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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	1	AUS	8	20	8.20-8.28 Consider a reference to GSR Part 7	The text refers to accident management, and could benefit from a reference to GSR Part 7.			x	Instead we made reference to DS483 which is a safety guide on severe accident management.
2	1	BR	3	14	The allocation of functions to human and machine resources should consider human and machine strengths while avoiding human and machine limitations. Human limitations include perceptual, cognitive and physiological factors as well as physical strengths	Include the terms "perceptual" and "physiological"			x	reformulated with Comment DE#6.
3	2	BR	4	163	Reference [2] (Para 7.9) requires that the number of alarms is minimized for any analysed operational state, outage or accident condition of the plant in order to prevent unnecessary or meaningless alarms that could result in alarm overload."	Text adjustment (the word "to" seems to be out of context			x	Let's leave to editors.
4	1	CAN	1	6	An item to which the following apply, in all or part: a) not subject to design or specification requirements unique to nuclear facilities, b) generally used in applications other than nuclear facilities, c) ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description, e.g., a catalogue.	One or all of the lettered notes can apply to a COTs product, so the text should be adapted accordingly.			x	COTS are described in section 8; 1.6 is an introduction.
5	6	CAN	2	8	... - Human factors, e.g., factors that influence how well humans perform their work tasks, such as an individual's knowledge and expertise, cognition, strength and body size (anthropometry). ... Organizational factors, e.g., management system, organizational structure, governance, resources, task support provisions, the roles and responsibilities of plant personnel.	Further clarity is needed in describing the human and organizational factors.			x	We believe that current description is sufficient. It is an introductory part.
6	2	CAN	2	17	The HFE program should include a framework for formally documenting and tracking HFE issues that are identified in conducting the HFE process. This may be part of the wider design engineering project's issues register, or managed within the HFE program itself, with interfaces to the wider engineering design project's processes. HFE issues are matters that can or could negatively influence human performance in relation to the designed system and its context of use within the organization.	See comment on clause 5.39. HFE issues are specific entities that are formally identified and tracked within the project, and they need some explanation. Later in DS-492 (clauses 5.39 and 8.2) "HFE issues" are referred to as "Human Engineering Discrepancies", which is a specific term used by the US NRC. Given that "Human Engineering Discrepancies", is not intuitively understood by a non-nuclear human factors specialist, or naïve reader, it is preferable to refer to "HFE issues".			x	The proposed text is too specific. We prefer existing wording.
7	3	CAN	2	18	For the new plant design, the purchasers should assure themselves that the intended plant design has followed appropriate HFE standards and elements of this safety guide.	Given clause 1.11, the phrase which includes SMRs is superfluous. Remove the words relating to SMRs.	x			
8	4	CAN	2	21	... HFE analyses should identify relevant operating experience (both positive and negative) with a focus on human performance issues, which include the risk of human error and its mitigation, while considering task support to be provided to the system users, such as training and procedures, and organizational factors.	Use of OPEX to inform design goes beyond human error, and the bullet point should be broadened accordingly.			x	We agree, therefore we say both positive and negative.
9	5	CAN	2	22	... The following HFE inputs should be considered in the requirements development phase:... Add the following bullet: - Regulatory requirements that apply to the design of specific systems.	Figure 1 identifies the second phase as requirements development. It is usual to refer to this as requirements development, not just functional requirements development. Requirements identified in this stage may not necessarily be functional, such as regulatory requirements related to the design of specific systems, and requirements identified during HFE developmental testing. Make the text consistent with this terminology, by removing the word "functional".  Regulatory requirements that apply to specific systems and components should also be considered. These may be HFE requirements or other requirements that impact the HFE aspects of the design.	x			
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1	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
11	7	CAN	3	10	Functional requirements analysis should be used to identify high-level acceptance criteria associated with maintaining safe operation of the plant.	Functional requirements analysis does not in itself identify the acceptance criteria. The relation between functional requirements analysis and high-level acceptance criteria needs to be specified i.e., high level acceptance criteria may be derived from the functional requirements analysis.	x	3.10. Functional requirements analysis should <b>help identifying high level acceptance criteria associated with maintaining safe operation of the plant.</b>		
12	8	CAN	3	11	...Higher level functions should be decomposed into lower level functions that can be mapped to tasks to be performed by plant automation of the human(s)	More than one human will operate and maintain the plant.			x	IAEA terminology uses a singular human.
13	9	CAN	3	12	... and the human actions required for success.	Not clear if the term "human interaction" is being used in the technical sense as per HRA terminology. "Human action" is clearer to the naïve reader.	x			
14	10	CAN	3	25	Task analysis should be conducted to document and analyze the physical and cognitive activities associated with the tasks that are performed by humans.	Task analysis is not merely a task description. It involves analysis of various dimensions of the task, such as the consequences of errors, the error-prone steps, workload, need for specific skills, capabilities or training, difficulties when wearing protective equipment, etc.	x	3.25. Task analysis should be conducted to <b>analyse and</b> document physical and cognitive activities associated with performing tasks to which personnel have been assigned		
15	11	CAN	3	32	... Walk-through and talk-through to analyze the predecessor system's task activities and to analyze tasks from similar plants; Data from other analyses that are inputs to the HFE design process...	Clarity is needed concerning what previous activities are intended in the text. Words seem to be missing from this sentence.	x			
16	12	CAN	3	39	Task analysis should particularly be performed in instances where cognitive aspects, such as decision-making, problem-solving, memory, attention and judgement are important for successful task performance, and where cognition may be impaired in high-stress situations, or when high workload is anticipated.	While task analysis is important for cognitive tasks, it is especially important where performance impairment may occur due to high stress or high workload.		3.39. Task analysis should particularly be performed in instances where cognitive processes, such as decision-making, problem-solving, memory, attention and judgement, are important to tasks	x	We believe that existing description sufficiently covers the intent of the para.
