

AUXILIARY INFORMATION

SEMI S2-93A AND KOSHA S-MARKING COMPARISON MATRIX

FOREWORD

Publication of this document as Auxiliary Information independent of any standards was authorized by a 2/3-majority vote of the North American Environmental Health and Safety (EHS) Committee at a meeting on March 22, 2001. This action was subsequently approved by the EHS Global Coordinating Subcommittee by email on March 30, 2001 and by the NA Regional Standards Committee by electronic ballot on April 30, 2001.

The information in this document has been furnished by SEMI Standards and the “S” Mark Comparison Task Force for informational use only and is subject to change without notice.

The comparison matrix between KOSHA S-Marking requirements and SEMI S2-93A is a valuable tool to equipment suppliers, third parties and device manufacturers. It identifies the similarities and differences between those technical requirements in S2-93A and those required for KOSHA S-Marking.

The KOSHA S-Marking Comparison Task Force’s objective is to compile a full comparison matrix of the requirements for KOSHA S-Marking and related sections of SEMI S2-93A. This comparison will allow equipment suppliers to make good decisions regarding compliance with worldwide requirements.

LIMITATION

This document is intended to be used as background information only. It is not the intent of this document to alter the criteria of SEMI S2. This information is the opinion of the Task Force and is not meant to imply agreement by staff at KOSHA.

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NOTE: The comments in the column titled “Comments” are not intended to alter the requirements of the S2 guidelines. Instead, these comments are provided by the Task Force members with the intent of identifying the similarities and differences between those technical requirements in S2-93A and those required for KOSHA “S” Marking.

Comparison Matrix Between SEMI S2-93A and KOSHA “S” Mark

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certification has been cancelled according to the Article 34-5. Article 66 Fee, etc. Any person who falls under any of the following Subparagraphs, shall pay the fee under the conditions as prescribed by the Order of the Ministry of Labor: Person who desires to receive the certification of use of the safety certificate under Article 34-2.		KOSHA Specific Requirements
Enforcement Decree mission of administrative authority Matters which are commissioned to the Korea Occupational Safety and Health Agency or not-for-profit corporation are as follows; Receiving and deliberating the applicants for the license of the use of safety marks and certificating them pursuant to the Article 34-2.		KOSHA Specific Requirements

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Article 59-3 (Standards of safety certifications) The "machines and equipment which meet the safety and health standards as set forth by the Ordinances of the Ministry of Labor" in the Paragraph 1 of the Article 32-2 of the Law shall mean the machines and equipment as set forth in the Article 59-2 herein which meet the following requirements : 1. The design and production shall be such that the danger and hazard which are possible during the use or handling may be eliminated or protected to reduce the danger. 2. The design and production shall consider the fatigue, stress and inconvenient posture during the use and handling. 3~9. 10. The quality control and after sales maintenance system will be established. Article 59-4 (Application for Safety Certification) Those who wish to apply for the safety certification pursuant to the paragraph 2 of the Article 34-2 of the Law shall submit to the Safety Certification Organizations following document: 1. Copies of the business register 2. Descriptions on the structure, materials, dimensions, performance and manual for the use of the products concerned; 3. Data on the safety inspection including the design standards, safety testing methods and quality control methods; 4. Results of safety tests performed by the manufacturers and independent institutes(if any tests have been performed) ; 5. Copies of the performance inspection as set forth in the Paragraph 3 of the Article 33 of the Law and of the test conformity certificates as set forth in the Article 34 of the Law(if any) ; 6. Documents proving any certifications from domestic or foreign institutes (if any) ; and 7. Manuals for safe use of the products including the safety checklists, etc. If the Safety Certification Organizations view the documents provided with the application as insufficient, the Organizations may have the applicable applicant supplement them. Article 59-5 (Issue of Safety Certificates) The Safety Certification Organizations shall examine the applied items within 6 months from the reception of the application and, if the Organizations judge that the items satisfy the safety and health standards as set forth in the Article 59-3, issue the safety certificates in the amended form no. 10-3.	SEMI S2-93A Sections 3.1, 3.2, 3.3, 4.5 SEMI S2-93A Section 14, SEMI S8 SEMI S2-93A Section 4.4, 18.1	This establishes the basic requirements for equipment to meet the Korean Law. KOSHA Specific Requirements These establish instructions for applying to KOSHA for Certification Industry feels that the information related to the EH&S aspect of the equipment should be included in the TCF. Any information related to the unique technology of the product shall not be included in the TCF.
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Article 59-6 (Method of Examination) The examination for the safety certification shall be conducted for each different type and model of machines and equipment. The examination as mentioned in the preceding Paragraph 1 may include the field examination and inspection on the products, as well as the document examination. With regard to the products which have been recognized by domestic and foreign certifications which are enumerated by the Minister of Labor, the whole or part of the examination as set forth in the preceding Paragraph 1 may be exempted. Article 59-7 (Safety Marking, etc.) The marking of the safety marks pursuant to the Article 34-3 of the Law shall follow the methods in the annexed Table 8-3. When the advertising is made with regard to the safety certifications pursuant to the Article 34-3 of the law, the contents of the certifications shall be specifically and distinctively indicated. Article 59-8 (Follow-up Control for safety Certifications) ? In order to confirm that the certified items satisfy the safety and health standards as set forth in the Paragraph 1 of the Article 34-2, the Minister of Labor shall have the Safety Certification Organizations conduct the follow-up examination at least once a year. If the heads of the local labor offices view that the safety of any certified products should be confirmed including the occurrence of any serious accidents related to the certified products, they may request the Safety Certification Organizations to perform the follow-up examination to confirm if any certified products still satisfy the safety and health standards as set forth in the Paragraph 1 of the Article 34-2 of the Act. Article 59-9 (Cancellation of Safety Certifications) When the heads of the Safety Certification Organizations have found any machines or equipment for which the safety certifications should be cancelled pursuant to the Article 34-5 of the Act, they shall report such machines or equipment to the heads of the local labor offices. If the heads of the local labor offices have cancelled the safety certifications, they shall notify to the Safety Certification Organizations the said cancellation within 10 days therefrom and the heads of the Safety Certification Organizations shall announce the followings on a daily newspaper, etc. within 30 days from the notice of the cancellation : 1. Safety certificate number ; 2. Product names and model number of the products for which the certificate has been cancelled ; 3. Manufacturers ; 4. Dates of cancellations ; and 5. Reasons for cancellations		KOSHA Specific Requirements – These set the expectations for applicants that the Certifying Organization will evaluate the equipment quickly. KOSHA Specific Requirements – Outlining basic premises for evaluation of equipment and the exemption of previously certified equipment. The industry would like to see acceptance of Certifications in the US or elsewhere for equipment that has been approved. The industry would like to know what parts can be exempted if they are approved. KOSHA Specific Requirements – Establishes requirements for application and use of the S-mark. Also establishes reinspection procedures when equipment is
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The manufactures whose safety certifications have been cancelled pursuant to the Article 34-5 of the Act shall immediately return to the heads of the local labor offices the safety certificates as set forth in the Article 59-5 herein. Article 59-10 (Support for the Safety Certified Products) In order to promote the use of safety certified products, the Minister of Labor may request the related and other public authorities to provide necessary co-operation including the preferred purchase of the safety certified products. Article 59-11 (Detailed Rules) The Safety Certification Organizations may determine the detailed rules for the standard of the safety certifications, certification fees and others with the approval from the Minister of Labor.	procedures when equipment is found to be involved in an incident. KOSHA Specific Requirements – Establishes procedures for revoking S-mark privileges for non-conforming equipment. KOSHA Specific Requirements – Establishes the possibility for public authorities to require or prefer S-Marked equipment. KOSHA Specific Requirements – Gives scope of authority for Certification Organizations.
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according to the paragraph 1, Article 106 of Safety Certification Regulation. 9. “Exposed person” means any person wholly or partially in a danger zone. 10. “Operator” means the person or persons to be given the task of installing, operating, adjusting, maintaining, cleaning, repairing or transporting machinery. 11. “Electromagnetic Compatibility” means the ability of a device, unit of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. 12. “Electromagnetic Disturbances” means any electromagnetic phenomenon which may degrade the safety of a device, unit of equipment or system. 13. “Electromagnetic Immunity” means the ability of a device, unit of equipment or system to perform without degradation of safety in the presence of an electromagnetic disturbance. Unless otherwise defined hereunder, the terms used in this regulations shall have the meanings as defined in the OSH Law, the Enforcement Regulation and Decree.		
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In particular, where fluids are used, machinery must be designed and constructed for use without risks due to filling, use, re-filling or draining.	<u>13 Heated Chemical Baths</u> Use SEMI S3 as the minimum safety design considerations. All baths should have the following: - Grounded or GFCI heaters - Power interrupt - Manual reset - Automatic temperature controller - Liquid level sensor - Fail-safe over-temperature protection - Proper construction materials - Exhaust failure interlock - Overcurrent protection <u>20 Environmental</u> 20.1 Introduction - The end user has a responsibility to employees and the community to minimize the environmental impact of processes and operations. The equipment suppliers have a responsibility to assist the end users in achieving this goal. Minimization of chemical consumption, characterization of air emissions and waste water effluent, minimization of waste, and control of chemical spills should be addressed during equipment design. If the end user's specific process chemistry is not defined, the equipment manufacturer's baseline process may be used for evaluation pursuant to this guideline . 20.2 General Requirements 20.2.1 Upon request, the equipment manufacturer should supply information to the customer's environmental engineer as soon as is possible for the development of necessary permit applications. This information should include raw material chemical consumption requirements, wastewater effluent quality, hazardous waste generation and collection quantities, solid waste generation, exhaust effluent characterization, on-board control technologies, chemical process efficiencies, and a chemical mass balance. 20.2.2 The equipment supplier should identify spill prevention features of the equipment. 20.2.3 The equipment supplier should identify any maintenance, ancillary equipment, or peripheral operations that require chemicals (e.g., lubricants, cleaners, coolants). The supplier should specify anticipated change-out frequency, quantity, and potential for contamination by process. 20.2.4 Using the baseline process, supplier should notify end user of environmental regulatory restrictions (current and potential future) on	
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	chemicals used in the equipment. 20.2.5 Upon receipt of the supplier’s evaluation, a qualified end user environmental engineer should complete the environmental component of an Environmental/Health/Safety Impact Appraisal. This appraisal should determine if the equipment meets or exceeds the environmental guidelines presented here, considering specific process chemistries which will be used and site-specific requirements. Information from the evaluation should be used to negotiate any design changes necessary to provide the end user with environmentally acceptable equipment. The supplier should consider integrating these modifications into future units of the model in question. 20.3 Hazardous Materials Use - Use of hazardous materials should be kept to a minimum or eliminated wherever possible. 20.3.1 Prior to final design, chemicals used with the equipment should be reviewed jointly by the supplier and end user to determine if specific regulatory restrictions exist. As part of the evaluation process, a Materials Safety Data Sheet (MSDS) for each of the chemicals should be available. 20.3.2 Chemical delivery to the equipment and use of chemicals in the equipment should be carefully controlled to avoid excess chemical consumption, waste generation, and chemical losses to the exhaust system. The equipment and process should have provisions to minimize chemical usage when no processing is occurring. 20.3.3 A less hazardous chemical should be used wherever possible for process chemistries, equipment maintenance, and utility uses (cleaners, lubricants, and coolants). 20.3.4 Recycling or reusing chemicals in the equipment, rather than consuming only virgin materials, should be evaluated. 20.4 Air Emissions 20.4.1 Process by-products, fugitive emissions, and exhaust effluent should be characterized. The equipment manufacturer should provide the end user with pertinent information necessary to address the best method of handling (controlling or treating) process by-products and exhaust effluent. 20.4.2 The equipment supplier should specify exhaust flow rates and differentiate among the types of exhaust required for various applications (heat, scrubbed, solvent, pyrophoric, etc.). 20.4.3 The manufacturer should evaluate on-board controls for process chamber exhaust effluent treatment or external point-of-use abatement methods and provide alternatives to the equipment end users.	
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	20.4.3.1 In the case of volatile organic compound (VOC) emissions, on-board controls, such as thermal destruction or physical capture should be evaluated and the possible abatement alternatives described to the equipment end user for their choice on implementation. 20.4.3.2 The equipment, equipment maintenance, and process should be designed to operate without the use of Ozone Depleting Substances (ODS), such as chlorofluorocarbons (CFC), methylchloroform, and carbon tetrachloride. 20.4.3.3 In the case of emissions of toxic compounds, on-board controls such as physical capture should be evaluated and the possible abatement alternatives described to the end user. 20.5 Wastewater Effluent - Contaminant concentrations in the waste water discharges from the equipment should be as low as practical and controlled as to terms of contaminant type. 20.5.1 Discharge of regulated substances, such as organic compounds and heavy metals, should be avoided or minimized through waste stream segregation or by-product reduction. Reduction activities may include process changes, such as lower chemical concentrations in the process and mechanical separation methods, such as diverter valves and increased dwell time over chemical baths prior to rinsing. 20.5.2 Methods to minimize the amounts of corrosive materials entering the waste water effluent should be evaluated and alternatives described to the equipment end user for potential implementation. 20.5.3 Dilution with water or other dilute stream, in the excess of process requirements, solely to meet any categorical pretreatment limits as set by EPA or local sanitary sewer ordinances, is not acceptable. 20.5.4 The equipment/process should avoid unnecessary deionized water use when no processing is occurring. 20.6 Waste Generation - Solid and hazardous waste generation should be kept to a minimum, and dissimilar waste chemicals should not be mixed. 20.6.1 Methods of collection of chemical wastes generated in the form of liquids and solids should be designed into the equipment for temporary accumulation within the unit, or connections should be provided to permit central collection (dependent on facility installation). 20.6.2 In-equipment collection should be designed to avoid evaporative or spill-over losses or mixing of dissimilar waste streams. 20.6.3 Provisions should be made to allow operators to determine the collection containers' remaining available capacity conveniently without having to open the containers. Collection containers should be readily	
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Article 6 (Lighting) The manufacturer must supply integral lighting suitable for the operations concerned where its lack is likely to cause a risk despite ambient lighting of normal intensity. The manufacturer must ensure that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle and that there are no dangerous stroboscopic effects due to the lighting provided by the manufacturer. Internal parts requiring frequent inspection, and adjustment and maintenance areas, must be provided with appropriate lighting.	accessible and designed to allow their contents to be transferred to another container or to allow them to be disposed of and replaced. Level detectors and alarms should be considered for in-equipment collection 20.6.4 The equipment should be designed such that any clean-up, maintenance, and repair generates the least amount of by-products possible. This requirement should include deposits in drains, ducts (which may be minimized by equipment design), and on replaceable parts. 20.6.5 The equipment should be designed to facilitate machine clean up or disposal after its useful life has expired. Parts which become contaminated with hazardous materials should be kept to a minimum. Use of removable liners or modular parts should be considered. 20.7 Secondary Containment - All equipment feed, storage, and waste collection systems should be protected against an unwanted chemical release. 20.7.1 Secondary containment should be provided to collect releases (110% of capacity) and to allow any material released in the secondary containment to be easily removed. 20.7.2 Detection and alarm systems should be incorporated into units that use automated or pressured chemical feeds to provide automated shutdown of the unit if an unwanted release occurs and should be capable of providing alarms. 20.7.3 Equipment design should eliminate potential direct unwanted release routes to the environment, or cross contamination of waste streams due to an emergency condition or a control failure. Recommendations for mitigating emergency releases should be provided to the end user if applicable. <u>Section 14, Specifically 14.1 reference to SEMI S-8 SESC (Supplier Ergonomic Success Criteria) Appendix 1 Section 7.1</u> 14 Ergonomics/Human Factors 14.1 General - Process equipment should be designed to prevent personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.2 Ergonomic Hazards - Ergonomic hazards should be designed out or otherwise reduced to the maximum extent practicable. Ergonomic hazards exist whenever the system design or installation results in task	
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Article 7 (Design of machinery to facilitate its handling) Machinery or each component part thereof must be capable of being handled safely, be packaged or designed so that it can be stored safely and without damage (e.g. adequate stability, special supports, etc). Where the weight, size or shape of machinery or its various component parts prevents them from being moved by hand, the machinery or each component part must be as follows; 1. Lifting accessory shall be fitted to the machinery or the machinery shall have the structure which lifting accessory can be fitted firmly.	demands that exceed the information processing and/or physical capabilities of trained personnel. Hazards may result from: (a) controls that are confusing to operate; (b) displays that are difficult to read or understand; (c) lifting of heavy or bulky components; (d) repetitive motion; (e) static and/or awkward postures; (f) poor access, inadequate clearance, and excessive reaching, bending, or stooping. 14.3 Human Characteristics - Equipment should be designed to fit the physical characteristics of 90 percent of the user population (from 5th percentile Asian female through 95th percentile American male). User population design considerations include: (a) ensuring that frequently performed physical task requirements are located within the functional reach envelope of small operators; (b) providing sufficient access and clearance for large operators; (c) ensuring that manual handling requirements are within the strength capability of all operators; (e) locating displays for ease of viewing. Control and display operation should be compatible with user expectations (e.g., behavioral stereotypes). 14.4 Operability 14.4.1 System controls and displays should promote ease of use. Equipment design should consider both routine and non-routine (e.g., emergency or fault) operation. Risk to operators should be minimized by decreasing both the likelihood and consequence of procedural errors. 14.4.2 Visual and/or auditory signals should alert operators to conditions that are unsafe or require immediate intervention. 14.4.3 Prompt and consistent feedback should be provided to indicate system status, control inputs, and changes in system condition. 14.5 Maintainability/Serviceability - Equipment design and installation should facilitate maintenance and service. Specific considerations should include: (a) design for positive malfunction detection and isolation of faulty components; (b) unit packaging of component parts for ease of removal and replacement; (c) access to components that require testing, servicing, maintenance, or replacement; (d) lifting aids for heavy or bulky components. 14.6 Training - System design should minimize personnel and training requirements considering time, cost, and performance trade-offs. 14.7 Documentation - Documentation should describe and validate the ergonomics/human factors design features of the equipment. Accepted methods and practices should be used when evaluating the human-machine interface. Same response as Article 6	
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2. It has to be the structure such as threaded holes which allowing lifting accessory to be fitted easily. Machinery or components to be moved by hand shall be as follows; 1. It must be easily movable. 2. It must be equipped for picking up (e.g. hand-grips etc) and moving in complete safety. Special arrangements must be made for the handling of tools and/or machinery parts, even if lightweight, which could be dangerous (shape, material, etc).		
Sub-section 2 Controls Article 8 (Safety and reliability of control systems) Control systems must be designed and constructed so that they are safe and reliable, in a way that will prevent a dangerous situation arising. Above all they must be designed and constructed in such a way that as follows. 1. They can withstand the rigours of normal use and external factors. 2. Errors in logic do not lead to dangerous situations. Article 9 (Control devices)	3.2 The safety philosophy set forth in these guidelines is that potential hazards in the operation and maintenance of equipment be identified and engineered out of equipment during the design and construction phases. Where identified hazards cannot be eliminated, 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. All equipment should be fail-safe or of a fault-tolerant design. 4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss. 5.1 All equipment should use fail-safe hardware safety interlocks to protect against hazards inherent in the operation of the equipment. 5.8 Computer hardware failure should automatically place the equipment in a safe standby mode. Software safety interlocks should be backed up by hardware safety interlocks in all cases. 8.3 Where supplemental administrative controls are needed to limit the non-ionizing radiation exposures, these procedures should be described in detail in the suppliers operation and maintenance manuals. A description of supplemental monitoring and alarms should also be required. 12.1 The equipment should have an □emergency off□ (EMO) circuit which, when activated, places the equipment into a safe shutdown condition. A safe shutdown should not increase the level of hazard in the system. EXCEPTION: Components which are not intended to be used as stand-alone equipment, but rather within an overall end-use system (and receive their power from the end-user system), need not be provided with an emergency off circuit. The component installation manual, however, should need to provide clear instruction to the end-user system manufacturing to connect the component to the end-user system's emergency off circuit. 14.1 General - Process equipment should be designed to prevent	Equivalent Equivalent

