SEMI AUX031-1114
S2 MAPPING INTO THE MACHINERY DIRECTIVE (2006/42/EC) ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

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Introduction

Below is a table showing the output of the MD/S2 Mapping Task Force which had the goals stated below, and was working from a background stated in the following sections. The following matrix was created over the course of several years. During those years the SEMI standards referenced may have been revised, impacting the section references. We have made an effort to correct all S2 references to the S2-0712 publication.

Background Rationale

- Conformance to the Machinery Directive is an EU market entry requirement for most semiconductor and photovoltaic manufacturing equipment. Additionally, many equipment end users require Machinery Directive conformance for equipment going into regions other than the EU.
- Where a company typically must do S2 and Machinery Directive assessments, S2 is typically the higher priority as it is customarily done by a third party, and S2 has more specific criteria than the MD.
- Such companies often then use their S2 report as the basis for declaring conformance to much of the MD Annex I criteria. However, there is no industry accepted mapping of current S2 criteria into the MD Annex I criteria, so each company pursuing this route must argue its own mapping rationale.

Goal

Creation of an Related Information to S2, or an Auxiliary Information, to provide an informative mapping of S2 paragraphs onto Machinery Directive Annex I (essentially health and safety requirements) paragraphs typically relevant to equipment in the semi/photovoltaic industries and perhaps additional commentary on what might be missing if an S2 paragraph is found to partly, but not completely, address an MD Annex I paragraph.

Past, Somewhat Similar, SEMI Efforts

1. In Spring of 2001 the SEMI EHS committee published a comparison of the Korean Kosha S-mark regulation to SEMI S2-93. The S-mark regulation was substantially similar to parts of – but not all of – the EU Machinery Directive 98/37/EC in effect at that time.
2. In Fall of 2001 SEMI EHS committee published an auxiliary information document AUX005 which was a comparison of S2-93 to S2-0200.

This New Project

Interpretations of the Machinery Directive for this project were primarily informed by the EU Commissions MD Guidance Document (2nd Edition). The Task Force limited their considerations to S2 and S-Type Normative references from S2. For example, the ergonomics concern of the MD could be answered by an S8 assessment because S8 is a normative reference from S2.
Not all of the MD Annex I sections were reviewed, because not all of them are relevant to SEMI Equipment. Only Section 1 (General) and Section 4 ("Supplementary Essential Health and Safety Requirements To Offset Hazards Due To Lifting Operations") were considered.

With regard to S2, only sections that are points of assessment were used (e.g., S2 Section 6, Philosophy, was not used except where MD Annex 1 presented equivalently broad and general philosophical criteria)

General Work Method

Read an MD Annex I section, review MD Guidance as needed, compare the MD section to S2 and related S-type guidelines, and provide, in effect, one of the following conclusions.

A. This topic is **not** addressed in SEMI S2 or other S-type guidelines that are typically used to support an S2 evaluation.

B. This topic is **fully** addressed in SEMI S*___ with section(s)* _____

C. This topic is **partially** addressed in SEMI S*___ with section(s)* _____, but this remaining aspect is not addressed _____

**add more references as appropriate*

Key Decisions

As work progressed, the task force made some key decisions to clarify and simplify the task. Note- the current S2 revision changed over the course of the project so some section references to S2 are off.

1. We have decided (e.g. with regard to use of equipment in potentially explosive atmospheres and marking) to frame our assessment of S2 towards "complete" machines. Though there may be companies in the industry that sell partly completed machines, expanding this document to that area is a different work product.
2. S2 is scoped to only equipment used to manufacture, assemble, measure and test semiconductor products. We *Think* this would exclude industry equipment such as ingot saws, so that type of equipment is not considered in this analysis.
3. We decided that we will not analyze the question of combined machinery (e.g., ref 155 in table below).
4. For many of the [MD] sections we looked at related to controls, while S2 did not explicitly address the issues, we suspect the typical electrical design standards used in the industry might. If we can survey those standards and show that they do, I think we can declare those sections covered, but this could take quite some effort. The electrical design standards we think we would have to assess are S22, NFPA 79, 60204-1, 60204-33, UL 508A, UL/EN 61010. It was proposed that "… we not try to claim the handful of issues not covered in S2 that might be covered by all reasonably used electrical design standards are therefore covered by S2,. because we do not have the means to determine this. Therefore where we have made a notation about this in the past, the section will be changed, most likely, to status 3 (not

covered), or perhaps 2 (partially covered). " The TF agreed to the proposal with the additional thought that if S22 covers the topic we can claim partial coverage.

5. We really struggled with the MD's guard criteria and our thoughts about general standard of care in the industry. [We strived to stay focused on what the words in the documents actually said but did use "standard of care" arguments occasionally when we felt the MD was being particularly in-specific/subjective in its requirements].
6. Exceptions to MD criteria are counted as 5 – not an assessment section (reference color and number code, below). Since this is an exercise to see what S2 criteria could "serve" MD criteria, MD exceptions do not need to be considered.
7. [also stated above] Issues covered by S22 can provide partial coverage at most since S22 is not required by S2 (except, of course, for the few S2 sections that require the use of particular S22 subsections such as S2 13.4.7)

Regarding the table codes and colors

Color code and numeric codes (for monochrome situations) for the following table

[1]	This chunk seems to be completely covered by the indicated S2+ section
[2]	This chunk seems to have partial coverage by an S2+ section.
[3]	This chunk is not addressed at all by S2+
[4]	A concern for machinery in general, but not a concern for typical wafer, solar or FPD manufacturing equipment.
[5]	This chunk provides background or is a heading, but is not an MD assessment section.

"+]" → Indicates how S2+ has coverage of the topic
"-]" → Indicates how S2+ does not have coverage of the topic.
"***G:*** " is an excerpt from the Commission guidance for an MD criterion.
Text in *{blue braces}* is task force commentary on an MD criterion.
The first three columns are marker columns.
"ref" is an absolute row reference
"wrk" gives a count of the rows the task force set to review
"flg" was used to indicate when the row review was completed.
"§"→ Indicates the Citation number in the EU's 'Guide to the application of the machinery directive 2006/42/EC', 2nd Edition, June 2010

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
1			**Essential health and safety requirements relating to the design and construction of machinery**	**[5]**
2			**GENERAL PRINCIPLES**	**[5]**
3	1	¢	1. The manufacturer of machinery or his authorised representative must ensure that a risk assessment is carried out in order to determine the health and safety requirements which apply to the machinery. The machinery must then be designed and constructed taking into account the results of the risk assessment.	-] Section 6.8 of S2 recommends a hazard analysis with 6.8.2 calling for the risks associated with the hazards to be assessed per S10. But 6.8 is not assessable criteria. +] S2 section 8.5.1 bullet 4 requires a hazard analysis, referencing 6.8 in parens, be provided to or developed by the assessor (see 8.5). Since determining risk is a method of analyzing a hazard, and since section 6.8 is referenced in parentheses, it is reasonable to infer that the risk assessment mentioned in 6.8.2 must be part of the hazard analysis. +] While S2 does not have an assessible section saying the tool must be designed to mitigate risks identified in the hazard analysis to an acceptable level, this is implicit in how the industry works with S2. And in the sense that this MD section does not require the risks be reduced (only taken account of), they are equivalent. [1]
4			By the iterative process of risk assessment and risk reduction referred to above, the manufacturer or his authorised representative shall:	**[5]**
5			— determine the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof,	**[5]**
6			— identify the hazards that can be generated by the machinery and the associated hazardous situations,	**[5]**
7			— estimate the risks, taking into account the severity of the possible injury or damage to health and the probability of its occurrence,	**[5]**
8			— evaluate the risks, with a view to determining whether risk reduction is required, in accordance with the objective of this Directive,	**[5]**
9			— eliminate the hazards or reduce the risks associated with these hazards by application of protective measures, in the order of priority established in section 1.1.2(b).	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
10			2. The obligations laid down by the essential health and safety requirements only apply when the corresponding hazard exists for the machinery in question when it is used under the conditions foreseen by the manufacturer or his authorised representative or in foreseeable abnormal situations. In any event, the principles of safety integration referred to in section 1.1.2 and the obligations concerning marking of machinery and instructions referred to in sections 1.7.3 and 1.7.4 apply.	**[5]**
11			3. The essential health and safety requirements laid down in this Annex are mandatory; However, taking into account the state of the art, it may not be possible to meet the objectives set by them. In that event, the machinery must, as far as possible, be designed and constructed with the purpose of approaching these objectives.	**[5]**
12			4. This Annex is organised in several parts. The first one has a general scope and is applicable to all kinds of machinery. The other parts refer to certain kinds of more specific hazards. Nevertheless, it is essential to examine the whole of this Annex in order to be sure of meeting all the relevant essential requirements. When machinery is being designed, the requirements of the general part and the requirements of one or more of the other parts shall be taken into account, depending on the results of the risk assessment carried out in accordance with point 1 of these General Principles.	**[5]**
13			**1. *ESSENTIAL HEALTH AND SAFETY REQUIREMENTS***	**[5]**
14			**1.1. GENERAL REMARKS**	**[5]**
15			**1.1.1. *Definitions***	**[5]**
16			For the purpose of this Annex:	**[5]**
17			(a) ‘hazard’ means a potential source of injury or damage to health;	**[5]**
18			(b) ‘danger zone’ means any zone within and/or around machinery in which a person is subject to a risk to his health or safety;	**[5]**
19			(c) ‘exposed person’ means any person wholly or partially in a danger zone;	**[5]**
20			(d) ‘operator’ means the person or persons installing, operating, adjusting, maintaining, cleaning, repairing or moving machinery;	**[5]**
21			(e) ‘risk’ means a combination of the probability and the degree of an injury or damage to health that can arise in a hazardous situation;	**[5]**
22			(f) ‘guard’ means a part of the machinery used specifically to provide protection by means of a physical barrier;	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
23			(g) ‘protective device’ means a device (other than a guard) which reduces the risk, either alone or in conjunction with a guard;	**[5]**
24			(h) ‘intended use’ means the use of machinery in accordance with the information provided in the instructions for use;	**[5]**
25			(i) ‘reasonably foreseeable misuse’ means the use of machinery in a way not intended in the instructions for use, but which may result from readily predictable human behaviour.	**[5]**
26			**1.1.2. *Principles of safety integration*** ***{The principles of safety integration are not a clearly assessable aspect of the MD per se. Rather they are principles that must underlie all other efforts to mitigate risks identified later. In this sense it is roughly equivalent in purpose to the S2 philosophy and general provisions sections 6 and 7. Note particularly that (a) thru (d) is a criterion ‘assigned’ to the machine design, while (b) is more of a background philosophy. }***	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
27	2	¢	(a) Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen but also taking into account any reasonably foreseeable misuse thereof. The aim of measures taken must be to eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping.	+] S2 addresses operation, service and maintenance tasks which is essentially equivalent to the MD's "operation, adjustment and maintenance", perhaps a bit broader. +] Though S2 does not address "mis-use" per se, it does call for consideration of operational errors. (ref 6.5). +] The S2 philosophy does not rule out putting people or the environment at risk, but rather sets a scale for risk and recommends that Very High, High and Medium risks be mitigated at least to Low or Very Low (ref Note 8). +] The scope of S2 considerations is set in the philosophy section to "installation, operation, maintenance, service, and disposal of equipment" (ref 6.1) -] The philosophy section does not address the MD concern about "transportation." -] Thus, in general, a passing assessment to S2 would meet this principle requirement except for consideration of transportation. [2]
28			(b) In selecting the most appropriate methods, the manufacturer or his authorised representative must apply the following principles, in the order given: — eliminate or reduce risks as far as possible (inherently safe machinery design and construction), — take the necessary protective measures in relation to risks that cannot be eliminated, — inform users of the residual risks due to any shortcomings of the protective measures adopted, indicate whether any particular training is required and specify any need to provide personal protective equipment.	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
29	3	¢	(c) When designing and constructing machinery and when drafting the instructions, the manufacturer or his authorised representative must envisage not only the intended use of the machinery but also any reasonably foreseeable misuse thereof. **{this first part is a philosophy (a requirement to 'envisage'). It is not assessable in the product itself.** The machinery must be designed and constructed in such a way as to prevent abnormal use if such use would engender a risk. Where appropriate, the instructions must draw the user's attention to ways — which experience has shown might occur — in which the machinery should not be used.	-}S2 does not explicitly ~~take into account or~~ discuss foreseeable **unintended** operation or abnormal operation. It only discusses abnormal operation as a result of a single point failure {potential examples of "intentional misuse" could be interlock bypassing, failure to follow PM schedules or procedures, failure to lock out according to instructions. } +] The idea misuse is adequately addressed for our industry by the criteria to consider "single point failure" [1]
30	4	¢	(d) Machinery must be designed and constructed to take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment.	+] The S8 SESC checklist calls requires consideration of PPE in many instances. +] the sense of this requirement is conveyed in S8 section 6.9. -] S8 section 6.9 can be superceded by using the SESC checklist. +]S13 calls for PPE to be called out for tasks (ref sect. 12) but this is different from requiring the design to accommodate the PPE. [2]
31	5	¢	(e) Machinery must be supplied with all the special equipment and accessories essential to enable it to be adjusted, maintained and used safely.	+] S2 section 7.4 is essentially equivalent to this. -] S2 section 7.4 is not assessable, but it may nonetheless influence behavior. [2]
32			**1.1.3. *Materials and products***	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
33	6	¢	The materials used to construct machinery or products used or created during its use must not endanger persons' safety or health. In particular, where fluids are used, machinery must be designed and constructed to prevent risks due to filling, use, recovery or draining.	-] Hazardous solid materials of construction are anticipated in our industry such as lead for xray shielding, chromium 6 for metal plating, PVC in cables, etc... +]S2 addresses "chemicals anticipated to be used or generated in the equipment" (ref 23.1) -] S2+ does not address inherent hazards of materials of construction. +]S2 particularly addresses fluids and concerns of filling etc… (ref appendix 2) -]however, S2 criteria for exposure are focused on "breathing zones" and so do not necessarily robustly address contact hazards. [2]
34			**1.1.4. *Lighting***	**[5]**
35	7	¢	Machinery must be supplied with integral lighting suitable for the operations concerned where the absence thereof is likely to cause a risk despite ambient lighting of normal intensity.	-] S8 SESC section 7.1 (may be moved and slightly reworded in recent ballots) calls for supply of a minimum amount of light (300 lux) for certain scenarios, but it allows that it could be provided by portable lights rather than having to be integral. S2 contains no criteria on lighting. [2]
36	8	¢	Machinery must be designed and constructed so 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 on moving parts due to the lighting.	-] S8 only address providing light for visibility. There is nothing in S2+ which address concerns like these about the quality of light or the potential risks of providing light in the wrong way. [3]
37	9	¢	Internal parts requiring frequent inspection and adjustment, and maintenance areas must be provided with appropriate lighting. ***G: Specifications for integral lighting are given in standard EN 1837*** ***{no explanation in the guide about meaning of "frequent"}***	+] The issue of integral is limited to ref35. Without other qualification in the MD or the guide, there seems to be no reason to assume 300lux is not appropriate. Therefore, this section is addressed by the S8 section noted in ref35 [1]
38			**1.1.5. *Design of machinery to facilitate its handling***	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
39			Machinery, or each component part thereof, must: ***G:*** *Section 1.1.5 applies to 'machinery or each component part thereof'. This does not mean that all parts of machinery must be designed for safe handling, but only those parts of the machinery, or the machinery itself, which may have to be handled separately.* *{'Component' can be understood a something different than a 'part'. The obligation is not to assess each part to these criteria.}*	**[5]**
40	10	¢	— be capable of being handled and transported safely,	+] The assessment to S8, particularly MMH, would address handling concerns during O, M or S. +] S2 18.1 addresses stability during shipping and installation -] S2 does not address transportation of equipment for comprehensive general safety. See ref 27 [2]
41	11	¢	— be packaged or designed so that it can be stored safely and without damage.	-] S2 does not address packaging or design for storage and damage prevention. See ref 27 [3]
42	12	¢	**=DELTA=** During the transportation of the machinery and/or its component parts, there must be no possibility of sudden movements or of hazards due to instability as long as the machinery and/or its component parts are handled in accordance with the instructions.	+] S2 addresses shipping stability in sect. 18.2 [1]
43	13	¢	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: — either be fitted with attachments for lifting gear, or — be designed so that it can be fitted with such attachments, or — be shaped in such a way that standard lifting gear can easily be attached.	There is nothing in S8 or S2 that drives consideration of designing components intended for handling to be fitted for interfacing with lifting gear. Tradition, but no explicit criteria, limits lifting to 2 people. Regardless, the next progression if a multi-person lift cannot be done, would be to use lifting gear. The natural consequence of assessing a lifting task would most likely result in the fulfilling these criteria. [1]
44	14	¢	Where machinery or one of its component parts is to be moved by hand, it must: — either be easily moveable, or — be equipped for picking up and moving safely.	The S8 task assessment will address this concern. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
45	15	¢	Special arrangements must be made for the handling of tools and/or machinery parts which, even if lightweight, could be hazardous. *G; See section header at ref39* *Also – "When designing machinery or parts of machinery to be safely moved or lifted by hand, sharp edges must be avoided."*	+] S2 addresses sharp edges and burrs regardless of weight. -] The MD expects consideration of all lifecycle stages, S2 only addresses in 6.1 installation, operation, maintenance, service, and disposal. S8 MMH only addresses operation, service and maintenance (SESC 1.1) +] S13 section 6.2 calls for instructions for "safe" install, operation, maintenance, decontamination, decommissioning. -] S8 requires manual material handling analysis only for objects over 5 or 10 pounds (2.2 or 4.4 kg) (under certain frequency conditions). There is nothing in S2 that calls for the assessment of small parts that will be handled for other hazards. +]Though other than sharp edges, it is not clear what the other hazards could be in our industry. The guide only seems to address sharp edges. +] For hazards such as toxic materials or hot and cold surfaces, S2 addresses these without consideration of the item size, and so these consideration would apply to lightweight and heavy objects alike. Furthermore the MD does not seem be meaning chemical or temp issues here because there are other sections addressing them such as ref250 and ref225. -] small powerful magnets can be used in our industry and these can present a pinch or sudden movement hazard if not handled correctly. However the biologic impact of magnets is addressed (e.g., section 25.2, 25.5.1, Appendix 4 of S2) [2]
46			**1.1.6. *Ergonomics***	[5]
47	16	¢	**=DELTA=** Under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as: — allowing for the variability of the operator's physical dimensions, strength and stamina, — providing enough space for movements of the parts of the operator's body, — avoiding a machine-determined work rate, — avoiding monitoring that requires lengthy concentration, — adapting the man/machinery interface to the foreseeable characteristics of the operators.	+] S8 covers physical dimension variability and body space considerations, adapting the interface to operator characteristics. -] S8 does not cover avoiding machine determined work rate (we are not certain this point is relevant to semiconductor manufacturing equipment), or lengthy concentration. [2]
48			**1.1.7. *Operating positions***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
49	17	¢	**=DELTA=** The operating position must be designed and constructed in such a way as to avoid any risk due to exhaust gases and/or lack of oxygen.	+] There generally are no reasonably foreseeable hazards of exhaust gas or lack of oxygen at operating positions. However in some limited cases (e.g., operator in from of a wet bench with fire suppression systems) they may be exposed. S2 sect. 14 addresses the concern of suppressants. There are occasional equipment designs that present a risk of asphyxiation (e.g., due to nitrogen flooding), but these are not foreseen at the "operating positions" of equipment. [1]
50	18	¢	**=DELTA=** If the machinery is intended to be used in a hazardous environment presenting risks to the health and safety of the operator or if the machinery itself gives rise to a hazardous environment, adequate means must be provided to ensure that the operator has good working conditions and is protected against any foreseeable hazards. *G: NOTE: from the guide, a hazardous environment is a broad range of concerns "Such risks may include, for example, exposure to hot and cold atmospheres, to risks due to noise, radiation, humidity, adverse weather conditions or atmospheres polluted by hazardous substances."*	First clause is NA for our industry as we expect operator environment to be safe. The machine could give rise to hazards and S2 has elements which call for assessing these points for adequate operator protection, such as 1% chemical exposure requirement, noise, radiation, etc… [1]
51	19	¢	**=DELTA=** Where appropriate, the operating position must be fitted with an adequate cabin designed, constructed and/or equipped to fulfil the above requirements. The exit must allow rapid evacuation. Moreover, when applicable, an emergency exit must be provided in a direction which is different from the usual exit.	+] foreseeable conditions for semiconductor manufacturing equipment do not require cabins for the operating position. [4]
52			**1.1.8. *Seating***	[5]
53	20	¢	Where appropriate and where the working conditions so permit, work stations constituting an integral part of the machinery must be designed for the installation of seats.	+] S8 addresses the heights of work surfaces which by consequence (if not by design) allows the use of commercially available seats. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
54	21	¢	If the operator is intended to sit during operation and the operating position is an integral part of the machinery, the seat must be provided with the machinery.	NOTE: the MD guide clarifies (§183) that this applies where the location for the seat would be in/on the machine . Such a scenario is not typical for semiconductor manufacturing equipment but is not impossible. -] S2+ does not require the provision of seats at seated operator locations. [3]
55	22	¢	The operator's seat must enable him to maintain a stable position. Furthermore, the seat and its distance from the control devices must be capable of being adapted to the operator.	-] There are no criteria in S2+ related to the stability or adjustability of seats if provided by the supplier. [3]
56	23	¢	If the machinery is subject to vibrations, the seat must be designed and constructed in such a way as to reduce the vibrations transmitted to the operator to the lowest level that is reasonably possible.	It is not foreseeable that semiconductor manufacturing equipment would be subject to vibrations requiring such action. [4]
57	24	¢	The seat mountings must withstand all stresses to which they can be subjected. Where there is no floor beneath the feet of the operator, footrests covered with a slip-resistant material must be provided.	-] There are no criteria in S2+ related to the stability or adjustability of seats if provided by the supplier. [3]
58			**1.2. CONTROL SYSTEMS**	[5]
59			**1.2.1. *Safety and reliability of control systems***	[5]
60	25	¢	Control systems must be designed and constructed in such a way as to prevent hazardous situations from arising. Above all, they must be designed and constructed in such a way that:	-] S2+ has no criteria targeted to “Control Systems” as a general concept. +] S2+ does have criteria targeted to some subset types of control systems e.g., 21.2.4.7. – Chemical mixing control systems, 14.4.4.2 – Fire protection control systems, 11.6.1 – Programmable Safety Control Systems, {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] – for now