17	13	CAN	3	48	... Task requirements	Editorial	x			
18	14	CAN	4	11	... - Task analysis - Safety analyses	Safety analyses (both deterministic and probabilistic) can also indicate requirements. Add a bullet "safety analysis" to the list.	x			
19	15	CAN	4	18	The style guide should be used to ensure a common look and feel across the HMI. It should be developed from generic HFE design guidance and HMI design-related guidelines. An HFE guide, that contains specific system design guidelines or which references suitable HFE guidelines, should be used jointly with the style guide.	A style guide is intended to promote consistency and common look and feel. HFE guidance is intended ensure that the users' needs and characteristics are considered in developing the design, so that the whole system can meet the performance requirements. These guidelines are normally compiled into an HFE guide. In practice, both types of guides are needed to support suitable and sufficient HMI design.			x	We believe that the intent of 'style guide' is described in paras 4.16-4.18 correctly.
20	16	CAN	4	26	e) Should, as far as practicable, apply the simplest design from the users' perspective, that is consistent with the function and task requirements.	Clarification is needed concerning simplicity. A design may be simple from an engineering perspective, yet is complex and confusing from the perspective of the system users.	x			
21	17	CAN	4	36	A description should be provided of how the HMI...	editorial	x			
22	18	CAN	4	37	The design should determine the necessary ...	It is unclear why the term "HFE" has been applied to the design. It could be that "HMI" is intended, but this is not correct, since the system design is broader than just the HMI that is viewed or touched by the users.	x			

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	19	CAN	4	41						
23					Clauses 4.41 through to 4.217: Remove these clauses and refer to well-established and comprehensive HFE design guidelines, such as NUREG-0700 or MIL STD 1472. Explain that these sources should be tailored for the specific design project, and compiled into a specific "HFE Guide".	Clauses 4.41 through to 4.217 are a partial approximation of existing design guidance and do not provide full coverage. It is very difficult to cover the detailed design guidelines / principles in a condensed fashion. It is uncertain how useful the guidelines currently presented in DS-492 will be to the reader, except as examples of HFE design guidelines, and there is potential for the guidelines to be applied inappropriately and out of context. There are often valid exceptions to HFE design guidelines, and they need to be applied with skill and experience. This comment also relates to clause 4.18, because style guides and design guides are both needed.			x	DS492 is the IAEA safety guide which provides high level guidance. In the safety guide, we have to provide recommendations. We cannot just say - please follow NUREG-0700 or even MIL STD 1472. We have intentionally included para 1.7 Additional guidance on HFE design and development of human machine interface (HMI) is available from Member States and from other organizations that develop industrial standards. Such standards give much greater detail than is appropriate for IAEA safety standards. It is expected that this Safety Guide will be used in conjunction with detailed industry standards. Applicable standards are provided in Annex I.
24	20	CAN	4	41	If a control can be accessed from more than one location, such as within the control room, the supplementary control area or equipment in the plant, protective measures should ensure its coordinated use among multiple operators	This guideline applies outside the main control room, to include the secondary / supplementary control room or direct control of equipment in the field.	x			
25	21	CAN	4	42	... control devices and combinations thereof.	editorial	x			
26	22	CAN	4	43	Physical control devices...	It is not clear what is meant by "conventional" control devices. We assume that this refers to physical hard(ware) controls as opposed to virtual soft(ware) controls. The terminology needs to be consistent e.g. in clause 4.44			x	push buttons, keys, trip buttons.
27	23	CAN	4	46	Controls should display feedback for the operators to indicate...	editorial	x			
28	24	CAN	4	47	The HMI design should reduce...or the interface design should reduce...	HMI stands for "Human-Machine Interface". Therefore "interface" is repeated in the original text.	x			
29	25	CAN	4	49	To minimize operator errors... with the controlled variable's attributes.	editorial	x			
30	26	CAN	4	58	If the system uses function keys...	editorial	x			
31	27	CAN	4	64	HFE design for workstations	editorial	x			
32	28	CAN	4	67	The height of a console should permit that the operator must see over its top e.g., to see shared displays or other operators.	Not immediately clear to a naïve reader why the operator must see over the top.	x			
33	29	CAN	4	68	... reach of the operators	editorial	x			
34	30	CAN	4	94	A new clause, before or after 4.94, should be included, with the following text: "A main control room could be implemented using an organized collection of smaller or dedicated control facilities, or a combination of fixed and mobile facilities."	Conventional (including digital) control rooms have traditionally been implemented as a monolithic facility. There is a need for DS-492 to reflect that user interface technologies are rapidly evolving in both function and information capabilities, and include newer technologies, which are either currently available or will available over a short time horizon. These new technologies might be advantageously leveraged in ways that differ from conventional control rooms. DS-492 should not preclude their use, but rather it should recognize that existing guidance that is derived from fundamental principles can be applied in a risk-informed approach. This approach will ensure that DS-492 will not become obsolete within a short time span.	x			
35	31	CAN	4	95	A control room design should be consistent with the concept of operation, which should...	Editorial. In addition, the reader should be directed to the definition of "concept of operation" in the Definitions section. It is not clear to the reader that a "Concept of Operation" is anything specific.			x	Well, a concept of operation is defined in Definition section. We do not provide in the safety guide cross references.