Control devices must be as follows. 1. Clearly visible and identifiable and appropriately marked where necessary. 2. Positioned for safe operation without hesitation or loss of time, and without ambiguity. 3. Designed so that the movement of the control is consistent with its effect. 4. Located outside the danger zones, except for certain controls where necessary, such as emergency stop or a console for training of robots. 5. Positioned so that their operation cannot cause additional risk. 6. Designed or protected so that the desired effect, where a risk is involved, cannot occur without an intentional operation. 7. Made so as to withstand foreseeable strain; particular attention must be paid to emergency stop devices liable to be subjected to considerable strain. Where a control is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence (e.g. keyboards, etc). the action to be performed must be clearly displayed and subject to confirmation where necessary. Controls must be so arranged that their layout, travelling route and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles. Constraints due to the necessary or foreseeable use of PPE must be taken into account. Machinery must be fitted with indicators (dials, signals, etc) as required for safe operation. The operator must be able to read them from the control position. Where operator can be exposed to danger zone, machinery must be as follows. 1. From the main control position the operator must be able to ensure that there are no exposed persons in the danger zones. 2. If this is impossible, the control system must be designed and constructed so that an acoustic and/or visual warning signal is given whenever the machinery is about to start. The exposed person must have the time and the means to take rapid action to prevent the machinery starting up. Article 10 (Starting) It must be possible to start machinery only by actuation of a control provided for the purpose. The same requirement applies to Paragraph 1 when restarting the machinery after a stoppage, whatever the cause, and when effecting a significant change in the operating conditions (e.g. speed, pressure, etc) unless such restarting or change in operating conditions is without risk to exposed persons. This essential requirement does not apply to the	personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.3 (e) Locating displays for ease of viewing. Control and display operation should be compatible with use expectations (e.g., behavioral stereotypes) 14.4 Operability 14.4.1 System controls and displays should promote ease of use. Equipment design should consider both routine and non-routine (e.g., emergency or fault) operation. Risk to operators should be minimized by decreasing both the likelihood and consequence of procedural errors. 11.2 Equipment should be provided with means to allow the user to comply with OSHA 29 CFR 1910.147 (Control of Hazardous Energies, Lockout/Tagout) and 29 CFR 1910.331-335 (Electrical Safety-Related Work Practices) as related to lockout/tagout. Recommended lockout/tagout procedures should be supplied and installation instructions for user-supplied lockout devices provided as part of the maintenance/installation instructions. 11.3 Electrical Design - The supplier should meet the following electrical	Equivalent
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restarting of the machinery or to the change in operating conditions resulting from the normal sequence of an automatic cycle. Where machinery has several starting controls and the operators can therefore put each other in danger, additional devices (e.g. enabling devices or selectors allowing only one part of the starting mechanism to be actuated at any one time) must be fitted to rule out such risks. It must be possible for automated plant functioning in automatic mode to be restarted easily after a stoppage once the safety conditions have been fulfilled.	design guidelines. (See NFPA 79 for specific detail of design.) 11.3.1 The equipment manufacturer should provide non-conductive and/or grounded conductive physical barriers on all areas where exposed circuits are greater than 30 volts RMS or 42.4 volts peak. Barriers concealing hazards should be labeled identifying the hazards concealed. Visual hazard alerts should be in accordance with SEMI S1, ANSI Z535, or an equivalent. 11.3.2 The equipment design should minimize the probability of electrical shock during maintenance, repair, modification, calibration, or adjustment. Exposed energized circuits, components, and terminal strips should have removable non-conductive and non-combustible covers to protect personnel from incidental contact. EXCEPTION: Covers are not required for enclosures which require a tool to open and are properly labeled and designed to minimize accidental contact with energized circuits. 11.3.8 Incoming electrical power from the facility to the process equipment should come from a single feed location and should terminate at the main disconnect defined in 11.3.7. This disconnect should have the lockout capabilities specified in 11.2. (For additional information, see OSHA 29 CFR 1019.147.) EXCEPTION 1: Internal power distribution to support modules and sub-panels is acceptable. EXCEPTION 2: Equipment with more than one feed should be provided with provisions for lockout and be marked with the following text, □DANGER, RISK OF ELECTRIC SHOCK. DISCONNECT ALL (number of feed locations) SOURCES OF SUPPLY PRIOR TO SERVICING□ at each disconnect. EXCEPTION 3: A second power feed may be used when power is supplied from a facilities UPS system to maintain critical equipment system, but not the entire system. Power supplied from an external UPS will be removed when the emergency off circuit is activated or the main equipment breaker is opened. 12.2 The emergency off circuit (EMO) should be a fail safe circuit that shuts off all electrical power to the equipment so that only the safe voltage EMO circuit (typically 24 volts) and its supply may be energized. The EMO should be designed to ensure that it cannot be disabled without causing the main power circuit to open. The EMO should be hardwired to the equipment's operating system. The EMO circuit should require manual resetting so that power cannot be restored automatically. Resetting of the EMO switch should not re-energize the equipment. NOTE: The EMO should perform its function by de-energizing rather than energizing control components. 5.7 When triggered, each affected safety interlock should require individual manual reset or restart before the equipment function can be restored.	
Article 11 (Stopping device) Normal stopping devices shall be as follows. 1. Each machine must be fitted with a control whereby the machine can be	12. Emergency Shutdown 12.1 The equipment should have an □Emergency off□ (EMO) circuit which, when activated, places the equipment into a safe shutdown condition. A safe shutdown should not increase the level of hazard in the	Equivalent

brought safely to a complete stop. 2. Each work station must be fitted with a control to stop some or all of the moving parts of the machinery, depending on the type of hazard, so that the machinery is rendered safe. The machinery's stop control must have priority over the start controls. 3. Once the machinery or its dangerous parts have stopped, the energy supply to the actuators concerned must be cut off. Each machine must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: 1. Machines in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken; 2. Hand-held portable machines and hand-guided machines. This device must be as follows. 1. Emergency devices have clearly identifiable, clearly visible and quickly accessible controls. 2. Emergency devices must stop the dangerous process as quickly as possible, without creating additional hazards. 3. Emergency devices must, where necessary, trigger or permit the triggering of certain safeguard movements. 4. Once active operation of the emergency stop control has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden. 5. It must not be possible to engage the device without triggering a stop command. 6. It must be possible to disengage the device only by an appropriate operation, and disengaging the device must not restart the machinery but only permit restarting. In the case of machinery or parts of machinery designed to work together, the manufacturer must so design and construct the machinery that the stop controls including the emergency stop, can stop not only the machinery itself but also all the movement of interlocked machines if its continued operation can be dangerous.	system. Exception: Components which are not intended to be used as a stand alone equipment, but rather within an overall end-use system (and receive their power form the end-user system), need not be provided with an emergency off circuit. 12.2 The emergency off circuit (EMO) should be a fail safe circuit that shuts off all electrical power to the equipment so that only the safe voltage EMO circuit (typically 24 volts) and its supply may be energized. The EMO should be designed to ensure that it cannot be disabled without causing the main power circuit to open. The EMO should be hardwired to the equipment's operating system. The EMO circuit should require manual resetting so that power cannot be restored automatically. Resetting of the EMO switch should not re-energize the equipment. NOTE: The EMO should perform its function by de-energizing rather than energizing control components. 12.3 The emergency off function and hardware configuration should be clearly described in the facilities installation instructions and maintenance manuals. 12.4 All emergency off buttons should be clearly labeled and easily accessible from operating and maintenance locations. 12.5 The emergency off button should be red, palm or mushroom shaped and located to minimize accidental activation. lockable types should be considered at the rear of the equipment and maintenance areas 11.4.2 UPS should be located within the main power enclosure. If not, it must be physically isolated from other equipment systems. 5.8 Computer hardware failure should automatically place the equipment in a safe standby mode. Software safety interlocks should be backed up by hardware safety interlocks in all cases. 3.2 The safety philosophy set forth in these guidelines is that potential hazards in the operation and maintenance of equipment be identified and engineered out of equipment during the design and construction phases. Where identified hazards cannot be eliminated, 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. All equipment should be fail-safe or of a fault-tolerant design.	
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Article 12 (Mode selection) The control mode selected must override all other control systems with the exception of the emergency stop. If machinery has been designed and built to allow for its use in several control or operating modes presenting different safety levels (e.g. to allow for repair, adjustment, maintenance, inspection etc), it must be fitted with a mode selector which can be locked in each position. Each position of the selector must correspond to a single operating or control mode. If, for certain operations, the machinery must be able to operate with its protection devices neutralised, the mode selector must simultaneously: 1. Disable the automatic control mode; 2. Permit movements only by controls requiring sustained action; 3. Permit the operation of dangerous moving parts only in enhanced safety conditions (eg reduced speed, reduced power, step-by-step, or other adequate provision) while preventing hazards from linked sequences; 4. Prevent any movement liable to pose a danger by acting voluntarily or involuntarily on the machine's internal sensors. In addition, the operator must be able to control operation of the parts he is working on at the adjustment point.	11.3 Electrical Design - The supplier should meet the following electrical design guidelines. (See NFPA 79 for specific detail of design.) 11.3.1 The equipment manufacturer should provide non-conductive and/or grounded conductive physical barriers on all areas where exposed circuits are greater than 30 volts RMS or 42.4 volts peak. Barriers concealing hazards should be labeled identifying the hazards concealed. Visual hazard alerts should be in accordance with SEMI S1, ANSI Z535, or an equivalent. 11.3.2 The equipment design should minimize the probability of electrical shock during maintenance, repair, modification, calibration, or adjustment. Exposed energized circuits, components, and terminal strips should have removable non-conductive and non-combustible covers to protect personnel from incidental contact. EXCEPTION: Covers are not required for enclosures which require a tool to open and are properly labeled and designed to minimize accidental contact with energized circuits. 11.3.9 All equipment should be provided with a nameplate, located adjacent to the input power connection, containing, as a minimum, the manufacturer's name, model number, serial number, and electrical ratings (voltage, current, frequency, and, for multi-phase systems, the number of phases and number of wires. For more information, see NEC 670-3 and NFPA 79, Chapter 2-7.)	Equivalent
Article13 (Failure of the power supply) The interruption, re-establishment after an interruption or fluctuation in whatever manner of the power supply to the machinery must not lead to a dangerous situation. And following requirements must be complied. 1. The machinery must not start unexpectedly. 2. The machinery must not be prevented from stopping if the command has already been given. 3. No moving part of the machinery or piece held by the machinery must fall or be ejected. 4. Automatic or manual stopping of the moving parts whatever they may be must be unimpeded. 5. The protection devices must remain fully effective.	3.2 The safety philosophy set forth in these guidelines is that potential hazards in the operation and maintenance of equipment be identified and engineered out of equipment during the design and construction phases. Where identified hazards cannot be eliminated, 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. All equipment should be fail-safe or of a fault-tolerant design. 11.4 UPS, Uninterrupted Power Supplies - Applies to UPS with outputs greater than 30 volts ac or dc or energy level in the excess of 500 volt-amperes and integrated inside equipment footprint (for additional info see NFPA 110A) 11.4.1 Output of the UPS should be removed when the emergency off circuit is activated or the main equipment breaker is opened. The emergency off circuit or the main equipment breaker should be a hardware-based fail-safe circuit. 11.4.2 UPS should be located within the main power enclosure. If not, it must be physically isolated from other equipment systems.	Equivalent
Article 14 (Failure of the control circuit) A fault in the control circuit logic, or failure of or damage to the control circuit must not lead to dangerous situations. And following requirements must be complied. 1. The machinery must not start unexpectedly.	5.7 5.8 computer hardware failure should automatically place the equipment in a safe standby mode. Software safety interlocks should be backed up by hardware safety interlocks in all cases.	Equivalent

