fist to wrist access.	Height (fist thickness), minimum 89 mm (3.5 in) Width (fist width), minimum 127 mm (5.0 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.3.4	Clearance provided for two hands arm to shoulders access (does not ensure visual access).	Reach, maximum 610 mm (24.0 in) Width, minimum 483 mm (19 in) Height, minimum 114 mm (4.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.3.5	Clearance provided for two hands, hand to wrist access (does not ensure visual access).	Reach, maximum 203 mm (8.0 in) Width, minimum 191 mm (7.5 in) Height, minimum 114 mm (4.5 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

Section 7.3: Hand / Arm Clearance **Note: Where appropriate to do so, dimensions have been adjusted for the use of cleanroom gloves.**				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
7.3.6	Clearance provided for one arm to shoulder access (does not ensure visual access)	Minimum 132 mm (5.2 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
7.3.7	Clearance provided for one arm to elbow access, diameter, or square area (does not ensure visual access)	Minimum 119 mm (4.7 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

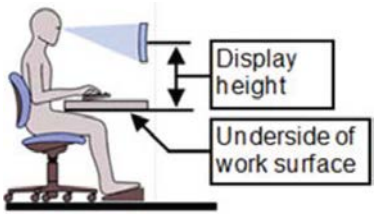
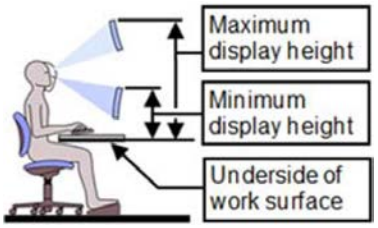
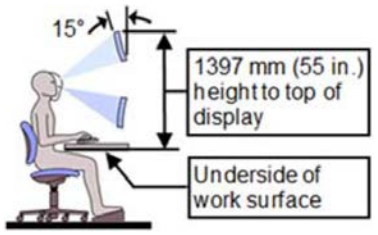
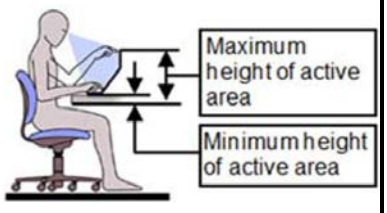
NOT APPLICABLE
The system does not require finger access during system maintenance and service.

Section 8: Display Location				
Section 8.1: Location for Operator Primary Interface, Standing Station				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
8.1.1	Height of video display terminal (single monitor). Does not include touch screens, measured from floor to center of screen.	Maximum 1470 mm (58 in) Minimum 1320 mm (52 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
8.1.2	Height of video display terminal (stacked monitors). Does not include touch screens, measured from floor to top line of the top monitor. The primary monitor in a stacked configuration is the bottom monitor.	Maximum 1680 mm (66 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
8.1.3	Height of infrequently used video display terminal (viewed briefly less often than once per hour), measured to top line of monitor.	Maximum 1680 mm (66 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A
8.1.4	Height of very infrequently used video display terminal (viewed briefly less often than once per day), measured to top line of monitor.	Maximum 1880 mm (74 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

8.1.5	Height of infrequently viewed visual signal measured to the top of the signal. This guideline does not apply to light towers.	Maximum 2130 mm (84 in)		Measurement: Conforms? ☐Yes ☐No ☒N/A

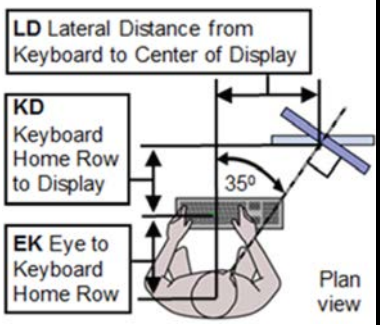
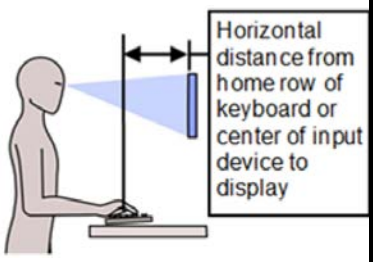
Section 8.1: Location for Operator Primary Interface, Standing Station				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
8.1.6	Height of touch screen monitor. See section 9 for horizontal reach criteria.	Maximum 1470 mm (58 in), measured from floor to uppermost active pad on screen. Minimum 910 mm (36 in), measured from floor to lowest active pad on the screen.		Measurement: Conforms? ☐Yes ☐No ☒N/A
8.1.7	Tilt angle of touch screen monitor between 1041 mm (41 in.) and 1219 mm (48 in.) in height to top of screen.	Upward minimum 30°		Measurement: Conforms? ☐Yes ☐No ☒N/A
8.1.8	Tilt angle of touch screen monitor less than 1041 mm (41 in.) in height to top of screen.	Upward minimum 45°		Measurement: Conforms? ☐Yes ☐No ☐N/A

NOT APPLICABLE
The system touch screen control panel is used infrequently and is therefore covered in Section 9, Hand Control Location.

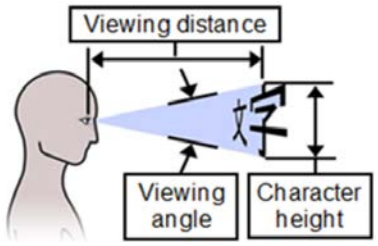
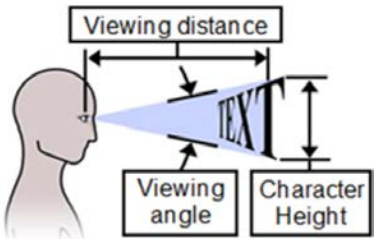
Section 8.2: Location for Operator Primary Interface, Seated Station Note: A seated station is where a short cylinder office-style chair is used.				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
8.2.1	Height of video display terminal (single monitor). Does not include touch screens, measured from the underside of the work surface to the centerline of the monitor.	Maximum 517 mm (20.5 in) Minimum 267 mm (10.5 in)		Measurement: Conforms? ☐Yes ☐No ☐N/A
8.2.2	Height of video display terminal (stacked monitors), does not include touch screens, measured from the underside of the work surface to the top line of top monitor. The primary monitor in a stacked configuration is the bottom monitor.	Maximum 727 mm (28.5 in) Minimum 267 mm (10.5 in)		Measurement: Conforms? ☐Yes ☐No ☐N/A
8.2.3	Tilt angle of video display terminal greater than 1397 mm (55 in.) from underside of work surface to top of display. Note: This line item becomes significant in the event that the maximum height criteria cannot be met.	Downward minimum 15°		Measurement: Conforms? ☐Yes ☐No ☐N/A
8.2.4	Height of touch screen monitor.	Maximum 397 mm (15.5 in), measured from the underside of work surface to highest active pad on the screen. Minimum 77 mm (3.5 in), measured from underside of work surface to lowest active pad on the screen. See Section 9 for horizontal reach criteria.		Measurement: Conforms? ☐Yes ☐No ☐N/A

NOT APPLICABLE
Not a seated station.

Section 8.3: Display Characteristics

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
8.3.1	Lateral distance from the centerline of the display to the center of the keyboard home row, which is typically the midpoint between the "G" and "H" keys on a keyboard with a standard "QWERTY" key layout. When practical, off-center displays should be angled perpendicular to the user's line of sight to minimize image distortion.	Calculate maximum lateral offset distance using the following formula: (KD+EK) × tan 35° = LD KD = Forward distance from keyboard home row to display. EK = 304 mm (12.0 in.) Constant forward distance from eye to keyboard home row. LD = Maximum recommended lateral distance to center of display.	 Examples of maximum recommended offset dimensions using the provided formula. Keyboard home row to display distance / Maximum offset 229 mm (9.0 in.) / 373 mm (14.7 in.) 300 mm (11.8 in.) / 423 mm (16.6 in.) 350 mm (13.8 in.) / 458 mm (18.0 in.) 400 mm (15.7 in.) / 493 mm (19.4 in.)	Measurement: Conforms? ☐Yes ☐No ☐N/A
8.3.2	Display distance. Measure horizontal distance from keyboard home row or center of input device in the home position to the display. Applies to seated and standing workstations. This recommendation does not apply to applications where input devices (keyboard, trackball, or mouse) are used more like machine controls (intermittent one finger entry on the keyboard, intermittent short term use of the mouse or trackball) than for standard typing (continuous use of	Minimum 229 mm (9.0 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A

	keyboard for entry of long character strings, extended use of trackball or mouse in a graphical environment).			

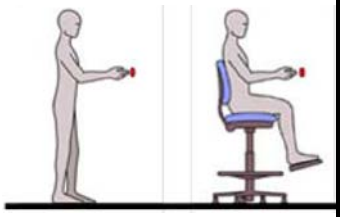
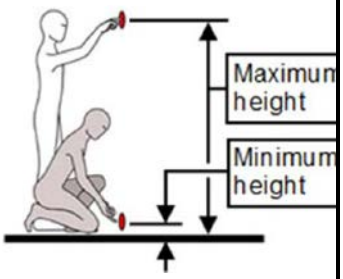
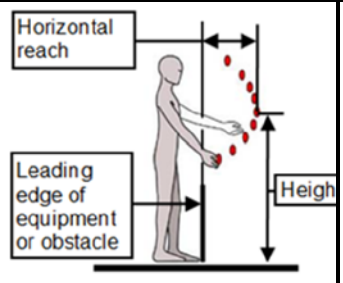
Section 8.3: Display Characteristics				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
8.3.3	Character height (specific to Chinese, Korean, and Japanese characters).	Minimum 25 minutes of arc (character height is greater than or equal to the viewing distance divided by 137.5). Minimum recommended viewing distance is 500 mm (19.7 in.).		Measurement: Conforms? ☐Yes ☐No ☐N/A
8.3.4	Character height (all characters other than Chinese, Korean, and Japanese).	Minimum 16 minutes of arc (character height is greater than or equal to the viewing distance divided by 215). Minimum recommended viewing distance is 500 mm (19.7 in.).		Measurement: Conforms? ☐Yes ☐No ☐N/A

CONFORMS TO THE STATED CRITERIA

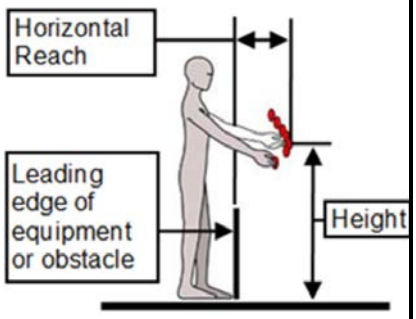
The system is provided with a touch screen control screen, configured for English and character height is greater than 0.1 inches.