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61	26	¢	— they can withstand the intended operating stresses and external influences,	-] S2+ does not address this specific point. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [3] for now
62	27	¢	— a fault in the hardware or the software of the control system does not lead to hazardous situations,	-] S2 22.2 requires chemical ventilation to provide protection if there is a failure in software or hardware, but this is different from requiring the control system itself to be designed so that a fault in hardware or software does not lead to hazardous situations. +] S2 11.5 and 11.6 requires fault tolerant electromechanical safety systems or Fail-to-safe electronic safety systems. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] – for now
63	28	¢	— errors in the control system logic do not lead to hazardous situations,	+] S2 11.5 and 11.6 requires fault tolerant electromechanical safety systems or Fail-to-safe electronic safety systems. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] – for now

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64	29	¢	**=DELTA=** — reasonably foreseeable human error during operation does not lead to hazardous situations.	+] In many places S2 requires risk assessment which draws in the ideas of reasonably foreseeable human error. -] S2+ does not have a criteria for assessing the human error aspects of a control system in general. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] – for now
65			Particular attention must be given to the following points:	[5]
66	30	¢	— the machinery must not start unexpectedly,	+] S2 has a couple sections that discuss start up for certain types of control systems. E.g., 12.2.4. and 12.2.6 – start up on resetting EMO actuator, or 11.8 related to safety interlocks. -] S2 does not have a general concern about unexpected startup. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} - section 13.2.2 addresses unexpected startup but it is tucked under “safety circuits”} [2] for now

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
67	31	¢	**=DELTA=** — the parameters of the machinery must not change in an uncontrolled way, where such change may lead to hazardous situations,	+] S2 address this for interlock setpoints at 11.5 -] S2+ does not have this as general requirement. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] for now
68	32	¢	— the machinery must not be prevented from stopping if the stop command has already been given,	+] S2 address the priority of the Emergency Stop command – 12.1. -] S2 is silent on "stop command" as a general concept. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1}
69	33	¢	— no moving part of the machinery or piece held by the machinery must fall or be ejected,	+] S2 18.3 address the possibility of falling or ejected machine parts. However, this is already covered in ref151 below, so does not help this concern per se. -]S2+ does not address the falling or ejection of "pieces held by the machinery" which in our industry could be wafers, flat panel substrates, full FOUPS and cassettes. [3]
70	34	¢	— automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, {this could be referring to accessibility but this is under safety and reliability of control systems, so this must mean the certainty with which the stopping system will work given anticipated scenarios}	+] S2 12.5 on EMO accessibility +] manual stopping of moving parts is generally not anticipated (except where energy source is human effort which is outside stop) {this may well be already covered by emergency stopping and normal stopping criteria} See ref (68) for stopping {??? What types of impeding are envisioned that must be avoided?} [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
71	35	¢	— the protective devices must remain fully effective or give a stop command,	+] S2 11.5 and 11.6 requires fault tolerant electromechanical safety systems or Fail-to-safe electronic safety systems. And S2 12.2.1 EMO circuit should not include controls that enable it to be defeated or bypassed; [1]
72	36	¢	— the safety-related parts of the control system must apply in a coherent way to the whole of an assembly of machinery and/or partly completed machinery.	+] S2 interlock criteria requires that safety interlocks, when triggered, must provide a notification on the operator interface. This implies a reasonable level of "coherence" is required. Likewise, for emergency off, there is a clause which allows particularly qualified subsystems to have independent EMO circuits/methods, and this implies a requirement of coherence otherwise. Could apply section 11 Safety Interlock Systems {combining things together, looking for hooks and documentation. This includes EMOs and safety interlocks} [1]
73	37	¢	**=DELTA=** For cable-less control, an automatic stop must be activated when correct control signals are not received, including loss of communication.	-] S2 has no criteria related to cable-less controls. They are anticipate in the industry for use in maintenance activities (e.g., wireless tablet computers). [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
74			**1.2.2. *Control devices*** ***G:*** *Control devices are parts of the control system which detect input signals given by the operators, usually by means of hand or foot pressure. There are many different kinds of control devices including, for example, push-buttons, levers, switches, knobs, sliders, joy-sticks, hand wheels, pedals, keyboards and tactile screens.* {The tone of the further guidance in the guide indicates that these are devices used to direct the operation of the machine from a system perspective. That is to say, it would include devices related to the operation of the machine for its intended use (e.g., what S2 might call operator tasks) and also for scheduled maintenance tasks such as interlock bypassing, or EMOs, etc…, but not necessarily all the controls that could be used in a service task such as an adjustment trim pot in a power supply}	R5 of S8 does discuss control topics but it is not required for assessment. [5]
75			Control devices must be:	[5]
76	38	¢	— clearly visible and identifiable, using pictograms where appropriate,	-] S2 is silent on “control devices”. +] A touch screen is a common control device in our industry, S8 address the visibility of control screens (e.g., height, stacking, readability). {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] for now
77	39	¢	— positioned in such a way as to be safely operated without hesitation or loss of time and without ambiguity,	-] S2 is silent on “control devices”. +] S8 –required by S2 - discusses position requirements for frequently and infrequently used controls. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
78	40	¢	— designed in such a way that the movement of the control device is consistent with its effect,	-] S2 is silent on “control devices”. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [3] for now
79	41	¢	— located outside the danger zones, except where necessary for certain control devices such as an emergency stop or a teach pendant, **{saying that the devices must be outside of dangers zones is an objective decision (e.g., identifying where danger zones are and ensure controls are outside of them), not related to risk. It is the following point that addresses the consideration of risk. }**	-] S2 is silent on “control devices”. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} } [3] for now
80	42	¢	— positioned in such a way that their operation cannot cause additional risk,	-] S2 is silent on “control devices”. +] S2 does say that EMO actuators should be operable without putting personnel at additional risk. (ref 12.5.3) {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] for now
81	43	¢	— designed or protected in such a way that the desired effect, where a hazard is involved, can only be achieved by a deliberate action,	-] S2 is silent on “control devices”. +] S2 does discuss the need for deliberate actions for EMO resetting (ref 12.2.6), interlock set point changing (11.5), interlock bypassing (11.7.2), and interlock restoration (11.8). {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] for now

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
82	44	¢	— made in such a way as to withstand foreseeable forces; particular attention must be paid to emergency stop devices liable to be subjected to considerable forces.	-] S2 is silent on “control devices”. -] S2 does not discuss force considerations for EMO actuators. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [3] for now
83	45	¢	Where a control device is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence, the action to be performed must be clearly displayed and subject to confirmation, where necessary.	-] S2 is silent on “control devices”. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [3] for now
84	46	¢	Control devices must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	-] S2 is silent on “control devices”. -] S8 does not address issues such as device layout, travel and resistance to operation. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [3] for now
85	47	¢	Machinery must be fitted with indicators as required for safe operation. The operator must be able to read them from the control position.	-] S2 is silent on “control devices”. +] A common indicator in our industry is a video display terminal. S8 has many criteria for the positioning of video display terminals. -] Not all indicator types are addressed by S8. Particularly “frequently viewed” visual signals. {Needs additional study– see what typical Electrical Design standards say – SEMI S22, NFPA 79, EN 60204-1, EN 60204-33, UL 508A, UL/EN 61010-1} [2] for now