2. The machinery must not be prevented from stopping if the command has already been given. 3. No moving part of the machinery or piece held by the machinery must fall or be ejected. 4. A automatic or manual stopping of the moving parts whatever they may be must be unimpeded. 5. The protection devices must remain fully effective. Article15 (Software) Interactive software between the operator and the command or control system of a machine must be user-friendly.	14.4.2 Visual and/or auditory signals should alert operators to conditions that are unsafe or require immediate intervention. 14.4.3 Prompt and consistent feedback should be provided to indicate system status, control inputs, and changes in system condition. 14.4.1 System controls and displays should promote ease of use. Equipment design should consider both routine and non-routine (e.g., emergency or fault) operation. Risk to operators should be minimized by decreasing both the likelihood and consequence of procedural errors	
Sub-section 3 Protection against mechanical hazards Article 16 (Stability) Machinery, components and fittings thereof must be so designed and constructed that they are stable enough, under the foreseen operating conditions (if necessary taking climatic conditions into account) for use without risk of overturning, falling or unexpected movement. If the shape of the machinery itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions. Article 17 (Risk of break-up during operation) The various parts of machinery and their linkages must be able to withstand the stresses to which they are subject when used as foreseen by the manufacturer. The durability of the materials used must be adequate for the nature of the work place foreseen by the manufacturer, in particular as regards the phenomena of fatigue, ageing, corrosion and abrasion. The manufacturer must indicate in the instructions the type and frequency of inspection and maintenance required for safety reasons. He must, where appropriate, indicate the parts subject to wear and the criteria for replacement. Where a risk of rupture or disintegration remains despite the measures taken (e.g. as with grinding wheels) the moving parts must be mounted and positioned in such a way that in case of rupture their fragments will be contained. Both rigid and flexible pipes carrying fluids, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected against all manner of external stresses and strains: precautions must be taken to ensure that no risk is posed by a rupture (sudden movement, high pressure jets, etc).	SEMI S2-93A reference 17.1 The equipment and its sub-assemblies should have protection from movement during earthquakes. 17.2 All tie-ins and attachments to equipment should be able to accommodate the expected displacement of the equipment 3.2 The safety philosophy set forth in these guidelines is that potential hazards in the operation and maintenance of equipment be identified and engineered out of equipment during the design and construction phases. Where identified hazards cannot be eliminated, 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. All equipment should be fail-safe or of a fault-tolerant design. 4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss. 18.2 Potential safety hazards, safety controls, and safety procedures should be documented and clearly communicated through the use of pictorial hazard alerts (warnings) in the supplier's operation and maintenance manuals. These manuals should be available in the national language of the end user.	

Where the material to be processed is fed to the tool automatically, the following conditions must be fulfilled to avoid risks to the persons exposed (e.g. tool breakage). 1. when the workpiece comes into contact with the tool the latter must have attained its normal working conditions; 2. when the tool starts and/or stops (intentionally or accidentally) the feed movement and the tool movement must be co-ordinated. Article 18 (Risks due to falling or ejected objects) Precautions must be taken to prevent risks from falling or ejected objects (e.g. workpieces, tools, cuttings, fragments, waste, etc). Article 19 (Risks due to surfaces, edges or angles) In so far as their purpose allows, accessible parts of the machinery must have no sharp edges, no sharp angles, and no rough surfaces likely to cause injury. Article 20 (Risks related to combined machinery) Where the machinery is intended to carry out several different operations with the manual removal of the piece between each operation(combined machinery), it must be designed and constructed in such a way as to enable each element to be used separately without the other elements constituting a danger or risk for the exposed person. For this purpose it must be possible to start and stop separately any elements that are not protected. Article 21 (Risks relating to variations in the rotational speed of tools) When the machine is designed to perform operations under different conditions of use (e.g. different speeds or energy supply), it must be designed and constructed in such a way that selection and adjustment of these conditions can be carried out safely and reliably.	Related Information 1 - 1.3.3 Risks due to falling objects Precautions must be taken to prevent risks from falling or ejected objects (e.g., workpieces, tools, cuttings, fragments, waste, etc.) SEMI S8 Sections 9.1.6 Exposed edges or corners in contact with users should be rounded and surfaces smooth. 10.1.6 Sharp edges and corners that present a personnel safety hazard or potential damage to clothing or equipment should be suitably protected or rounded. Related information section 1.3.5 4.2 The design of the completed equipment and its options should be examined and a risk analysis performed and documented by a qualified product-safety professional or other qualified engineering/technical professional. The risk analysis and documentation should be issued in the form of a report no later than 30 days prior to system shipment. This report should state that the equipment, including its components and sub-assemblies, conforms to applicable laws, regulations, and codes in effect at the time of purchase, and to the guidelines presented here or other applicable product safety standards. An independent laboratory or product safety consulting firm may be commissioned to supply additional testing, listings, or evaluations of conformance to this document. EXCEPTIONS: All hazards that cannot be engineered out of the product should be clearly identified and controlled to reduce personnel exposure and/or property damage. These hazards should be addressed specifically in the product operations and maintenance manual or in an accompanying notice. The manufacturer should continue to work to eliminate these hazards. Related Information section 1.3.6 5.2 The safety interlock scheme should be designed to minimize the need to override automatic fail-safe safety interlock systems during maintenance activities. Safety interlocks in conjunction with physical barriers that operate at the point of the hazard are preferred (for example, a safety interlocked cover over a laser beam). When access to hazards that cannot be eliminated is required during maintenance,	
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Article 22(Prevention of risks related to moving parts) The moving parts of machinery must be designed, built and laid out to avoid hazards or, where hazards persist, fixed with guards or protective devices in such a way as to prevent all risk of contact which could lead to accidents. In cases where, despite the precautions taken, a blockage is likely to occur, specific protection devices or tools, the instruction handbook and important sign on the machinery should be provided by the manufacturer . Article 23 (Choice of protection against risks related to moving parts) Guards or protection devices used to protect against the risks related to moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help make the choice. 1. Guards designed to protect exposed persons against the risks associated with moving transmission parts (such as pulleys, belts, gears, rack and pinions, shafts, etc) must be either fixed, complying with requirements Article 24 and paragraph 1 of Article 25 or movable, complying with requirements Article 24 and paragraph 2 of Article 25. 2. Guards or protection devices designed to protect exposed persons against the risks associated with moving parts contributing to the work (such as cutting tools, moving parts of presses, cylinders, parts in the process of being machined, etc) must be fulfilled as following requirements. A. Wherever possible fixed guards shall be complied with requirements in the Article 24 and paragraph 1 of Article 25. B. Otherwise, movable guards shall be complied with requirements Article 24 and type A in paragraph 2 of Article 25. C. Protection devices such as sensing devices, position controlled protection devices (e.g. two-hand controls), or protection devices in accordance with requirements Article 24 and paragraph 4 of Article 25 shall be installed. However, when certain moving parts directly involved in the process	defeatable safety interlocks should be provided. Upon exiting the maintenance mode, all safety interlocks should be automatically restored. 5.4 Equipment using greater than 30 volts RMS or 42.2 volts peak, rf power, hazardous chemicals, lasers, and uv light, as well as radiation-generating equipment, should be provided with physical barriers (labeled as to the hazards they protect) or safety interlocks, at the point of hazard, which effectively protect from personnel exposure. If the physical barrier does not require a tool to obtain access, the interlock is mandatory. hazardous chemicals, lasers, and uv light, as well as radiation-generating 18.2 Potential safety hazards, safety controls, and safety procedures should be documented and clearly communicated through the use of pictorial hazard alerts (warnings) in the supplier's operation and maintenance manuals. These manuals should be available in the national language of the end user. Related Information section 1.3.8 5.1 All equipment should use fail-safe hardware safety interlocks to protect against hazards inherent in the operation of the equipment. Hardware safety interlocks should back up the equipment's operating system to ensure that, upon activation, the equipment is brought to a safe standby condition automatically and the operator alerted immediately. The operator notification should provide an explanation of the cause. 5.2 The safety interlock scheme should be designed to minimize the need to override automatic fail-safe safety interlock systems during maintenance activities. Safety interlocks in conjunction with physical barriers that operate at the point of the hazard are preferred (for example, a safety interlocked cover over a laser beam). When access to hazards that cannot be eliminated is required during maintenance, defeatable safety interlocks should be provided. Upon exiting the maintenance mode, all safety interlocks should be automatically restored. 5.4 Equipment using greater than 30 volts RMS or 42.2 volts peak, rf power, hazardous chemicals, lasers, and uv light, as well as radiation-generating equipment, should be provided with physical barriers (labeled as to the hazards they protect) or safety interlocks, at the point of hazard, which effectively protect from personnel exposure. If the physical barrier does not require a tool to obtain access, the interlock is mandatory.	
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cannot be made completely or partially inaccessible during operation owing to operations requiring nearby operator intervention, where technically possible such parts must be fitted with following guards. 1. Fixed guards, complying with requirements Article 24 and paragraph 1 of Article 25 preventing access to those sections of the parts that are not used in the work. 2. Adjustable guards, complying with requirements Article 24 and paragraph 3 of Article 25 restricting access to those sections of the moving parts that are strictly for the work.			
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Sub-section 4 Guards and protection devices Article 24 (General requirement) Guards and protection devices must be fulfilled following requirements. 1. It must be of robust construction. 2. It shall not give rise to any additional risk. 3. It shall not be easy to remove the function. 4. It shall be located at an adequate distance from the danger zone. 5. It shall cause minimum obstruction to the view of the production process. 6. It shall enable essential work to be carried out on installation and/or replacement of tools and also for maintenance by restricting access only to the area where the work has to be done, if possible without the guard or protection device having to be dismantled. Article 25 (Special requirements for guards)	4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss. 5 Safety-Related Interlocks...(entire section) 6.5 Components used in systems designed to contain hazardous production materials under pressure should be rated for the service in which they are used. Mechanical connections are to be enclosed in such a way as to prevent exposure of personnel should a leak occur. (For additional information, see UFC Article 51.) 7.4 All point-of-hazard panels and shields, when removed or accessed, should be safety-interlocked to prevent operation of x-ray sources or exposures of personnel to sealed radioactive sources. These interlocks, by design, should not be defeatable. 8.5 All point-of-hazard panels and shields should be rigidly affixed and require a tool for removal and be labeled as outlined by the preceding standards. 10.5.2 The secondary containment should control emissions into the work room air to less than 25% of ACGIH recommended TLV or PEL during a delivery system failure. 10.6 The size of the enclosure, the removable panels, and the openings should be minimized. 11.3.1 The equipment manufacturer should provide non-conductive and/or grounded conductive physical barriers on all areas where exposed circuits are greater than 30 volts RMS or 42.4 volts peak. Barriers concealing hazards should be labeled identifying the hazards concealed. Visual hazard alerts should be in accordance with SEMI S1, ANSI Z535, or an equivalent. 11.3.2 The equipment design should minimize the probability of electrical shock during maintenance, repair, modification, calibration, or adjustment. Exposed energized circuits, components, and terminal strips should have removable non-conductive and non-combustible covers to protect personnel from incidental contact. EXCEPTION: Covers are not required for enclosures which require a tool to open and are properly labeled and designed to minimize accidental contact with energized circuits. 11.3.6 Electrical enclosures should be constructed to National Electrical Manufacturers Association (NEMA) standards or equivalent. 14.5 Maintainability/Serviceability - Equipment design and installation should facilitate maintenance and service. Specific considerations should include: (a) design for positive malfunction detection and isolation of faulty components; (b) unit packaging of component parts for ease of removal and replacement; (c) access to components that require testing, servicing, maintenance, or replacement; (d) lifting aids for heavy or bulky components.	
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Fixed guards must be fulfilled following requirements. 1. It must be securely held in place. 2. They must be fixed by systems that can be opened only with tools. 3. Where possible, guards must be unable to remain in place without their fixings. Movable guards shall be fulfilled following requirements. 1. Type A movable guards must as far as possible remain fixed to the machinery when open and must be associated with a locking device to prevent moving parts starting up as long as these parts can be accessed and to give a stop command whenever they are no longer closed. 2. Type B movable guards must be designed and incorporated into the control system so that: A. moving parts cannot start up while they are within the operator's reach; B. the exposed person cannot reach moving parts once they have started up; C. they can be adjusted only by means of an intentional action, such as the use of a tool, key, etc; D. the absence or failure of one of their components prevents starting or stops the moving parts; E. protection against any risk of ejection is provided by means of an appropriate barrier. Adjustable guards restricting access such as cover for sawing blades shall be fulfilled following requirements. 1. It must be adjustable manually or automatically according to the type of work involved. 2. It must be readily adjustable without the use of tools. 3. It must reduce as far as possible the risk of ejection. Protection devices must be designed and incorporated into the control system so that: 1. moving parts cannot start up while they are within the operator's reach; 2. the exposed person cannot reach moving parts once they have started up; 3. they can be adjusted only by means of an intentional action, such as the use of a tool, key, etc; 4. the absence or failure of one of their components prevents starting or stops the moving parts.	8.5 All point-of-hazard panels and shields should be rigidly affixed and require a tool for removal and be labeled as outlined by the preceding standards. Related Information 1: Movable guards Type A movable guards must: - as far as possible remain fixed to the machinery when open; - be associated with a locking device to prevent moving parts starting up as long as these parts can be accessed and to give a stop command whenever they are no longer closed. Type B movable guards must be designed and incorporated into the control system so that: - moving parts cannot start up while they are within the operators reach; - the exposed person cannot reach moving parts once they have started up; - they can be adjusted only by means of an intentional action, such as the use of a tool, key etc.; - the absence or failure of one of their components prevents starting or stops the moving parts; - protection against any risk of ejection is provided by means of an appropriate barrier.	
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Sub-section.5 Protection against other hazards		
Article 26 (Electricity supply) Where machinery has an electricity supply it must be designed, constructed and equipped so that all hazards of an electrical nature are or can be prevented. The specific rules in force relating to electrical equipment designed for use within certain voltage limits must apply to machinery which is subject to those limits. Article 27 (Static electricity) Machinery must be so designed and constructed as to prevent or limit the build-up of potentially dangerous electrostatic charges and/or be fitted with a discharging system. Article 28 (Energy supply other than electricity) Where machinery is powered by an energy other than electricity (e.g. hydraulic, pneumatic or thermal energy, etc), it must be so designed, constructed and equipped as to avoid all potential hazards associated with these types of energy. Article 29 (Errors of fitting) Errors likely to be made when fitting or refitting certain parts which could be a source of risk must be made impossible by the design of such parts or, failing this, by information given on the parts themselves and/or the housings. The same information must be given on moving parts and/or their housings where the direction of movement must be known to avoid a risk. Any further information that may be necessary must be given in the instructions. Where a faulty connection can be the source of risk, incorrect fluid connections, including electrical conductors, must be made impossible by the design or, failing this, by information given on the pipes, cables, etc and/or connector blocks. Article 30 (Dangerous temperatures) Steps must be taken to eliminate any risk of injury caused by contact with or proximity to machinery parts or materials at high or very low temperatures. The risk of hot or very cold material being ejected should be assessed. Where this risk exists, the necessary steps must be taken to prevent it or, if this is not technically possible, to render it non-dangerous.	11.3.4 All electrical components and wiring should be designed to conform with the most recent electrical code for the country of use at the time of the equipment's assembly - US; NEC/NFPA 70, NFPA 79 - Japan; JIS - Europe; IEC 950, IEC 204 Critical electrical/electronic components (whose failure could increase the risk of electrical shock, fire, or personal injury) should be listed or recognized by a nationally recognized testing laboratory, or otherwise enclosed and protected by a protection device which is listed or recognized by a nationally recognized testing laboratory 4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss. 14.1 General - Process equipment should be designed to prevent personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.5 Maintainability/Serviceability - Equipment design and installation should facilitate maintenance and service. Specific considerations should include: (a) design for positive malfunction detection and isolation of faulty components; (b) unit packaging of component parts for ease of removal and replacement; (c) access to components that require testing, servicing, maintenance, or replacement; (d) lifting aids for heavy or bulky components. 18. Documentation (entire section) 16. Hazard Warning All electrical, chemical, thermal, and mechanical hazards should be identified on the equipment. All chemical hazards should be identified by descriptive labels. All other hazard labels should conform with SEMI S1 or ANSI Z535, IEC 417, or an equivalent. All hazards should also be identified in the operation and maintenance manuals. The use of the	Equivalent Not Equivalent. Task force opinion: equipment that meets EMC Directive requirements would meet the requirements of Article 27. Not Equivalent. To address the hazards presented by these energy sources, a hazard analysis of the equipment should be performed. Equivalent Not Equivalent. Hazard analysis should be performed to determine the degree of risk and appropriate control should be used.