Section 9: Hand Control Location

These criteria only apply to controls accessed for routine production operation and maintenance tasks from floor-standing postures and from chair-seated postures at a workstation or console.
EXCEPTION 1: These criteria do not apply to freestanding equipment or sub-systems with an installed height of less than 838 mm (33 in.) such as pumps, power supplies, chillers, and heat exchangers.
EXCEPTION 2: Infrequently used or critical controls may be located outside the recommended height ranges if their location makes them more readily accessible for other postures adopted during maintenance activities anticipated by the supplier. If this exception is used, the evaluator should note the activity and the means used to access the control recommended by the supplier (e.g., ladder or step platform).
Controls that move as designed should be measured in the least favorable position.
Interpolate for intermediate values.
NOTE 1: See § 7 for other work postures.
NOTE 2: Devices outside the recommended ranges may have an operational means to meet the criteria (e.g., pull cord or extension rod).
NOTE 3: Visual access is assumed for these reach criteria.

<table>
<tr><th>Section</th><th>Indicator</th><th>Acceptance Criteria</th><th>Reference Pictogram</th><th>Actual/Conforms?</th></tr>
<tr><td>9.1</td><td>Standing station
NOTE: A standing station is one where the operator can assume a standing posture or a seated posture in a tall stool which places the operator at approximately the same stature.</td><td>-</td><td>  </td><td>-</td></tr>
<tr><td>9.1.1</td><td>Vertical location of very infrequently used controls (controls used less often than once every 24 hours) measured from the standing surface to the centerline of the control.</td><td>Maximum 1640 mm (64.5 in)
Minimum 0 mm (0 in)</td><td> 
</td><td>Conforms?
☐Yes
☐No
☒N/A</td></tr>
<tr><td>9.1.2</td><td>Location of infrequently used and/or critical controls. Maximum reaches are indicated for various heights. Reaches are measured from the leading edge of the equipment or obstacle. Interpolate for intermediate values.</td><td>Controls should not be located above 1638 mm (64.5 in.) or below 838 mm (33 in.).
<table>
<tr><th>Height</th><th>Horizontal reach</th></tr>
<tr><td>1638 mm (64.5 in.)</td><td>254 mm (10 in.)</td></tr>
<tr><td>1524 mm (60 in.)</td><td>368 mm (14.5 in.)</td></tr>
<tr><td>1422 mm (56 in.)</td><td>432 mm (17 in.)</td></tr>
<tr><td>1321 mm (52 in.)</td><td>470 mm (18.5 in.)</td></tr>
<tr><td>1219 mm (48 in.)</td><td>483 mm (19 in.)</td></tr>
<tr><td>1118 mm (44 in.)</td><td>470 mm (18.5 in.)</td></tr>
<tr><td>1016 mm (40 in.)</td><td>394 mm (15.5 in.)</td></tr>
<tr><td>914 mm (36 in.)</td><td>292 mm (11.5 in.)</td></tr>
<tr><td>838 mm (33 in.)</td><td>178 mm (7 in.)</td></tr>
</table></td><td> 
</td><td>Conforms?
☒Yes
☐No
☐N/A

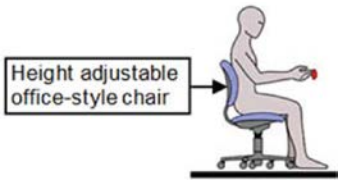
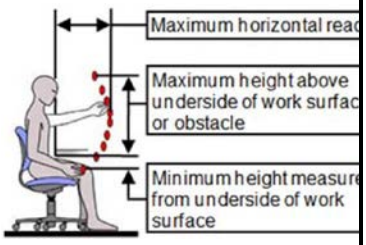
EMO at 155 cm
1573 mm – touch screen top line; 1460 mm bottom line</td></tr>
</table>

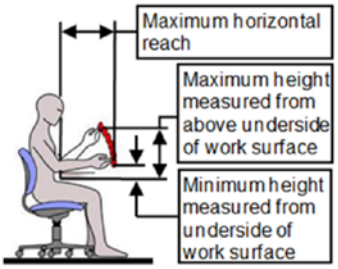
<table>
<tr><th colspan="5">Section 9: Hand Control Location</th></tr>
<tr><th>Section</th><th>Indicator</th><th>Acceptance Criteria</th><th>Reference Pictogram</th><th>Actual/Conforms?</th></tr>
<tr>
<td>9.1.3</td>
<td>Location of frequently used controls. Maximum reaches are indicated for various heights. Reaches are measured from the leading edge of the equipment or obstacle. Interpolate for intermediate values.</td>
<td>Controls should not be located above 1270 mm (50 in.) or below 940 mm (37 in.).
<table>
<tr><th>Height</th><th>Horizontal reach</th></tr>
<tr><td>1270 mm (50 in.)</td><td>292 mm (11.5 in.)</td></tr>
<tr><td>1219 mm (48 in.)</td><td>330 mm (13 in.)</td></tr>
<tr><td>1168 mm (46 in.)</td><td>368 mm (14.5 in.)</td></tr>
<tr><td>1118 mm (44 in.)</td><td>394 mm (15.5 in.)</td></tr>
<tr><td>1067 mm (42 in.)</td><td>406 mm (16 in.)</td></tr>
<tr><td>1016 mm (40 in.)</td><td>394 mm (15.5 in.)</td></tr>
<tr><td>940 mm (37 in.)</td><td>318 mm (12.5 in.)</td></tr>
</table>
</td>
<td> 
</td>
<td>Conforms?
☐Yes
☐No
☒N/A</td>
</tr>
</table>

CONFORMS TO THE STATED CRITERIA

Very infrequently used controls, EMO, Main Disconnect and Reset Button are located at less than 64.5 in.

Infrequently used controls, the touch screen control panel, is located at less than 64.5 in and above 33 in. (62.5 in.)

<table>
<tr><th>Section</th><th>Indicator</th><th>Acceptance Criteria</th><th>Reference Pictogram</th><th>Actual/Conforms?</th></tr>
<tr><td>9.2</td><td>Seated station
NOTE: A seated station is one where a short cylinder office-style chair is used.</td><td>-</td><td> 
</td><td>Conforms?
☐Yes
☐No
☐N/A</td></tr>
<tr><td>9.2.1</td><td>Location of infrequently used and/or critical controls. Maximum reaches are indicated for various heights. Reaches are measured from the leading edge of the work surface or obstacle. Heights are measured from the underside of the work surface. Interpolate for intermediate values.</td><td>Controls should not be located greater than 724 mm (28.5 in.) above or 140 mm (5.5 in.) below the underside of the work surface.<table><tr><th>Height</th><th>Horizontal reach</th></tr><tr><td>724 mm (28.5 in.)</td><td>356 mm (14 in.)</td></tr><tr><td>597 mm (23.5 in.)</td><td>432 mm (17 in.)</td></tr><tr><td>495 mm (19.5 in.)</td><td>470 mm (18.5 in.)</td></tr><tr><td>394 mm (15.5 in.)</td><td>483 mm (19 in.)</td></tr><tr><td>292 mm (11.5 in.)</td><td>483 mm (19 in.)</td></tr><tr><td>191 mm (7.5 in.)</td><td>470 mm (18.5 in.)</td></tr><tr><td>89 mm (3.5 in.)</td><td>445 mm (17.5 in.)</td></tr><tr><td>-13 mm (-0.5 in.)</td><td>381 mm (15 in.)</td></tr><tr><td>-140 mm (-5.5 in.)</td><td>254 mm (10 in.)</td></tr></table></td><td> 
</td><td>Measurement:

Conforms?
☐Yes
☐No
☐N/A</td></tr>
<tr><td>9.2.2</td><td>Location of frequently used controls. Maximum reaches are indicated for various heights. Reaches are measured from the leading edge of the work surface or obstacle. Heights are measured from the underside of the work surface. Interpolate for intermediate values.</td><td>Controls should not be located greater than 394 mm (15.5 in.) above or less than 89 mm (3.5 in.) above the underside of the work surface.<table><tr><th>Height</th><th>Horizontal reach</th></tr><tr><td>394 mm (15.5 in.)</td><td>330 mm (13 in.)</td></tr><tr><td>343 mm (13.5 in.)</td><td>368 mm (14.5 in.)</td></tr><tr><td>292 mm (11.5 in.)</td><td>394 mm (15.5 in.)</td></tr><tr><td>241 mm (9.5 in.)</td><td>406 mm (16 in.)</td></tr><tr><td>191 mm (7.5 in.)</td><td>419 mm (16.5 in.)</td></tr><tr><td>140 mm (5.5 in.)</td><td>419 mm (16.5 in.)</td></tr><tr><td>89 mm (3.5 in.)</td><td>419 mm (16.5 in.)</td></tr></table></td><td> 
</td><td>Measurement:

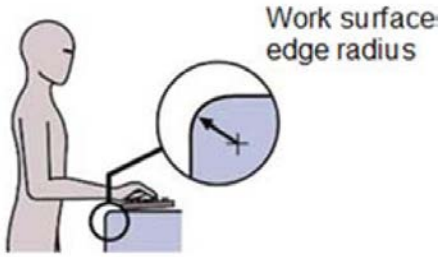
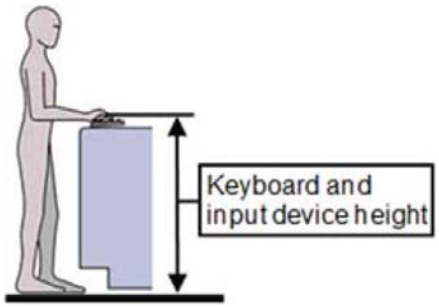
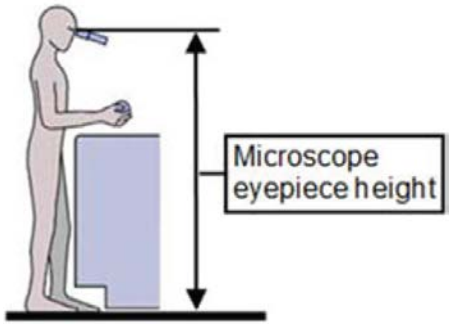
Conforms?
☐Yes
☐No
☐N/A</td></tr>
</table>

NOT APPLICABLE
Not a seated station

Section 10: Workstation Design

Section 10.1: Standing Station

NOTE: A standing station is one where the operator can assume a standing posture or a seated posture in a tall stool which places the operator at approximately the same stature.

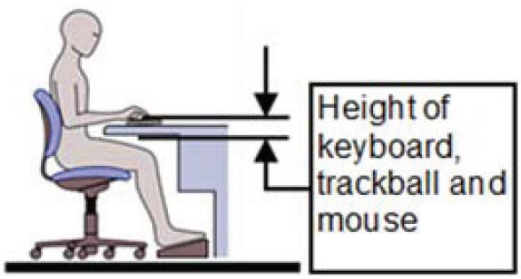
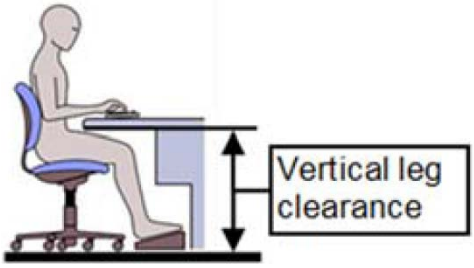
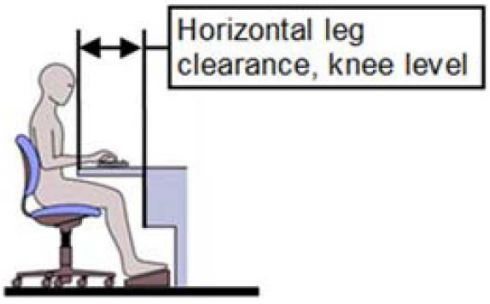
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
10.1.1	Work surface edge radius where the operator can assume a static posture in contact with the edge.	Minimum 6.4 mm (0.25 in.) radius		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.1.2	Height of keyboard, trackball, or mouse, (to home row, top of ball / mouse). *NOTE: In applications where input devices (keyboard, trackball, or mouse) are used more like machine controls (intermittent one finger entry on the keyboard, intermittent short term use of the mouse or trackball) than for standard typing (continuous use of keyboard for entry of long character strings, extended use of trackball or mouse in graphical environment), it is appropriate to use the height and reach locations described in Section 9, Hand Control Location (standing station).*	Maximum 1020 mm (40 in.) Minimum 970 mm (38 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.1.3	Height of microscope eyepieces. Should be adjustable through at least this range.	Range includes 1270 mm (50 in) to 1730 mm (68 in)		Measurement: Conforms? ☐Yes ☐No ☐N/A

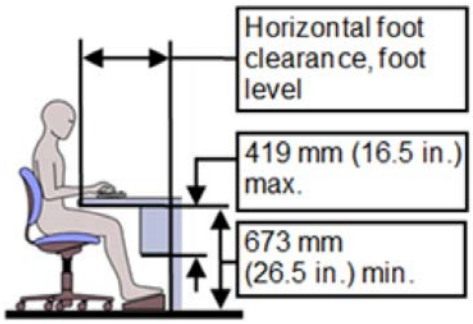
NOT APPLICABLE

The system is not provided with a horizontal work surface.

Section 10.2: Seated Station

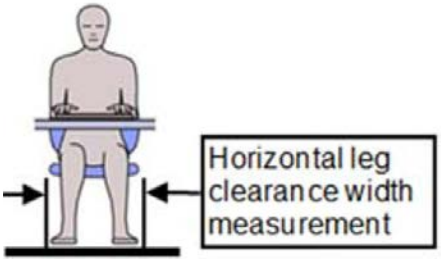
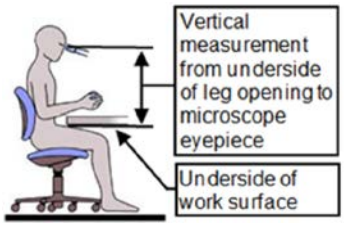
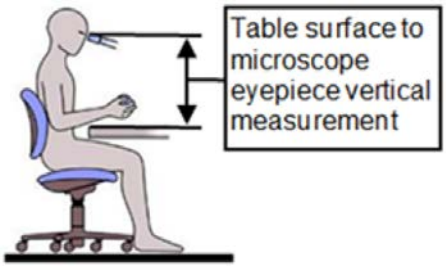
NOTE: A seated station is one where a height-adjustable, office-style chair is used.

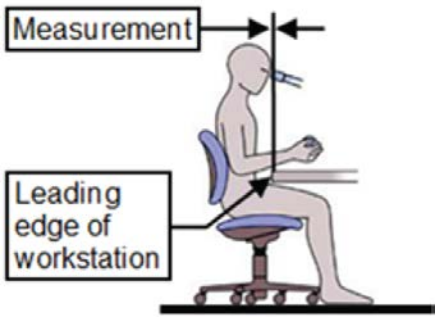
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
10.2.1	Height of keyboard, trackball, or mouse (measured to home row and top of ball / mouse from the underside of the wok surface).	Maximum 87 mm (3.5 in.) Minimum 37 mm (1.5 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
	NOTE: In applications where input devices (keyboard, trackball, or mouse) are used more like machine controls (intermittent one finger entry on the keyboard, intermittent short term use of the mouse or trackball) than for standard typing (continuous use of keyboard for entry of long character strings, extended use of trackball or mouse in graphical environment), it is appropriate to use the height and reach locations described in Section 9 of this table, Hand Control Location (seated station).			
10.2.2	Vertical leg clearance.	Minimum 673 mm (26.5 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.2.3	Horizontal leg clearance, depth at knee level.	Minimum 508 mm (20 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A

10.2.4	Horizontal leg clearance, depth at foot level.	Minimum 660 mm (26 in.) depth clearance at a minimum vertical range of 419 mm (16.5 in.) to 673 mm (26.5 in.) below the underside of the work surface		Measurement: Conforms? ☐Yes ☐No ☐N/A

Section 10.2: Seated Station

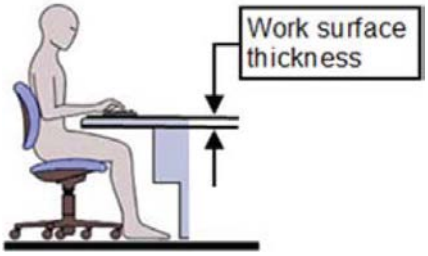
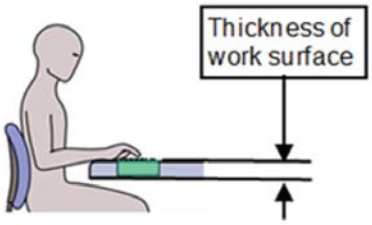
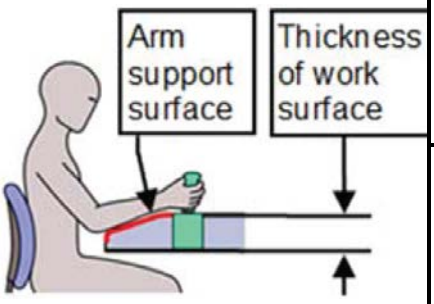
NOTE: A seated station is one where a height-adjustable, office-style chair is used.

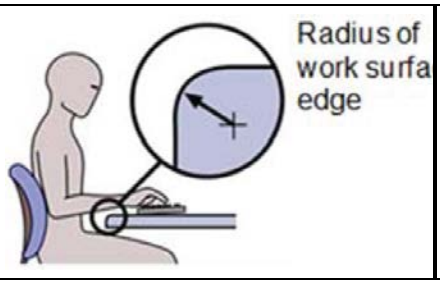
Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
10.2.5	Horizontal leg clearance, width.	Minimum 610 mm (24 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.2.6	Equipment integrated microscope: Height of microscope eyepiece measured from underside of work surface to center of eyepiece. Must be adjustable with the entire range.	Range includes 495 mm (19.5 in.) to 658 mm (25.9 in.).		Measurement: Conforms? ☐Yes ☐No ☐N/A
	NOTE: The intent of the change of reference from the floor to the underside of the work surface is to allow for higher work surfaces in situations where there is a specific advantage, and to ensure in those cases that the other design features are located appropriately for the higher work surface.			
	Stand-alone (table top) microscopes: Height of microscope eyepiece measured from the top of the work surface to center of eyepiece. Must be adjustable with the entire range.	Range includes 445 mm (17.5 in.) to 607 mm (23.9 in.).		Measurement: Conforms? ☐Yes ☐No ☐N/A

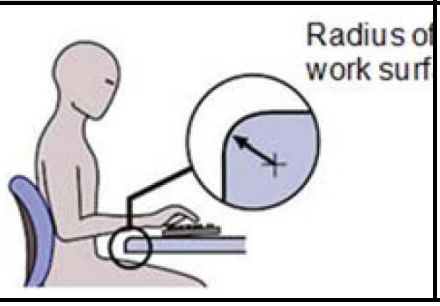
10.2.7	Microscope eyepiece location in relation to leading edge of workstation.	Eye pieces are flush with or protrude horizontally beyond the leading edge of the workstation toward the user (applicable at all eyepiece height adjustment settings).		Measurement: Conforms? ☐Yes ☐No ☐N/A

Section 10.2: Seated Station

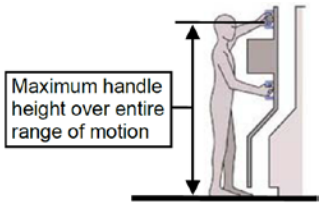
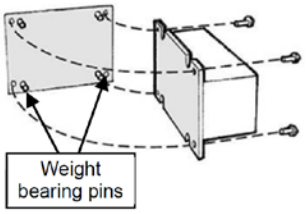
NOTE: A seated station is one where a height-adjustable, office-style chair is used.