36	32	CAN	4	116	Hardware properties of display devices should be adequate for the operator's human performance needs in the context of use, e.g., resolution, contrast, luminance, glare, and avoiding display distortion and flicker.	Clarification needs to be added regarding the "human factors needs". Glare (interference and disability) is an important consideration, which should be included.	x			
37	33	CAN	4	138	... including in emergency scenarios, auditory environments that promote clear verbal communications, and facility layout	editorial	x			
38	34	CAN	4	178	HFE analysis and validation should determine whether one alarm is masking the occurrence of (an)other alarm(s)."	As originally written, the clause is unclear.	x			
39	35	CAN	4	182	... (changing with time)...	editorial	x			
40	36	CAN	4	186	Filtering / suppressing consequential alarms should be analyzed to avoid the operator's initial responses being based on the consequence as opposed to the cause.	editorial	x			

NUSSC and EPRReSC comments on:  
Human Factors Engineering in Nuclear Power Plants (DS492, Rev. "F")

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	37	CAN	4	192	The dark-board principle should be applied, in which the minimum number of alarms are presented, in accordance with safety goals. Abnormal indications are displayed and for normal indications no alarms are shown.	The original definition is incomplete. In addition, clause 4.192 should precede clause 4.191.	x	Moved to Alarm presentation and modified.		
41	38	CAN	4	199	Acknowledgement control should only affect selected alarms.	Only selected, rather than visible, alarms should be acknowledgeable.			x	We believe this original wording is correct. We should
42	39	CAN	4	203	Human factors engineers should determine (e.g., by human factors task analysis) the nature of ...	Editorial. Also check the document for other instances of "human factor". The correct term is "human factors".	x	corrected in the entire document.		
43	40	CAN	4	205	Add a clause: Information about state changes and alarms should be presented and managed separately.	A common issue with alarms, which often leads to alarm avalanches, is to combine the presentation of state changes and true alarms. This is a common mistake by designers; the guide should warn of this issue.	x			
44	41	CAN	4	218	Guidance in this section provides recommendations on human factors aspects of procedure development in support of operational limits and conditions (Ref. [11]) and periodic safety review (Ref. [7]).	It is useful for the reader to know the topics of references 11 and 7, without having to look them up.			x	This is the Agency style for references.
45	42	CAN	4	221	Procedures should be verified to confirm their technical accuracy and that document development and document management processes have been adhered to.	It is not clear how verification of procedures relates to document management in the current wording	x			
46	43	CAN	4	222	... - Validity of any assumptions or claims made in safety analyses about tasks performed by humans that are related to safety.	It is unclear what is meant by "drive important human tasks".	x			
47	44	CAN	4	223	Procedures should be validated to ensure they can be completed as specified and that the results or outputs are as intended.	It is unclear what is meant by "function as intended".	x			
48	45	CAN	4	224	The assumptions that support the bases of the procedures should be documented in order to identify whether changes to the assumptions may affect the procedure.	editorial	x			
49	46	CAN	4	226	Provide required flow of information, actions, and feedback necessary for successful completion of a task;	editorial	x			
50	47	CAN	4	227	Procedure development should be assisted by a writer's guide to achieve clarity and consistency across various categories of procedures.	editorial	x			
51	48	CAN	4	233	The procedure may provide guidance for safe contingent actions if the actions specified cannot be achieved, or provide guidance for terminating the procedure safely.	editorial	x			
52	49	CAN	4	235	The training programme for operating personnel should be consistent with the HMI design, the system functions, the current plant configuration and the operating procedures.	editorial	x			
53	50	CAN	4	236	The HFE task analysis should provide a basis for early determination of training requirements for the system being designed.	It is not clear which task analysis is being referred to. We assume it is the HFE task analyses, not the specific Training Needs Analysis.	x			
54	51	CAN	4	237	The training programme should specify the knowledge, skills and abilities that the operating personnel need to be able to use and understand the information provided through HMI design.	editorial	x			
55	53	CAN	5	0	There needs to be a clear statement that verification is concerned with assessing that the system has been designed "right", by following the required processes, procedures and requirements, while validation is concerned with assessing whether the right system has been designed, in terms of achieving the required safe and desirable total system performance when the human, technology and organizational factors are brought together				x	DS492 provides recommendations on verification and validation individually.
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	52	CAN	5	1	Section 5 should be reviewed and updated to specifically include provisions for part-system or component modifications or upgrades.	This section of DS-492 seems to relate solely to full integrated system validations of full control room system upgrades / refurbishments, or new designs of control rooms. It does not cater for the verification and validation of smaller-scale component modification designs, which are regularly conducted in Canadian NPPs. In addition, verification and validation are often considered together in the same clauses, which has not kept a clear distinction between the two types of evaluations. While verification and validation have been described briefly in clause 2.24, it is necessary to elaborate on what each type of evaluation entails, and aims to achieve at the start of section 5.			x	Yes, this is correct observation. What is common to verification and validation, it is proposed in one para. Otherwise there are recommendations separated for verification and validation. Modifications are treated in different place.