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Article 32 (Fire) Machinery must be designed and constructed to avoid all risk of fire or overheating posed by the machinery itself or by gases, liquids, dusts, vapours or other substances produced or used by the machinery.	identified in the operation and maintenance manuals. The use of the words CAUTION, WARNING, and DANGER should conform to the requirements of 29 CFR 1910.144-147 and ANSI Z535. 4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss.	Equivalent
Article 32 (Explosion) Machinery must be designed and constructed to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dusts, vapours or other substances produced or used by the machinery. The manufacturer must take as following steps. 1. Manufacturer shall take steps to avoid a dangerous concentration of hazardous substances. 2. Manufacturer shall take steps to prevent ignition sources within the	19.1 The use of combustible and smoke-generating materials in the construction of the process equipment should be limited. No flammable or combustible material should come in contact with potential ignition sources such as electrical components or heated surfaces. 19.2 A materials flammability test report should be available upon request. The use of combustible plastics, rated less than UL 94V-0, should be limited to less than 20% of the surface area and protected from such sources of ignition. (For additional information, see Flame Spread per ASTM E-84, Limited Oxygen Index per ASTM D-2863 and Heat Deflection Temperature per ASTM D-648 or other technical reference which address combustible plastics.) 19.2.1 Circuit boards should be UL 94V-1 rated or better. 19.3 Equipment with enclosures greater than 1.4 m3 (50 ft3) should be evaluated for fire detection system. All fire detection systems should be listed or recognized by a nationally recognized testing lab. The supplier should consider fire suppression systems. 19.3.1 The fire detection systems should be capable of interfacing with the user's facility alarm systems. 13 Heated Chemical Baths (entire section) 10.3 Equipment that uses process materials with an NFPA 704 hazard rating in health, flammability, or reactivity of 3 or 4, should place non-welded connections handling such materials in an exhausted enclosure. The equipment supplier should document when external exhaust is required and specify the requirements. 10.4 Secondary enclosure and exhaust systems for gas plumbing should be designed to ensure that a "realistic worst case" leak will be contained or captured. 19.1 The use of combustible and smoke-generating materials in the construction of the process equipment should be limited. No flammable or combustible material should come in contact with potential ignition sources such as electrical components or heated surfaces. 19.2 A materials flammability test report should be available upon	Equivalent

potentially explosive atmosphere. 3. Manufacturer shall take steps to minimise any explosion which may occur so that it does not endanger the surroundings. The same precautions in paragraph 2 must be taken if the manufacturer foresees the use of the machinery in a potentially explosive atmosphere. Electrical equipment forming part of the machinery must conform, as far as the risk from explosion is concerned, to the provision of the specific legislation in force. Article 33 (Noise) Machinery must be so designed and constructed that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise, in particular at source. Article 34 (Vibration) Machinery must be so designed and constructed that risks resulting from vibrations produced by the machinery are reduced to the lowest level, taking account of technical progress and the availability of means of reducing vibration, in particular at source. Article 35 (Radiation) Machinery must be so designed and constructed that any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are nonexistent or reduced to non-dangerous proportions.	request. The use of combustible plastics, rated less than UL 94V-0, should be limited to less than 20% of the surface area and protected from such sources of ignition. (For additional information, see Flame Spread per ASTM E-84, Limited Oxygen Index per ASTM D-2863 and Heat Deflection Temperature per ASTM D-648 or other technical reference which address combustible plastics.) 19.2.1 Circuit boards should be UL 94V-1 rated or better. 19.3 Equipment with enclosures greater than 1.4 m3 (50 ft3) should be evaluated for fire detection system. All fire detection systems should be listed or recognized by a nationally recognized testing lab. The supplier should consider fire suppression systems. 19.3.1 The fire detection systems should be capable of interfacing with the user's facility alarm systems. 10.3 Equipment that uses process materials with an NFPA 704 hazard rating in health, flammability, or reactivity of 3 or 4, should place non-welded connections handling such materials in an exhausted enclosure. The equipment supplier should document when external exhaust is required and specify the requirements. 10.4 Secondary enclosure and exhaust systems for gas plumbing should be designed to ensure that a "realistic worst case" leak will be contained or captured. 9 Audio Noise 9.1 The equipment should be designed to operate at the lowest practical dB(A) level but in no case greater than 80 dB(A). (For additional information, see 29 CFR 1910.95.) Test results indicating conformance to requirements should be available to the equipment user upon request. 14.1 General - Process equipment should be designed to <u>prevent personal injury</u> and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.2 Ergonomic Hazards - Ergonomic hazards should be designed out or otherwise reduced to the maximum extent practicable. Ergonomic hazards exist whenever the system design or installation results in task demands that exceed the information processing and/or physical capabilities of trained personnel. Hazards may result from: (a) controls that are confusing to operate; (b) displays that are difficult to read or understand; (c) lifting of heavy or bulky components; (d) repetitive motion; (e) static and/or awkward postures; (f) poor access, inadequate clearance, and excessive reaching, bending, or stooping. 7 Ionizing Radiation 7.1 Ionizing radiation emissions during operation and maintenance activities should be limited to the lowest practical level. Shielding, safety interlocks, and other safeguards should be used to ensure the lowest	Equivalent Not Equivalent Due to the nature of the semiconductor manufacturing technology, high vibrations will result in a performance issue. Equivalent
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Article 36 (Electromagnetic compatibility) Machinery must be so designed and constructed that electromagnetic disturbances shall not interfere safe operation of machinery, or safe operation of machinery shall not be affected from the external electromagnetic radiation.	practical leakage level. Under normal operating conditions, the equipment should meet or exceed all requirements of OSHA (29 CFR 1910), NRC, FDA (21 CFR 1000 through 1050), or local regulations, whichever is most stringent. 7.2 Suppliers of radiation-producing equipment should be registered with the NRC and the state (if an agreement state). If required by government regulations, documentation stating the type of ionizing radiation and levels of external radiation from the equipment at time of manufacture should be furnished to the user. (For additional information, see 29 CFR 1910.96.) Documentation that provides a performance guarantee may be submitted by the supplier, if based on established ratings for the same type of equipment and allowed by regulations. 7.3 Where supplemental administrative controls are needed to limit radiation exposures, these procedures should be described in detail in the supplier's operation and maintenance manuals. 7.4 All point-of-hazard panels and shields, when removed or accessed, should be safety-interlocked to prevent operation of x-ray sources or exposures of personnel to sealed radioactive sources. These interlocks, by design, should not be defeatable. 7.5 Labeling of radiation-producing equipment should be provided by the equipment manufacturer or supplier in accordance with 21 CFR 1020.40, NRC Part 20, 29 CFR 1910 or state and local regulations, whichever is most stringent 8 Non-Ionizing Radiation 8.1 During operation or maintenance activities, exposure to non-ionizing radiation and fields (ranging from static electric and magnetic fields through ultra-violet radiation, including: ultraviolet, infrared, visible light, radio frequency, laser, and microwave), should be limited to the lowest practical level and should not exceed applicable standards or guidelines. Shielding, safety interlocks, and other safeguards should be used to ensure the lowest practical leakage level. The equipment design should minimize potential non-ionizing radiation exposure to persons performing routine operations, maintenance, and service procedures. Under no circumstances should non-ionizing radiation levels exceed the maximum permissible exposure in the areas occupied by personnel. (For additional information, see ANSI Z-136.1 and C95.1 or OSHA 29 CFR 1046.10.) 8.2 Documentation showing the frequency/wavelength and the energy level of non-ionizing radiation from the equipment and its fields should be available to the user for all portions of the equipment that contains sources of non-ionizing radiation. (For additional information, see ANSI Z-136.1 and C95.1.) 8.3 Where supplemental administrative controls are needed to limit the non-ionizing radiation exposures, these procedures should be described in detail in the supplier's operation and maintenance manuals. A description of supplemental monitoring and alarms should also be required. 1000 through 1050.)	Not Equivalent. The equipment that meets the EMC Directive requirements of the CE marking, should be in compliance with these requirements.
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Tests for electromagnetic compatibility according to Paragraph 1 are divided into test for electromagnetic disturbances and test for electromagnetic immunity. And test items are as follows; 1. Machinery and equipment to be tested for electromagnetic disturbances A. Processing machine using high frequency energy such as industrial electrical induction heater, industrial high frequency heater, RF excited welder B. Arc or spark producing machines during work process such as electro discharge machine, electrical welding machine. C. Machinery and equipment which applicants want to get test for electromagnetic disturbances. 2. Machinery and equipment to be tested for electromagnetic immunity A. Industrial robot B. Machinery and equipment using numerical control such as numerical machine tool C. Machinery and equipment using wireless remote control device D. Machinery and equipment which applicants want to get test for electromagnetic immunity. 3. Machinery and equipment to be tested for electromagnetic disturbances and immunity A. The machinery and equipment applied to both requirements Number 1 and 2 of Paragraph 2. B. Machinery and equipment which applicants want to get test for electromagnetic disturbances and immunity. Article 37 (Laser equipment) Where laser equipment is used, the following provisions should be taken into account. 1. Laser equipment on machinery must be designed and constructed so as to prevent any accidental radiation. 2. Laser equipment on machinery must be protected so that effective radiation, radiation produced by reflection or diffusion and secondary radiation do not damage health. 3. Optical equipment for the observation or adjustment of laser equipment on machinery must be such that no health risk is created by the laser rays. Article 38 (Emissions of dust, gases, etc) Machinery must be so designed, constructed and/or equipped that risks	8.1 During operation or maintenance activities, exposure to non-ionizing radiation and fields (ranging from static electric and magnetic fields through ultra-violet radiation, including: ultraviolet, infrared, visible light, radio frequency, laser, and microwave), should be limited to the lowest practical level and should not exceed applicable standards or guidelines. Shielding, safety interlocks, and other safeguards should be used to ensure the lowest practical leakage level. The equipment design should minimize potential non-ionizing radiation exposure to persons performing routine operations, maintenance, and service procedures. Under no circumstances should non-ionizing radiation levels exceed the maximum permissible exposure in the areas occupied by personnel. (For additional information, see ANSI Z-136.1 and C95.1 or OSHA 29	Equivalent
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due to gases, liquids, dust, vapours and other waste materials which it produces can be avoided. Where a hazard exists, the machinery must be so equipped that the said substances can be contained and/or evacuated. Where machinery is not enclosed during normal operation, the devices for containment and/or evacuation must be situated as close as possible to the source of the emission. Article 39 (Risk of being trapped in a machine) Machinery must be designed, constructed or fitted with a means of	CFR 1046.10.) 10.5.1 The goal is zero leakage, and under normal operating conditions, should not exceed 1% of ACGIH-recommended TLV, PEL, or the lower detectable limit. 10.5.2 The secondary containment should control emissions into the work room air to less than 25% of ACGIH recommended TLV or PEL during a delivery system failure. 6.1 Operation and maintenance manuals should contain descriptions or diagrams of potential key failure points and trouble spots in equipment that use hazardous process materials or contain hazardous by-products. Text should be highlighted with such words as CAUTION, WARNING, or DANGER. (The use of these words should conform to the requirements of 29 CFR 1910.144-147 [OSHA] and ANSI Standard Z535.) 10.1 Ventilation enclosures should be designed and test validated for efficient and safe control of chemical emissions during routine operation and maintenance, and during the failure of other control systems. These systems should optimize the use of air flow, as far as practical, directing escaping chemicals so they do not impinge on the equipment. These means should be based on application-specific design principles as specified in the ACGIH Industrial Ventilation - A Manual of Recommended Practice, OSHA Regulations, 29 CFR 1910, SEMI S6 for ventilation, or the model mechanical codes applicable at the site of installation. 10.2 Equipment that uses hazardous materials or that generates hazardous chemical by-products should be designed to use local exhaust ventilation as the primary safety control. Exhaust loads that require continuous flow external treatment should be minimized. Supplementary exhaust to support maintenance should be used where appropriate to reduce the continuous exhaust requirements for the equipment. 20.4 Air Emissions 20.4.1 Process by-products, fugitive emissions, and exhaust effluent should be characterized. The equipment manufacturer should provide the end user with pertinent information necessary to address the best method of handling (controlling or treating) process by-products and exhaust effluent. 20.4.2 The equipment supplier should specify exhaust flow rates and differentiate among the types of exhaust required for various applications (heat, scrubbed, solvent, pyrophoric, etc.). 20.4.3 The manufacturer should evaluate on-board controls for process chamber exhaust effluent treatment or external point-of-use abatement methods and provide alternatives to the equipment end users. 20.4.3.1 In the case of volatile organic compound (VOC) emissions, on-board controls, such as thermal destruction or physical capture should be evaluated and the possible abatement alternatives described to the equipment end user for their choice on implementation. 4.5 No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss.	Equivalent Not Equivalent. A Hazard analysis of the equipment should be performed to
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preventing an exposed person from being enclosed within it or, if that is impossible, with a means of summoning help. Article 40 (Risk of slipping, tripping or falling) Parts of the machinery where persons are liable to move about or stand must be designed and constructed to prevent persons slipping, tripping or falling on or off these parts.		determine the risk and to design the control methods. Not Equivalent. A Hazard analysis of the equipment should be performed to determine the risk and to design the control methods.
Sub-section 6 Maintenance Article 41 (Machinery maintenance) Adjustment, lubrication and maintenance must be carried out outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery is at a standstill. If one or more of the above conditions cannot be satisfied for technical reasons, these operations must be possible without risk. In the case of automated machinery and, where necessary, other machinery, the manufacturer must make provision for a connecting device for mounting diagnostic fault-finding equipment. Automated machine components which have to be changed frequently, in particular for a change in manufacture or where they are liable to wear or likely to deteriorate following an accident, must be capable of being removed and replaced easily and in safety. Access to the components must enable these tasks to be carried out with the necessary technical means (tools, measuring instruments, etc) in accordance with an operating method specified by the manufacturer.	3 Safety Philosophy 3.1 Few safety standards exist that specifically address the design and construction of process equipment used in the manufacturing of semiconductors. Because of the expense and disruptive effects of safely retro-fitting equipment, these guidelines should be used, during design and construction of process equipment, to help eliminate known safety and health hazards inherent in operation and maintenance. Industry standards; building, electrical and fire codes; government regulatory requirements; and good practice should be considered in all equipment development programs. 3.2 The safety philosophy set forth in these guidelines is that potential hazards in the operation and maintenance of equipment be identified and engineered out of equipment during the design and construction phases. Where identified hazards cannot be eliminated, 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. All equipment should be fail-safe or of a fault-tolerant design. 3.3 These guidelines define the minimum safety considerations for semiconductor manufacturing equipment. The areas of concern in the operation and maintenance of equipment are: - Chemical hazards - Radiation hazards - Electrical hazards - Physical hazards - Mechanical hazards - Environmental hazards - Fire and explosions - Seismic activity hazards - Ventilation - Ergonomics 4 General Guidelines This section describes the general safety guidelines for all semiconductor manufacturing process and test equipment. 4.2 The design of the completed equipment and its options should be examined and a risk analysis performed and documented by a qualified product-safety professional or other qualified engineering/technical professional. The risk analysis and documentation should be issued in	Equivalent