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
10.2.8	Thickness of work surface. Only needs to be applied to depth of work surface in section 10.2.3 of this table.	Maximum 51 mm (2 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.2.9	Thickness of work surface used for an enclosed keyboard. Only needs to be applied to depth of work surface in section 10.2.3 of this table.	Maximum 75 mm (3 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.2.10	Maximum work surface thickness for non-keyboard applications. Only needs to be applied to depth of work surface in section 10.2.3 of this table.	Maximum 145 mm (5.7 in.)		Measurement: Conforms? ☐Yes ☐No ☐N/A
10.2.11	For work surfaces thicknesses greater than 75 mm (3 in.), arm support surface should be present in front of primary controls used by each hand.	Arm support surface should be present in front of primary controls.		Measurement: Conforms? ☐Yes ☐No ☐N/A

10.2.12	Work surface edge radius where the operator can assume a static posture in contact with the edge.	Work surfaces less than or equal to 51 mm (2.0 in.) thick, minimum 6 mm (0.25 in.) radius. Work surfaces greater than 51 mm (2.0 in.) thick, minimum 13 mm (0.5 in.) radius.		Measurement: Conforms? ☐Yes ☐No ☐N/A

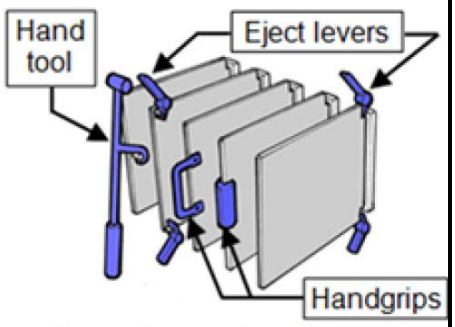
Section 10.2: Seated Station NOTE: A seated station is one where a height-adjustable, office-style chair is used.				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
10.2.13	Work surface edge radius where the operator can assume a static posture in contact with the edge.	Minimum 6 mm (0.25 in.) radius		Measurement: Conforms? ☐Yes ☐No ☐N/A

NOT APPLICABLE
Not a seated station.

Section 11: Equipment Maintainability and Serviceability				
Section	**Indicator**	**Acceptance Criteria**	**Reference Pictogram**	**Actual/Conforms?**
11.1	Minimum lighting level in maintenance areas is required where the worker has to read information, use a hand tool, or make a connection. This provision can be met by providing integral lighting or portable lighting that does not have to be hand held. Lighting should be properly rated for the environment of intended use.	Minimum 300 lux (30 fc)	-	Conforms? ☐Yes ☐No ☐N/A
11.2	Covers or doors must, unless fully removable, be self-supporting, in the open position, and not require manual support during maintenance. Exceptions may be allowed for self-closing doors for fire safety or compliance reasons.	Supports present	-	Conforms? ☐Yes ☐No ☐N/A
11.3	Height of access cover handle over the entire range of motion required for maintenance. This requirement can be met by the use of a ladder or step platform; however, its use should be noted in the assessment report.	Maximum 1700 mm (67 in.).		Measurement: Conforms? ☐Yes ☐No ☐N/A
11.4	Serviceable components are replaceable as modular packages, and are configured to facilitate removal and replacement.	Serviceable components configured as described.	-	Conforms? ☐Yes ☐No ☐N/A
11.5	Serviceable components should not be stacked directly on one another (i.e., a lower layer should not support an upper layer).	Serviceable components independently accessible.	-	Conforms? ☐Yes ☐No ☐N/A
11.6	Weight bearing aids to support items that can fall if not supported by at least one hand while being attached should be provided for items which are specified for installation as part of a maintenance or service task. Alignment aids provided to facilitate positioning when	Weight bearing/alignment aids present.	 An example of weight bearing aids	Conforms? ☐Yes ☐No ☐N/A

	precise alignment is needed to insert fasteners for items which are specified for installation as part of a maintenance or service task. Note: aids include, but are not limited to pins, hooks, bayonet mounts, and keyholes.			

Section 11: Equipment Maintainability and Serviceability

Section	Indicator	Acceptance Criteria	Reference Pictogram	Actual/Conforms?
11.7	Cables, connectors, plugs, and receptacles should be labeled, keyed, color coded, or otherwise configured to make connection easier and prevent cross connection. This feature is assessed only if a SEMI S2 assessment is not being conducted.	Identification present, keyed where needed.	-	Conforms? ☐Yes ☐No ☐N/A
11.8	Circuit boards mounted in a card cage configuration should have gripping or ejecting aids for mounting and removal.	Finger access, gripping, or ejecting aids available.	 Several examples of circuit board removal devices	Conforms? ☐Yes ☐No ☐N/A

CONFORMS TO THE STATED CRITERIA

Maintenance tasks rely on facility lighting. Doors are self-supporting. The system includes serviceable components that are replaceable as modular packages, and are configured for rapid removal and replacement. There are no serviceable components that are stacked directly on one another. All cables and connectors are labeled, marked, or color coded to make connections easier and prevent errors.

Attachment Six
Intertek Ergonomic Data Worksheet

Trebor International
Quantum NXT

Intertek Ergonomic Data Worksheet

Component Name	(1) Location	(2) Type of Task	(3) Freq of Use	(4) Height in.	(5) Width in.	(6) Reach in.	(7) Comments:
Touch screen	Control Cabinet Front	Operator	Infrequent	62.5 / 61.9 (208V) Measured to top of touch screen		0mm (0 in)	Standing Workstation, Good Access and clearance.
EMO	Control Cabinet Front	Critical	Infrequent	59.5 / 61 (208V)		0mm (0 in)	Standing Workstation, Good Access and clearance.
Main Disconnect	Control Cabinet Front	Maintenance	Very Infrequent	60.0 / 61.5 (208V) Measured to grasp point		0mm (0 in)	Standing Workstation, Good Access and clearance.
Reset Button	Control Cabinet Front	Maintenance	Infrequent	57.5		0mm (0 in)	Standing Workstation, Good Access and clearance.

Directions for Use:

When performing a SEMI S8 Ergonomic Assessment, all points of human contact with the system should be analyzed for conformance with placement criteria as specified in SEMI S8-0915 and SESC. Use this worksheet to collect measurement and usage data required to complete this analysis. Include all controls, displays, computer screens, input devices, and points of maintenance and service contacts.

(1) Location: e.g., mainframe, rear.
(2) Type of Task: Operator = Performed by Operator; Maintenance = Performed by Maintenance; Critical = Emergency Control (e.g., EMO)
(3) Frequency: Frequent = <1 hr; Infrequent = >1 hr<24hrs; Very Infrequent = >24hrs
(4) Height: Unless otherwise specified, measured from standing surface to grasp point.
(5) Width: Width of object
(6) Reach: Unless otherwise specified, measured from the leading edge of equipment or obstacle
(7) Comments: Relative to posture, access, clearance, interference, etc.

Attachment Seven
SEMI S13 Checklist

Trebor International
Quantum NXT

SEMI S13 Checklist

Method

Documents provided by Trebor International regarding the 480V systems, as described in Section 2.2, were reviewed by Intertek for content to verify conformity with SEMI S13-0113. The following checklist identifies, by clause from SEMI S13, the specific information to be included in documentation as requested by SEMI S2-0715, paragraph 9.6.2.

The verdicts for conformity are identified by the following responses:

Description	Verdict
Requirement does not apply to the equipment	N/A (Not Applicable)
Equipment meets the requirement	P (Pass)
Equipment does not meet the requirement	F (Fail)
Requirement is Informative	G (General Information)

Results-Remarks pertaining to the requirement verdict are provided.

Conclusion

The 480V manuals reviewed provide the necessary information requested by SEMI S13 for conformance to SEMI S2-0715, paragraph 9.6.2.

The 208V manuals reviewed during the February 2019 evaluation did not provide the necessary information requested by SEMI S13 for conformance to SEMI S2-0715, paragraph 9.6.2.

On May 9, 2019 Trebor International supplied updated documentation that addressed the previous non-conformances. All documentation now conforms to SEMI S13 fully.