57	54	CAN	5	4	Verification and validation should be performed by persons or parties independent of the design team to provide objective evidence that HFE designers have adhered correctly to design principles and the requirements for usability and system performance can be met by the system (when the human, technical and organizational aspects are combined).	Total system performance (with the human users in the loop) is important, as well as usability	x	We propose to split this para into two to make it more clear.		
58	55	CAN	5	5	<i>Verification of task support, which includes the provision of tools, job aids, personal protective equipment, task-related equipment, training, qualifications of operators, and accessible and usable procedures at the point of need.</i>	It is not clear what is meant by "Verification of task support"	x			
59	56	CAN	5	6	Verification activities may include interactions with system users. Validation activities necessarily include user representatives who are independent from the design team.	The types of user input for verification and validation need clarification.	x			
60	57	CAN	5	8	The layout for the main and supplementary control rooms supports the operators' tasks; The effectiveness of measures relating to monitoring, control and maintenance activities (inside and outside of the control rooms);	Further clarification of the bullets needs to be added	x			
61	58	CAN	5	9	Add an explanation of "integrated system validation" to this clause, or add it to the definitions section.	The term "integrated system validation" is used in this clause for the first and only time in the document, with no introduction or explanation. It should be described in terms of combining the human, technology and the organizational elements as far as is practicable, to evaluate the total system performance under simulated "real world" conditions. It may be appropriate to avoid using the term "Integrated System Validation", given that it is used only once in the document.	x	deleted integrated.		
62	59	CAN	5	12	Training requirements for the evaluation team, including for those participating as user representatives, as well as for the people running the evaluations.	Further information is needed about training for clarity.	x	— Training requirements for the evaluation team including for those participating as user representatives		
63	60	CAN	5	14	With the project's HFE requirements;	Unclear what is meant by "standard ergonomic requirements". All HFE-related requirements, including for workstation ergonomics must be specified as project-specific requirements, otherwise they are likely to be overlooked. Suggest deleting the parentheses.	x	deleted 'standard'		
64	61	CAN	5	15	... - The analysis and assessment of any HFE issues; - The tracking of the HFE issues (see also clause 5.39);	See also the comment relating to clause 5.39. The term "HFE discrepancies" is used for the first time. This should be changed to "HFE issues" for consistency with clause 5.39 etc. It would be useful to refer the reader to clause 5.39, which discusses issues tracking.	x			
65	62	CAN	5	16	Incorporate an additional section entitled "Verification Team" in the document.	It is not clear why there is a section "Validation Team" but no corresponding section relating to the "Verification Team"	x	Deleted Validation team		
66	63	CAN	5	16	The validation should be defined and conducted by a multidisciplinary validation team with different skills and expertise (e.g. specialists in the operation of the installation, instructors, experts in operations in the event of incidents and accidents, HFE experts, etc.).	editorial	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	64	CAN	5	19	The test participants should be trained beforehand, because the validation tests are not intended to train future plant operators.	editorial	x			
68	65	CAN	5	21	The members of the validation team should be trained in data collection, post-test interviews and the post factum analysis of the collected data.	The terms "evaluation team" and "validation team" are used in clauses 5.20 and 5.21. Given the section is about validation, the term validation team should be used instead of evaluation team in 5.21	x			
69	66	CAN	5	22	Remove "Eye tracking" from the list	While eye tracking can provide useful information when used by skilled practitioners, it is not essential, and it is more a way of acquiring information about the user's behaviour with the system than a test method in its own right. Eye tracking is included by inference as a possible technique in clause 5.25, i.e., gaze and dwell time.	x			
70	67	CAN	5	24	HFE verification and validation should incorporate human performance measures related to the actual work environment. — Required domain expertise	editorial	x			
71	68	CAN	5	25	— Perceived workload and fatigue should replace "— Fatigue and time of day"	It is not clear why time of day is included as a parameter to indicate human performance, so remove it.			x	It may be very different to work in the morning and during the night.
72	69	CAN	5	25	— Gaze and dwell time (e.g., from eye tracking methods)	Indicate that gaze and dwell time can be evaluated by eye-tracking methods	x			
73	70	CAN	5	25	— Reliability (e.g., repeatability of results)	It is unclear whether "reliability" means "repeatability"	x			
74	71	CAN	5	27	Verification of HMI designs should also be performed to identify whether task requirements that were identified in the HFE task analysis have been met.	This clause is unclear.	x			
75	72	CAN	5	30	Include design extension conditions in this clause, if this is the intended scope.	Should design extension conditions be included in this clause?	x	— The coordination between the teams involved in the management of an anticipated operational occurrences and accident conditions in the control room and in the crisis management room		accident conditions include DBA and DEC.