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
86	48	¢	**=DELTA=** From each control position, the operator must be able to ensure that no-one is in the danger zones, or the control system must be designed and constructed in such a way that starting is prevented while someone is in the danger zone. *{"control position" can be understood as "operator station" in S2}*	-] S2 has no requirement related to the visibility of danger zones from the control position(s) nor an explicit requirement about preventing starting if someone is in a danger zone. In ¶12.5 S2 requires EMO actuators to be "readily accessible" and ¶12.5.2, that they be no more than 3m from operation and maintenance locations, but there is nothing that drives assessment of where danger zones may be and how to prevent unexpected startup. +]However, it is implicit in the S2 interlock and HEI philosophies that there should be no active danger zones with people in them. Thus, S2 addresses the concern, by making it moot. +] often control positions for semi tools are elsewhere in the fab or the world because of remote control capabilities in the equipment. Our "remote control" work addressed this. [2]
87	49	¢	If neither of these possibilities is applicable, before the machinery starts, an acoustic and/or visual warning signal must be given. The exposed persons must have time to leave the danger zone or prevent the machinery starting up.	-] S2 does not have this provision, [3]
88	50	¢	If necessary, means must be provided to ensure that the machinery can be controlled only from control positions located in one or more predetermined zones or locations.	-] It is common for equipment in our industry to have more than one control position. Alternate control positions can occur near the machine, or very remotely. While S2 does discuss concerns of remote operation in RI 15, this is not a mandatory assessment point, and the reference to RI 15 is made from 6.8.1 which is itself a philosophy section, not an assessment section. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
89	51	¢	Where there is more than one control position, the control system must be designed in such a way that the use of one of them precludes the use of the others, except for stop controls and emergency stops.	-] It is common for equipment in our industry to have more than one control position. Alternate control positions can occur near the machine, or very remotely. While S2 does discuss concerns of remote operation in RI 15, this is not a mandatory assessment point, and the reference to RI 15 is made from 6.8.1 which is itself a philosophy section, not an assessment section. [3]
90	52	¢	When machinery has two or more operating positions, each position must be provided with all the required control devices without the operators hindering or putting each other into a hazardous situation.	It is common for equipment in our industry to have more than one control position. Alternate control positions can occur near the machine, or very remotely. While S2 does discuss concerns of remote operation in RI 15, this is not a mandatory assessment point, and the reference to RI 15 is made from 6.8.1 which is itself a philosophy section, not an assessment section. [3]
91			**1.2.3. *Starting***	**[5]**
92			It must be possible to start machinery only by voluntary actuation of a control device provided for the purpose. The same requirement applies:	This is really just an intro to the next two dashes. [5] {Note the following draft assessment was here ~~-] S2 has no criteria for normal equipment starting.~~ ~~+] S2 interlock restart concern~~ ~~{defer to electrical design standard survey~~ ~~NFPA 79 section 9.2.5.2.4 }~~}
93	53	¢	— when restarting the machinery after a stoppage, whatever the cause,	-] S2+ has no criteria for normal equipment starting. +] S2 has a criteria related to restarting after a safety interlock trips (11.8) +]S22 13.2.2 provides a general caution against unexpected startup, but no detail like this in the MD [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
94	54	¢	— when effecting a significant change in the operating conditions.	-] S2+ has no criteria related to significant change in operating conditions. {e.g. transitioning in an implanter from no beam to beam (w/ xrays) or a laser from off to on} [3]
95			However, the restarting of the machinery or a change in operating conditions may be effected by voluntary actuation of a device other than the control device provided for the purpose, on condition that this does not lead to a hazardous situation.	This is permissive – not a restriction. [5]
96			For machinery functioning in automatic mode, the starting of the machinery, restarting after a stoppage, or a change in operating conditions may be possible without intervention, provided this does not lead to a hazardous situation.	This is permissive – not a restriction. [5]
97	55	¢	Where machinery has several starting control devices and the operators can therefore put each other in danger, additional devices must be fitted to rule out such risks. If safety requires that starting and/or stopping must be performed in a specific sequence, there must be devices which ensure that these operations are performed in the correct order.	-] S2+ has no criteria related to this topic +] RI15-6 speaks of multiple control points related to remote operation. [2]
98			**1.2.4. *Stopping***	**[5]**
99			**1.2.4.1. Normal stop**	**[5]**
100	56	¢	Machinery must be fitted with a control device whereby the machinery can be brought safely to a complete stop.	-] S2+ has no criteria related to **normal** stopping [3]
101	57	¢	Each workstation must be fitted with a control device to stop some or all of the functions of the machinery, depending on the existing hazards, so that the machinery is rendered safe.	-] S2+ has no criteria related to **normal** stopping [3]
102	58	¢	The machinery's stop control must have priority over the start controls.	-] S2+ has no criteria related to **normal** stopping [3]
103	59	¢	Once the machinery or its hazardous functions have stopped, the energy supply to the actuators concerned must be cut off.	-] S2+ has no criteria related to **normal** stopping [3]
104			**1.2.4.2. Operational stop**	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
105	60	¢	**=DELTA=** Where, for operational reasons, a stop control that does not cut off the energy supply to the actuators is required, the stop condition must be monitored and maintained. *G: Section 1.2.4.2 recognises that, for operational reasons, for example, in order to permit an easier or more rapid restart of the machinery, it may be necessary to provide, in addition to the normal stop control required by section 1.2.4.1, a stop control that does not cut off the energy supply to the actuators. Since, in that case, a failure in the control system could lead to an unintended start, the control system must include the means of monitoring the stop condition in order to ensure that the machinery remains at a stop until it is intentionally restarted using the start control device.*	-] S2+ has no criteria related to **operational** stopping [3] {it is a little ambiguous how operational stopping is relevant in the semi arena, but it seems possible it could be. This is similar to a category 2 stop. }
106			**1.2.4.3. Emergency stop**	**[5]**
107	61	¢	Machinery must be fitted with one or more emergency stop devices to enable actual or impending danger to be averted. The following exceptions apply: — machinery 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, — portable hand-held and/or hand-guided machinery.	+] S2 requires an emergency off function (§12) with exception for low energy level equipment [1]
108			The device must:	
109	62	¢	— have clearly identifiable, clearly visible and quickly accessible control devices,	+] S2 requires EMO actuators be red on yellow (¶12.3) and readily accessible (¶12.5) [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
110	63	¢	— stop the hazardous process as quickly as possible, without creating additional risks,	+]S2 covers the question of additional risks in ¶12.1 but does not discuss timing explicitly. However the requirement is that when the EMO system is activated, the equipment should be placed into a safe shutdown condition. This could be seen as a requirement for immediate transition. The expectation and practice in the industry is for "as quickly as possible", and there is nothing in S2 that otherwise invites delays. [1]
111	64	¢	— where necessary, trigger or permit the triggering of certain safeguard movements.	+] the S2 definition of "safe shutdown condition" (¶5.2.68)includes ideas of "suitably contained" which could include safeguard movements. [1]
112	65	¢	1. Once active operation of the emergency stop device has ceased following a stop command, that command must be sustained by engagement of the emergency stop device until that engagement is specifically overridden; 2. it must not be possible to engage the device without triggering a stop command; 3. it must be possible to disengage the device only by an appropriate operation, and 4. disengaging the device must not restart the machinery but only permit restarting.	+] ¶12.3 requires the actuator to be "self latching", addressing bullet 1. ¶12.1 requires the equipment to go safe <u>when the actuator is pressed.</u> It seems logical that "latching" must follow pressing, and that "engaging" has a meaning similar to "latching" so bullet 2 is addressed in effect. The use of "engaging" in bullets 3 and 4 further suggest its equivalence to "latching" Since the actuator must be "self-latching" it is implied that some appropriate action is required to un-latch it. ¶12.2.4 addresses bullet 4 [1]
113	66	¢	**=DELTA=** The emergency stop function must be available and operational at all times, regardless of the operating mode.	¶12.1 requires the equipment to go safe <u>when the actuator is pressed.</u> This implies it is always available. Further, ¶12.2.1 dis-allows features to defeat or bypass the EMO circuit. [1]
114	67	¢	**=DELTA=** Emergency stop devices must be a back-up to other safeguarding measures and not a substitute for them.	+] inherent in philosophy of S2 ??? [1]
115			**1.2.4.4. Assembly of machinery**	**[5]**