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
6	**General Criteria of Documents Provided to the Equipment User**		P
6.1	EHS information needed to perform a task should either be:		-
	a) included in the document provided to the user that describes how to perform a task, or	Provided in the documentation	P
	b) provided separately in another document	See previous comment	N/A
	If provided separately in another document, document identifies where to find EHS information relevant to the task.	See previous comment	N/A
6.2	Documents provided to the equipment user should provide specific instructions to enable equipment:		P
	- safe installation	Provided in the documentation	P
	- operation	Provided at the time of installation	P
	- maintenance	Provided in the documentation	P
	- decontamination	Equipment does not use hazardous materials that would require decontamination of parts	N/A
	- decommissioning	Instructions on decommissioning the system are provided in the documentation.	P
	EXCEPTION: Any procedure that is to be performed only by the equipment supplier's personnel does not need to be described in the documentation provided to the equipment user.		-
6.2.1	The documents provided to the equipment user should describe:		P
	- the hazards inherent in equipment,	Identified in safety information	P
	- warn of the potential of exposure to hazards, and	Warnings provided in manual with labelling information	P
	- provide information as to how to minimize risk	Where applicable, instructions or warnings are identified in the documentation	P
6.3	The documents provided to the equipment user should identify the intended audience for each document supplied to the user.	All documentation provided is intended for the End User. Specific Service related documentation for service personnel are not provided to the End User.	P
6.4	Safety features provided in the equipment according to the equipment user's requisition or request may be described in documents provided to the equipment User as a separate attachment.	No specific User requirements identified at time of evaluation	N/A
6.5	The equipment supplier should provide at least the EHS information related to items in the following list:		P
	- Safety interlocks	Identified in the documentation	P
	- Emergency shutdown	Identified in the documentation	P
	- Ergonomics	Identified in the documentation	P

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
	- Seismic performance	Seismic performance information for the system are provided in the documentation	P
	- Environmental performance	Identified in the documentation	P
	- Industrial Hygiene	Equipment does not use hazardous materials or stores/emits hazardous substances.	N/A
	- Fire Protection	Fire protection is inherent to equipment design. Equipment does not use an installed fire protection system.	N/A
	- Decontamination	Equipment does not use hazardous materials that would require decontamination of parts	N/A
	- Decommissioning	Removal and disposal information is provided in the documentation	P
6.6	Information in the documents that is required by applicable regulation, or is otherwise essential to personnel safety be provided in one or more official languages of the location where the equipment will be used, or as otherwise agreed to between the equipment supplier and user.	Original language is English. Translated documentation is available from Trebor upon request.	P
6.7	Translated documents provided to the equipment user should identify the language(s) in which it was originally written.	See previous comment.	N/A
6.8	The documents provided to the equipment user should include procedures for all activities needed to maintain the effectiveness of safety design features or devices.	The documentation provides service procedures for applicable activities needed to maintain the effectiveness of safety design features.	P
	They may include:		-
	- inspection for wear or damage	No routine inspections are required	N/A
	- functional checks of circuits	Functional checks are performed after servicing is performed.	P
	- calibration or replacement of components (e.g., chemical sensor heads)	See previous comment.	P
6.9	The documents provided to the equipment user may state that the user is responsible for analyzing and controlling the risks of work not described in the documents.	Documentation does not specify that the user is responsible for analysing and controlling the risk of work not described in the documents.	N/A
6.10	The equipment supplier should ensure information in the documents provided to the equipment user clearly identifying the equipment to which it applies.	Documentation clearly identifies the equipment to which it applies.	P
6.10.1	Each document that comprises the supplier's view of the minimum set of the documents required for the EHS and regulatory goals of the equipment provided to the equipment user should include a reference to a list of all documents in the set or,	Provided in the documentation	P

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
	Reference may be made to a website containing the list	See previous comment	N/A
7	**Hazards Inherent in Equipment**		P
7.1	The hazards inherent in equipment, such as those identified as part of the SEMI S2 or SEMI S26 evaluation should be described in the documents provided to the equipment user.	Hazards inherent to the equipment are identified in the documentation.	P
7.2	The description should include the location and the type of hazard.	Locations of identified hazards are provide in the documentation	P
7.3	The documents provided to the equipment user should include a list of hazardous materials (e.g., lubricants, cleaners, and coolants) required for maintenance, ancillary equipment or peripheral operations.	Equipment does not use hazardous materials	N/A
7.4	Hazards related to by-products and effluents of supplier-characterized baseline processes should be described in the documents provided to the equipment user.	Equipment does not create or emit hazardous materials	N/A
7.5	The documents provided to the equipment user should describe the safety measures in the equipment that mitigate risk in the event of fire, explosion or chemical leakage within the equipment.	Equipment design mitigates risk of fire. Refer to the SEMI S14 report for details on fire mitigation.	N/A
7.6	The documents provided to the equipment user should describe the seismic forces anticipated and equipment configuration in the safety measures provided to mitigate risk in the seismic event.	The documentation provides Seismic performance information.	P
8	**Hazardous Energy Control Procedures**		P
8.1	Any source of hazardous energy (such as electrical, chemical, thermal, mechanical, radiation, pneumatic or hydraulic energy) that poses a medium or high risk to workers maintaining or servicing the equipment should have related isolation ("lockout/tagout") procedures provided in the document provided to the equipment user.	The documentation identifies electrical and non-electrical LOTO procedures for the system.	P
	NOTE 7: Local workplace regulations can have specific isolation requirements (such as 29 CFR1910.147 in the United States) that may apply to an equipment user's facility. It is suggested that an equipment supplier considers such criteria when designing its equipment and energy isolation procedures.		-
9	**Hazard Alerts**		P
9.1	The equipment supplier should explain, in the documents provided to the equipment user, the meaning of hazard alerts. Hazard alerts include: visual alerts, auditory alarms, safety labels, status indicators; and hazard alert systems integral with the equipment's operating system (e.g., displayed through the video display).	Hazard alerts are explained in the documentation for applicable hazards inherent to the equipment.	P
9.2	Descriptions of the label locations and, if appropriate, additional safety information relating to the hazards they describe should also be provided.	Label locations are identified in the documentation.	P
9.3	Pictographs or symbols may be used to represent the hazard alerts in the document provided to the equipment user.	Both text and pictographs are used.	P
	NOTE 8: Pictographs or symbols may also be adapted to help communicate safety information in installation instructions, operation and maintenance manuals, and other similar written communication relating to a product.		-

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
	NOTE 9: If pictographs or symbols are used instead of text, then it is recommended that the document include explanations of the pictographs or symbols. This recommendation does not apply if the pictographs are used with text messages, as is the common practice in Hazard Alert Labels that conform to SEMI S1.		-
10	**Hazards Inherent in Tasks**		P
10.1	In the documents provided to the equipment user, hazards inherent in each task should be indicated using the signal words "Danger," "Warning," or "Caution", as described in SEMI S1. The signal word and the explanation of the hazard should be highlighted in the documentation (e.g., by enlarged lettering or by being enclosed in a box). The equipment supplier should include the definitions of "Danger," "Warning," and "Caution" that are provided in SEMI S1 in the documents provided to the equipment user if those terms are used.	Hazards warnings are identified and described in the documentation.	P
10.2	Specific instructions should be provided for routine Type 4 energized electrical work tasks (as defined in SEMI S2), excluding troubleshooting. General procedures for troubleshooting, including Type 4 work, should be provided.	No Type 4 tasks identified	N/A
	NOTE 10: SEMI S2 provides guidance that suppliers should design the equipment to minimize the need to calibrate, modify, repair, test, adjust, or maintain equipment while it is energized, and to minimize work that must be performed on components near exposed energized circuits. SEMI S2 also states that the supplier should move as many tasks as practical from category Type 4 to Types 1, 2, or 3.		-
	NOTE 11: NFPA70E describes the identification of the Flash Protection Boundary in the USA.		-
10.3	Specific instruction may be provided for the unjamming task.	The system does not require unjamming tasks	N/A
	NOTE 12: 'Unjamming' (also called 'jam clearing') is considered to be a service task.		-
10.4	Each maintenance and service task should include a list of the materials required for the task.	The system does not require service or maintenance tasks by the end user	N/A
11	**Material Safety Data Sheet (MSDS)**		P
11.1	The equipment supplier should provide MSDSs covering those chemical substances which are inherent in, or shipped with, the equipment.	Chemical substances are not used with the equipment	N/A
11.2	For those chemical substances which are used for processing, maintenance, or service of equipment, but are not provided in or with the equipment, the documents provided to the equipment user should state that the user must obtain the MSDSs from their chemical suppliers, rather than from the equipment supplier. The user is responsible for obtaining process related MSDSs and should contact their suppliers to obtain them.	Chemical substances are not used with the equipment	N/A
	NOTE 13: The equipment user may request, from the equipment supplier, the list of chemicals prepared in accordance with the chemical section in SEMI S2.		-

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
	NOTE 14: International Labor Convention No. 170 and ANSI Z400.1 call for MSDSs to describe: • *Product and company identification* • *Composition* • *Hazard identification* • *First aid measures* • *Firefighting measures* • *Accidental release measure* • *Handling and storage* • *Exposure controls / Personal protection* • *Physical and chemical properties* • *Stability and reactivity* • *Toxicological information* • *Ecological information* • *Disposal considerations* • *Transport information* • *Regulatory information* • *Other information*		-
12	**Personal Protective Equipment (PPE)**		
12.1	The documents provided to the equipment user should clarify which tasks require personal protective equipment and which kind of PPE (e.g., goggles, aprons, gloves, masks, safety shoes, helmets) is needed for each task.	PPE is not required for service tasks.	N/A
12.2	The documents should identify the characteristics, such as being shatterproof or acid resistant, of the personal protective equipment to be used.	No specific characteristics of PPE are given in the documentation.	N/A
12.3	The equipment supplier should state in the documents provided to the equipment user that PPE should be used in accordance with the instructions provided by the PPE supplier, except where additional instructions by the equipment supplier are required.	PPE is not required for service tasks.	N/A
13	**Equipment Inspection, Consumables, and Maintenance**		P
13.1	The documents provided to the equipment user should describe the recommended methods of periodic inspections including the frequency of each inspection.	Recommended periodic inspections are described in the documentation	P
13.1.1	Periodic inspections include periodic situations that have long intervals between procedures (e.g., changing memory batteries in computers, replacing UPS batteries, replacing sensor modules for detection systems).	See previous comment	P
13.2	The equipment supplier should provide a list of consumable parts and materials, with their replacement intervals, maintenance methods, and part/material number in the documents provided to the equipment user.	The system does not use consumable parts.	N/A
13.2	The equipment supplier should provide information on the specific tools necessary for inspections and maintenance in the documents provided to the equipment user.	Specific tools are not identified in the maintenance procedures	N/A
14	**Training Requirement**		P