76	73	CAN	5	32	The section on Data Collection should be written to include part system validations and equipment for which there is no simulator.	Not all evaluations require the use of a simulator, e.g., for field systems and operation of equipment in the plant, as opposed to in the control room.	x	5.32. The means of collecting data should be deployed in the course of the tests on mock-up, field part task simulator, or full scope simulators in order to detect, for example:		
77	74	CAN	5	33	Delete or re-write this paragraph. Part of it is erroneous, and the intent and purpose is unclear.	Verification and validation evaluations do not always include collecting deficiencies. Where goal-setting requirements apply, the emphasis may be on collecting data to demonstrate that the described performance goals have been met. It is unclear if this clause is about the distinction between safety-related performance and efficiency / effectiveness, which may not be directly related to safety. A caveat could be included, to indicate that where processes or activities are inefficient or ineffective, people may conduct them as the designers intended, which may introduce unforeseen safety issues.			x	Para 5.33 is about necessary improvements as a result of validation testing.
78	75	CAN	5	35	... - The identification of tasks that were performed consistently well and without issues.	It is a good practice to identify and record what went well during evaluations.	x			
79	76	CAN	5	39	The HFE issues should be systematically documented and tracked. The corresponding mitigation solutions and their effectiveness should be documented, evaluated and monitored.	See also the comment on clause 2.17. The term "human engineering discrepancies" is specific to the US NRC's guidance documents and it is not intuitively understood by the naïve reader. This term is not explained in DS-492 and if it is used, it should be described in the definitions section. DS-492 has used the term "HFE issues" previously, e.g., in clauses 2.17 and 3.5, and this term is preferable, although it still needs a little explanation in the document. A suggested explanation has been suggested in the comment on clause 2.17. The term "human engineering discrepancies" is also used in clauses 7.7 and 8.2, and which should be amended accordingly, to replace "human engineering discrepancies" with "HFE issues".	x	Modified and split into 5.39 and 5.39.a.		
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	77	CAN	5	41	Specify who should review the results, which are "made available for review"	It is not clear who should review the results that are made available. Is this intended to be the regulatory body, the evaluation test participants, the "customer", or all of these? It should be noted that the raw results will be unintelligible to most readers, so they need to be described and interpreted in the report.	x	Deleted ....and made available for review		
81	78	CAN	6	3	The HFE design implementation phase should evaluate whether the as-built HFE design conforms to the verified and validated design, and if there are any unforeseen issues that arise when the design is implemented in the actual plant and work environment.	The evaluation goes beyond conforming to the verified and validated design. Good practice is to identify if there are any "surprises" i.e., unforeseen issues when the design is implemented in the real-world situation. It may be appropriate to link this with system commissioning activities.	x			
82	79	CAN	6	7	implementing the HFE design includes suitably qualified and experienced personnel; ...Where practicable, contingency strategies in the event that the implementation fails to deliver against its performance objectives. ...A method for capturing, assessing and resolving HFE issues that are identified in the implementation phase	editorial	x			
83	80	CAN	6	7	Assess the intended meaning of this bullet, and re-write, for clarity.	The following bullet is unclear: — An assessment, which considers the consequences of the as-built HFE design on: a) Actions to mitigate any undesirable consequences from implementing the HFE design process. b) The most suitable intervention point to implement the HFE design process, e.g. an outage or maintenance period.  The consequences of the design as a whole should be assessed, not just the "HFE" aspects of the design	x	deleted "process", because it is related to HFE design as such.		
84	81	CAN	6	9	— Evidence that the outputs of the design project, including support provisions (HMIs, procedures, training, improvement initiatives, etc.) meet the relevant standards, performance, and success criteria, defined for it at the start of the project;	In Canada the procedures and training development are not considered part of the HFE program, although they are considered to be relevant human and organizational factors, which are design inputs and human performance shaping factors. The first bullet should more correctly relate to the "design project, including support provisions"	x			
85	82	CAN	7	1	The monitoring of human performance should be an active and ongoing process to evaluate the continuing effectiveness of the design to properly support people to carry out their work tasks safely and effectively. It provides insight into: — Whether the design meets (and continues to meet) the original safety, operability and performance assumptions; — Whether the HMI design can be effectively used by operating personnel to conduct their tasks in the main control room, supplementary control room, local control stations and emergency response facilities; — Whether changes made to the HMI design, procedures and training have any adverse effects on how operators carry out their work tasks; —Whether human tasks can be accomplished within time response and performance criteria; — Whether the level of performance established during the system validation is maintained over the plant life.	Human Performance Monitoring should be a planned, active and ongoing process, carried out by the operating organization. It aims to ensure that the system is performing as the designers intended, i.e., the design basis is being maintained, and that the system performance is not being eroded or undermined by changes and practices that occur over time. Human Performance Monitoring is not merely a one-time assessment of human performance in relation to the newly implemented system. It should not be a passive process that relies solely on issue reporting, because people will tolerate ineffective and unusable designs, or find informal workarounds, rather than report the issues. People may not realize that the difficulties that they encounter should be reported and corrected, the burden of effort of reporting may be perceived as too high, or they may be unable to properly identify or articulate the issues that are causing performance problems.	x			
86	83	CAN	7	2	Human performance monitoring should consider the following: — All administrators of human performance monitoring and the users of its outputs are adequately trained;	editorial	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	84	CAN	7	2	... - The administrators are suitably qualified and experienced in the domains of human and organizational factors, systemic approaches, and root cause analysis methods, to ensure that the causes and significance of deficient human performance are comprehensively understood and the suitable paths to performance improvement are identified and implemented....	It is clearer and more correct to say that experience and knowledge of human and organizational factors is needed to assess and correct deficient human performance. In addition, root cause analysis approaches and concepts are needed to ensure that a systems approach is considered in identifying and correcting human performance deficiencies.	x			