	the form of a report no later than 30 days prior to system shipment. This report should state that the equipment, including its components and sub-assemblies, conforms to applicable laws, regulations, and codes in effect at the time of purchase, and to the guidelines presented here or other applicable product safety standards. An independent laboratory or product safety consulting firm may be commissioned to supply additional testing, listings, or evaluations of conformance to this document. EXCEPTIONS: All hazards that cannot be engineered out of the product should be clearly identified and controlled to reduce personnel exposure and/or property damage. These hazards should be addressed specifically in the product operations and maintenance manual or in an accompanying notice. The manufacturer should continue to work to eliminate these hazards. 5 Safety-Related Interlocks 5.2 The safety interlock scheme should be designed to minimize the need to override automatic fail-safe safety interlock systems during maintenance activities. Safety interlocks in conjunction with physical barriers that operate at the point of the hazard are preferred (for example, a safety interlocked cover over a laser beam). When access to hazards that cannot be eliminated is required during maintenance, defeatable safety interlocks should be provided. Upon exiting the maintenance mode, all safety interlocks should be automatically restored. 5.3 Each type of safety interlock and its operation should be fully explained in the operations and maintenance manuals. 5.4 Equipment using greater than 30 volts RMS or 42.2 volts peak, rf power, hazardous chemicals, lasers, and uv light, as well as radiation-generating equipment, should be provided with physical barriers (labeled as to the hazards they protect) or safety interlocks, at the point of hazard, which effectively protect from personnel exposure. If the physical barrier does not require a tool to obtain access, the interlock is mandatory. 5.5 All equipment using hazardous gas requiring detection should be able to interface with gas monitoring equipment. The output from gas monitoring equipment should initiate automatic shutdown of gas flows and place the equipment in a safe state. 5.6 When triggered, safety interlocks should place the point of hazard area in a safe state. When triggered, each affected safety interlock should require individual manual reset or restart before the equipment function can be restored. 6 Chemicals	
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	6.2 Equipment that uses hazardous production materials requiring detection based on regulations (such as federal, state, and local codes) should have sample points mounted in the equipment, or have recommended sampling points identified in the product literature. The equipment should be able to interface with an external monitoring device and shut down the supply of the hazardous process materials. 7 Ionizing Radiation 7.1 Ionizing radiation emissions during operation and maintenance activities should be limited to the lowest practical level. Shielding, safety interlocks, and other safeguards should be used to ensure the lowest practical leakage level. Under normal operating conditions, the equipment should meet or exceed all requirements of OSHA (29 CFR 1910), NRC, FDA (21 CFR 1000 through 1050), or local regulations, whichever is most stringent. 7.3 Where supplemental administrative controls are needed to limit radiation exposures, these procedures should be described in detail in the supplier's operation and maintenance manuals 8 Non-Ionizing Radiation 8.1 During operation or maintenance activities, exposure to non-ionizing radiation and fields (ranging from static electric and magnetic fields through ultra-violet radiation, including: ultraviolet, infrared, visible light, radio frequency, laser, and microwave), should be limited to the lowest practical level and should not exceed applicable standards or guidelines. Shielding, safety interlocks, and other safeguards should be used to ensure the lowest practical leakage level. The equipment design should minimize potential non-ionizing radiation exposure to persons performing routine operations, maintenance, and service procedures. Under no circumstances should non-ionizing radiation levels exceed the maximum permissible exposure in the areas occupied by personnel. (For additional information, see ANSI Z-136.1 and C95.1 or OSHA 29 CFR 1046.10.) 8.3 Where supplemental administrative controls are needed to limit the non-ionizing radiation exposures, these procedures should be described in detail in the supplier's operation and maintenance manuals. A description of supplemental monitoring and alarms should also be required. 8.5 All point-of-hazard panels and shields should be rigidly affixed and require a tool for removal and be labeled as outlined by the preceding standards. 8.6 Removable shielding or filtering material (such as film shielding used on windows) should be designed or arranged to prevent reverse or faulty installation and labeled as outlined by ANSI Z-136.1, and C95.1, and	
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	Center for Device and Radiological Health, 21 CFR 1000 through 1050. 10 Ventilation and Exhaust 10.1 Ventilation enclosures should be designed and test validated for efficient and safe control of chemical emissions during routine operation and maintenance, and during the failure of other control systems. These systems should optimize the use of air flow, as far as practical, directing escaping chemicals so they do not impinge on the equipment. These means should be based on application-specific design principles as specified in the ACGIH Industrial Ventilation - A Manual of Recommended Practice, OSHA Regulations, 29 CFR 1910, SEMI S6 for ventilation, or the model mechanical codes applicable at the site of installation. 10.2 Equipment that uses hazardous materials or that generates hazardous chemical by-products should be designed to use local exhaust ventilation as the primary safety control. Exhaust loads that require continuous flow external treatment should be minimized. Supplementary exhaust to support maintenance should be used where appropriate to reduce the continuous exhaust requirements for the equipment. 10.3 Equipment that uses process materials with an NFPA 704 hazard rating in health, flammability, or reactivity of 3 or 4, should place non-welded connections handling such materials in an exhausted enclosure. The equipment supplier should document when external exhaust is required and specify the requirements. 10.4 Secondary enclosure and exhaust systems for gas plumbing should be designed to ensure that a “realistic worst case” leak will be contained or captured. 10.7 The equipment supplier should specify static pressure, volumetric flow rate, the location where exhaust measurements should be made, and the duct material requirements for the user’s exhaust systems. 10.9 Exhaust flow interlocks should be provided by the equipment manufacturer (but the actual exhaust system is part of the facilities, and its monitoring system should be supplied by the end user) on all equipment that use hazardous process materials. When the exhaust falls below the prescribed set point a visual and audible alarm should be provided in visual and audible range of the operator, and the process equipment should be placed in a safe stand-by mode. 11 Electrical 11.1 Energized Electrical Work (“Hot Work”) - The supplier should design the equipment to minimize the need to conduct calibration, testing, or maintenance on equipment that may be energized and to	
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	minimize work that must be performed on components near exposed energized circuits. The supplier is expected to move as many tasks as possible from the “Hot Work” categories type 3, 4, and 5 to type 1 or 2. This can be accomplished through such hardware changes as remote safe testing points for high-voltage measurements. Work in types 3, 4, and 5 should have specific written instructions in the maintenance manuals. The following are the five types of energized electrical work: Type 1 - Equipment is fully de-energized (electrically “cold”). Type 2 - Equipment is energized. Live circuits are covered or insulated. Work is performed at a remote location to preclude accidental shock. Type 3 - Equipment is energized. Live circuits are exposed and accidental contact is possible. Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amperes, and 20 Joules. (See NFPA 79-14.3, IEC 204, UL 1950 & 1262, IEC 950.) Type 4 - Equipment is energized. Live circuits are exposed and accidental contact is possible. Voltage potentials are greater than 30 volts RMS, 42.2 volts peak, 240 volt-amperes, 20 Joules, or radio frequency (rf) is present. Type 5 - Equipment is energized and measurements and adjustment require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes. The supplier should list type 3 or higher electrical hazard tasks by their type (as defined in Section 11.1) in its equipment operation and maintenance manuals. 11.3.2 The equipment design should minimize the probability of electrical shock during maintenance, repair, modification, calibration, or adjustment. Exposed energized circuits, components, and terminal strips should have removable non-conductive and non-combustible covers to protect personnel from incidental contact. EXCEPTION: Covers are not required for enclosures which require a tool to open and are properly labeled and designed to minimize accidental contact with energized circuits. 15 Robotics and Automation ANSI/RIA R15.06 should be used as the minimum safety design considerations. Robotics and automation should not add to the overall degree of hazard presented by the equipment and should be designed in a manner that minimizes pre-existing procedural, chemical, electrical, and mechanical hazards. 18 Documentation 18.2 Potential safety hazards, safety controls, and safety procedures should be documented and clearly communicated through the use of	
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[illegible]