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
116	68	¢	In the case of machinery or parts of machinery designed to work together, the machinery must be designed and constructed in such a way that the stop controls, including the emergency stop devices, can stop not only the machinery itself but also all related equipment, if its continued operation may be dangerous.	+] ¶12.1 Exception 2 addressed the spirit of this requirement. [1]
117			**1.2.5. *Selection of control or operating modes***	**[5]**
118	69	¢	The control or operating mode selected must override all other control or operating modes, with the exception of the emergency stop. *G:Section 1.2.5 deals with risks that may arise when machinery is designed with several control or operating modes. In some cases, machinery may be designed with specific control modes, for example, for setting or maintenance operations. In other cases, different operating modes are foreseen, for example, for operation with manual or automatic feeding of workpieces. Mobile machinery may be designed to be controlled by a ride-on driver or by remote control.* *The first paragraph of section 1.2.5 applies in all such cases and requires the different control or operating modes to be exclusive of each other, except for the emergency stop function, which must be available whichever control or operating mode is selected.*	-]While the primacy of the EMO system is established in S2, there is no discussion of how other modes of operation must interact. [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
119	70	¢	**=DELTA=** If machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and/or work procedures, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must be clearly identifiable and must correspond to a single operating or control mode. *G: The second paragraph of section 1.2.5 applies to operating modes requiring different protective measures and work procedures having a different impact on safety. For example, for an operating mode with manual feeding of workpieces, safeguarding with interlocking moveable guards or with protective devices, such as optoelectronic protective devices or two-hand control devices, may be appropriate. For an operating mode with automatic feeding, the use of a two-hand control device as the main means of safeguarding will probably not be acceptable.* *Setting or maintenance modes may enable certain functions of the machinery to be controlled with guards open or with protective devices muted or by means of a special control device such as a pendant control or a remote control device, instead of the control devices used for normal operation.* *In these cases, each position of the mode selector must correspond to a single control or operating mode and it must be possible to lock the mode selector device in each position, while the device must be provided with the necessary indicators to make it clear to operators which control or operating mode has been selected*	-] The closest S2+ comes to this is 11.7.2 requiring an intentional act to bypass interlocks, but there is no requirement for a single locking mode selector for the various possible modes of the equipment. +]HOWEVER see also ref120. We utilize the 'exception' of ref120 [1]
120	71	¢	The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator. *G: The third paragraph of section 1.2.5 permits, as an alternative to a physically lockable selector, that selection of a control or operating mode such as, for example, a setting or maintenance mode, may be restricted to specially trained and authorised operators by other means, such as, for example, an access code.*	+] covered by S2 criteria on bypassing interlocks ??? [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
121			**=DELTA=** If, for certain operations, the machinery must be able to operate with a guard displaced or removed and/or a protective device disabled, the control or operating mode selector must simultaneously: **{This is effectively the area of concern in which bypassed interlocks fit}**	This is an intro to the following bullets. Not an assessable section on its own. [5]
122	72	¢	**=DELTA=** — disable all other control or operating modes,	-]S2+ addresses bypassed interlocks, but does not require other operational modes to be disabled. [3]
123	73	¢	— permit operation of hazardous functions only by control devices requiring sustained action,	-]S2+ addresses bypassed interlocks, but does not require sustained action controls. [3]
124	74	¢	**=DELTA=** — permit the operation of hazardous functions only in reduced risk conditions while preventing hazards from linked sequences,	-]S2+ addresses bypassed interlocks, but does not require reduced risk operating conditions or explicit consideration of linked sequences. [3]
125	75	¢	**=DELTA=** — prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. ***G: The fourth condition requires the mode selector not only to disable all other control modes but also to disable any sensors on the machinery that might otherwise trigger movements or other hazardous functions of the machinery or parts of the machinery during the operation concerned***	-]S2+ addresses bypassed interlocks, but does not require explicit consideration of impact of actions triggered by machine sensors. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
126	76	¢	**=DELTA=** If these four conditions cannot be fulfilled simultaneously, the control or operating mode selector must activate other protective measures designed and constructed to ensure a safe intervention zone. ***G: The fifth paragraph of section 1.2.5 applies if it is necessary to provide an operational mode with certain of the normal protective means disabled and where one or more of the four conditions set out in the fourth paragraph cannot be fulfilled. In that case, the machinery must be provided with other protective means to ensure that the zone in which the operator is intended to intervene is safe. It should be underlined that these means must be integrated in the design and construction of the machinery and that it is not sufficient, in such a case, to rely solely on the manufacturer's instructions, on warnings on the machinery or on the training of the operators.***	-]S2+ addresses bypassed interlocks, but does not have similar criteria [3]
127	77	¢	In addition, the operator must be able to control operation of the parts he is working on from the adjustment point.	-]S2+ does not have similar criteria applicable when interlocks are bypassed. [3]
128			**1.2.6. *Failure of the power supply***	**[5]**
129	78	¢	The interruption, the re-establishment after an interruption or the fluctuation in whatever manner of the power supply to the machinery must not lead to dangerous situations.	-] S2+ does not have criteria related to the general consideration of failure of power and how it might impact safety. +] for solid state safety systems, power fluctuation should be considered. [2]
130			Particular attention must be given to the following points:	This is an intro to the following bullet points. It is not an assessable section on its own. [5]
131	79	¢	— the machinery must not start unexpectedly,	-] S2+ does not have criteria related to unexpected startup following interruption of a power supply. +]S22 has a general concern about unexpected startup (13.2.2) [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
132	80	¢	— the parameters of the machinery must not change in an uncontrolled way when such change can lead to hazardous situations,	-] S2+ does not have criteria related to parameters that change because of power failure. [3]
133	81	¢	— the machinery must not be prevented from stopping if the command has already been given, ***G: The third indent applies to the parts of the control system controlling stop and emergency stop functions. The control system must be designed so that, once a stop command has been given, it remains effective even if the power supply is interrupted.***	-] S2+ does not have criteria related to a stop being successful even if power fails mid-sequence. {e.g., ensuring a rotary device successfully stops even if power fails mid stop}. [3]
134	82	¢	— no moving part of the machinery or piece held by the machinery must fall or be ejected, ***G: This may be achieved by clamps, brakes, locking devices, check valves and so on that operate by removal of power or, if that is not possible, by a source of stored energy such as, for example, a spring or a reservoir of compressed air.***	-] S2+ does not have criteria related to retaining work pieces. {e.g., making sure a wafer on a robot is not dropped if power fails. Note that this is probably relevant to even drops that are of themselves not hazardous, since dropping an item of value may lead people to take drastic actions to save the item. } [3]
135	83	¢	— automatic or manual stopping of the moving parts, whatever they may be, must be unimpeded, ***G: Where energy is required to stop the moving parts safely, it may be supplied from a source of stored energy. In certain cases, it may be necessary to provide a reserve power supply to enable the moving parts of the machinery to be stopped safely.***	-] S2+ does not have criteria related to retaining work pieces. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
136	84	¢	— the protective devices must remain fully effective or give a stop command. ***G: The last indent requires protective devices to be designed so that they remain effective in the absence of the power supply or so that a stop command is automatically triggered if the power supply is interrupted.*** ***{from elsewhere in the guide, some sense of what is meant by 'protective devices'}…Protective devices include, for example, two-hand control devices, sensitive protective equipment such as pressure sensitive mats and sensitive edges, trip bars and trip wires, and opto-electronic protective devices such as light curtains, laser scanners or camera-based safeguarding systems…withdrawal of a person or the detected part of a person from the sensing field of a protective device. {They are different from guards} …guards and protective devices***	-] S2+ does not have criteria related to assessing how protective devices would act given power failure or fluctuation. +] S2+ does require power fluctuations to be considered for solid state safety systems (e.g. 11.6), -] the consideration does not have to be applied to electromechanical systems. [2]
137			**1.3. PROTECTION AGAINST MECHANICAL HAZARDS**	**[5]**
138			**1.3.1. *Risk of loss of stability***	**[5]**
139	85	¢	Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery.	+]S2 18.3 addresses stability during transportation ("foreseeable shipping") and installation and operating conditions (covering "any other action") {moving around in the facility is part of the "installation" step in S2} -]S2 does not address stability during dismantling [2]
140	86	¢	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.	+] ¶18.3 addresses this concern. [1]
141			**1.3.2. *Risk of break-up during operation***	[5]
142	87	¢	The various parts of machinery and their linkages must be able to withstand the stresses to which they are subject when used.	+] ¶18.4 addresses this concern. [1]
143	88	¢	The durability of the materials used must be adequate for the nature of the working environment foreseen by the manufacturer or his authorised representative, in particular as regards the phenomena of fatigue, ageing, corrosion and abrasion.	+] ¶18.4.1 addresses this concern. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
144	89	¢	The instructions must indicate the type and frequency of inspections and maintenance required for safety reasons. They must, where appropriate, indicate the parts subject to wear and the criteria for replacement.	+]S2 9.6.2 calls for S13 which has section 13 covers equipment inspection consumables and maint. Methods of periodic inspections and frequency. [1]
145	90	¢	Where a risk of rupture or disintegration remains despite the measures taken, the parts concerned must be mounted, positioned and/or guarded in such a way that any fragments will be contained, preventing hazardous situations.	+] ¶18.4.2 addresses this concern. [1]
146	91	¢	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 to ensure that no risk is posed by a rupture.	+] ¶18.4.3 addresses this concern. [1]
147			Where the material to be processed is fed to the tool automatically, the following conditions must be fulfilled to avoid risks to persons:	[5]
148	92	¢	— when the workpiece comes into contact with the tool, the latter must have attained its normal working condition,	+] S2 does not explicitly discuss achieving working conditions but the general breakup criterion (18.4) and the requirement to provide safety interlocks or covers as needed for hazards (11.10) would sufficiently address this concern. Because of the delicate nature of industry workpieces they tend to be protected from human contact as a general principle. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
149	93	¢	— when the tool starts and/or stops (intentionally or accidentally), the feed movement and the tool movement must be coordinated. {at west 12 we decided this does not need to be limited to manual feed concerns but could be automatic. We are fairly comfortable that this must mean an external coordination with the tool such as external chemistry feed or external pod feed. }	-] S2 appears to be silent about coordinating incoming feeds with tool operation. -] S2 21.2.4.1 uses “feed” but in the context of possible chemical spillage from tanks. [3] ~~-] S2 does not explicitly address starting and normal stopping, but per discussion above all workpieces are expected to be protected from conact, and any significant risks from workpieces during start up is expected to be caught in a general risk assessment {???}.~~ ~~Optional RI2-talks about standards incl. EN 1037.~~ ~~There is discussion of UTV startup safety in 20.5.2.2.~~ ~~Furthermore equipment in our industry typically has to be verified as started properly before a work piece is introduced.~~ ~~{need to study this one more to see if it’s a relevant potential hazard in the industry.~~ ~~- at Jun28tfm decided it was moot. It might be relevant to ingot saws but we have decide to exclude such products from our consideration. }~~
150			**1.3.3. *Risks due to falling or ejected objects***	[5]
151	94	¢	Precautions must be taken to prevent risks from falling or ejected objects.	+] ¶18.4 addresses this concern. [1]
152			**1.3.4. *Risks due to surfaces, edges or angles***	[5]
153	95	¢	Insofar 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.	+] S2 18.2 addresses this concern [1]
154			**1.3.5. *Risks related to combined machinery***	[5]
155	96	¢	Where the machinery is intended to carry out several different operations with 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 risk for exposed persons.	Combined machinery is outside the scope of this project. [4]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
156	97	¢	For this purpose, it must be possible to start and stop separately any elements that are not protected.	Combined machinery is outside the scope of this project. [4]
157			**1.3.6. *Risks related to variations in operating conditions***	[5]
158	98	¢	**=DELTA=** Where the machinery performs operations under different conditions of use, it must be designed and constructed in such a way that selection and adjustment of these conditions can be carried out safely and reliably. ***G: The requirement set out in section 1.3.6 concerns machinery that can operate under different conditions of use such as, for example, with different kinds of tools, at different speeds or feeding rates, with different materials or under different environmental conditions. In such cases, the selection of the desired condition of use must be clear to the operators and, where necessary, must also trigger the corresponding protective measures. Involuntary or nintended selection must be prevented by the design of the control devices if this can lead to hazardous situations***	-] S2+ has no related criteria to consider hazards that might arise from variations in operating conditions. **{e.g., lasers on or off, ion beam on or off, chambers under vacuum or under pressure from venting}** **[3]**
159			**1.3.7. *Risks related to moving parts***	[5]
160	99	¢	The moving parts of machinery must be designed and constructed in such a way as to prevent risks of contact which could lead to accidents or must, where risks persist, be fitted with guards or protective devices.	+] S2 section 18.5 is this wording almost verbatim [1]
161	100	¢	All necessary steps must be taken to prevent accidental blockage of moving parts involved in the work. In cases where, despite the precautions taken, a blockage is likely to occur, the necessary specific protective devices and tools must, when appropriate, be provided to enable the equipment to be safely unblocked. ***G: The second and third paragraphs of section 1.3.7 deal with the problem of the blockage of moving parts involved in the work. Even if a blockage does not itself create a dangerous situation, the occurrence of blockages often requires operators to intervene quickly in order to avoid damage and loss of production,***	-] S2+ has no criteria related to assessing the possibility of blockage or tools for unblocking. {blockage is an unusual concern in the semi industry, but not impossible. Chemical delivery systems could get blocked. Some equipment could feasibly become blocked with work pieces, particularly farther down the line such as individual IC testing. Wafers dropped by a wafer handling robot is probably a relevant example.} [3]
162	101	¢	The instructions and, where possible, a sign on the machinery shall identify these specific protective devices and how they are to be used.	-] S2+ has no criteria related to assessing the possibility of blockage or tools for unblocking, and so no requirements for signs either. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
163			**1.3.8. *Choice of protection against risks arising from moving parts***	[5]
164	102	¢	Guards or protective devices designed to protect against risks arising from moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help to make the choice.	+]S2-0712a section 18.5, particularly 18.5.2 calls for guards to be selected based on risk assessment, but there is no requirement to use the "following guidelines" – but those will be assessed separately. [1]
165			**1.3.8.1. Moving transmission parts**	[5]
166	103	¢	Guards designed to protect persons against the hazards generated by moving transmission parts must be: — either fixed guards as referred to in section 1.4.2.1, or — interlocking movable guards as referred to in section 1.4.2.2.	-] S2+ has no specific requirements for guards of moving transmission parts. [3]
167	104	¢	Interlocking movable guards should be used where frequent access is envisaged. {the EU guide does not explain the meaning of "frequent"}	-] S2 has no criteria related to guard type and frequency of access. +] The TF believes the time pressures of the industry in general would drive interlock guards where frequent access is needed. [2]
168			**1.3.8.2. Moving parts involved in the process**	[5]
169			Guards or protective devices designed to protect persons against the hazards generated by moving parts involved in the process must be: — either fixed guards as referred to in section 1.4.2.1, or — interlocking movable guards as referred to in section 1.4.2.2, or — protective devices as referred to in section 1.4.3, or — a combination of the above.	{there does not seem to be a pracitable way to protect personnel other than the first three bullets given, so this MD section does not constrain any design choice. } [5]
170			However, when certain moving parts directly involved in the process cannot be made completely inaccessible during operation owing to operations requiring operator intervention, such parts must be fitted with:	This section is just a header for the following two bullets. [5]
171	105	¢	— fixed guards or interlocking movable guards preventing access to those sections of the parts that are not used in the work, and	-] S2+ has no specific requirements for guards of moving parts involved in the process. [3]
172	106	¢	— adjustable guards as referred to in section 1.4.2.3 restricting access to those sections of the moving parts where access is necessary.	-] S2+ has no specific requirements for guards of moving parts involved in the process. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
173			**1.3.9. *Risks of uncontrolled movements***	[5]
174	107	¢	**=DELTA=** When a part of the machinery has been stopped, any drift away from the stopping position, for whatever reason other than action on the control devices, must be prevented or must be such that it does not present a hazard.	At west 12 several people felt that the standard of hazard analysis present in the industry these days would reveal the issue of drift and so 18.4 of S2 provides complete coverage. The room was not completely agreed. A straw poll of 8 for, 6 against. [risk] ~~+] S2 18.5 addresses moving parts hazards, but no more than the MD above in ref160 (1.3.7 first para).~~ ~~-] S2+ does not explicitly address the risk of drift after stopping.~~ TFM 2may2013 thinks S2 offers complete coverage via the general care put into 18.5 for assessing moving part hazards. Also some coverage explicitly related to hinged loads in 18.7. And also 17.4.1 addressing isolation of stored energy. [3]
175			**1.4. REQUIRED CHARACTERISTICS OF GUARDS AND PROTECTIVE DEVICES**	[5]
176			**1.4.1. *General requirements***	[5]
177			Guards and protective devices must:	[5]
178	108	¢	— be of robust construction,	-] S2 does not address the construction of guards and protective devices regarding their robustness. -]S2 has criteria for hinged loads, but it only applies after 11bs of mass. +]S2 18.4.2 addressed construction related to containing ejected parts. +]S22 has criteria for robustness of elec. Enclosures. [2]
179	109	¢	— be securely held in place,	-] S2 does not specifically address the construction of guards and protective devices regarding their securement. +]S22 15.1.4 provides some coverage related to guard deflection. [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
180	110	¢	— not give rise to any additional hazard,	-] S2 does not address the construction of guards and protective devices regarding the additional hazards they might introduce. +] S8 mmh requirements would kick in for a guard weighing more than 10lbs (4.4 kg), and for those under 10lbs (4.4 kg) weight is not a hazard issue +] S2 has a criterion about sharp edges . {a guard might be heavy, or have a sharp edge, or have to be held up while open} [2]
181	111	¢	— not be easy to by-pass or render non-operational,	-]S2 has criteria about bypassing interlocks but this MD section is focused also on bypassing guards. S2 allows bypassing but does not address, explicitly, the question of “easy.” To the extent this phrase is related to bypassing interlock systems vs. bypassing a physical barrier, there is partial coverage via the S2 rules about bypassing. [2]
182	112	¢	— be located at an adequate distance from the danger zone,	+]S2 has criteria related to accessibility to shock hazards (ref 13.4.7) +] We think this would be covered somewhat by the general standard of care applied to S2 evaluations and the industry focus on protecting personnel from hazards. [2]
183	113	¢	— cause minimum obstruction to the view of the production process, and	-] S2 has no criteria related to the view provided to the production process. +] We think this would be covered somewhat by the general standard of care applied to S2 evaluations and the industry focus on protecting personnel from hazards. windows are often provided in guards in the industry, and where they cannot be provided [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
184	114	¢	— enable essential work to be carried out on the installation and/or replacement of tools and for maintenance purposes by restricting access exclusively to the area where the work has to be done, if possible without the guard having to be removed or the protective device having to be disabled.	-] S2 has nothing like this. Particularly the strategic consideration of what is guarded and what not. +] S2 11.7 has a criterion to minimize the need to bypass interlocks. [2]
185	115	¢	In addition, guards must, where possible, protect against the ejection or falling of materials or objects and against emissions generated by the machinery. ***G: The second paragraph of section 1.4.1 underlines that guards can often provide protection against several hazards simultaneously and must be designed and constructed accordingly***	+] S2 has general criteria about parts ejection and emissions (chemical, radiation), but nothing that cautions that a guard, for example, provided to prevent access should also be design to contain ejection. +] We think this would be covered somewhat by the general standard of care applied to S2 evaluations and the industry focus on protecting personnel from hazards. [2]
186			**1.4.2. *Special requirements for guards***	[5]
187			**1.4.2.1. Fixed guards**	[5]
188	116	¢	Fixed guards must be fixed by systems that can be opened or removed only with tools.	-] Not in S2+ +] some of the criteria related to accessing hazards requires tool-accessible enclosures (but not always - e.g., if labeled). [3]