88	85	CAN	7	2	The effective use of issue reporting by system users in monitoring human performance needs a culture of open and honest reporting;	Where human performance monitoring is a passive process that relies solely on issue reporting by system users, it is true to say that "the effective monitoring of human performance needs a culture of open and honest reporting". However issue reporting should be only one part of human performance monitoring.	x			
89	86	CAN	7	3	<i>Plant exercises and drills provide important opportunities to gather information during a wide range of plant responses in all plant states. Where reasonably practicable, high levels of fidelity should be used to simulate the conditions faced during</i>	Add drills to this clause	x			
90	87	CAN	8	1	The content of the HFE chapter in safety analysis report should describe the HFE programme and its application to the specific plant design.	editorial	x			
91	89	CAN	8	2	The human factors analysis methods applied;	Editorial	x			
92	90	CAN	8	3	Human factors verification and validations including identification and resolution of HFE issues identified during the design project, and	The term "human engineering discrepancies" is used (see comment on clause 5.39). It is better to use the more intuitive term, "HFE issues"	x			
93	91	CAN	8	3	HFE review should be conducted to verify that acceptable HFE practices and guidelines were incorporated into the design and the safety analysis report.	editorial	x			
94	92	CAN	8	5	HFE analysis should be considered whenever manual actions are credited to backup automatic actions in the design analysis as part of diversity.	editorial	x			
95	93	CAN	8	5	Modernizations and modifications of the HFE design should be documented in safety analysis report.	The consideration is wider than just the Human Machine Interface (HMI), because the total system includes the integration of the human, technical and organizational factors. HFE considers the interactions and impacts of human, technical and organizational factors. The HMI is merely the interfaces between the humans and the technical system.	x			
96	94	CAN	8	9	HFE review should be conducted whenever changes (sequencing, timing, and workload) are made to procedures for which credit is taken in the safety analysis.	editorial	x			
97	95	CAN	8	12	Any modification and modernizations that require changes in human and organizational factors need to ensure that changes to the management system and task supports are made before the design changes are implemented. This means that any processes, procedures, training, job aids, new roles and responsibilities and administrative controls are verified, validated and implemented prior to the new design is implemented.	Unclear what is intended by this clause. Suggested text has been provided, but this may not be the intent. We are not sure why "layout" has been specified – does this mean plant layout?		x	We meant HMI layout.	
98	96	CAN	8	15	The periodic safety review should confirm whether the following continue to be valid: a) the most resource intensive conditions feasible in each operational mode / plant state b) the division and coordination of work in the most resource intensive conditions is feasible, through assessing function allocation, task analyses, and workload analyses.	editorial	x			
99	97	CAN	8	16	The periodic safety review should consider whether the staffing, organization, system design, training, procedures, tools, equipment and other resources needed for successful human performance during the most resource intensive conditions are suitable and sufficient.	The consideration needs to be broader than just the human machine interface and staffing provisions. The range of related human and organizational factors needs to be considered, as well as the HMI and staffing provisions.	x			
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NUSSC and EPRReSC comments on:  
Human Factors Engineering in Nuclear Power Plants (DS492, Rev. "F")

	A	B	C	D	E	F	G	H	I	J
	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	98	CAN	8	19	The periodic safety review should identify reasonably practicable improvements in managing human and organizational factors to ensure that sufficient human performance is achieved, including through the HFE programme.	Unclear what is intended in this clause. Is it just that the HFE program continues to deliver against requirements? Is the issue broader, in terms of ensuring that the organization manages human and organizational factors appropriately to ensure sufficient human performance is achieved, including human factors considerations in design engineering covered by the HFE program?	x			
101	99	CAN	8	20	The likelihood of human error increases during severe accident situations because of the increased stress, uncertainty due to novel or unknown situations, transition from emergency operating procedures to severe accident management guides, fear of the potential accident outcomes, and the harsh environmental conditions associated with the event.	Include the uncertainty due to novel and unknown situations, and other lessons learned from the Fukushima Daiichi accident in this clause.	x			
102	100	CAN	8	21	Operating experience reviews, including the results of emergency exercises combined with functional requirements analysis and task analysis should provide the bases for identifying the human performance-related requirements for accident monitoring and operation of severe accident mitigation equipment.	The requirements extend beyond the human machine interface, to include the breadth of human and organizational factors that influence human performance.	x			
103	101	CAN	8	22	HFE analyses should consider resource allocation strategies (e.g. staffing), the physical conditions of a facility (e.g. power supply, accessibility, and habitability under environmental and radiological conditions), exacerbating factors, such as weather conditions (extreme heat, cold, or precipitation) and technology selection in relation to human performance under emergency conditions. [NOTE: The meaning of "HFE" needs to be clarified in relation to clauses 8.23, 8.25, 8.26, and 8.27 as well.]	Unclear exactly what is referred to by "HFE". Is it the group that carries out the HFE activities (including analyses), the HFE processes, or the results of the processes? This comment also applies to clauses 8.23, 8.25, 8.26, and 8.27, and should be clarified in relation to these specific clauses.	x			
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NUSSC and EPRReSC comments on:  
Human Factors Engineering in Nuclear Power Plants (DS492, Rev. "F")

	A	B	C	D	E	F	G	H	I	J
	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	102	CAN	8	24	Accident monitoring displays supporting situation awareness should be designed through application of accepted human factors engineering methods and principles. These include illumination, size, geometry, display and control layouts, available content, suitable format and standardization of the displays, and fundamentally consider the task to be performed with the information provided by the display.	Clarification of ambiguity in the clause	x	Moved to 4.157 a and b.		