into a circuit, separation of the plug is sufficient. 1. Such isolators must be clearly identified. 2. They must be capable of being locked if reconnection could endanger exposed persons. 3. The isolator must be capable of being locked also where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. 4. After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to exposed persons. As an exception to the above requirements, certain circuits may remain connected to their energy sources in order, for example, to hold parts, protect information, light interiors, etc. In this case, special steps must be taken to ensure operator safety. Article 44 (Operator intervention) Machinery must be so designed, constructed and equipped that the need for operator intervention is limited. If operator intervention cannot be avoided, it must be possible to carry it out easily and in safety.	lockout/tagout procedures should be supplied and installation instructions for user-supplied lockout devices provided as part of the maintenance/installation instructions. 11.3.8 Incoming electrical power from the facility to the process equipment should come from a single feed location and should terminate at the main disconnect defined in 11.3.7. This disconnect should have the lockout capabilities specified in 11.2. (For additional information, see OSHA 29 CFR 1019.147.) EXCEPTION 1: Internal power distribution to support modules and sub-panels is acceptable. EXCEPTION 2: Equipment with more than one feed should be provided with provisions for lockout and be marked with the following text, “DANGER, RISK OF ELECTRIC SHOCK. DISCONNECT ALL (number of feed locations) SOURCES OF SUPPLY PRIOR TO SERVICING” at each disconnect. EXCEPTION 3: A second power feed may be used when power is supplied from a facilities UPS system to maintain critical equipment system, but not the entire system. Power supplied from an external UPS will be removed when the emergency off circuit is activated or the main equipment breaker is opened. 14 Ergonomics/Human Factors 14.5 Maintainability/Serviceability - Equipment design and installation should facilitate maintenance and service. Specific considerations should include: (a) design for positive malfunction detection and isolation of faulty components; (b) unit packaging of component parts for ease of removal and replacement; (c) access to components that require testing, servicing, maintenance, or replacement; (d) lifting aids for heavy or bulky components. 14 Ergonomics/Human Factors 14.1 General - Process equipment should be designed to prevent personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.2 Ergonomic Hazards - Ergonomic hazards should be designed out or otherwise reduced to the maximum extent practicable. Ergonomic hazards exist whenever the system design or installation results in task demands that exceed the information processing and/or physical capabilities of trained personnel. Hazards may result from: (a) controls	
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Article 45 (Cleaning of internal parts) The machinery must be designed and constructed in such a way that it is possible to clean internal parts which have contained dangerous substances or preparations without entering them; any necessary unblocking must also be possible from the outside. If it is absolutely impossible to avoid entering the machinery, the manufacturer must take steps during its construction to allow cleaning to take place with the minimum of danger.	that are confusing to operate; (b) displays that are difficult to read or understand; (c) lifting of heavy or bulky components; (d) repetitive motion; (e) static and/or awkward postures; (f) poor access, inadequate clearance, and excessive reaching, bending, or stooping. 14.4 Operability 14.4.1 System controls and displays should promote ease of use. Equipment design should consider both routine and non-routine (e.g., emergency or fault) operation. Risk to operators should be minimized by decreasing both the likelihood and consequence of procedural errors. 14.4.2 Visual and/or auditory signals should alert operators to conditions that are unsafe or require immediate intervention. Prompt and consistent feedback should be provided to indicate system status, control inputs, and changes in system condition. 14 Ergonomics/Human Factors 14.1 General - Process equipment should be designed to prevent personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.2 Ergonomic Hazards - Ergonomic hazards should be designed out or otherwise reduced to the maximum extent practicable. Ergonomic hazards exist whenever the system design or installation results in task demands that exceed the information processing and/or physical capabilities of trained personnel. Hazards may result from: (a) controls that are confusing to operate; (b) displays that are difficult to read or understand; (c) lifting of heavy or bulky components; (d) repetitive motion; (e) static and/or awkward postures; (f) poor access, inadequate clearance, and excessive reaching, bending, or stooping. 14.3 Human Characteristics - Equipment should be designed to fit the physical characteristics of 90 percent of the user population (from 5th percentile Asian female through 95th percentile American male). User population design considerations include: (a) ensuring that frequently performed physical task requirements are located within the functional reach envelope of small operators; (b) providing sufficient access and clearance for large operators; (c) ensuring that manual handling requirements are within the strength capability of all operators; (e) locating displays for ease of viewing. Control and display operation should be compatible with user expectations (e.g., behavioral	
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	stereotypes). 20 Environmental 20.4.3 The manufacturer should evaluate on-board controls for process chamber exhaust effluent treatment or external point-of-use abatement methods and provide alternatives to the equipment end users. 20.4.3.1 In the case of volatile organic compound (VOC) emissions, on-board controls, such as thermal destruction or physical capture should be evaluated and the possible abatement alternatives described to the equipment end user for their choice on implementation. 20.6.3 Provisions should be made to allow operators to determine the collection containers' remaining available capacity conveniently without having to open the containers. Collection containers should be readily accessible and designed to allow their contents to be transferred to another container or to allow them to be disposed of and replaced. Level detectors and alarms should be considered for in-equipment collection containers. 20.6.4 The equipment should be designed such that any clean-up, maintenance, and repair generates the least amount of by-products possible. This requirement should include deposits in drains, ducts (which may be minimized by equipment design), and on replaceable parts. 20.6.5 The equipment should be designed to facilitate machine clean up or disposal after its useful life has expired. Parts which become contaminated with hazardous materials should be kept to a minimum. Use of removable liners or modular parts should be considered. 20.7.1 Secondary containment should be provided to collect releases (110% of capacity) and to allow any material released in the secondary containment to be easily removed.	
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NOTE: The comments in the column titled “Comments” are not intended to alter the requirements of the S2 guidelines. Instead, these comments are provided by the Task Force members with the intent of identifying the similarities and differences between those technical requirements in S2-93A and those required for KOSHA “S” Marking.

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Sub-section 7 Indicators Article 46 (Information devices) The information needed to control machinery must be unambiguous and easily understood. It must not be excessive to the extent of overloading the operator. Where the health and safety of exposed persons may be endangered by a fault in the operation of unsupervised machinery, the machinery must be equipped to give an appropriate acoustic or light signal as a warning.	Semi S2-93a, section 4.5: No single point failure or equipment operational error should allow exposure of personnel, facilities, or community to hazards or directly result in injury, death, or equipment loss. Semi S2-93a, section 3.2: ... "All equipment should be fail-safe or of a fault-tolerant design." Semi S2-93a, section 18.2: Potential safety hazards, safety controls, and safety procedures should be documented and clearly communicated through the use of pictorial hazard alerts (warnings) in the supplier's operation and maintenance manuals. These manuals should be available in the national language of the end user. 14 Ergonomics/Human Factors 14.1 General - Process equipment should be designed to prevent personal injury and equipment damage and to minimize procedural errors. Equipment design features should ensure that operator workload, information processing requirements, and physical demands do not exceed user capabilities or compromise safety. The following sections provide general guidelines that are further explained or detailed in SEMI S8 and applicable references in Appendix 2. 14.2 Ergonomic Hazards - Ergonomic hazards should be designed out or otherwise reduced to the maximum extent practicable. Ergonomic hazards exist whenever the system design or installation results in task demands that exceed the information processing and/or physical capabilities of trained personnel. Hazards may result from: (a) controls that are confusing to operate; (b) displays that are difficult to read or understand; (c) lifting of heavy or bulky components; (d) repetitive motion; (e) static and/or awkward postures; (f) poor access, inadequate clearance, and excessive reaching, bending, or stooping. 14.3 Human Characteristics - Equipment should be designed to fit the physical characteristics of 90 percent of the user population (from 5th percentile Asian female through 95th percentile American male). User population design considerations include: (a) ensuring that frequently performed physical task requirements are located within the functional reach envelope of small operators; (b) providing sufficient access and clearance for large operators; (c) ensuring that manual handling requirements are within the strength capability of all operators; (e) locating displays for ease of viewing. Control and display operation should be compatible with user expectations (e.g., behavioral stereotypes).	
Article 47 (Warning devices) Where machinery is equipped with warning devices (such as signals, etc), these must be unambiguous and easily perceived. The operator must have facilities to check the operation of such warning devices at all times.	Semi S2-93a, Related section 1.7.1: Warning Devices Where machinery is equipped with warning devices (such as signals, etc.), these must be unambiguous and easily perceived. The operator must have facilities to check the operation of such warning devices at all times.	

The requirements of the specific relevant standards concerning colours and safety signals must be complied with. Article 48 (Warning of residual risks) Where risks remain despite all the measures adopted or in the case of potential risks which are not evident (e.g. electrical cabinets, radioactive sources, bleeding of a hydraulic circuit, hazard in an unseen area, etc), the manufacturer must provide warnings. Such warnings should preferably use readily understandable pictograms and/or be drawn up in one of the languages of the country in which the machinery is to be used, accompanied, on request, by the languages understood by the operators. Article 49 (Marking) All machinery must be marked legibly and indelibly with the following minimum particulars. 1. Name and address of the manufacturer. 2. The year of construction. 3. Name and designation of series or type. 4. Serial number 5. Necessary matters, if any. Furthermore, where the manufacturer constructs machinery intended for use in a potentially explosive atmosphere, this must be indicated on the machinery. Machinery must also bear full information relevant to its type and essential to its safe use (e.g. maximum speed of certain rotating parts, maximum diameter of tools to be fitted, mass, etc). Where a machine part must be handled during use with lifting equipment, its mass must be indicated legibly, indelibly and unambiguously. Article 50 (Instructions) All machinery must be accompanied by instructions including at least the following information. 1. The information with which the machinery is marked, except the serial number, together with any appropriate additional information to facilitate maintenance.	The requirements of the specific Directives concerning colours and safety signals must be complied with. Semi S2-93a, section 4.2, Exceptions: All hazards that cannot be engineered out of the product should be clearly identified and controlled to reduce personnel exposure and/or property damage. These hazards should be addressed specifically in the product operations and maintenance manual or in an accompanying notice. The manufacturer should continue to work to eliminate these hazards. Semi S2-93a, section 18.2: Potential hazards, safety controls, and safety procedures should be documented and clearly communicated through the use of pictorial hazard alerts (warnings) in the supplier's operation and maintenance manuals. These manuals should be available in the national language of the end user. Semi S2-93a, related 1.7.3: Marking All machinery must be marked legibly and indelibly with the following particulars: - name and address of the manufacturer, - the CE marking, (see Annex III) - designation of series or type, - serial number, if any, - the year of construction. Furthermore, where the manufacturer constructs machinery intended for use in a potentially explosive atmosphere, this must be indicated on the machinery. Machinery must also bear full information relevant to its type and essential to its safe use (e.g., maximum speed of certain rotating parts, maximum diameter of tools to be fitted, mass, etc.) Where a machine part must be handled during use with lifting equipment, its mass must be indicated legibly, indelibly and unambiguously. The interchangeable equipment referred to in Article 1 (2), third paragraph must bear the same information. Semi S2-93a, Related Information 1.7.4 (a): Instructions All machinery must be accompanied by instructions including at least the following: - A repeat of the information with which the machinery is marked, except the serial number, (see 1.7.3), together with any appropriate additional information to facilitate maintenance (e.g., addresses of the importer	
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2. Foreseen use of the machinery within the meaning of paragraph 3 of Article 4. 3. Work station(s) likely to be occupied by operators; this can be a drawing showing operator positions. 4. Instructions for safe. 5. Instruction for use. 6. Handling, giving the mass of the machinery and in various parts where they are regularly to be transported separately. 7. Assembly, dismantling. 8. Adjustment. 9. Maintenance (servicing and repair). 10. Where necessary, training instructions. 11. Where necessary, the essential characteristics of tools which may be fitted to the machinery. 12. Where necessary, the instructions should draw attention to ways in which the machinery should not be used. The instructions must contain the drawings and diagrams necessary for use, maintenance, inspection, checking of correct operation and, where appropriate, repair of the machinery, and all useful instructions in particular with regard to safety. Any literature describing the machinery must not contradict the instructions as regards safety aspects. The technical documentation describing the machinery must give information regarding the airborne noise emissions referred to in paragraph 5 and, in the case of hand-held and/or hand-guided machinery, information regarding vibration. Where necessary, the instructions must give the requirements relating to installation and assembly for reducing noise or vibration (e.g. use of dampers, type and mass of foundation block, etc). The instructions must give the following information concerning airborne noise emissions by the machinery, either the actual value or a value established on the basis of measurements made on identical machinery. 1. Equivalent continuous A-weighted sound pressure level at work stations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact must be indicated. 2. Peak C-weighted instantaneous sound pressure value at work stations, where this exceeds 63 Pa (130 dB in relation to 20 µPa). 3. Sound power level emitted by the machinery where the equivalent continuous A-weighted sound pressure level at work stations exceeds	repairers, etc.) - Foreseen use of the machinery within the meaning of 1.1.2 (c) - Workstation(s) likely to be occupied by operators - Instructions for safe - Putting into service - Use; - Handling, giving the mass of the machinery and its various parts where they are regularly to be transported separately. - Installation - Assembly, dismantling - Adjustment - Maintenance (servicing and repair) - Where necessary, training instructions - Where necessary, the essential characteristics of tools which may be fitted to the machinery. Where necessary, the instructions should draw attention to ways in which the machinery should not be used. Related 1.7.4 (c) The instructions must contain the drawings and diagrams necessary for putting into service, maintenance, inspection, checking of correct operation, and, where appropriate, repair of the machinery, and all useful instructions in particular with regard to safety. Related 1.7.4 (d): Any literature describing the machinery must not contradict the instructions as regards safety aspects. The technical documentation describing the machinery must give information regarding the airborne noise emissions referred to in (f) and, in the case of hand-held and/or hand-guided machinery, information regarding vibration as referred to in 2.2. Semi S2-93a, Related 1.7.4 (e): Where necessary, the instructions must give the requirements relating to installation and assembly for reducing noise or vibration (e.g., use of dampers, type and mass of foundation block, etc.) Semi S2-93a, Related 1.7.4 (f): The instructions must give the following information concerning airborne noise emission by the machinery, either the actual value or a value established on the basis of measurements made on identical machinery: - equivalent continuous A-weighted sound pressure level at workstations, where this exceeds 70 dB(A); where this level does not exceed 70 dB(A), this fact must be indicated, - peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relations to 20 mPa), relation to 20 mPa,	
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85 dB(A). In the case of very large machinery, instead of the sound power level in provision 2 in paragraph 5, the equivalent continuous sound pressure levels at specified positions around the machinery may be indicated. The manufacturer must indicate the operating conditions of the machinery during measurement and what methods have been used for the measurement according to the paragraph 5. Where the work station(s) are undefined or cannot be defined, sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at height of 1.60 metres from the floor or access platform. The position and value of the maximum sound pressure must be indicated. If the manufacturer foresees that the machinery will be used in a potentially explosive atmosphere, the instructions must give all the necessary information. In the case of machinery which may also be intended for use by non-professional operators, the wording and layout of the instructions for use, whilst respecting the other essential requirements mentioned above, must take into account the level of general education and acumen that can reasonably be expected from such operators.	- sound power level emitted by the machinery where the equivalent continuous A-weighted sound pressure level at workstations exceeds 85 dB(A). In the case of very large machinery, instead of the sound power level, the equivalent continuous sound pressure levels at specified positions around the machinery may be indicated. Where the harmonized standards are not applied, sound levels must be measured using the most appropriate method for the machinery. The manufacturer must indicate the operating conditions of the machinery during measurements and what methods have been used for the measurement. Where the workstation(s) are undefined or cannot be defined, sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at a height of 1.60 metre from the floor or access platform. The positions and value of the maximum sound pressure must be indicated. Semi S2-93a, Related 1.7.4 (g): If the manufacturer foresees that the machinery will be used in a potentially explosive atmosphere, the instructions must give all the necessary information. Semi S2-93a, Related 1.7.4 (h): In the case of machinery which may also be intended for use by non-professional operators, the wording and layout of the instructions for use, while respecting the other essential requirements mentioned above, must take into account the level of the general education and acumen that can reasonably be expected from such operators.	
Section 2 ADDITIONAL REQUIREMENTS FOR CERTAIN CATEGORIES OF MACHINERY Article 51 (Agri-foodstuffs machinery) In addition to the essential health and safety requirements set out in section 1 above, where machinery is intended to prepare and process foodstuffs (e.g. cooking, refrigeration, thawing, washing, handling, packaging, storage, transport or distribution), it must be so designed and constructed as to avoid any risk of infection, sickness or contagion and the following hygiene rules must be observed. 1. Materials in contact, or intended to come into contact, with the foodstuffs must satisfy the conditions set down in the relevant legislations. The machinery must be so designed and constructed that these materials can be cleaned before each use.		Not applicable to the Semiconductor Equipment