189	117	¢	**=DELTA=** Their fixing systems must remain attached to the guards or to the machinery when the guards are removed. *{NOTE: email exchange with Commission and Guarding standard committee lead suggest practicality and risk assessment may be applied to this new criterion}*	-] Not in S2+ [3]
190	118	¢	Where possible, guards must be incapable of remaining in place without their fixings.	-] Not in S2+ [3]
191			**1.4.2.2. Interlocking movable guards**	[5]
192			Interlocking movable guards must:	[5]
193	119	¢	— as far as possible remain attached to the machinery when open,	-] Not in S2+ [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
194	120	¢	— be designed and constructed in such a way that they can be adjusted only by means of an intentional action. ***G: Their adjustment must be possible only by means of an intentional action in order to prevent, for example, the distance between the guard and the danger zone from being modified unintentionally during opening or closing.***	{"adjusting" is equivalent to altering a set point} +] S2 has criteria limiting the accessibility of setpoints. Eg., 0712a section 11.5 [1]
195			Interlocking movable guards must be associated with an interlocking device that:	[5]
196	121	¢	— prevents the start of hazardous machinery functions until they are closed and	+] Equiv to S2 11.3 that requires equipment safety on interlock "activation". +]11.8 of S2 also addresses this …~"closing should not allow unsafe condition" [1]
197	122	¢	— gives a stop command whenever they are no longer closed.	+] Equiv to S2 11.3 that requires equipment safety on interlock "activation". +]11.8 of S2 also addresses this "The restoration of a safety interlock should not initiate equipment operation or parts movement where this can give rise to a hazardous condition. [1]
198			Where it is possible for an operator to reach the danger zone before the risk due to the hazardous machinery functions has ceased, movable guards must be associated with a guard locking device in addition to an interlocking device that:	[5]
199	123	¢	— prevents the start of hazardous machinery functions until the guard is closed and locked, and	+] There is a requirement to bring equipment to a safe state when interlocks are activated (S2 11.3) -] S2 has no criteria related to guard locking [2]
200	124	¢	— keeps the guard closed and locked until the risk of injury from the hazardous machinery functions has ceased.	+] There is a requirement to bring equipment to a safe state when interlocks are activated (S2 11.3) -] S2 has no criteria related to guard locking [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
201	125	¢	Interlocking movable guards must be designed in such a way that the absence or failure of one of their components prevents starting or stops the hazardous machinery functions.	+] S2 requires Interlocks to must be fault tolerant. (11.5 of 0712) [1]
202			**1.4.2.3. Adjustable guards restricting access**	[5]
203			Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work must be:	[5]
204	126	¢	— adjustable manually or automatically, depending on the type of work involved, and	{we considered light curtains, temp guards and other devices but could not think of an analogous guarding scenario where the guard would be adjusted to provide more or less exposure depending on the work piece} [4]
205	127	¢	— readily adjustable without the use of tools.	{ditto above} [4]
206			**1.4.3. *Special requirements for protective devices*** ***G: Protective devices are distinguished from guards since they do not constitute a physical barrier between the exposed person and the danger zone but reduce risks by preventing exposure to the hazard by other means. Protective devices include, for example, two-hand control devices, sensitive protective equipment such as pressure sensitive mats and sensitive edges, trip bars and trip wires, and opto-electronic*** ***protective devices such as light curtains, laser scanners or camera-based safeguarding systems*** **{all of these appear to be types of interlocks in the realm of S2}**	[5]
207			Protective devices must be designed and incorporated into the control system in such a way that:	[5]
208	128	¢	— moving parts cannot start up while they are within the operator's reach,	+] Equiv to S2 11.3 that requires equipment safety on interlock “activation”. The specific issue of reach is highlighted in note 31 of S2 . +] also 11.8 of S2 [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
209	129	¢	— persons cannot reach moving parts while the parts are moving, and	+] Equiv to S2 11.3 that requires equipment safety on interlock "activation". The specific issue of reach is highlighted in note 31 of S2 +] also 11.8 of S2 [1]
210	130	¢	— the absence or failure of one of their components prevents starting or stops the moving parts.	+] S2 requires Interlocks to must be fault tolerant. (11.5 of 0712) -] S2 does not explicitly required moving mechanical parts to be stopped if there is a fault in an eletrosensitve interlock system. [2]
211	131	¢	Protective devices must be adjustable only by means of an intentional action.	{"adjusting" is equivalent to altering a set point} +] S2 has criteria limiting the accessibility of setpoints. Eg., 0712a section 11.5 [1]
212			**1.5. RISKS DUE TO OTHER HAZARDS**	[5]
213			**1.5.1. *Electricity supply***	[5]
214	132	¢	Where machinery has an electricity supply, it must be designed, constructed and equipped in such a way that all hazards of an electrical nature are or can be prevented.	S2 §13 thoroughly covers hazards and risks related to electrical supply. [1]
215	133	¢	The safety objectives set out in Directive 73/23/EEC shall apply to machinery. However, the obligations concerning conformity assessment and the placing on the market and/or putting into service of machinery with regard to electrical hazards are governed solely by this Directive.	S2+ does not address conformity assessment methods that are in line with those stated in this MD directive. [3]
216			**1.5.2. *Static electricity***	[5]
217	134	¢	Machinery must be designed and constructed to prevent or limit the build-up of potentially dangerous electrostatic charges and/or be fitted with a discharging system.	S2+ does not directly address the issue of static electricity. Though it may be covered in a selected electrical design standard (I don't think static electricity is covered by NFPA 79,EN 60204 or UL/EN 61010-1) [3]
218			**1.5.3. *Energy supply other than electricity***	[5]
219	135	¢	Where machinery is powered by source of energy other than electricity, it must be so designed, constructed and equipped as to avoid all potential risks associated with such sources of energy.	S2+ anticipates a variety of energy sources and has appropriate considerations for safety given the expected use in the clean room environment. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
220			**1.5.4. *Errors of fitting***	[5]
221	136	¢	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 and construction of such parts or, failing this, by information given on the parts themselves and/or their housings. The same information must be given on moving parts and/or their housings where the direction of movement needs to be known in order to avoid a risk.	S8 SESC P7.5.4 – addresses this, scoped as "Cables, connectors, plugs, and receptacles" but oddly exempts the criterion if an S2 assessment is being done. S2 does not appear to explicitly cover the same concern. Therefore, it should probably be considered as NOT covered by S2+ +] Typical electrical design standards used to support an S2 assessment would cover this for electrical concerns but not other media. [2]
222	137	¢	Where necessary, the instructions must give further information on these risks.	S13 does not have any considerations related to errors of fitting. Neither does S2 (see ref221,above) [3]
223	138	¢	Where a faulty connection can be the source of risk, incorrect connections must be made impossible by design or, failing this, by information given on the elements to be connected and, where appropriate, on the means of connection. {This is faulty connection vs. mis-connection. E.g., the risk of connecting the right thing to the right port, but the connection does not seal or engage completely}	-]S2+ does not contain any criteria related to this topic. [3]
224			**1.5.5. *Extreme temperatures***	[5]
225	139	¢	Steps must be taken to eliminate any risk of injury arising from contact with or proximity to machinery parts or materials at high or very low temperatures.	+] S2 18.8 address this concern [1]
226	140	¢	The necessary steps must also be taken to avoid or protect against the risk of hot or very cold material being ejected.	Ejection of hot or cold materials in the operator space is not foreseen, but it is foreseen into drains etc… S2+ has criteria asking that containment for drain lines etc… be compatible with the materials they will meet. [1]
227			**1.5.6. *Fire***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
228	141	¢	Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.	S2 §14 and S14 cover concerns related to fire very well. [1]
229			**1.5.7. *Explosion***	[5]
230	142	¢	Machinery must be designed and constructed in such a way as to avoid any risk of explosion posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery.	+] S2 23.5.4 limits the explosive gas emissions outside enclosures during worst-case failures to 25% of LEL. -] S2 does not address the issue of explosive atmospheres developing inside enclosures. -] S2 22.2 calls for an S6 assessment, but only in regard to employee exposure to chemicals. -] S6 is for the assessment of ventilation provided for safety. Its does not set the criteria of whether such ventilation must be provided in the first place. +]S14 related information 4 addresses explosion risks, but it is not normative. [2]
231	143	¢	Machinery must comply, as far as the risk of explosion due to its use in a potentially explosive atmosphere is concerned, with the provisions of the specific Community Directives.	Equipment as a whole is not expected to be used in a potentially explosive atmosphere. Though it could contain PxATMs inside, this risk would be addressed by ref230, above. [4]
232			**1.5.8. *Noise***	[5]
233	144	¢	Machinery must be designed and constructed in such a way 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.	+] S2 27.1 sets noise thresholds on equipment. -] however, the MD is clearly concerned with reducing noise a far as possible rather than to a particular limit. -] Ref234 does not provide any particular relief except to help establish the minimum to be achieved. [2]
234			The level of noise emission may be assessed with reference to comparative emission data for similar machinery.	This is a permissive criterion, not restrictive. [5]
235			**1.5.9. *Vibrations***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
236	145	¢	Machinery must be designed and constructed in such a way 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.	S2+ has no criteria related to vibration. But vibration risks are not anticipated in our industry. Vibration disturbs process. [4]
237			The level of vibration emission may be assessed with reference to comparative emission data for similar machinery.	This is a permissive criterion, not restrictive. [5]
238			**1.5.10. *Radiation***	[5]
239	146	¢	Undesirable radiation emissions from the machinery must be eliminated or be reduced to levels that do not have adverse effects on persons. **{we take "undesirable" to mean not intended for a functional purpose of the machine}**	+] S2 section 24 addresses ionizing radiation and Section 25 addresses non-ionizing radiation, both with a view towards protecting personnel from adverse effects. S2 addresses functional and "undesirable" radiation in the same manner. [1]
240	147	¢	Any functional ionising radiation emissions must be limited to the lowest level which is sufficient for the proper functioning of the machinery during setting, operation and cleaning. Where a risk exists, the necessary protective measures must be taken.	+] S2 section 24 addresses ionizing radiation and these considerations. [1]
241	148	¢	Any functional non-ionising radiation emissions during setting, operation and cleaning must be limited to levels that do not have adverse effects on persons.	+] S2 section 25 addresses ionizing radiation and these considerations. [1]
242			**1.5.11. *External radiation***	[5]
243	149	¢	Machinery must be designed and constructed in such a way that external radiation does not interfere with its operation.	-] S2 is completely silent on the potential effects of EMR on the functioning of the equipment. This is a relevant potential hazard in our industry as technicians near the equipment often have cell phones or more powerful communication electronics, or other equipment nearby could be significant EMR radiators. [3]
244			**1.5.12. *Laser radiation***	[5]
245			Where laser equipment is used, the following should be taken into account:	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
246	150	¢	— laser equipment on machinery must be designed and constructed in such a way as to prevent any accidental radiation,	+] S2 requires all equipment to be no greater than a class 2 laser product (ref 26.1.2) . This will force consideration of accidental laser radiation. [1]
247	151	¢	— laser equipment on machinery must be protected in such a way that effective radiation, radiation produced by reflection or diffusion and secondary radiation do not damage health,	+] S2 requires all equipment to be no greater than a class 2 laser product (ref 26.1.2) and other considerations in section 26 such as 26.2 . This will force consideration of accidental laser radiation. [1]
248	152	¢	— optical equipment for the observation or adjustment of laser equipment on machinery must be such that no health risk is created by laser radiation. **{This is not PPE that might be carried by a tech as a tool. This would have to be something fitted to the machine. }**	Need to talk more about this to see if the scenario exists in our industry. +] 26.1 and 26.2 requires lasers to be properly classified which requires use of an appropriate standard, and 26.2 explicitly addresses service and maintenance risks and potential exposures. [1]
249			**1.5.13. *Emissions of hazardous materials and substances***	[5]
250	153	¢	Machinery must be designed and constructed in such a way that risks of inhalation, ingestion, contact with the skin, eyes and mucous membranes and penetration through the skin of hazardous materials and substances which it produces can be avoided.	+] S2 only focuses on “breathing zones” for its chemical exposure criteria. [2]
251	154	¢	Where a hazard cannot be eliminated, the machinery must be so equipped that hazardous materials and substances can be contained, evacuated, precipitated by water spraying, filtered or treated by another equally effective method.	Tf thoughts on 29jun2012 - Seems to be a facility obligation given ref250 already requires risks to be avoided. Maybe this simply means provision of documentation about what is coming out of the machine. TF30may2013 This seems reasonably related to hazardous chems that can’t be eliminated but might be encountered e.g., during service or maintenance, such as chamber build up. The equip should be designed for safe service or maintenance nonetheless. -] S2 only has specific concerns about breathing zone exposure (i.e., not dermal or ingestion) (ref section 23.5) And only focuses on maintenance and not service, though safe decommissioning (ref 9.6.5) is addressed. [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
252	155	¢	Where the process is not totally enclosed during normal operation of the machinery, the devices for containment and/or evacuation must be situated in such a way as to have the maximum effect. **{analogous SEMI equipment – wet bench, solder dip}**	+}S2 section 22 on exhaust ventilation provides a very robust consideration of this concern. [1]
253			**1.5.14. *Risk of being trapped in a machine***	[5]
254	156	¢	Machinery must be designed, constructed or fitted with a means of preventing a person from being enclosed within it or, if that is impossible, with a means of summoning help.	-] entrapment is not addressed by S2. [3]
255			**1.5.15. *Risk of slipping, tripping or falling***	[5]
256	157	¢	Parts of the machinery where persons are liable to move about or stand must be designed and constructed in such a way as to prevent persons slipping, tripping or falling on or off these parts.	+]S2 addresses tripping and falling a bit in discussing access to EMOs (ref 12.5.3 of 0712), and HEI devices (17.1.3 of 0712). +] the fall protection criteria Ron's task force is working on will robustly address falls if/when it is approved. -] there is no comprehensive requirement to look for trip and slip hazards. TF consensus is that the S2 sections are not general enough to be considered the same. [3]
257	158	¢	Where appropriate, these parts must be fitted with handholds that are fixed relative to the user and that enable them to maintain their stability.	-] neither the current S2 nor the planned fall protection criterion address providing handholds for personnel stability +] The requirement for handrails in the not-yet-realized fall protection RI might be thought of addressing a small sector of this concern. ???] besides falling, would we ever expect a slip or trip prone area to be designed in such that a handhold was the only solution? Perhaps this is really status [4] (not relevant to our industry) [4]
258			**1.5.16. *Lightning***	[5]
259	159	¢	Machinery in need of protection against the effects of lightning while being used must be fitted with a system for conducting the resultant electrical charge to earth.	Direct Lighting strikes are not a hazard relevant to the semiconductor and collateral industries. [4]
260			**1.6. MAINTENANCE**	[5]
261			**1.6.1. *Machinery maintenance***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
262	160	¢	Adjustment and maintenance points must be located 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, measures must be taken to ensure that these operations can be carried out safely (see section 1.2.5).	+] Several sections of S2 discuss designing equipment so it can be safely maintained; Section 17, and 17.1.2 specifically discusses hazardous energy isolation – electrical, mechanical, thermal, etc. – which for SEMI products is at a standstill, per the terms of the Machinery Directive +] S2 covers this by requiring detailed maintenance information in the maintenance and service manuals +]TFM modifying this MD list to show the pair of sentences it is clearer that S2 covers the concern completely. [1]
263			DELETED – moved paragraph to the above cell as they are linked topics and should not be assessed separately.	
264	161	¢	In the case of automated machinery and, where necessary, other machinery, a connecting device for mounting diagnostic fault-finding equipment must be provided. **G: The requirements set out in the third and fourth paragraphs of section 1.6.1 aim to reduce risks due to operator intervention, particularly for automated machinery. The third paragraph of section 1.6.1 requires machinery to be provided, where appropriate, with the means of connecting the necessary diagnostic fault-finding equipment.**	~~-] This requirement is not applicable to SEMI products as they have diagnostic and fault detection equipment designed in; it is however discussed in R13 and R15~~ ~~[4]~~ TFM -] S2 is completely silent on the need for diagnostic equipment, but it seems to be relevant to our industry as we can't say with certainty that all products have the diagnostics suggested above. [3]
265	162	¢	Automated machinery components which have to be changed frequently must be capable of being removed and replaced easily and safely. Access to the components must enable these tasks to be carried out with the necessary technical means in accordance with a specified operating method. **G: The fourth paragraph requires the manufacturer to design automated machinery to facilitate the removal and replacement of components that have to be changed frequently. The safe method to be employed for such maintenance operations must be clearly specified and explained in the instructions – see §272: comments on section 1.7.4.2 (s).**	Section 16.2 of SEMI S2-0712a calls for assessment to SEMI S8 (SESC Checklist). In the SESC, Section 7.5.1 of the SEMI S8-0712 reads: "Serviceable components are replaceable as modular packages, and are configured for rapid removal and replacement." TFM +] Also S13-0113 section 6.2 requires instructions for safe maintenance etc… regardless of whether the equipment is automated or not. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
266			**1.6.2. *Access to operating positions and servicing points***	[5]
267	163	¢	Machinery must be designed and constructed in such a way as to allow access in safety to all areas where intervention is necessary during operation, adjustment and maintenance of the machinery.	Section 18.5 of SEMI S2-0712a reads: *Moving Parts* — The moving parts of equipment should be designed, built, and positioned to avoid hazards. Where hazards persist, equipment should be fitted with guards or protective devices that reduce the likelihood of contact that could lead to injury. Section 16.2 of SEMI S2-0712a calls for assessment to SEMI S8 (SESC Checklist). In the SESC, Section 7 includes specific requirements for accessibility, and Section 7.4 provides for Service and Maintenance access. TFM +] The standard of care in our industry in using S2 is to provide safety for foreseeable interactions with the equipment. This is particularly suggested in section 6.5 of S2. [1]
268			**1.6.3. *Isolation of energy sources***	[5]
269	164	¢	Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. **{The Commission MD guide does not explain whether this identification means via a label at the isolator (vs., say, in documentation), and whether the identification text must include the 'isolation' concept.}**	+] S2 requires isolation capabilities only for tasks that may result in contact with hazardous energy sources (ref 17.1.1). The MD is a bit broader than that. -] S2 has no criteria about the identification of the isolation' +] S13 requires medium or higher risk present lockouts to have procedures for the end user which presumably would identify the location of the isolator. (ref 8.1 0113). [2]
270	165	¢	They must be capable of being locked if reconnection could endanger persons.	+] here S2 and MD seem equivalent, as MD only requires lockability where one could be endangered, which seems essentially equivalent to S2 focus only on hazardous energies. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
270.1	166	¢	Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off. ***{This appears to apply regardless of whether reconnection could endanger}***	Section 17.3.1 of SEMI S2-0712a reads: "The Main energy isolation capabilities (equipment supply disconnect) should be in a location that is readily accessible and should be lockable only in the de-energized position" For non-electrical energy isolation, Section 17.4.3 of SEMI S2-0712a reads: "The hazardous energy isolation devices should be capable of being locked in the position in which the hazardous energy is isolated." [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
271	167	¢	**=DELTA=** In the case of machinery capable of being plugged into an electricity supply, removal of the plug is sufficient, provided that the operator can check from any of the points to which he has access that the plug remains removed.	The Exception to clause Section 13.4.1 of SEMI S2-0712a allows for the conditional use of plug connected equipment. The exception reads “Cord- and plug-connected single phase equipment, rated no greater than 240 volts line-to-line/150 volts line-to-ground and no greater than 2.4 kVA, may have overcurrent protection devices with interrupting capacity of at least 5,000 rms symmetrical AIC.” Section 17 (Hazardous Energy Isolation) makes no mention of the plug being used as the isolation method. SEMI S2 would require a commercial lockout device on the plug, if it were the LO/TO means. This provides a higher level of safeguard than the MD calls for in this DELTA section. 17.1.3 notes: NOTE 80: In order to minimize down-time and provide ease of use, it is preferred to have energy isolation devices located in the areas where maintenance or service is performed. NOTE 83: Energy isolation devices with integral locking capabilities are preferred, but may not be feasible or commercially available, in which case detachable lockout adapters may be used. TFM +] We believe this is actually moot as S2 does not allow monitoring as a means of energy isolation safety. Locking is always required per 17.1.1. ~]FYI S22 9.4.1 allows monitoring of plug and cord main disconnect, but it is no less severe than the MD. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
272	168	¢	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 persons.	Section 17 of SEMI S2 does discuss lock-out tagout. It does define hazardous energy in note 79 and 82 as including capacitance and stored pressure . I think that SEMI goes a bit further than the MD. TFM -] S2 doesn't directly say stored energy needs to be dissipated. +] But it does say there must be documentation on how to dissipate the energy (S2-0712 section 17.2.2 4th bullet). -]S13-0113 in section 8 discusses loto but also does *not* specifically mention the steps required such as dissipation of stored energy. [1]