105	103	CAN	8	27	HFE should consider the level of stress and workload that can exist during accident management situations.	What is meant by "burden"?	x			
106	104	CAN	8	29	Where applicable, computerized procedures can assist personnel by transforming paper based procedures into digital formats that can provide different levels of functionality including varying levels of automation.	Computerized procedures should not be advocated in all situations. There is a risk that computerized procedures may result in decrements, in some circumstances, and moving from paper to computerized procedures is a very significant undertaking with considerable safety risks. This comment applies throughout this subsection relating to "Design and use of computerized procedures"	x	8.29. Where applicable, computerized procedures should assist personnel by transforming paper based procedures into digital form that provides different levels of functionality including varying levels of automation.		
107	106	CAN	8	29	Consider moving the sections concerning computerized procedures into an annex.	While the information on computerized procedures seems useful, it is out of place in the body of this document. This is a very specific design topic, which is not applicable to all NPPs. This information should be moved to an annex, accordingly.			x	We believe that this is fast developing topic. If a decision is made to use computerized procedures than it should be include in the main part of the safety guide.
108	105	CAN	8	30	8.30-8.35	Use the words "may" or "can" in these clauses, as opposed to "should", because computerized procedures should not be advocated in all situations, and their implementation is associated with significant safety risks.			x	We believe that this is fast developing topic. If a decision is made to use computerized procedures than it should be include in the main part of the safety guide. Recommendations are provided accordingly.
109	107	CAN	8	35	Add new clause: The design of computerized procedures should consider the practical feasibility of authoring, quality assurance, review, verification, validation, control and updating the procedures		x			
110	108	CAN	8	37	HFE should be applied to the design of computerized procedures for both new and currently operating plants.	editorial	x			
111	109	CAN	8	40	Clarify how "dedicated displays" relates to ease of navigation across the displays.	It is not clear how "dedicated displays" relates to ease of navigation across the displays.	x			
112	110	CAN	8	88	Personal protective equipment and their characteristics should be selected and be compatible with the users' anthropometry, the tasks performed while wearing it, and the range of environments in which the users are expected to work. HFE design criteria that relate to the use of personal protective equipment should be applied to the anticipated use of systems, tools and job aids that may be used while wearing it.	Need to add compatibility with the users' tasks and the environments in which they are expected to work	x			
113	111	CAN	8	90	HFE analysis should determine that the task can be carried out whilst using protective equipment, which may affect the users' vision, hearing dexterity, mobility and abilities to work in extreme temperatures.	Editorial, and addition of factors impacted by PPE	x			
114	112	CAN	8	91	Personal protective equipment should be verified and validated related to its intended use across various plant conditions (e.g. during drills and emergency exercises). This verification and validation needs to consider the full range of body sizes of the user population to be accommodated.	Add the need to consider the full range of body size to be accommodated by the PPE	x			
115	113	CAN	8	93	— With existing station conventions for HMI characteristics.	editorial	x			
116	114	CAN	8	95	HFE processes should ensure that the installation of a COTS product does not result in undesirable changes in the work environment.	Editorial. In addition, as per comments on clause 8.22, it is not clear what is meant by "HFE" in clauses 8.95 and 8.96	x			
117	115	CAN	8	99	Mobile devices and their characteristics should be selected and be compatible with the users' anthropometry, the environmental conditions of use, and HFE design criteria, e.g. for lighting, grip, size and weight.	The correct term is "anthropometry", not anthropometrics	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
119	117	CAN	8	104	New clause: Security considerations and the potential for interference from High Intensity Radiated Fields should be considered and are likely to pose design constraints.		x	8.105. The potential for interference from high intensity radiated fields should be considered and are likely to pose design constraints.		Security considerations are not include in safety guide.
120	119	CAN	Definiton		The behaviors of people within a system and the outputs or results of that behavior, which relate to system performance. Human performance may be considered at the level of a specific individual, or more broadly at the level of a department or in the organization as a whole. Human performance is one aspect of human and organizational factors	The definition provided in DS-492 does not align with the use of the term in the document, e.g., in clauses 2.22, 2.23 2.25, 4.20, 4.39, 5.24 and 5.25, where the individual's performance, as well as that of the wider user group must be considered. Human factors in design must consider the individual's behaviours and work results as well as that of the wider user population, in order to support and accommodate the whole user population in the design solution. In addition, the definition provided does not align with the INPO use of the term	x	I propose deleteing definition of human performance. IAEA safety glossary mentions human performance as part of HFE.		