2. All surfaces including their joining must be smooth, and must have neither ridges nor crevices which could harbour organic materials. 3. Assemblies must be designed in such a way as to reduce projections, edges and recesses to a minimum. (They should preferably be made by welding or continuous bonding. Screws, screw heads and rivets may not be used except where technically unavoidable.) 4. All surfaces in contact with foodstuffs must be easily cleaned and disinfected, where possible after removing easily dismantled parts. The inside surfaces must have curves of a radius sufficient to allow thorough cleaning. 5. Liquid deriving from foodstuffs as well as cleaning, disinfecting and rinsing fluids should be able to be easily discharged from the machine. 6. Machinery must be so designed and constructed as to prevent any liquids or living creatures, in particular insects, entering, or any organic matter accumulating in areas that cannot be cleaned. 7. Machinery must be so designed and constructed that no ancillary substances (e.g. lubricants, etc.) can come into contact with foodstuffs. Where necessary machinery must be designed and constructed so that continuing compliance with this requirement can be checked. The instructions must indicate recommended products and methods for cleaning, disinfecting and rinsing (not only for easily accessible areas but also where areas to which access is impossible or unadvisable, such as piping, have to be cleaned in situ). Article 52 (Portable hand-held and/or hand-guided machinery) In addition to the essential health and safety requirements set out in section 1 above, portable hand-held and/or hand-guided machinery must conform To the following essential health and safety requirements. 1. According to the type of machinery, it must have a supporting surface of sufficient size and have a sufficient number of handles and supports of an appropriate size and arranged to ensure the stability of the machinery under the operating conditions foreseen by the manufacturer. 2. Except where technically impossible or where there is an independent control, in the case of handles which cannot be released on complete safety, it must be fitted with start and stop controls arranged in such a way that the operator can operate them without releasing the handles. 3. It must be designed, constructed or equipped to eliminate the risks of accidental starting and/or continued operation after the operator has released the handles. Equivalent steps must be taken if this requirement is not technically feasible.		
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4. Portable hand-held machinery must be designed and constructed to allow, where necessary, a visual check of the contact of the tool with the material being processed. The instructions must give the information concerning vibrations transmitted by hand-held and hand-guided machinery; the weighted root mean square acceleration value to which the arms are subjected, if it exceeds 2.5 m/s² as determined by the appropriate test code. Where the acceleration does not exceed 2.5 m/s², this must be mentioned. If there is no applicable test code, the manufacturer must indicate the measurement methods and conditions under which measurements were made. Article 53 (Machinery for working wood and analogous materials) In addition to the essential and safety requirements set out in section 1 above, machinery for working wood and machinery for working materials with physical and technological characteristics similar to those of wood, such as cork, bone, hardened rubber, hardened plastic material and other similar stiff material must conform to the following essential health and safety requirements. 1. The machinery must be designed, constructed or equipped so that the piece being machined can be placed and guided in safety; where the piece is hand-held on a work-bench the latter must be sufficiently stable during the work and must not impede the movement of the piece. 2. Where the machinery is likely to be used in conditions involving the risk of ejection of pieces of wood, it must be designed, constructed or equipped to eliminate this ejection, or, if this is not the case, so that the ejection does not engender risks for the operator and/or exposed persons. 3. The machinery must be equipped with an automatic brake that stops the tool in a sufficiently short time if there is a risk of contact with the tool whilst it runs down. 4. Where the tool is incorporated into a non-fully automated machine, the latter must be so designed and constructed as to eliminate or reduce the risk of serious accidental injury, for example by using cylindrical cutter blocks, restricting depth of cut, etc.		Not applicable to the Semiconductor Equipment
Section 3 ADDITIONAL REQUIREMENTS FOR THE MOBILITY OF MACHINERY Sub-section 1 General Provisions Article 54 (Safety of movable machinery) If intended by the manufacturer to be used in dark places, self-propelled machinery must be fitted with a lighting device appropriate to the work to be carried out, without prejudice to any other regulations applicable (road traffic regulations, navigation rules, etc).		May be applicable to UTV's

During the handling of the machine and/or its parts there must be no possibility of sudden movements or of hazards due to instability as long as the machine and/or its parts are handled in accordance with instruction. Sub-section 2 Work stations Article 55 (Driving position) The driving position or location must be complied following requirements. 1. It must be designed with due regard to ergonomic principles. 2. There may be two or more driving positions and, in such cases, each driving position must be provided with all the requisite controls. 3. Where there is more than one driving position, the machinery must be designed so that the use of one of them precludes the use of the others, except in emergency stops. 4. Visibility from the driving position must be such that the driver can in complete safety for himself and the exposed persons, operate the machinery and its tools in their intended conditions of use. 5. Where necessary, appropriate devices must be provided to remedy hazards due to inadequate direct vision. Machinery must be so designed and constructed that, from the driving position, there can be no risk to the driver and operators on board from inadvertent contact with the wheels or tracks. The driving position must be designed and constructed so as to avoid any health risk due to exhaust gases and/or lack of oxygen. The driving position of ride-on drivers must be so designed and constructed that a driver's cab may be fitted as long as there is room. In that case, the cab must incorporate a place for the instructions needed for the driver and/or operators. The driving position must be fitted with an adequate cab where there is a hazard due to a dangerous environment. Where the machinery is fitted with a cab, this must be designed, constructed and/or equipped to ensure that the driver has good operating conditions and is protected against any hazards that might exist (for instance: inadequate heating and ventilation, inadequate visibility, excessive noise and vibration, falling objects, penetration by objects, rolling over, etc). The exit must allow rapid evacuation. Moreover, an emergency exit must be provided in a direction which is different from the usual exit. The materials used for the cab and its fittings must be fire-resistant. Article 56 (Seating) The driving seat of any machinery must fulfilled following requirements. 1. The driving seat of any machinery must enable the driver to maintain a stable position and be designed with due regard to ergonomic		Following Sections are Not applicable to the Semiconductor Equipment
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principles. 2. The seat must be designed to reduce vibrations transmitted to the driver to the lowest level that can be reasonably achieved. 3. The seat mountings must withstand all stresses to which they can be subjected, notably in the event of roll over. 4. Where there is no floor beneath the driver's feet, the driver must have footrests covered with a slip-resistant material. 5. Where machinery is fitted with provision for a roll over protection structure, the seat must be equipped with a safety belt or equivalent device which keeps the driver in his seat without restricting any movements necessary for driving or any movements caused by the suspension. Article 57 (Other places) If the conditions of use provide that operators other than the driver are occasionally or regularly transported by the machinery, or work on it, appropriate places must be provided which enable them to be transported or to work on it without risk particularly the risk of falling. Where the working conditions so permit, these work places must be equipped with seats. Should the driving position have to be fitted with a cab, the other places must also be protected against the hazards which justified the protection of the driving position in Article 54. Sub-section 3 Controls Article 58 (Control devices) The driver must be able to actuate all control devices required to operate the machinery from the driving position, except for functions which can be safely activated only by using control devices located away from the driving position. Where there are pedals they must be so designed, constructed and fitted to allow operation by the driver in safety with the minimum risk of confusion, and they must have a slip-resistant surface and be easy to clean. Where their operation can lead to hazards, notably dangerous movements, the machinery's controls, except for those with preset positions, must return to the neutral position as soon as they are released by the operator. In the case of wheeled machinery, the steering system must be designed and constructed to reduce the force of sudden movements of the steering lever caused by shocks to the guide wheels. Any control that locks the differential must be so designed and arranged that it allows the differential to be unlocked when the machinery is moving.		
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Where the machinery is moving, paragraph 5, Article 9 does not apply to the mobility function. Article 59 (Starting/moving) Self-propelled machinery with a ride-on driver must be so equipped as to deter unauthorised persons from starting the engine. Travel movements of self-propelled machinery with a ride-on driver must be possible only if the driver is at the controls. Where, for operating purposes, machinery must be fitted with devices which exceed its normal clearance zone (e.g. stabilisers, jib, etc), the driver must be provided with the means of checking easily, before moving the machinery, that such devices are in a particular position which allows safe movement. It must not be possible for movement of the machinery to occur while the engine is being started. Article 60 (Travelling function) Without prejudice to the provisions of road traffic regulations, self-propelled machinery and its trailers must meet the requirements for slowing down, stopping, braking and immobilisation so as to ensure safety under all the operating, loading, speed, ground and gradient conditions allowed for by the manufacturer and corresponding to conditions encountered in normal use. The driver must be able to slow down and stop self-propelled machinery by means of a main device. Where safety so requires in the event of a failure of the main device, or in the absence of the energy supply to actuate the main device, an emergency device with fully independent and easily accessible controls must be provided for slowing down and stopping. Where safety so requires, a parking device must be provided to render stationary machinery immobile. This device may be combined with one of the devices referred to in the second paragraph, provided that it is purely mechanical. Remote-controlled machinery must be designed and constructed to stop automatically if the driver loses control. Article 11 does not apply to the travelling function of self-propelled machinery. Article 61 (Movement of pedestrian-controlled machinery) Movement of pedestrian-controlled self-propelled machinery must be possible only through sustained action on the relevant control by the driver. In particular, it must not be possible for movement to occur while the engine is being started. The control systems for pedestrian-controlled machinery must be		
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designed to minimise the hazards, in particular crushing and injury from rotating tools, arising from inadvertent movement of the machine towards the driver. Also, the speed of normal travel of the machine must be compatible with the pace of a driver on foot. In the case of machinery on which a rotary tool may be fitted, it must not be possible to actuate that tool when the reversing control is engaged, except where movement of the machinery results from movement of the tool. In the latter case, the reversing speed must be such that it does not endanger the driver. Article 62 (Control circuit failure) A failure in the power supply to the power-assisted steering, where fitted, must not prevent machinery from being steered during the time required to stop it. Sub-section 4 Protection against mechanical hazards Article 63 (Uncontrolled movements) When a part of a machine has been stopped, any drift away from the stopping position, for whatever reason other than action at the controls, must be such that it is not a hazard to exposed persons. Machinery must be so designed, constructed and where appropriate placed on its mobile support as to ensure that when moved the uncontrolled oscillations of its centre of gravity do not affect its stability or exert excessive strain on its structure. Article 64 (Risk of break-up during operation) Parts of machinery rotating at high speed which, despite the measures taken, may break up or disintegrate, must be mounted and guarded in such a way that, in case of breakage, their fragments will be contained or, if that is not possible, cannot be projected towards the driving and/or operation positions. Article 65 (Roll over) Where, in the case of self-propelled machinery with a ride-on driver and possibly ride-on operators, there is a risk of rolling over, the machinery must be designed for and be fitted with anchorage points allowing it to be equipped with a roll over protective structure (ROPS). This structure must be such that in case of rolling over it affords the ride-on driver and where appropriate the ride-on operators an adequate deflection-limiting volume (DLV). Article 66 (Falling objects) Where, in the case of machinery with a ride-on driver and possibly ride-on operators, there is a risk due to falling objects or material, the machinery should be designed for, and fitted with if its size allows anchorage points allowing it to be equipped with a falling-object protective structure (FOPS).		
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This structure must be such that in the case of falling objects or material, it guarantees the ride-on operators an adequate deflection-limiting volume (DLV). Article 67(Means of access) Handholds and steps must be designed, constructed and arranged in such a way that the operators use them instinctively and do not use the controls for that purpose. Article 68 (Towing devices) All machinery used to tow or to be towed must be fitted with towing or coupling devices designed, constructed and arranged to ensure easy and safe connection and disconnection, and to prevent accidental disconnection during use. Article 69 (Transmission of power between self-propelled machinery (or tractor) and recipient machinery) Transmission shafts with universal joints linking self-propelled machinery (or tractor) to the first fixed bearing of recipient machinery must be guarded on the self-propelled machinery side and the recipient machinery side over the whole length of the shaft and associated universal joints. Torque limiters or freewheels may be fitted to universal joint transmissions only on the side adjoining the driven machine. The universal-joint transmission shaft must be marked accordingly. The outside parts of the guard must be so designed, constructed and arranged that they cannot turn with the transmission shaft. The guard must cover the transmission shaft to the ends of the inner jaws in the case of simple universal joints and at least to the centre of the outer joint or joints in the case of "wide-angle" universal joints. Manufacturers providing means of access to working positions near to the universal joint transmission shaft must ensure that shaft guards as described in the sixth paragraph cannot be used as steps unless designed and constructed for that purpose. Sub-section 5 Protection against other hazards Article 70 (Batteries) The battery housing must be constructed and located and the battery installed so as to avoid as far as possible the chance of electrolyte being ejected on to the operator in the event of roll over and/or to avoid the accumulation of vapours in places occupied by operators. Machinery must be so designed and constructed that the battery can be disconnected with the aid of an easily accessible device provided for that purpose. Article 71(Fire) Depending on the hazards anticipated by the manufacturer when in use,		
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machinery must, where its size permits either allow easily accessible fire extinguishers to be fitted or be provided with built-in extinguisher systems. Article 72 (Emissions of dust, gases, etc.) Where such hazards exist, the containment equipment provided for in Article 38 may be replaced by other means, for example precipitation by water spraying. The second and third paragraph of Article 38 do not apply where the main function of the machinery is the spraying of products. Sub-section 6 Indications Article 73 (Signs and warning) Machinery must have means of signalling and/or instruction plates concerning use, adjustment and maintenance, wherever necessary, to ensure the health and safety of exposed persons. They must be chosen, designed and constructed in such a way as to be clearly visible and indelible. Without prejudice to the requirements to be observed for travelling on the public highway, machinery with a ride-on driver must have the following devices. 1. An acoustic warning device to alert exposed persons. 2. A system of light signals relevant to the intended conditions of use such as stop lamps, reversing lamps and rotating beacons. This requirement does not apply to machinery intended solely for underground working and having no electrical power. Remote-controlled machinery which under normal conditions of use exposes persons to the hazards of impact or crushing must be fitted with appropriate means to signal its movements or with means to protect exposed persons against such hazards. The same applies to machinery which involves, when in use, the constant repetition of a forward and backward movement on a single axis where the back of the machine is not directly visible to the driver. Machinery must be so constructed that the warning and signalling devices cannot all be disabled unintentionally. Where this is essential for safety, such devices must be provided with the means to check that they are in good working order and their failure must be made apparent to the operator. Where the movement of machinery or its tools is particularly hazardous, signs on the machinery must be provided to warn against approaching the machinery while it is working; the signs must be legible at a sufficient distance to ensure the safety of persons who have to be in the vicinity. Article 74 (Marking) In addition to the minimum requirements set out in Article 49, the following information must be marked on the machinery.		
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1. Nominal power expressed in kW. 2. Mass in kg of the most usual configuration and, where appropriate. 3. Maximum drawbar pull provided for by the manufacturer at the coupling hook, in N. 4. Maximum vertical load provided for by the manufacturer on the coupling hook, in N. Article 75 (Instruction handbook) Apart from the minimum requirements set out in Article50, the instruction handbook must contain the following information. 1. Regarding the vibrations emitted by the machinery, either the actual value or a figure calculated from measurements performed on identical machinery. The weighted root mean square acceleration value to which the arms are subjected, if it exceeds 2.5 m/s^2, should it not exceed 2.5 m/s^2, this must be mentioned. The weighted root mean square acceleration value to which the body (feet or posterior) is subjected, if it exceeds 0.5 m/s^2, should it not exceed 0.5 m/s^2, this must be mentioned(The manufacturer must indicate the operating conditions of the machinery during measurement and which methods were used for taking the measurements) 2. In the case of machinery allowing several uses depending on the equipment used, manufacturers of basic machinery to which interchangeable equipment may be attached and manufacturers of the interchangeable equipment must provide the necessary information to enable the equipment to be fitted and used safely.		
Section 4 ADDITIONAL REQUIREMENTS FOR A LIFTING OPERATION Article 76 (Scope) Machinery presenting hazards due to lifting operations - mainly hazards of load falls and collisions or hazards of tipping caused by a lifting operation - must be designed and constructed to meet the requirements of section 2 and section 3. Risks due to a lifting operation exist particularly in the case of machinery designed to move a unit load involving a change in level during the movement. The load may consist of objects, materials or goods. Sub-section 1 General provisions Article 77 (Definitions) The definition of the terminology used in this section are as follows; 1. "Lifting accessories" means components or equipment not attached to the machine and placed between the machinery and the load or on the load in order to attach it.		Not applicable to the Semiconductor Equipment Not applicable to Semiconductor Equipment