273			As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety.	I do not see anything like this with the possible exception of EMOs TFM – exceptions have been treated as non-assessable with regard to S2 mapping in this document. [5]
274			**1.6.4. *Operator intervention***	[5]
275	169	¢	Machinery must be so designed, constructed and equipped that the need for operator intervention is limited.	-] Not in S2 nor S8. [3]
276	170	OPN	If operator intervention cannot be avoided, it must be possible to carry it out easily and safely.	-] S2 does not require that operator intervention be easy +] 11.7.1 appears to address operator safety regarding interlock bypassing. +] S13 6.2 requires provision of information for safe operation. +] S8 addresses "ease" of the operator from an ergonomics point of view. -] While font size is considered the navigation aspect of menus is not addressed in S2+ and can often be complicated in our industry. +] 10.3 of S13 calls for "unjamming" instructions though the following note claims this would be a service task (operator would call for service instead of doing themselves). {TF notes that the EU Guide limits the scope of "ease" consideration to the task of clearing, for example, jams, and not the ease of all possible operator tasks} [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
277			**1.6.5. *Cleaning of internal parts***	[5]
278	171	OPN	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 impossible to avoid entering the machinery, it must be designed and constructed in such a way as to allow cleaning to take place safely.	+] S2 requires consideration of breathing zone exposures during normal operation, failure and maintenance. +] S2 9.6.5 requires provision of decontamination information per S12. +] S2 9.6.1 requires provision of information in manuals for safe maintenance. +] S2 9.6.3 requires provision of a list of hazardous materials. [1]
279			**1.7. INFORMATION**	[5]
280			**1.7.1. *Information and warnings on the machinery***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
281	172	¢	Information and warnings on the machinery should preferably be provided in the form of readily understandable symbols or pictograms. Any written or verbal information and warnings must be expressed in an official Community language or languages, which may be determined in accordance with the Treaty by the Member State in which the machinery is placed on the market and/or put into service and may be accompanied, on request, by versions in any other official Community language or languages understood by the operators. **G: The second sentence of section 1.7.1 applies when information is provided in the form of written words or text on the machinery, on a monitor screen or in the form of oral text provided, for example, by means of voice synthesiser. In such cases the information and warnings must be provided in the official language or languages of the Member States in which the machinery is placed on the market and/or put into service.** **The user of machinery may also request the manufacturer to provide the information and warnings on the machinery or on monitor screens accompanied by versions in any other language or languages of the EU that are understood by the operators.** **{TFM notes that the guide seems to interpret "Community language" more specifically than usual. That is to say, Community language usaually means an official language of the EU Community which are French German and English. A Member State language would be one required in each country.**	-] Though S1 does allow labels w/o message panel, a signal word is always required. -] there is no requirement to translate labels in S2+ [2]
282			**1.7.1.1. Information and information devices**	[5]
283	173	¢	The information needed to control machinery must be provided in a form that is unambiguous and easily understood. It must not be excessive to the extent of overloading the operator.	+] ~~This topic is partially addressed within S1, Section 6.1 for machine safety label information only.~~ -] Other machinery control information (placed on the machinery)is not addressed in S2. TFM – thinks there is not partial coverage as the section and the guide are focused on information about normal control not hazard alert information. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
284	174	¢	**=DELTA=** Visual display units or any other interactive means of communication between the operator and the machine must be easily understood and easy to use.	-] no such requirement in S2+ +] S8 addresses the ergonomics of where the info is position and font size but not the message itself. [3]
285			**1.7.1.2. Warning devices**	[5]
286	175	¢	Where the health and safety of persons may be endangered by a fault in the operation of unsupervised machinery, the machinery must be equipped in such a way as to give an appropriate acoustic or light signal as a warning.	+] This topic is partially addressed within S2 by the implied use of warning devices in Section 10.1 (supported by provision of warning devices in the S2 "Safety Philosophy" Section 6.9.3). -] S2 does NOT mention any requirement for the type of machine warning device indication (e.g. acoustic or light signal). TFM\ +] S2 14.4.4.4 requires pre-warning of fire suppression release. +] S22 has a section (section 8.1, 8.3) on providing hazard warning signals {note: since S22 is not required by S2, the TFM has decided to only allow partial coverage because S22 is a general reference for the industry nonetheless} -] though 10.1 does discuss warning devices it is not as strong, particularly regarding reference to acoustic or light signals. [2]
287	176	¢	Where machinery is equipped with warning devices these must be unambiguous and easily perceived. The operator must have facilities to check the operation of such warning devices at all times.	-] This topic is not addressed within S2. Characteristics of warning devices (with regards to human interface) placed on the machine are not addressed in S2. There is no requirement in S2 for the operator to be provided with the facilities to check the operation of warning devices at all times. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
288	177	¢	The requirements of the specific Community Directives concerning colours and safety signals must be complied with.	+] S2 section 10.3 has criteria for warning devices (SEMI S1). Machinery Directive(2006/42/EC) refers to community Directive (92/58/EEC) . Both(SEMI S1 and 92/58/EEC) covers colors and safety signals requirements. TFM -] Neither S2 nor s1 specifically call out the directive noted above, but coincidentally S1 appears to align well with its criteria. The directive also has criteria for acoustic signals which is absent from S2+ [2]
289			**1.7.2. *Warning of residual risks***	[5]
290	178	¢	Where risks remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted, the necessary warnings, including warning devices, must be provided.	+] S2 section 10.3 addresses warning devices. +] S13 section 7 addresses warnings of residual risks in document. TFM +] Also, general standard of care in the industry covers this well. +] S2 10.1 also addresses this. [1]
291			**1.7.3. *Marking of machinery***	[5]
292			All machinery must be marked visibly, legibly and indelibly with the following minimum particulars:	[5]
293	179	¢	**=DELTA=** — the business name and full address of the manufacturer and, where applicable, his authorised representative,	+] S2 sect. 13.4.12 has criteria for a permanent nameplate. It requires the manufacturer's name. -] S2 nameplate criteria does not include the full address of the manufacturer, nor any discussion (of course) about ARs {e.g. NFPA 79 does not require address either, just name} [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
294	180	¢	— designation of the machinery, *G: The term 'designation of the machinery' refers to the usual name of the category of machinery to which the specific model of machinery belongs. (The term has a similar meaning to the terms 'generic denomination and function' used in Annex II with respect to the EC Declaration of conformity). Wherever possible, the term used to designate the category of machinery concerned in harmonised standards should be used. The same information must be given in the EC Declaration of conformity [more…]*	-] S2 nameplate criteria does not include any designation term criterion. [3]
295	181	¢	— the CE Marking (see Annex III),	-] S2 nameplate criteria does not include CE marking [3]
296	182	¢	— designation of series or type,	-] Surprisingly S2 nameplate criteria does not include any mention of tool or model names. [3]
297	183	¢	— serial number, if any,	+] S2 nameplate criteria includes “machine serial number” [1]
298	184	¢	— the year of construction, that is the year in which the manufacturing process is completed.	-] S2 nameplate criteria does not include any date criteria. [3]
299			It is prohibited to pre-date or post-date the machinery when affixing the CE marking.	{This is guidance for the criterion above (298) } [5]
300	185	¢	Furthermore, machinery designed and constructed for use in a potentially explosive atmosphere must be marked accordingly.	Equipment (at total machine) in the semi industry is never anticipate to be used in a potential explosive atmosphere. [4]
301	186	¢	Machinery must also bear full information relevant to its type and essential for safe use. Such information is subject to the requirements set out in section 1.7.1. {check for typo – no typo} *G: However information concerning essential aspects of safe use must be marked on the machinery, such as, for example, the maximum dimensions of workpieces, the maximum dimensions of the tools to be used, the maximum slope on which the machinery is stable, the maximum wind speed and so on.*	+] S2 nameplate criteria requires provision of Electrical information. -] S2 nameplate criteria is limited to only electrical information, so if other info is essential for safe use, it does not need to be marked. +] S2 would tend to require hazard alert labels for any other issues of safe use that present a significant risk. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
302	187	¢	Where a machine part must be handled during use with lifting equipment, its mass must be indicated legibly, indelibly and unambiguously.	-]S2 does address lifting equipment extensively, but it does not address the components anticipated for lift. There is not requirement to mark them. {??? steve will double check} {if S2 is modified this criteria should be outside 18.5 as it is related to parts that are anticipated to be lifted} [3]
303			**1.7.4. *Instructions***	[5]
304	188	¢	**=DELTA=** All machinery must be accompanied by instructions in the official Community language or languages of the Member State in which it is placed on the market and/or put into service.	+] S2 section 9.6.2 has criteria for instruction.(SEMI S13-0113: 6.6). TFM – note that the S13 section is a recommendation, and that it also allows supplier-user negotiation which does not appear to be allowed by the MD. Partial coverage seems a more realistic conclusion. [2]
305	189	¢	**=DELTA=** The instructions accompanying the machinery must be either 'Original instructions' or a 'Translation of the original instructions', in which case the translation must be accompanied by the original instructions.	+} S2 does not cover how the manuals should be delivered, but references S13 which does in section 6.7 require translated documents to have their original language identified; However Note 5 does suggest documentation to comply with the Machinery Directive [1]
306			By way of exception, the maintenance instructions intended for use by specialised personnel mandated by the manufacturer or his authorised representative may be supplied in only one Community language which the specialised personnel understand.	+] S2 references S13,and S13 6.6 recommends but does not require this consideration. This is an exemption and so is irrelevant to mapping of "requirements" [5]
307			The instructions must be drafted in accordance with the principles set out below.	[5]
308			**1.7.4.1. General principles for the drafting of instructions**	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
309	190	¢	(a) The instructions must be drafted in one or more official Community languages. The words 'Original instructions' must appear on the language version(s) verified by the manufacturer or his authorised representative.	-]S2/S13 has no requirement for instruction language (though S13 does recommend (6.6) using an official language appropriate to where the equipment will be used. But if this were, say, Taiwan, the EU interest would not be met) -] S2/S13 has no requirement for an "Original Instructions" phrase. Though S13 does ask for the original language of a manual to be identified if it was translated (6.7). [3]
310	191	¢	**=DELTA=** (b) Where no 'Original instructions' exist in the official language(s) of the country where the machinery is to be used, a translation into that/those language(s) must be provided by the manufacturer or his authorised representative or by the person bringing the machinery into the language area in question. The translations must bear the words 'Translation of the original instructions'.	-]S2/S13 has no requirements for translation, (though S13 does recommend (6.6) using an official language appropriate to where the equipment will be used.) -]S2/S13 has no requirement for tagging translations as indicated. Though S13 does ask for the original language of a manual to be identified if it was translated (6.7). [3]
311	192	¢	**=DELTA=** (c) The contents of the instructions must cover not only the intended use of the machinery but also take into account any reasonably foreseeable misuse thereof.	-] S2 9.6.1 comes close but there is no specific instruction in S2/S13 to take into account forseeable misuse. [3]
312	193	¢	(d) In the case of machinery intended for use by non-professional operators, the wording and layout of the instructions for use must take into account the level of general education and acumen that can reasonably be expected from such operators.	SEMI equipment is essentially always intended for professional operators. [4]
313			**1.7.4.2. Contents of the instructions**	[5]
314			Each instruction manual must contain, where applicable, at least the following information:	[5]
315	194	¢	(a) the business name and full address of the manufacturer and of his authorised representative;	-] There is no requirement in S2 or S13 to put the suppliers/manufacturers name and address in the documents for the user. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
316	195	¢	(b) the designation of the machinery as marked on the machinery itself, except for the serial number (see section 1.7.3);	-] S2 does not appear to require this. S13 (6.10) requires "The equipment supplier should ensure information in the documents provided to the equipment user clearly identifying [sic] the equipment to which it applies." But this is a little different than requiring the same designation as that which appears on the equipment. [2]
317	196	¢	**=DELTA=** (c) the EC declaration of conformity, or a document setting out the contents of the EC declaration of conformity, showing the particulars of the machinery, not necessarily including the serial number and the signature;	-] S2+ of course makes no reference to DoC's [3]
318	197	¢	**=DELTA=** (d) a general description of the machinery;	+] This topic is fully addressed in SEMI S2-0712a with section(s) 8.5.1, and 9.6.1, and in SEMI S13-0113, Section 6. [1] [LC15may2013 -8.5.1 is information that must be provided to the evaluator, not the user, so does not cover this MD criterion, 9.6.1 however, is info provided to the user but does not include a "description of the machinery". While S13 section 6 does not require in any of its subsections a "description of the machinery/equipment" – I think this should be [3]] TF settled on [3] at the meeting
319	198	¢	(e) the drawings, diagrams, descriptions and explanations necessary for the use, maintenance and repair of the machinery and for checking its correct functioning;	+] This topic is fully addressed in SEMI S2-0712a , Section 9.6, SEMI S13-0113, primarily Section 6; additional information is also provided in other Sections of S13-0113 which may or may not apply to some products [1] [LC15may2013 – S2 9.6.1 requires information for normal use and for safe operation, maintenance and service. It is a little vague as to whether S2 or S13 addresses providing information that allows the user to check an equipment's correct functioning – but this is implicit in operations instructions.]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
320	199	¢	(f) a description of the workstation(s) likely to be occupied by operators;	In TFM- nothing in S2/S13 [3]
321	200	¢	(g) a description of the intended use of the machinery;	S2 9.6.1 requires a description of the normal use of the equipment. [1]
322	201	¢	(h) warnings concerning ways in which the machinery must not be used that experience has shown might occur;	In TFM – not explicitly required, but implicit in the requirement to describe hazards and hazard alert labels. [1]
323	202	¢	(i) assembly, installation and connection instructions, including drawings, diagrams and the means of attachment and the designation of the chassis or installation on which the machinery is to be mounted;	In TFM – last requirement (mounting) is moot for semi industry. S2 and S13 cover facilitization and installation which is essentially equivalent to assembly, installation and connection. [1]
324	203	¢	(j) instructions relating to installation and assembly for reducing noise or vibration;	In TFM – we feel the concern as expressed here is essentially moot for our industry as vibration, particularly, is controlled in equipment specifications to a very low level. There is basically no risk of vibrations that could injure personnel. But for noise, this is relevant and S2/S13 does not require installation instructions specifically related to noise abatement. [3]
325	204	¢	(k) instructions for the putting into service and use of the machinery and, if necessary, instructions for the training of operators;	In TFM – S13 section 14 addresses training. 6.2 covers putting into service (making operational) [1]
326	205	¢	**=DELTA=** (l) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;	In TFM – section 7 of S13 covers hazards that are in the equipment as provided (i.e., that remain) [1]
327	206	¢	**=DELTA=** (m) instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided;	S2 13.3 covers PPE for electrical. PPE is mentioned in S2's ranking of preference of control measures. 26.1.4.1 addresses laser PPE, Section 12 of S13 covers the general PPE topic. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
328	207	¢	**=DELTA=** (n) the essential characteristics of tools which may be fitted to the machinery;	+] S2 section 7.4 requires "Model-specific tools and accessories necessary to operate, maintain, and service equipment safely should be provided with the equipment or specified by the supplier."; Section 18 discusses lifting accessories TFM – this appears to be a moot concern for our industry as equipment that could potentially accept a variety of "tools" are not present. [4]
329	208	¢	**=DELTA=** (o) the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns; **G: Where the design and construction of the machinery ensures the stability of the machinery under certain defined conditions, these must be specified in the instructions.**	**This chunk is not addressed at all by S2+** The normative portion of SEMI S13 does not require any information on the instructions needed during transportation, but its scope does apply to install, operation and de-commissioning. Although S2 18.2 addresses stability during transportation ("foreseeable shipping") S2 or S13 or S2 do not appear to require specifics for the instructions to include the conditions in which the machinery meets the requirement of stability during use, transportation, assembly, dismantling when out of service, testing or foreseeable breakdowns. Note: SEMI S13 R1 1.3.1.3 does mention product liability when transporting for a repair TFM – We note that the MD allows for conditional stability based on configuration limits that must be detailed in instrucitons, while S2 does not appear to allow conditional (configuration based) stability. Equipment must be stable no matter what. However, S2 does not appear to address the same set of life cycle stages (e.g. S2 18.3). [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
330	209	¢	**=DELTA=** (p) instructions with a view to ensuring that transport, handling and storage operations can be made safely, giving the mass of the machinery and of its various parts where these are regularly to be transported separately; **G: section 183 describing the meaning of "parts of machinery" Section 1.1.5 applies to 'machinery or each component part thereof'. This does not mean that all parts of machinery must be designed for safe handling, but only those parts of the machinery, or the machinery itself, which may have to be handled separately.** **…** **Heavy parts of machinery such as, for example the mould of an injection moulding machine or the die of a metal working press, may need to be changed frequently, depending on the work to be carried out**	**This chunk seems to have partial coverage by an S2+ section.** SEMI S2 and S13 address safe handling of machinery or parts that are to be moved by hand, and attachment points for lifting, but do not specifically require instructions for machine or part transport or part storage: TFM – replicable component during normal operation may occasionally be relevant in our industry such as wafer size change kits or test heads on IC test equipment. -] we can find no requirement to put weight information of such items in instructions. +] Section 19 requires some mass info for seismic considerations. +] regarding the general requirement to provide ") instructions with a view to ensuring that transport, handling and storage operations can be made safely" this is covered by S13 section 6.2 [2]
331	210	¢	**=DELTA=** (q) the operating method to be followed in the event of accident or breakdown; if a blockage is likely to occur, the operating method to be followed so as to enable the equipment to be safely unblocked;	**This chunk is not addressed at all by S2+** Although the risk assessment may identify the need for such procedures, there are no specific requirements within SEMI S2 or SEMI S13 for requiring emergency procedures and the operating method to be followed in the event of accident or breakdown; TFM +] S13 has several sections calling for consideration of instructions for safe operation etc… which is not an explicit requirement to describe breakdown protocols, but would be expected to include consideration of common breakdown/blockage modes. [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
332	211	¢	(r) the description of the adjustment and maintenance operations that should be carried out by the user and the preventive maintenance measures that should be observed;	S2 9.6.1 say ..provide information to enable safe facilitization, operation, maintenance, and service of the equipment. section 9.6.2 call outs that manuals conform to SEMI S13. S13 or S2 do not appear to require specifics on description of adjustments. TFM – we think the above observations are a rationale for complete coverage. [1]
333	212	¢	(s) instructions designed to enable adjustment and maintenance to be carried out safely, including the protective measures that should be taken during these operations;	same note, nothing specific on adjustments TFM – "normal operation" appears to be synonymous with "adjustments" – ie., things tweaked to use the machine as intended. See above, full coverage. [1]
334	213	¢	(t) the specifications of the spare parts to be used, when these affect the health and safety of operators;	~~nothing listed in S2 or S13 on spares list~~ TFM S13 section 13.2 particularly has equivalent requirement. S2 section 9.6 also has criteria for a subset of potential spare parts that would require they be listed in instructions. [1]
335			(u) the following information on airborne noise emissions:	[5]
336	214	¢	— the A-weighted emission 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,	+] S2 27.3.4 has a requirement to document sound pressure above "75dBA". There is no requirement to indicate where levels are not above 70dB(A). The meaning of A in S2's "dBA" is ambiguous. It could mean 'acoustic'. It does not necessarily imply "a-weighted", therefore I think this is no coverage. TF in meeting felt the A in S2 must mean the a-weighted curve. Therefore the difference of 70 to 75 gets us partial coverage. [2]
337	215	¢	— the peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB in relation to 20 μPa),	-] no C weighted measurements required by S2 [3]
338	216	¢	**=DELTA=** — the A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A).	Note that this is sound <u>power</u> rather than sound <u>pressure.</u> Where S2 does call for measurement, it is of sound <u>pressure.</u> <u>[3]</u>