SEMI S13			
Clause	Requirement	Result - Remark	Verdict
14.1	The equipment supplier should describe the training required for safe operations and maintenance in the documents provided to the equipment user.	The system is intended to supply heated DI water to a host system. Training for the complete system is provided by the host system manufacturer. However, Trebor provides operator training upon request.	P
14.2	Documents provided to the equipment user should define what level of training is considered, by the supplier, to be sufficient.	See previous comment.	N/A
15	**Emergency Contact and Response**		P
15.1	The documents provided to the equipment user should include information on how to contact the equipment supplier in case of EHS issues related to the equipment.	Provided in the documentation	P
15.2	The documents provided to the equipment user should include an explanation of how the user may keep the equipment supplier notified of the appropriate user contact information for EHS related issues and what supplier equipment models are in use at which user locations, as well as appropriate supplier contact information where the user can address EHS concerns with the supplier equipment it owns.	Provided in the documentation	P

Attachment Eight
Sound Pressure Level Survey
Test Data Sheet

Trebor International
Quantum NXT

Sound Pressure Level Survey
Test Data Sheet

METHOD:

Intertek performed a sound pressure level survey on the 480V system on October 11, 2016 at West Jordan, Utah to verify the noise level generated by the system and its subassemblies are within acceptable levels. The survey was performed using a calibrated Type 2 sound level meter (SLM). Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The survey was performed using the method specified in SEMI S2-0715, Paragraph 27.3.1.2 and ANSI S1.13-1995. Three sound level readings (A-weighted scale, slow meter response) were taken and averaged for each of the four sides of the equipment to determine the resulting sound pressure level. The measurements were taken at approximately 1 meter away from the system and at a height of 1.5 meters to represent standing operators. When permitted, measurements were taken at least 3.5 meters away from any walls or other sound reflecting objects in the test environment. Specific test environmental conditions in the area are described below.

During this test, the system was configured as described in Section 2.0, Scope of Evaluation, in this report.

The system was located in an area with other noise sources that were operating at the time of the survey. The background sound pressure level is provided below.

Background Noise Level Correction Factor Table.

Difference between system sound pressure level (SPL) and background SPL dB(A)	Correction to be subtracted from the SPL measured with the noise source operating to obtain the SPL due to noise source alone dB(A)
3	3.0
4	2.5
5	1.7
6	1.3
7	1.0
8	0.8
9	0.6
10	0.4

Sound Pressure Survey Test Data for Main System – 480V

Sound Pressure Level Test Data for Main System

Location	Distance from System (m)	Height from floor (m)	Background noise dB(A)	Sound Pressure Level Readings dB(A)	Background corrected SPL dB(A)
Front	1.0	1.5	62.5	64.2	64.2
Left Side	1.0	1.5	62.0	66.2	63.7
Right Side	0.25	1.5	63.9	69.0	67.3
Rear	0.7	1.5	63.2	69.2	67.9

CONCLUSIONS:

Intertek performed a sound pressure level survey for the system in accordance with the criteria established in SEMI S2-0715, Paragraph 27.3.1.2 and ANSI S1.13-1995. Measurements were taken one meter from the system, where possible and 1.5 meters from floor to represent a standing operator position. During this test, the system was configured as described in Section 2.0 - Scope of Evaluation, in this report.

Refer to Section 27 of this report for details regarding the conformance of the results of this test.

METHOD:

Intertek performed a sound pressure level survey on the 208V system on February 12, 2019 at West Jordan, Utah to verify the noise level generated by the system and its subassemblies are within acceptable levels. The survey was performed using a calibrated Type 1 sound level meter (SLM). Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The survey was performed using the method specified in SEMI S2-0715, Paragraph 27.3.1.2 and ANSI S1.13-1995. Three sound level readings (A-weighted scale, slow meter response) were taken and averaged for each of the four sides of the equipment to determine the resulting sound pressure level. The measurements were taken at approximately 1 meter away from the system and at a height of 1.5 meters to represent standing operators. When permitted, measurements were taken at least 3.5 meters away from any walls or other sound reflecting objects in the test environment. Specific test environmental conditions in the area are described below.

During this test, the system was configured as described in Section 3.0, System Description and Section 2.1 System Scope, in this report.

The system was located in an area with other noise sources that were operating at the time of the survey. The background sound pressure level is recorded below.

Sound Pressure Survey Test Data for Main System – 208V

Sound Pressure Level Test Data for Main System

Location	Distance from System (m)	Height from floor (m)	Background noise dB(A)	Sound Pressure Level Readings dB(A)	Background corrected SPL dB(A)
Front	1.0	1.5	73.4	71.6	68.6
Left Side	1.0	1.5	73.4	74.1	71.1
Right Side*	1.0	1.5	73.4	78.7	77.0
Rear	1.0	1.5	73.4	74.7	71.7

*****Noise generating devices (flow box) within 2 meters of system

CONCLUSIONS:

Intertek performed a sound pressure level survey for the system in accordance with the criteria established in SEMI S2-0715, Paragraph 27.3.1.2 and ANSI S1.13-1995. Measurements were taken one meter from the system, where possible, and 1.5 meters from floor to represent a standing operator position. During this test, the system was configured as described in Section 3.0 – System Description, and Section 2.1 – System Scope, in this report.

Refer to Section 27 of this report for details regarding the conformance of the results of this test.

Attachment Nine
Earthing Continuity and Continuity of the Protective Bonding Circuit Test Data Sheet

Trebor International
Quantum NXT

Earthing Continuity and Continuity of the Protective Bonding Circuit Test Data Sheet

METHOD:

Intertek performed an Earthing Continuity and Continuity of the Protective Bonding Circuit test on the 480V system on October 11, 2016 at West Jordan, Utah to verify the accessible, conductive parts of the equipment are properly bonded to the main ground terminal with a grounding continuity of 0.1Ω or less. The test was performed using a calibrated automated ground resistance tester using the method specified in Earthing Continuity and Continuity of the Protective Bonding Circuit Test" in Section 22.3 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

RESULTS:

A maximum resistance of 0.1 ohms was measured from the internal chassis to ground.

CONCLUSIONS:

The measured resistance to ground did not exceed 0.1Ω; therefore, the test results were acceptable.

METHOD:

Intertek performed an Earthing Continuity and Continuity of the Protective Bonding Circuit test on the 208VAC system on February 12, 2019 at West Jordan, Utah to verify the accessible, conductive parts of the equipment are properly bonded to the main ground terminal with a grounding continuity of 0.1Ω or less. The test was performed using a calibrated automated ground resistance tester using the method specified in Earthing Continuity and Continuity of the Protective Bonding Circuit Test" in Section 22.3 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

RESULTS:

A maximum resistance of 0.000 ohms was measured from accessible conductive parts to ground.

CONCLUSIONS:

The measured resistance to ground did not exceed 0.1Ω; therefore, the test results were acceptable.

Refer to Paragraph 13.6.2 of this report for details.

Attachment Ten
Safety Circuit Function Test Data Sheet

Trebor International
Quantum NXT

Safety Circuit Function Test Data Sheet

METHOD:

Intertek performed a verification of the EMO and safety interlock functions on the 480V system on October 11, 2016 at West Jordan, Utah to ensure each of the critical safety EMO and interlock devices and circuits function as intended. The test was performed using the method specified in Section 22.10 of SEMI S22.

The system was connected, as intended, to a 480 VAC, three phase, 60 Hz source of power supply. The EMO button and safety interlocks listed below were actuated, one at a time, to verify that the circuits function properly by shutting the system down to a safe standby condition, required a manual reset, and provided operator notification.

RESULTS:

EMOs:

Location / Description	Test Condition	Function	Manual Reset	Operator Notification
Front Panel	Normal operation	Heater contactors turn off heaters	Required after EMO reset	Alarm displayed on VDU

CONCLUSIONS:

The EMO circuit and the safety interlocks on the system were tested and found to bring the system to a safe condition when activated. Intertek performed the test on the EMO. For the safety interlocks, the tests were performed by Trebor and sample interlock test results were verified by Intertek.

METHOD:

Intertek performed a verification of the EMO and safety interlock functions on the 208V system on February 12, 2019 at West Jordan, Utah to ensure each of the critical safety EMO and interlock devices and circuits function as intended. The test was performed using the method specified in Section 22.10 of SEMI S22.

The system was connected, as intended, to a 208 VAC, three phase, 60 Hz source of power supply. The EMO button and safety interlocks listed below were actuated, one at a time, to verify that the circuits function properly by shutting the system down to a safe standby condition, required a manual reset, and provided operator notification.