2. "Separate lifting accessories" means accessories which help to make up or use a slinging device, such as eye hooks, shackles, rings, eyebolts, etc. 3. "Guided load" means the load where the total movement is made along rigid or flexible guides, whose position is determined by fixed points. 4. "Working coefficient" means the arithmetic ratio between the load guaranteed by the manufacturer up to which a piece of equipment, and accessory or machinery is able to hold it and the maximum working load marked on the equipment, accessory or machinery respectively. 5. "Test coefficient" means the arithmetic ratio between the load used to carry out the static or dynamic tests on a piece of equipment, an accessory or machinery and the maximum working load marked on the piece of equipment, accessory or machinery. 6. "Static test" means the test during which the machinery or the lifting accessory is first inspected and then subjected to a force corresponding to the maximum working load multiplied by the appropriate static test coefficient and then re-inspected once the said load has been released to ensure no damage has occurred. 7. "Dynamic test" means the test during which the machinery is operated in all its possible configurations at maximum working load with account being taken of the dynamic behaviour of the machinery in order to check that the machinery and safety features are functioning properly. Article 78 (Protection against mechanical hazards) Machinery must be so designed and constructed that the stability required in Article 16 is maintained both in service and out of service, including all stages of transportation, assembly and dismantling, during foreseeable component failures and also during the tests carried out in accordance with the instruction handbook. To that end, machinery must be provided with devices which act on the guide rails or tracks to prevent derailment. However, if derailment occurs despite such devices, or if there is a failure of a rail or a running component, devices must be provided which prevent the equipment, component or load from falling or the machine overturning. Mechanical strength shall be complied with the following requirements. 1. Machinery, lifting accessories and removable components must be capable of withstanding the stresses to which they are subjected, both in and, where applicable, out of use, under the installation and operating conditions provided for by the manufacturer, and in all relevant configurations, with due regard, where appropriate, to the effects of atmospheric factors and forces exerted by persons (This requirement must also be satisfied during transport, assembly and dismantling).		
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2. Machinery and lifting accessories must be designed and constructed so as to prevent failure from fatigue or wear, taking due account of their intended use. 3. The materials used must be chosen on the basis of the working environments provided for by the manufacturer, with special reference to corrosion, abrasion, impacts, cold brittleness and ageing. 4. The machinery and the lifting accessories must be designed and constructed to withstand the overload in the static tests without permanent deformation or patent defect. The calculation must take account of the values of the static test coefficient chosen to guarantee an adequate level of safety. That coefficient has 1.5, as a general rule, in case of manually-operated machinery and lifting accessories, and 1.25 in case of other machinery. 5. Machinery must be designed and constructed to undergo, without failure, the dynamic tests carried out using the maximum working load multiplied by the dynamic test coefficient. This dynamic test coefficient is chosen so as to guarantee an adequate level of safety: the coefficient is, as a general rule, equal to 1.1. 6. The dynamic tests must be performed on machinery ready to be put into service under normal conditions of use. As a general rule, the tests will be performed at the nominal speeds laid down by the manufacturer. Should the control circuit of the machinery allow for a number of simultaneous movements (for example, rotation and displacement of the load), the tests must be carried out under the least favourable conditions, i.e. as a general rule by combining the movements concerned. Article 79 (Pulleys, etc.) Pulleys, drums and wheels or ropes must be satisfied with the following requirements. 1. Pulleys, drums and wheels must have a diameter commensurate with the size of rope or chains with which they can be fitted. 2. Drums and wheels must be so designed, constructed and installed that the ropes or chains with which they are equipped can wind round without falling off. 3. Ropes used directly for lifting or supporting the load must not include any splicing other than at their ends (splicings are tolerated in installations which are intended from their design to be modified regularly according to needs for use). Complete ropes and their endings have a working coefficient chosen so as to guarantee an adequate level of safety; as a general rule, this coefficient is equal to five.		
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4. Lifting chains have a working coefficient chosen so as to guarantee an adequate level of safety; as a general rule, this coefficient is equal to four. 5. In order to verify that an adequate working coefficient has been attained, the manufacturer or his authorised representative established within the Community must, for each type of chain and rope used directly for lifting the load, and for the rope ends, perform the appropriate tests or have such tests performed. Article 80 (Separate lifting accessories) Lifting accessories must be sized with due regard to fatigue and ageing processes for a number of operating cycles consistent with their expected life-span as specified in the operating conditions for a given application, and must be fulfilled with the following requirements. 1. The working coefficient of the metallic rope/rope-end combination is chosen so as to guarantee an adequate level of safety; this coefficient is, as a general rule, more than five. 2. Ropes must not comprise any splices or loops other than at their ends. 3. Where chains with welded links are used, they must be of the short link type. The working coefficient of chains of any type is chosen so as to guarantee an adequate level of safety; this coefficient is, as a general rule, more than four. 4. The working coefficient for textile ropes or slings is dependent on the material, method of manufacture, dimensions and use. This coefficient is chosen so as to guarantee an adequate level of safety; it is, as a general rule, more than seven, provided the materials used are shown to be of very good quality and the method of manufacture is appropriate to the intended use. Should this not be the case, the coefficient is, as a general rule, set at a higher level in order to secure an equivalent level of safety. Textile ropes and slings must not include any knots, connections or splicing other than at the ends of the sling, except in the case of an endless sling. 5. All metallic components making up, or used with a sling must have a working coefficient chosen as to guarantee an adequate level of safety; this coefficient is, as a general rule, more than four. 6. The maximum working capacity of a multi-legged sling is determined on the basis of the safety coefficient of the weakest leg, the number of legs and a reduction factor which depends on the slinging configuration. 7. In order to verify that an adequate working coefficient has been attained, the manufacturer must, for each type of component referred to in paragraph 1 to 5 perform the appropriate tests or have such tests		
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performed. Article 81 (Control of movements) Devices for controlling movements must act in such a way that the machinery on which they are installed is kept safe: 1. Machinery must be so designed or fitted with devices that the amplitude of movement of its components is kept within the specified limits. The warning signs shall be provided at appropriated places. 2. Where the collision hazards are existed during operation, due to several machinery in the same line, the collision prevention device shall be provided. 3. The mechanisms of machinery must be so designed and constructed that the loads cannot creep dangerously or fall freely and unexpectedly, even in the event of partial or total failure of the power supply or when the operator stops operating the machine. 4. It must not be possible, under normal operating conditions, to lower the load solely by friction brake, except in the case of machinery, whose function requires it to operate in that way. 5. It must be so designed and constructed that inadvertent dropping of the loads is avoided. Article 82 (Handling of loads) The driving position of machinery must be located in such a way as to ensure that widest possible view of trajectories of the moving parts, in order to avoid possible collisions with persons or equipment or other machinery which might be manoeuvring at the same time and liable to constitute a hazard. Machinery with guided loads fixed in one place must be designed and constructed so as to prevent exposed persons from being hit by the load or the counter-weights. Article 83 (Lightning) Machinery in need of protection against the effects of lightning while being used must be fitted with a system for conducting the resultant electrical charges to earth.		
Sub-section 2 Special requirements for machinery whose power source is other than manual effort Article 84 (Controls) The requirements laid down in Article 55, paragraph 1 and 2 of Article 56, and Article 57 also apply to non-mobile machinery. The devices controlling movements of the machinery or its equipment must return to their neutral position as soon as they are released by the operator. However, for partial or complete movements in which there is no		

risk of the load or the machinery colliding, the said devices may be replaced by controls authorising automatic stops at pre-selected levels without holding a hold-to-run control device. Machinery with a maximum working load of not less than 1000 kilograms or an overturning moment of not less than 40,000Nm must be fitted with devices to warn the driver and prevent dangerous movements of the load in the following events. 1. Overloading the machinery either as a result of maximum working loads being exceeded or as a result of the moments due to the loads being exceeded. 2. The moments conducive to overturning being exceeded as a result of the load being lifted. Cable carriers, tractors or tractor carriers must be held by counter-weights or by a device allowing permanent control of the tension. Article 85 (Risks to exposed persons) Machinery with guided loads and machinery whose load supports follow a clearly defined path must be equipped with devices to prevent any risks to exposed persons. Article 86 (Fitness of purposes) When machinery is placed on the market or is first put into service, the manufacturer or his authorised representative must ensure, by taking appropriate measures or having them taken, that lifting accessories and machinery which are ready for use - whether manually or power-operated - can fulfil their specified functions safely.		
Sub-section 3 Marking Article 87 (Chains and ropes) Each length of lifting chain, rope or webbing not forming part of an assembly must bear a mark or, where this is not possible, a plate or irremovable ring bearing the name and address of the manufacturer and the identifying reference of the relevant certificate. The certificate should show at least the following information. 1. Its nominal size. 2. Its construction. 3. The material from which it is made. 4. Any special metallurgical treatment applied to the material. 5. If tested, the standard used. 6. A maximum load to which the chain or rope should be subjected in service. A range of values may be given for specified applications. Article 88 (Lifting accessories) The following information shall be marked on lifting accessories. 1. Identification of the manufacturer. 2. Identification of the material (e.g. international classification) where this		

information is needed for dimensional compatibility. 3. Identification of the maximum working load. In the case of accessories including components such as cables or ropes, on which marking is physically impossible, the particulars referred to in the first paragraph must be displayed on a plate or by some other means and securely affixed to the accessory. The particulars must be legible and located in a place where they are not liable to disappear as a result of machining, wear, etc., or jeopardise the strength of the accessory. Article 89 (Machinery) In addition to the minimum information provided for in Article 49, each machine must bear the information in a manner of following, legibly and indelibly, to identify the nominal load. 1. Displayed in uncoded form and prominently on the equipment in the case of machinery which has only one possible value. 2. Where the nominal load depends on the configuration of the machine, each driving position must be provided with a load plate indicating, preferably in diagrammatic form or by means of tables, the nominal loads for each configuration. Machinery equipped with a load support which allows access to persons and involves a risk of falling must bear a clear and indelible warning prohibiting the lifting of persons. This warning must be visible at each place where access is possible.		
Sub-section 4 Instruction handbook Article 90 (Lifting accessories) Each lifting accessory or each commercially indivisible batch of lifting accessories must be accompanied with an instruction handbook setting out at least the following particulars. 1. Normal conditions of use. 2. Instructions for use, assembly and maintenance. 3. The limits of use (particularly for the accessories which cannot comply with paragraph 5 of Article 81).		

Article 91(Machinery) In addition to Article 50, the instruction handbook must include the following information. 1. The technical characteristics of the machinery, and in particular, where appropriate, a copy of the load table described in Number 2 of paragraph 1 of Article 89.the reactions at the supports or anchors and characteristics of the tracks, and , where appropriate, the definition and the means of installation of the ballast. 2. The contents of the logbook(if it is not supplied with the machinery). 3. Advice for use, particularly to offset the lack of direct sight of the load by the operator. The necessary instructions for performing the tests before first putting into service machinery which is not assembled on the manufacturer's premises in the form in which it is to be used.		
Chapter 5 REQUIREMENTS FOR ELEVATORS Sub-section 1 General provisions Article 92 (Definition) For the purposes of this Chapter, 'carrier' means the device by which persons are supported in order to be lifted, lowered or moved. Article 93 (Mechanical Strength) The working coefficients defined in Article 78 and Article 79 are inadequate for machinery intended for the lifting or moving of persons and must, as a general rule, be doubled. The floor of the carrier must be designed and constructed to offer the space and strength corresponding to the maximum number of persons and the maximum working load set by the manufacturer. Article 94 (Loading control) The requirements of Article 84 apply regardless of the maximum working load figure. This requirement does not apply to machinery in respect of which the manufacturer can demonstrate that there is no risk of overloading and/or overturning. Sub-section 2 Controls Article 95 (Control devices) The carrier must, as a general rule, be designed and constructed so that persons inside have means of controlling movements upwards and downwards, if appropriate, of moving the carrier horizontally in relation to the machinery. In operation, those controls must override the other devices controlling the same movement, with the exception of the emergency stop devices. The controls for these movements must be of the maintained command		Not applicable to the Semiconductor Equipment

type, except in the case of machinery serving specific levels. Article 96 (Safety during operation) If machinery for the lifting or moving of persons can be moved with the carrier in a position other than the rest position, it must be designed and constructed so that the person or persons in the carrier have the means of preventing hazards produced by the movement of the machinery. Article 97 (Prevention of overspeed) Machinery for the lifting or moving of persons must be designed, constructed or equipped so that excess speeds of the carrier do not cause hazards. Article 98 (Risks of persons falling from the carrier) If the measures referred to in Article 40 are not adequate, carriers must be fitted with a sufficient number of anchorage points for the number of persons possibly using the carrier, strong enough for the attachment of personal protective equipment against the danger of falling. Any trap-doors in floors or ceilings or side doors must open in a direction which obviates any risk of falling should they open unexpectedly. Machinery for lifting or moving must be designed and constructed to ensure that the floor of the carrier does not tilt to an extent which creates a risk of the occupants falling, including when moving. The floor of the carrier must be slip-resistant. Article 99 (Risks of the carrier falling or overturning) Machinery for the lifting or moving of persons must be designed and constructed to prevent the carrier falling or overturning. Acceleration and braking of the carrier or carrying vehicle, under the control of the operator or triggered by a safety device and under the maximum load and speed conditions laid down by the manufacturer, must not cause any danger to exposed persons. Article 100 (Markings) Where necessary to ensure safety, the carrier must bear the relevant essential information. Sub-section 6 Safety and Quality management of Manufactures Article 101(Products safety management) The manufactures shall establish the management policy and operate systematically it, based on the awareness of safety and the quality control. For the safety of products, manufactures must make checklists showing the following matters and inspect them. 1. Matters on the control of external products. 2. Matters on inspection of manufacturing process in each steps.		
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NOTE: The comments in the column titled “Comments” are not intended to alter the requirements of the S2 guidelines. Instead, these comments are provided by the Task Force members with the intent of identifying the similarities and differences between those technical requirements in S2-93A and those required for KOSHA “S” Marking. Page 63

3. Matters on inspection of the final products. 4. Others on products safety and quality control. One-off products are excluded from this paragraph. Article 102 (Technical resources) Deleted Article 103(Equipment for production and inspection) Deleted		
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