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
339	217	¢	These values must be either those actually measured for the machinery in question or those established on the basis of measurements taken for technically comparable machinery which is representative of the machinery to be produced.	Though S2 does not explicitly express this, this is nonetheless the defacto way equipment is assessed in our industry. [1]
340	218	¢	In the case of very large machinery, instead of the A-weighted sound power level, the A-weighted emission sound pressure levels at specified positions around the machinery may be indicated.	+] for the case of very large machinery – S2 becomes equivalent to MD [1]
341	219	¢	Where the harmonised standards are not applied, sound levels must be measured using the most appropriate method for the machinery. Whenever sound emission values are indicated the uncertainties surrounding these values must be specified. The operating conditions of the machinery during measurement and the measuring methods used must be described.	+] per s2 27.3.1 a recognized standard should be used, S2 does not allow an alternative. -] S2 does not required specification of uncertainties. +] Since S2 requires measurement while tool is operating as it would in actual use, the operating conditions are in effect described. [2]
342	220	¢	Where the workstation(s) are undefined or cannot be defined, A-weighted sound pressure levels must be measured at a distance of 1 metre from the surface of the machinery and at a height of 1,6 metres from the floor or access platform. The position and value of the maximum sound pressure must be indicated.	+] S2 requires measurement 1 meter from the surface and at 1.2 AND 1.5 meters above the floor. (27.3.1.2) -] S2 does not require a indication of the location of maximum sound pressure. [2]
343	221	¢	Where specific Community Directives lay down other requirements for the measurement of sound pressure levels or sound power levels, those Directives must be applied and the corresponding provisions of this section shall not apply;	-]S2 makes no reference to possible other EU directives about sound. Right now the only related directive is moot for the semi industry because it is related to outdoor equipment, but other noise directives might be written in the future. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
344	222	OPN	(v) where machinery is likely to emit non-ionising radiation which may cause harm to persons, in particular persons with active or non-active implantable medical devices, information concerning the radiation emitted for the operator and exposed persons.	+] S2 9.5 IH information is specified and would provide details on Ionizing radiation. +] S2 6.2.1 The documents provided to the equipment user should describe the hazards inherent in equipment, warn of the potential of exposure to hazards, and provide information as to how to minimize risk. +] S2 10.1 ... hazard warning labels should be provided to identify and warn against hazards. TFM +] S2 25.3 requires info on non-ionizing radiation be provided. [1]
345	223	¢	**=DELTA=** **Annex VI – Assembly Instructions for Partly Completed Machinery (line 1 of 2)** The assembly instructions for partly completed machinery must contain a description of the conditions which must be met with a view to correct incorporation in the final machinery, so as not to compromise safety and health.	S2 is sometime applied to “partly completed machinery” such as front end modules and wafer transfer robots. -]S2 does not address any special concerns that may be related to PCM particularly in instructions. +] however S13 does require a description of safe installation (ref 6.2 of S13 0113)which presumably would cover this concern if the item being installed were PCM. TF add -] S2 does not specifically address incorporation concerns for PCM. [2]
346			**=DELTA=** **Annex VI – Assembly Instructions for Partly Completed Machinery (line 2 of 2)** The assembly instructions must be written in an official Community language acceptable to the manufacturer of the machinery in which the partly completed machinery will be assembled, or to his authorised representative.	**[5]** **This concern is essentially redundant to ref 309 and 310**
347			**1.7.4.3. Sales literature**	[5]
348	224	¢	Sales literature describing the machinery must not contradict the instructions as regards health and safety aspects. Sales literature describing the performance characteristics of machinery must contain the same information on emissions as is contained in the instructions.	-]S2+ has no criteria related to sales literature. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
349			**2. *SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR CERTAIN CATEGORIES OF MACHINERY***	[5]
351			**2.1. FOODSTUFFS MACHINERY AND MACHINERY FOR COSMETICS OR PHARMACEUTICAL PRODUCTS**	Not expected in our industry [5]
352			**2.2. PORTABLE HAND-HELD AND/OR HAND-GUIDED MACHINERY**	Though there may be some hand guided machinery in our industry it is a minor category. Assessment is deferred until the task for has more time. [5]
381			**2.3. MACHINERY FOR WORKING WOOD AND MATERIAL WITH SIMILAR PHYSICAL CHARACTERISTICS**	[5]
382			**3. *SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS TO OFFSET HAZARDS DUE TO THE MOBILITY OF MACHINERY***	Though there may be some mobile machinery in our industry it is a minor category. Assessment is deferred until the task for has more time. [5]
503			**4. *SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS TO OFFSET HAZARDS DUE TO LIFTING OPERATIONS***	[5]
504			Machinery presenting hazards due to lifting operations must meet all the relevant essential health and safety requirements described in this chapter (see General Principles, point 4).	[5]
505			**4.1. GENERAL**	[5]
506			**4.1.1. *Definitions***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
507			(a) 'Lifting operation' means a movement of unit loads consisting of goods and/or persons necessitating, at a given moment, a change of level. **G: The expression *'at a given moment'* indicates that machinery intended to move objects, fluids, materials or persons in a continuous manner, for example, on conveyors, on escalators or through pipes are not considered as carrying out 'lifting operations' in this sense and are not subject to the requirements set out in Part 4. (ref pg 289)** **G: The expression *'unit loads'* does not cover parts of the machinery itself. Thus an operation where part of a machine is lifted but no external load is lifted is not considered as a lifting operation in this sense.** ***{This means then that lifts integral to the equipment for lifting parts of it such as for servicing would not be within scope of these Annex 1 section 4 criteria (though other criteria in Annex 1 do apply, such as in section 1). However, in the semi+ industry there is potentially application stockers, overhead foup transport systems, and lifts (e.g. Genie Lifts and the like) provided external to the equipment for the purpose of, for example, lift components of the equipment during servicing for removal or replacement.*** ***SEMI S2 definition of lifting equipment has no prejudice about it being integral or separate from the core equipment.*** ***S2 section 18.5 limits the application of criteria to equipment for service or maintenance. Therefore, S2 section 18.5 criteria can be used to answer for lifting devices provided that are not integral to the equipment } {18.5 is now 18.6 in S2}***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
508			(b) 'Guided load' means a load where the total movement is made along rigid or flexible guides whose position is determined by fixed points. ***G: The definition of 'guided load' covers both loads placed on carriers that follow guiderails, tracks or ropes and loads lifted by machinery with equipment that moves the carrier along a predetermined trajectory, such as a scissor mechanism…It should be noted that the term 'guided load' does not apply to machinery, such as, for example, gantry cranes or rail mounted tower cranes, where the movements of the machinery itself are guided but the movements of the load do not follow a predetermined trajectory. (pg 289)***	[5]
509			(c) 'Working coefficient' means the arithmetic ratio between the load guaranteed by the manufacturer or his authorised representative up to which a component is able to hold it and the maximum working load marked on the component.	[5]
510			(d) 'Test coefficient' means the arithmetic ratio between the load used to carry out the static or dynamic tests on lifting machinery or a lifting accessory and the maximum working load marked on the lifting machinery or lifting accessory.	[5]
511			(e) 'Static test' means the test during which lifting machinery or a lifting accessory is first inspected and 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 that no damage has occurred.	[5]
512			(f) 'Dynamic test' means the test during which lifting machinery is operated in all its possible configurations at the maximum working load multiplied by the appropriate dynamic test coefficient with account being taken of the dynamic behaviour of the lifting machinery in order to check that it functions properly.	[5]
513			(g) 'Carrier' means a part of the machinery on or in which persons and/or goods are supported in order to be lifted.	[5]
514			**4.1.2. *Protection against mechanical hazards***	[5]
515			**4.1.2.1. Risks due to lack of stability**	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
516	225	¢	Machinery must be designed and constructed in such a way that the stability required by section 1.3.1 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, the manufacturer or his authorised representative must use the appropriate verification methods. *{1.3.1 = "Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery.* *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."}*	S2 requires the equipment to be stable (essentially quoting the MD annex 1 section 1), but this part of the MD is related to stand alone lifting equipment. Section 18.6 of S2 addresses lifting equipment both integral and stand alone. So in the space of "stand alone" LE, S2 does not appear to address the stability concern. There is discussion about withstanding stress, but not necessarily 'stability' and certainly not in all the life cycle stages covered by this MD section. [3]
517			**4.1.2.2. Machinery running on guide rails and rail tracks**	Not expected in our industry [5]
518			Machinery must be provided with devices which act on the guide rails or tracks to prevent derailment.	[5]
519			If, despite such devices, there remains a risk of derailment or of failure of a rail or of a running component, devices must be provided which prevent the equipment, component or load from falling or the machinery from overturning.	[5]
520			**4.1.2.3. Mechanical strength**	[5]
521	226	¢	Machinery, lifting accessories and their 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 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.	+] S2 addressing stresses and safety factors for lifting equipment, -] but not necessarily including 'out of use' conditions, nor the forces 'exerted by persons', explicitly. "Atmospeheric factors" could well be relevant to the semi industry since, for example, corrosive atmospheres (though they should not be present) are occasionally noted in the industry . [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
522	227	¢	Machinery and lifting accessories must be designed and constructed in such a way as to prevent failure from fatigue and wear, taking due account of their intended use.	-] supplied LE (rather than integral LE) would not be covered by the general requirements of S2. There is no discussion in the specific section of 18.6 about failure from fatigue. [3]
523	228	¢	The materials used must be chosen on the basis of the intended working environments, with particular regard to corrosion, abrasion, impacts, extreme temperatures, fatigue, brittleness and ageing.	+] S2 18.6.1.2 addresses all but extreme temps, but extreme temps in the ambient semi manufacturing environment are a moot consideration. [1]
524	229	¢	Machinery and lifting accessories must be designed and constructed in such a way as to withstand the overload in the static tests without permanent deformation or patent defect. Strength calculations must take account of the value of the static test coefficient chosen to guarantee an adequate level of safety. That coefficient has, as a general rule, the following values:	+] the acceptance qualification in the static test includes demonstration of no permanent deformation or other physical damage. [1] {only the first sentence is a criterion. The rest is introduction to the subsections}
525	230	¢	(a) manually-operated machinery and lifting accessories: 1,5;	+] S2 18.6.1.1 requires 3. [1]
526	231	¢	(b) other machinery: 1,25.	+] S2 18.6.1.1 requires 3. [1]
527	232	¢	Machinery must be designed and constructed in such a way as 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. As a general rule, the tests will be performed at the nominal speeds provided for. Should the control circuit of the machinery allow for a number of simultaneous movements, the tests must be carried out under the least favourable conditions, as a general rule by combining the movements concerned.	+] S2's dynamic test criteria (18.6.3.2) essentially match all of this. [1]
528			**4.1.2.4. Pulleys, drums, wheels, ropes and chains**	[5]
529	233	¢	Pulleys, drums and wheels must have a diameter commensurate with the size of the ropes or chains with which they can be fitted.	-] there are no criteria in S2+ related to pulleys, drums or wheels, nor the appropriate sizing of ropes or chains used with them. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
530	234	¢	Drums and wheels must be designed, constructed and installed in such a way that the ropes or chains with which they are equipped can be wound without coming off.	-] there are no criteria in S2 specifically to drums or wheels, nor containing ropes or chains used. [3]
531	235	¢	Ropes used directly for lifting or supporting the load must not include any splicing other than at their ends. *{'ropes' could include wire ropes. So while hemp or nylon ropes might not be expected, stainless steel wire ropes could be present. }*	-] there are no criteria in S2 about splicing ropes. [3]
532	236	¢	Splicings are, however, tolerated in installations which are intended by design to be modified regularly according to needs of use.	This is a permissive exception. Tracking to S2 is not needed. – delete tally reference. [5]
533	237	¢	Complete ropes and their endings must have a working coefficient chosen in such a way as to guarantee an adequate level of safety. As a general rule, this coefficient is equal to 5.	+] S2 18.6.1.1 requires a safety factor of 3 for lifting equipment in general, even though there is no criteria specifically for ropes. We note that the safety factor of 5 stated by the MD is just a general rule and not a requirement. This is supported by discussions in the Commission's guide. [1]
534	238	¢	Lifting chains must have a working coefficient chosen in such a way as to guarantee an adequate level of safety. As a general rule, this coefficient is equal to 4.	+] S2 18.6.1.1 requires a safety factor of 3 for lifting equipment in general, even though there is no criteria specifically for ropes. We note that the safety factor of 5 stated by the MD is just a general rule and not a requirement. This is supported by discussions in the Commission's guide. [1]
535	239	¢	In order to verify that an adequate working coefficient has been attained, the manufacturer or his authorised representative 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.	-] S2 does not explicitly require this detail in LE assessment. [3]
536			**4.1.2.5. Lifting accessories and their components**	[5]
537	240	¢	Lifting accessories and their components 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. Moreover:	-] There is no consideration in S2 about operating cycles and expected lifespan. [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
538	241	¢	(a) the working coefficient of wire-rope/rope-end combinations must be chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 5. Ropes must not comprise any splices or loops other than at their ends;	-] S2 requires an SC of 3 as the rule for all parts of LE -] S2 has no specific requirements for rope ends. -] S2 has nothing about splices or loops at rope ends. [3]
539	242	¢	(b) where chains with welded links are used, they must be of the short-link type. The working coefficient of chains must be chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 4;	-] S2 requires an SC of 3 as the rule for all parts of LE -] S2 has no specific requirements for chains. [3]
540	243	¢	(c) the working coefficient for textile ropes or slings is dependent on the material, method of manufacture, dimensions and use. This coefficient must be chosen in such a way as to guarantee an adequate level of safety; it is, as a general rule, equal to 7, 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;	Textile ropes are not expected in our industry but slings are. -] S2 requires an SC of 3 as the rule for all parts of LE -] S2 has not criteria related to knots, or splicing of slings. [3]
541	244	¢	(d) all metallic components making up, or used with, a sling must have a working coefficient chosen in such a way as to guarantee an adequate level of safety; this coefficient is, as a general rule, equal to 4;	-] S2 requires an SC of 3 as the rule for all parts of LE -] S2 has not criteria related to metallic components used with or making up a sling.
542	245	¢	(e) the maximum working load of a multilegged sling is determined on the basis of the working coefficient of the weakest leg, the number of legs and a reduction factor which depends on the slinging configuration;	-] S2 has no such detailed discussion of how to set the max working load of a multilegged sling. [3]
543	246	¢	(f) in order to verify that an adequate working coefficient has been attained, the manufacturer or his authorised representative must, for each type of component referred to in (a), (b), (c) and (d), perform the appropriate tests or have such tests performed.	+]S2 does require the static and dynamic testing of all LE according to their indicated MWL. [1]
544			**4.1.2.6. Control of movements**	[5]
545	247	¢	Devices for controlling movements must act in such a way that the machinery on which they are installed is kept safe.	+] This generic design goal is inherent in S2 expectations and generally looked for in equipment assessments. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