RESULTS:

EMOs:

Location / Description	Test Condition	Function	Manual Reset	Operator Notification
Front Panel	Normal operation	Heater contactors turn off heaters	Required after EMO reset	Alarm displayed on VDU

Interlocks:

Location / Description	Test Condition	Function	Manual Reset	Operator Notification
Low Pressure	Turned off pressure at source (supply valve open)	Heater contactors open and temperature drops	Cannot turn heaters on until pressure restored; Needs command to start heaters	Alarm displayed on VDU
Low Level	Turned down sensor sensitivity	Heater contactors and SSR contacts open and temperature drops	Cannot turn heaters on until water level is restored; Needs command to start heaters	Alarm displayed on VDU
Leak	Spray sensor with water	Heater contactors and SSR contacts open and temperature drops; inlet valve closes	Cannot turn heaters on until water is removed; Needs Reset (stops audible alarm), Enable, then On commands to start heaters	Alarm displayed on VDU
Element Overtemperature	Disconnect the thermocouple	TLM light turns solid (no delay); heater contactors open, SSR control power removed, so SSR contacts open, and temperature drops	Reset clears audible alarm; TLM lights cycle; ON starts heaters	Alarm displayed on VDU

CONCLUSIONS:

The EMO circuit and the safety interlocks on the system were tested and found to bring the system to a safe condition when activated. Intertek witnessed the tests.

Attachment Eleven
Input Test Data Sheet

Trebor International
Quantum NXT

Input Test Data Sheet

METHOD:

Intertek performed an input current test on the 480V system on October 11, 2016 at West Jordan, Utah, to verify the system does not exceed 110% of its rated current when at full load. The test was performed using a calibrated current clamp and multimeter using the method specified in Section 22.5 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was connected, as intended, to a 480 VAC, three phase, 60 Hz source of supply. With the system operating at the conditions noted below including maximum normal load, the following measurements were taken;

RESULTS:

Operating Condition	Current (Amperes)	Voltage (Volts)
Maximum	L1: 158.4	L1 - L2: 491.0
	L2: 158.8	L1 - L3: 489.5
	L3: 158.5	L2 - L3: 490.0

CONCLUSIONS:

The measured input current did not exceed 110% of the current rating for the system; therefore, the test results were acceptable.

On May 9, 2019 Intertek evaluated, in a limited fashion the Rev6 Booster Pump to validate its electrical pull on the system as a whole. The pump was connected to a controller, which will also be included as a part of the installation.

RESULTS:

Operating Condition	Current (Amperes)	Voltage (Volts)
Maximum	L1: 8.2	L1-L2: 48.5 VDC
	L2: 7.3	

CONCLUSIONS:

The measured input current did not contribute additional current draw to cause the overall unit to exceed 110% of the current rating for the system; therefore, the test results were acceptable.

METHOD:

Intertek performed an input current test on the 208V system on February 12, 2019 at West Jordan, Utah, to verify the system does not exceed 110% of its rated current when at full load. The test was performed using a calibrated current clamp and multimeter using the method specified in Section 22.5 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was connected, as intended, to a 208 VAC, three phase, 60 Hz source of supply. With the system operating at the conditions noted below including maximum normal load, the following measurements were taken;

RESULTS:

Operating Condition	Current (Amperes)	Voltage (Volts)
Maximum, average	L1: 232	L1 - L2: 212.5
	L2: 231	L1 - L3: 211.9
	L3: 228	L2 - L3: 211.6
Inrush / startup*	L1: 336	-
Maximum, peak*	L1: 253	-

*For information only

CONCLUSIONS:

The measured input current did not exceed 110% of the 245A current rating for the system; therefore, the test results were acceptable.

Attachment Twelve
Temperature Test Data Sheet

Trebor International
Quantum NXT

Temperature Test Data Sheet

METHOD:

Intertek performed a temperature test on the 480V system on October 11, 2016 at West Jordan, Utah to verify the surface temperature of components during normal operation do not result in thermal burns or exceed the components approved ratings. The test was performed using a calibrated infrared temperature probe and multimeter using the method specified in Section 22.13 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was connected, as intended, to a 480 VAC, three phase, 60 Hz source of power and operated at maximum normal load for sufficient time to come up to maximum normal temperature. Temperatures were measured on the components and locations listed below. Temperatures were recorded after thermal equilibrium was achieved.

RESULTS:

Location / Description	Temperature (°C)
Ambient	23.6
Main disconnect	26.8
Reset button	30.2
EMO	29.2
Touchscreen	33.1
Front Enclosure Door	34.2
Right side enclosure	47.3
Left side enclosure	52.1
Rear enclosure	47.1
DIW In	24.8
DIW Out	49.0
CDA In	25.0

CONCLUSIONS:

The measured temperatures did not exceed the temperature ratings of the components and the surface temperatures did not exceed the limits of Table 1 of SEMI S2. Therefore, the test results were acceptable.

On May 9, 2019 Intertek evaluated, in a limited fashion the Rev6 Booster Pump to validate the worst case temperature contribution to the overall system. The pump was connected to a controller, which will also be included as a part of the installation.

RESULTS:

Location / Description	Temperature (°C)
Motor Chassis	**27.2**

CONCLUSIONS:

The measured temperatures did not exceed the temperature ratings of the components and the surface temperatures did not exceed the limits of Table 1 of SEMI S2. Therefore, the test results were acceptable.

METHOD:

Intertek performed a temperature test on the 208V system on February 12, 2019 at West Jordan, Utah to verify the surface temperature of components during normal operation do not result in thermal burns or exceed the components approved ratings. The test was performed using a calibrated infrared temperature probe and multimeter using the method specified in Section 22.13 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was connected, as intended, to a 208 VAC, three phase, 60 Hz source of power and operated at maximum normal load for sufficient time to come up to maximum normal temperature. Temperatures were measured on the components and locations listed below. Temperatures were recorded after thermal equilibrium was achieved.

RESULTS:

Location / Description	Temperature (°C)	Location / Description	Temperature (°C)
Ambient	**20.2**		
Main disconnect	**22.7**	**Front Enclosure Door**	**30.0**
Reset button	**23.2**	**Right side enclosure**	**51.5**
EMO	**24.4**	**Left side enclosure**	**46.5**
Touchscreen	**28.4**	**Rear enclosure**	**44.1**
DIW In	**20.6**		
DIW Out	**90.3**		
CDA In	**22.1**		
Interior – components, front		**Interior – components, rear**	
MCB1	**30.3**	**Heaters, left column**	**91.9, 92.5, 86.9, 90.6**
10AWG wires	**53.8**	**Heaters, right column**	**80.8, 80.0, 82.7, 81.0**
Filter	**35.4**	**Top tube**	**86.4**
Relays	**45.6**	**Heater cable trunk**	**54.5**
TLMs	**29.8**		
E-Net switch	**35.6**		
CBs	**59.0**		
Contactors	**57.7**		
Fans	**33.8**		
SSRs*	**78.6, 124.1, 69.8**		
SSRs (2/13/19)	**64.0**		

*High temperatures caused by loose connections, therefore test repeated after connections tightened.

CONCLUSIONS:

The measured temperatures did not exceed the temperature ratings of the components and the surface temperatures did not exceed the limits of Table 1 of SEMI S2. Therefore, the test results were acceptable.

Attachment Thirteen
Dielectric Test Data Sheet

Trebor International
Quantum NXT

Dielectric Test Data Sheet

METHOD:

Intertek performed a dielectric withstand test on the 480V system on November 12, 2016 at West Jordan, Utah, to verify there is no dielectric breakdown between the line and ground circuits. The survey was performed using a calibrated Dielectric Withstand tester using the method specified in IEC 61010-1, paragraph 6.7.1.5. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was at its normal operating temperature and disconnected from the source of supply. A 2210 VAC potential was applied for 60 seconds between live parts of the primary circuit and the grounding terminal. To ensure that the test potential was applied to all parts of the primary circuit, contactors were manually closed and circuit breakers and switches were set to their closed position.

RESULTS:

There was no indication of dielectric breakdown or arc-over.

Location	Test Voltage	Dielectric Breakdown?
L1 to Ground	2210	No
L2 to Ground	2210	No
L3 to Ground	2210	No

CONCLUSIONS:

As there was no breakdown or arc over, the test results were acceptable.

METHOD:

Intertek performed a dielectric withstand test on the 208VAC system on February 12, 2019 at West Jordan, Utah, to verify there is no dielectric breakdown between the line and ground circuits. The survey was performed using a calibrated Dielectric Withstand tester using the method specified in IEC 61010-1, paragraph 6.7.1.5. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was at its normal operating temperature and disconnected from the source of supply. A DC equivalent of 1500 VAC potential was applied for 60 seconds between live parts of the primary circuit and the grounding terminal. To ensure that the test potential was applied to all parts of the primary circuit, contactors were manually closed and circuit breakers and switches were set to their closed position.

RESULTS:

There was no indication of dielectric breakdown or arc-over.

Location	Test Voltage	Dielectric Breakdown?
L1, L2, L3 to Ground, outer 4 contactors closed	2280 VDC	No
L1, L2, L3 to Ground, inner 4 contactors closed	2240 VDC	No

CONCLUSIONS:

As there was no breakdown or arc over, the test results were acceptable.

Refer to Paragraph 13.4 of this report for details.

Attachment Fourteen
Static Magnetic Field Survey Test Data Sheet

Trebor International
Quantum NXT

Static Magnetic Field Survey
Test Data Sheet

METHOD:

Intertek performed a static magnetic field survey on the QNXT 208V system on February 13, 2019 at the Trebor facility in West Jordan, UT to verify the system is well designed to control static magnetic field emissions to within acceptable limits. The survey was performed using the method specified in SEMI S2-0715 Appendix 3, Table A3-1, Non-Ionizing Radiation.

The system contains no known components that generate static magnetic fields.

The survey was performed using a calibrated Holaday Magnetic Field Monitor (Hall effect probe) to determine the static magnetic field strengths generated by the system. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data. The measurements were made at 2 to 3 cm on all external surfaces. Measurements were also made to determine the 5 gauss (G) / 0.5 milliTesla (mT) line (i.e., the distance from the source at which the field strength equals 5 G) for pacemaker hazard warning. Pacemaker wearers exposed to static magnetic fields which exceed 5 G could experience a disruption in pacemaker function. In addition, if applicable, measurements were made at the 30 G line (i.e., the distance at which metal objects may be propelled due to the magnetic field strength) to determine the hazard for flying metal objects.

RESULTS:

Table 1
Summary of Static Magnetic Field Results

Component Description/ Location	Exterior surfaces of 208V model										
Measurement Location	**Distance**	**Measured Result**		**SEMI S2-0715 Operator Accessible Limit**		**SEMI S2-0715 Maintenance/ Service Accessible Limit**		**SEMI S2-0715 Pacemaker Labeling Level**		**ACGIH TLV**	
		(mT)	(G)	(mT)	(G)	(mT)	(G)	(mT)	(G)	(mT)	(G)
Front Surfaces	2-3 cm	0.28		200	2000	200	2000	0.5	5	60	600
Right Surfaces	2-3 cm	LD									
Back Surfaces	2-3 cm	0.18									
Left Surfaces	2-3 cm	0.29									
5 G Line	-	-									
30 G line	-	-									
Background	1 m	LD		200	2000	200	2000	0.5	5	60	600

LD = less than detectable
Detection Limit = 0.1mT

CONCLUSIONS:

The ACGIH Threshold Limit Value (TLV) for static magnetic fields to protect nearly all workers from repeated exposure day after day without producing adverse health effects has been established as 60 mT (600 Gauss) for whole body exposure. In addition, SEMI S2-0715, Appendix 3, Table A3-1, has established Accessible Limits for Operator, Maintenance and Service of 200 mT (2000 G), and for Pacemaker Labeling of 0.5 mT (5 G).

Based on the test results the measured magnetic fields were not detectable (detection limit 0.1 mT (1G)) or were below the control limit for pacemaker hazard in all areas. At the highest field measured location, the levels measured were 0.29 mT at 2 – 3 cm from the surface. No warnings or labels are required and no additional control measures are required at this time.

Refer to Section 25 of this report for details regarding the conformance of the results of this test.

Attachment Fifteen
Abnormal Test Data Sheet

Trebor International
Quantum NXT

ABNORMAL TEST DATA SHEET

METHOD:

Heaters or other circuits which, under any reasonably foreseeable single fault condition, are capable of causing abnormal temperatures that create a hazardous condition with an unacceptable level of risk should be provided with over temperature protection to detect these abnormally elevated temperatures and interrupt the source of energy driving them. Equivalent means of protection are acceptable.

Intertek performed a temperature test on the 208V system on February 12, 2019 at West Jordan, Utah to verify the surface temperature of the system and components during abnormal operation does not result in thermal burns or equipment damage. The test was performed using a calibrated infrared temperature probe and multimeter using the method specified in Section 22.13 of SEMI S22. Refer to Attachment Sixteen, Summary of Test Equipment and Calibration Data.

The system was connected, as intended, to a 208 VAC, three phase, 60 Hz source of power and operated at maximum normal load for sufficient time to come up to maximum normal temperature. Each of the following single fault conditions was then applied, one at a time: a) 100% Power Commanded; b) Fans Off; c) Loss of Control (PLC set High). Temperatures were measured on the locations listed below. Temperatures were recorded after the final result – thermal equilibrium or activation of a protective device – was achieved.

RESULTS:

Location / Description	Temperature (°C)	Result
Ambient	**22.4**	
a) 100% Power Commanded: 15 lpm		
Right side enclosure, upper rear	**54.4**	**Overtemperature control tripped within 2 minutes**
b) Fans Off; 95°C, 80.4% power, 14.5 lpm		
Ambient	**20.4**	
Right side enclosure, upper rear	**56.3**	**At 8:45 minutes Overtemperature alarm set power to 0%**
SSR	**79.0**	**Tripped Heat Sink overtemperature switch**
b) Loss of Control (PLC set High); 2.0 lpm, 16 psi, 19% power indicated		
Ambient	**19.9**	
Right side enclosure, upper rear	**36.4**	**0:45 minutes: alarm; 1:10 minutes Heaters trip off, OPR valve opened, ~188°C DI Water out temperature indicated at Monitor; ~ 3 minutes PVC fitting burst in facility outlet line.**

CONCLUSIONS:

The measured temperatures did not exceed the temperature ratings of the components and the surface temperatures did not exceed the limits of Table 1 of SEMI S2. Overtemperature devices operated as expected. However, output DIW temperatures under Loss of Control single fault condition exceeded the notified temperature for output DIW line fittings. The label on the equipment and the information in the documentation should identify a higher rating temperature for the facility DIW output lines and fittings, to correspond with results from this test.

Refer to Paragraphs 9.6.2 and 10.1.

Attachment Sixteen
Summary of Test Equipment
and
Calibration Data

Trebor International
Quantum NXT

TEST EQUIPMENT SUMMARY

Company Name: Trebor International
Model: Quantum NXT Series
Date of Evaluation: October 10, 2016 through October 11, 2016

Test Equipment Validation

All of the equipment listed below was shipped from the Intertek facility to the Trebor International facility. To ensure the test equipment's calibration and general operation remains valid, Intertek performed the following steps prior to performing any tests. In the event any test equipment is damaged and fails to operate as intended, Intertek will not use the test equipment until it has been repaired and recalibrated.

Calibration certification records of each Intertek owned test equipment is on file and available upon request. Calibration certification records of any rented or borrowed test equipment is attached to this report and is on file and available upon request.

- a visual inspection of the packaging of each test equipment for damage,
- a visual inspection of each test equipment for physical damage,
- a self diagnostic routine by powering up the test equipment to verify proper operation,
- verification of the calibration status of each test equipment

Type of Measurement	Make/Model	Serial/Asset Number	Calibration Date	Calibration Due Date	Validation
Temperature	Fluke 561	GS3-1750	15-Jan-2015	15-Jan-2016	Y
Ground Continuity	Hypatia 309	ITS-00792	15-Aug-2014	15-Aug-2015	Y
Voltage	Fluke 381	GS3-1749	20-Jan-2015	20-Jan-2016	Y
Current	Fluke 381	GS3-1749	20-Jan-2015	20-Jan-2016	Y
Time	Accusplit 601X	GS3-1746	13-Dec-2014	13-Dec-2015	Y
Dielectric Withstand	Associated Research 3770	ITS-01008	02-Apr-2015	02-Apr-2016	Y
Sound Pressure	Casella CEL-620A	ITS-01216	20-Jan-2015	20-Jan-2016	Y
Distance	Komelon 4916IM	GS3- 1745	06-Dec-2014	06-Dec-2015	Y

ENGINEER

Gerald R. Wellman

Senior Project Engineer

Date of 208V Evaluation: February 11 – 13, 2019

Item	Type of Measurement	Make/ Model No.	Asset Number	Calibration		Test Equipment Validation (Y/N)
				Interval	Due Date	
1	DMM – Voltage, Current	Fluke / 87	9127	1 year	9/04/2019	Y
2	AC Current Probe	Fluke / 80i-400A	1347	1 year	10/9/2019	Y
3	Temperature Meter	Fluke / 62 Max IR	1134	1 year	9/12/2019	Y
4	Atmospheric conditions	Control Co / Hygrometer-Thermometer	0322	3 year	1/12/2020	y
5	Sound Level Meter, Type 1	CEL / CEL-620A2 Sound Level Meter	1181	1 year	1/30/2020	Y
6	Acoustic Calibrator	CEL / CEL-110/2	0738	1 year	1/14/2020	Y
7	Tape Measure	Workforce 16 ft	1057	1 year	11/14/2020	y
8	Ground, Dielectric, Insulation Resistance, Leakage Current	Dranetz / DranEST III	1079	1 year	1/09/2020	y
9	Magnetic Field	Holaday / HI 3550	1412	1 year	11/06/2019	Y
10	Stop watch	Sportline / 226	1148	1 year	10/10/2019	y
11	IR Thermometer	Fluke 561	1750	1 year	1/12/2020	y
12	Multimeter	Fluke	01130	1 year	9/4/2019	y
13	Thermocouple Data Logger	EL	01351	1 year	1/7/2020	y

Aaron R. Bell

Project Engineer

Supplement A
Revision Summary

Trebor International
Quantum NXT

REVISION SUMMARY

This section provides a record of changes for this document. Where possible, each reason for update includes the appropriate section number where a change has occurred.

Date/ Project # Site ID	Project Handler/ Reviewer	Section #	Description of Change
May 16, 2017 / G102732084		-	Original Issue
March 28, 2019 / G102732084	Allan Cose / Lawrence E. Todd	1.0, 1.1, 2.1, 2.2, 2.2.1, 2.2.2, 2.2.3, 2.4, 3.0, 4.0, 9.6.2, 9.6.5, 10.1, 11.2, 11.3, 11.4, 11.6.1, 11.7, 12.1.1, 12.2.2 (grammar), 12.2.4, 12.4, 12.5.2, 13.4, 13.4.11, 13.6.2 (nomenclature), 14.3, 16.2, 17.3.1, 18.3, 21.2.4.2, 21.2.4.3, 21.2.4.4, 21.2.4.5, 21.2.4.6, 21.2.4.7, 21.2.4.9, 25, 27.1, 27.3.3, 27.3.4, Model name change on all Attachment title pages, Attachment One introduction and table, Attachment Five details, Attachment Six details, Attachment Seven Conclusion, Attachments Eight through Thirteen new data, new Attachment Fourteen, new Attachment Fifteen, renumbered Attachment Sixteen with new data	Add 2/2019 evaluation results and descriptions of 208V models, qty 4, in the series. Update formatting to rebranded.
May 10, 2019	Daron R. Bell/ Steve Baldwin	Attachment Ten new data, Attachment Eleven new data, Attachment Sixteen new data, 1.0, 2.0, 3.0, 9.6.2, 10.1, 13.4, 27.3.4	Responding to previously found non-conformances, implemented new test data to address earlier single fault testing issues.