546	248	¢	(a) Machinery must be designed and constructed or fitted with devices in such a way that the amplitude of movement of its components is kept within the specified limits. The operation of such devices must, where appropriate, be preceded by a warning.	-] S2 has no such specific concern, particularly regarding warnings [3]
547	249	¢	(b) Where several fixed or rail-mounted machines can be maneuvered simultaneously in the same place, with risks of collision, such machinery must be designed and constructed in such a way as to make it possible to fit systems enabling these risks to be avoided.	This concern is essentially moot for the semiconductor industry It is not expected that LE provided for service or maintenance would require several fixed or rail mounted machines. [4]
548	250	¢	(c) Machinery must be designed and constructed in such a way 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.	-] This is not specifically addressed in S2 [3]
549	251	¢	(d) 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.	-] This is not specifically addressed in S2 [3]
550	252	¢	(e) Holding devices must be designed and constructed in such a way that inadvertent dropping of the loads is avoided.	-] This is not specifically addressed in S2 [3]
551			**4.1.2.7. Movements of loads during handling**	[5]
552	253	¢	The operating position of machinery must be located in such a way as to ensure the widest possible view of trajectories of the moving parts, in order to avoid possible collisions with persons, equipment or other machinery which might be maneuvering at the same time and liable to constitute a hazard.	-] Concerns about visibility of the load are not addressed in S2 [3]
553	254	¢	Machinery with guided loads must be designed and constructed in such a way as to prevent persons from being injured by movement of the load, the carrier or the counterweights, if any.	+] The general design philosophy of S2 in combination with the specific concerns regarding handles and coupling points in 18.6.5.2 cover this general concern. [1]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
554			**4.1.2.8. Machinery serving fixed landings** ***G: Machinery serving fixed landings is machinery intended to move goods, persons or both goods and persons between pre-determined levels or floors of a building, a construction or a structure. Machinery serving fixed landings includes, for example, goods-only lifts, construction site hoists for goods and persons, lifts connected to machinery such as, for example, tower cranes or wind generators, for access to workstations, home lifts, lifting platforms for persons with impaired mobility and stair lifts. Machinery serving fixed landings is to be distinguished from machinery intended to provide access to positions at a height where access to and from the carrier is only foreseen at one level (usually the ground level), such as, for example, mast climbing or suspended work platforms, to which the requirements set out in section 4.1.2.8 are not applicable.*** ***{Stockers and Overhead Carrier Transport Systems probably are not such machinery because they are not moving "goods" in the general sense, they are dedicated to moving FOUPS, and their service points are not "landings of a building"This does not seem relevant for lifting systems that has a single, known, dedicated target object such as a FOUP.}***	Moot for the semi industry (and the scope of this project)
555			**4.1.2.8.1. *Movements of the carrier***	[5]
556	255	¢	The movement of the carrier of machinery serving fixed landings must be rigidly guided to and at the landings.	Moot for the semi+ industry See ref 554 [4]
557	256	¢	Scissor systems are also regarded as rigid guidance.	Moot for the semi+ industry See ref 554 [4]
558			**4.1.2.8.2. *Access to the carrier***	[5]
559	257	¢	Where persons have access to the carrier, the machinery must be designed and constructed in such a way as to ensure that the carrier remains stationary during access, in particular while it is being loaded or unloaded.	Moot for the semi+ industry See ref 554 [4]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
560	258	¢	The machinery must be designed and constructed in such a way as to ensure that the difference in level between the carrier and the landing being served does not create a risk of tripping.	Moot for the semi+ industry See ref 554 [4]
561			**4.1.2.8.3. *Risks due to contact with the moving carrier***	[5]
562	259	¢	Where necessary in order to fulfil the requirement expressed in the second paragraph of section 4.1.2.7, the travel zone must be rendered inaccessible during normal operation.	Moot for the semi+ industry See ref 554 [4]
563	260	¢	When, during inspection or maintenance, there is a risk that persons situated under or above the carrier may be crushed between the carrier and any fixed parts, sufficient free space must be provided either by means of physical refuges or by means of mechanical devices blocking the movement of the carrier.	Moot for the semi+ industry See ref 554 [4]
564			**4.1.2.8.4. *Risk due to the load falling off the carrier***	[5]
565	261	¢	Where there is a risk due to the load falling off the carrier, the machinery must be designed and constructed in such a way as to prevent this risk.	Moot for the semi+ industry See ref 554 [4]
566			**4.1.2.8.5. *Landings***	[5]
567	262	¢	Risks due to contact of persons at landings with the moving carrier or other moving parts must be prevented.	Moot for the semi+ industry See ref 554 [4]
568	263	¢	Where there is a risk due to persons falling into the travel zone when the carrier is not present at the landings,	Moot for the semi+ industry See ref 554 [4]
569	264	¢	guards must be fitted in order to prevent this risk. Such guards must not open in the direction of the travel zone. They must be fitted with an interlocking device controlled by the position of the carrier that prevents:	Moot for the semi+ industry See ref 554 [4]
570	265	¢	— hazardous movements of the carrier until the guards are closed and locked,	Moot for the semi+ industry See ref 554 [4]
571	266	¢	— hazardous opening of a guard until the carrier has stopped at the corresponding landing.	Moot for the semi+ industry See ref 554 [4]
572			**4.1.3. *Fitness for purpose***	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
573	267	¢	When lifting machinery or lifting accessories are placed on the market or are first put into service, the manufacturer or his authorised representative must ensure, by taking appropriate measures or having them taken, that the machinery or the lifting accessories which are ready for use — whether manually or power-operated — can fulfil their specified functions safely. ***G: The purpose of the measures required in the first paragraph of section 4.1.3 is not to verify the design of the machinery but to check the integrity of the construction and assembly of the machinery and the correct functioning of the controls and protective devices.*** ***The requirement means that the manufacturer must ensure that the necessary functional tests and inspections are carried out before the machinery is first put into service by the user. There is no obligation for the tests to be carried out by an independent or third-party test body. They can be carried out by the manufacturer himself or entrusted to any competent person or body acting on his behalf. [§350]***	-] while there is a requirement to apply static and dynamic tests to each piece of LE in S2, there is no requirement to generally check the safe functionality as envisioned by the EU guidance document. [3]
575	268	¢	The static and dynamic tests referred to in section 4.1.2.3 must be performed on all lifting machinery ready to be put into service.	+] S2 18.6.3 requires the testing and certification of each piece of testing equipment. The cert. should accompany each piece. [1] ***{This MD/S2 comparison does not address whether the testing requirements between MD and S2 are equivalent, only that both require such testing on each piece}***
576	269	¢	Where the machinery cannot be assembled in the manufacturer's premises or in the premises of his authorised representative, the appropriate measures must be taken at the place of use. Otherwise, the measures may be taken either in the manufacturer's premises or at the place of use.	S2 does not have specific instructions regarding this point, but it is the general practice of our industry ensure that equipment assembly is either completed at the manufacturer's site or the customer's, and that matters relevant to S2 conformance would be addressed at the appropriate location. [1]
577			**4.2. REQUIREMENTS FOR MACHINERY WHOSE POWER SOURCE IS OTHER THAN MANUAL EFFORT**	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
578			**4.2.1. *Control of movements***	[5]
579	270	¢	Hold-to-run control devices must be used to control the movements of the machinery or its equipment.	-] S2+ has no equivalent requirement for LE [3]
580	271	¢	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 control devices authorising automatic stops at pre-selected positions without the operator holding a hold-to-run control device.	-] S2+ has no equivalent requirement for LE [3]
581			**4.2.2. *Loading control***	[5]
582	272	¢	Machinery with a maximum working load of not less than 1 000 kilograms or an overturning moment of not less than 40 000 Nm must be fitted with devices to warn the driver and prevent dangerous movements in the event: — of overloading, either as a result of the maximum working load or the maximum working moment due to the load being exceeded, or — of the overturning moment being exceeded.	This criterion has limited application. It applies only to equipment with a MWL ≥ 1000 kg (2200 lbs). It is rare but feasible that lifting equipment of this size would be supplied or specified for equipment service or maintenance. -] S2 has no such criteria for LE of this size, or any size. [3]
583			**4.2.3. *Installations guided by ropes***	[5]
584	273	¢	Rope carriers, tractors or tractor carriers must be held by counterweights or by a device allowing permanent control of the tension.	+] S2+ has no discussion of tensioning ropes. Only wire ropes are anticipated in semi equipment. [3]
585			**4.3. INFORMATION AND MARKINGS**	[5]
586			**4.3.1. *Chains, ropes and webbing***	[5]
587	274	¢	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 or his authorised representative and the identifying reference of the relevant certificate.	+] S2 18.6.4.1.2 requires the manufacturer's name to be marked on LE, -] There is no discussion of markings have reference to a certificate. [2]
588			The certificate mentioned above must show at least the following information:	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
589	275	¢	(a) the name and address of the manufacturer and, if appropriate, his authorised representative;	-]S2 18.6.3 mentions a test certificate that must be provided with each unit, but there is no discussion of what information this certificate must contain. [3]
590			(b) a description of the chain or rope which includes:	[5]
591	276	¢	— its nominal size,	Ditto ref 589 [3]
592	277	¢	— its construction,	Ditto ref 589 [3]
593	278	¢	— the material from which it is made, and	Ditto ref 589 [3]
594	279	¢	— any special metallurgical treatment applied to the material;	Ditto ref 589 [3]
595	280	¢	(c) the test method used;	Ditto ref 589 [3]
596	281	¢	(d) the maximum load to which the chain or rope should be subjected in service. A range of values may be given on the basis of the intended applications.	Ditto ref 589 [3]
597			**4.3.2. *Lifting accessories***	[5]
598			Lifting accessories must show the following particulars:	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
599	282	¢	— identification of the material where this information is needed for safe use,	-]S2 18.6.4.1.2 addresses LE marking. It does not include any criteria to disclose material of construction under any circumstances. Though it is unclear how identification of the material could be relevant to safety (in light of weight limits already having been provided), but to the extent it could be necessary in the context of general machinery, it probably also is relevant to the semi industry. TFM23may2013 discussed further and this appears to be a moot point for our semi industry. TF thinks perhaps this is relevant for outdoor situations because of possible elasticity of organic ropes or change due to wetness. [4]
600	283	¢	— the maximum working load.	+] the S2 marking section (see ref 599) requires working load be marked on all LE including accessories. [1]
601	284	¢	In the case of lifting accessories on which marking is physically impossible, the particulars referred to in the first paragraph must be displayed on a plate or other equivalent means and securely affixed to the accessory.	+] seems equivalent to 18.6.4.1 [1]
602	285	¢	The particulars must be legible and located in a place where they are not liable to disappear as a result of wear or jeopardise the strength of the accessory.	+] S2 requires a 'lasting, legible manner.' [1]
603			**4.3.3. *Lifting machinery***	[5]
604	286	¢	The maximum working load must be prominently marked on the machinery. This marking must be legible, indelible and in an un-coded form.	+] S2 marking criteria are the same across all LE. See 18.6.4. S2 requires working load to be visible from the 'floor or working position' this seems essentially equivalent to 'prominently' [1]
605	287	¢	Where the maximum working load depends on the configuration of the machinery, each operating position must be provided with a load plate indicating, preferably in diagrammatic form or by means of tables, the working load permitted for each configuration.	-] This detail about configuration is not covered in S2, but could well be relevant to LE in the semi industry [3]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
606	288	¢	Machinery intended for lifting goods only, equipped with a carrier which allows access to persons, must bear a clear and indelible warning prohibiting the lifting of persons. This warning must be visible at each place where access is possible.	-] S2 does not include this detail [3]
607			**4.4. INSTRUCTIONS**	[5]
608			**4.4.1. *Lifting accessories***	[5]
609			Each lifting accessory or each commercially indivisible batch of lifting accessories must be accompanied by instructions setting out at least the following particulars:	[5]
610	289	¢	(a) the intended use;	+] S2 9.6.3 bullet 7 requires instructions for 'proper use' of lifting equipment (defined to include accessories ref 5.2.41) which is essentially equivalent to 'intended use' TF also adds that every use of lifting equipment should have some supporting documentation on the related procedure that would cover 'intended' use. [1]
611	290	¢	(b) the limits of use (particularly for lifting accessories such as magnetic or vacuum pads which do not fully comply with section 4.1.2.6(e));	-] Though arguable, it is not explicitly certain that a description of 'proper use' (see ref 610) would necessarily discuss limits of use [3]
612	291	¢	(c) instructions for assembly, use and maintenance;	+] the S2 section mentioned at ref 610 also requires instructions for proper use, maintenance. It seems fair that proper use would include how to assemble if needed. TF adds specific maintenance instructions would also include assembly if needed. [1]
613	292	¢	(d) the static test coefficient used.	-] S2's only criteria on lifting equipment user instructions (see ref 610) does not require disclosing static test coefficient used. [3]
614			**4.4.2. *Lifting machinery***	[5]
615			Lifting machinery must be accompanied by instructions containing information on:	[5]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
616	293	¢	(a) the technical characteristics of the machinery, and in particular:	-] There is no requirement in S2 to iterate the technical characteristics of the lifting machinery in user instructions. [3]
617	294	¢	**=DELTA=** — the maximum working load and, where appropriate, a copy of the load plate or load table described in the second paragraph of section 4.3.3,	-] There is no requirement in S2 to provide this specific info in user instructions. There is a requirement for explaining 'proper use' but that does not necessarily mean load limits and certainly does not mean a copy of the load plate or a load table. [3]
618	295	¢	— the reactions at the supports or anchors and, where appropriate, characteristics of the tracks,	-] S2 has no requirements for the provision of such detailed information to end users. This information might be developed for the LE report as part of, for example, "classical engineering calculations" used in S2 assessment, but there is no requirement to forward this to the end user. [3]
619	296	¢	— where appropriate, the definition and the means of installation of the ballast;	-] S2 has no user instruction criteria about adding ballast, but this could be relevant to SEMI industry LE [3]
620	297	¢	(b) the contents of the logbook, if the latter is not supplied with the machinery;	-] S2 has no user instruction criteria about logbooks [3]
621	298	¢	(c) advice for use, particularly to offset the lack of direct vision of the load by the operator;	+] S2 LE instructions must discuss proper use (see ref 610), but there is nothing in particular about direct vision of load. [2]
622	299	¢	**=DELTA=** (d) where appropriate, a test report detailing the static and dynamic tests carried out by or for the manufacturer or his authorised representative;	-] S2 has no user instruction criteria about providing test reports. [3]
623	300	¢	(e) for machinery which is not assembled on the premises of the manufacturer in the form in which it is to be used, the necessary instructions for performing the measures referred to in section 4.1.3 before it is first put into service.	-] S2 has no user instruction criteria about the topics of 4.1.3 which are to check for proper functionality after assembly is complete and to conduct static and dynamic tests. +] S2 does required instructions be provided about inspection of the LE (see 9.6.3 7th bullet which likely would cover some of the topics of inspection following first assembly. [2]

ref	wrk	flg	ANNEX I Checklist	Outcome & Rationale
624			**5. *SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR MACHINERY INTENDED FOR UNDERGROUND WORK***	No semi industry substrate processing equipment is for underground use. [5]
625			**6. *SUPPLEMENTARY ESSENTIAL HEALTH AND SAFETY REQUIREMENTS FOR MACHINERY PRESENTING PARTICULAR HAZARDS DUE TO THE LIFTING OF PERSONS***	No semi industry substrate processing equipment is intended to lift personnel [5]