121	116	CAN	Table	I-1	Remove NUREG-0711. Replace it with more generally applicable documents such as IEEE Std 845, IEC Std 61771, ISO 9241-210, UK Ministry of Defence Standard 00-250	NUREG-0711 is not a design-related standard and it does not appear in Table 1-1. It is a review guide for one regulatory body's of a HFE program. A broader perspective of validation may be necessary to provide assurance that design goals can be met safely, with the humans in the loop.			x	Although NUREG 711 is not a design guide but it provides information on HFE programme review model.
122	118	CAN	Table	I-2	Include an additional table that presents commonly available guidance sources that are not standards, and which relate to the topic areas of this guide.	E.g., NUREG-0711, The MITRE Corporation Systems Engineering Guide, INCOSE Systems Engineering Handbook, NASA Systems Engineering Handbook, various USA Federal Aviation Administration documents on HFE.			x	Is it possible to limit Annex-I to IEC, IEEE and NURGS only?.
123	2	CZ	4	0	To add TECHNICAL SUPPORT CENTRE (between SUPPLEMENTARY CONTROL ROOM and ALARM MANAGEMENT)	Taking into account that TSC is mentioned in ANALYSIS (see para 3.27 (first bullet)) any requirements to TSC are missing in HFE DESIGN	x	We used formulation emergency response facilities on the site consistent with SSR 2/1 rev.1. Provided new paras in section 4.157 a,b,c.		
124	1	CZ	Genera l	0	In the text are used terms "emergency, accident, incident" without any explanation if they mean the same or not. If they do not mean the same, they should be defined and whole the text should be controlled if they are used properly (including e.g. emergency/accident conditions, emergency/accident scenario).	The text is not clear and can cause confusion and misunderstandings.			x	All these terms are defined in the IAEA safety glossary, 2016 edition.
125	1	DE	2	8	Human factors (e.g. knowledge and expertise, cognition, performance requirements, motivation, stress);	To bring situational human factors into awareness.	x			
126	2	DE	2	8	Organizational factors (e.g. management system, organizational structure, governance, resources, the roles and responsibilities of managers and of plant personnel).	To bring into awareness that the organizational factors are relevant on all hierarchy-levels.	x			
127	3	DE	2	10	The HFE programme should apply a questioning and learning attitude to accepted design methods and solutions, taking newly developed information, analysis methods, knowledge and features of new technology into account.	Learning is important in context of a questioning attitude.	x			
128	4	DE	2	21	HFE programme should establish a capable human factors organisation with sufficient authority on all hierarchy-levels to effect necessary design changes to meet the HFE expectations;	To highlight that sufficient authority includes all levels of hierarchy.	x			
129	5	DE	3	6	Evidence of culture influences and trends that could provide excellent outcomes for future operations;	To highlight that the "good practices" of operating experience has to be maintained.			x	Well, the intent of this bullet is different; contrary to good practices we would like to identify those proved to be problematic in order to avoid that for future operation.

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
130	6	DE	3	14	<del>The allocation of functions to human and machine resources should consider human capabilities strengths (e.g., ability to improvise, flexibility, judgment, pattern detection) and machine strengths (e.g., rapidity, simultaneous processing of complex operations), while avoiding human and machine limitations. Human limitations include cognitive factors as well as physical strengths and limitations.</del>	The used wording implies a substitution-based approach based on the so-called "MABA-MABA lists": Men-are-better-at/ Machines-are-better-at (see e.g. Dekker & Woods, 2002). Even if this approach is reasonable to some extent, it has limitations, too. For instance, it often still requires human beings for the supervision and adjustment of the systems. Furthermore, automation is not something static or quantitative, rather it transforms human practice and it forces people to adapt their skills and routines. (That means automation is not only filling human gaps but actually it also can foster new human gaps.) Therefore, some authors (e.g., Grote et al., 1999) argue for a complementary instead of a substitution-based approach; man and machine are both seen as valuable resources and the degree of automation should consider the situation. I think that paragraph 3.14 oversimplifies these complex interactions. Therefore, as a quick fix, I suggest to stress the resources aspect of man and machine.	x			
131	7	DE	3	29	Tasks that <del>could deteriorate</del> raise safety e.g. latent errors <del>and</del> initiators should be ...	It is not clear what the examples (latent errors, initiators) refer to.			x	We prefer keeping existing text. Raise an issue does not necessarily mean to deteriorate safety.
132	8	DE	3	31	<del>The expectations requirements of each task concerning ...</del>	This bullet is too generic. Further specification after "concerning" is needed.			x	Please understand that term 'requirement'; has a specific meaning in the IAEA publications. Safety guide is not a requirement document.
133	9	DE	3	31	<del>The requirements of the personnel personal needs...</del>	It is not only about a person's (subjective) needs but also about his / her (objective) requirements for successful task execution. The term "requirements" summarizes both.			x	Please understand that term 'requirement'; has a specific meaning in the IAEA publications. Safety guide is not a requirement document.
134	10	DE	3	32	<del>Data from simulator studies.</del>	Parts of the task analysis can get useful information from simulator studies.	x			
135	11	DE	3	39	<del>... cognitive aspects processes ...</del>	We suggest to use the term "cognitive processes" instead of cognitive aspects because it's in line with glossary from psychology/ cognitive science.	x			
136	12	DE	3	54	<del>An analysis supporting HFE design for safety can take the form of either qualitative and/or quantitative analysis.</del>	The combination of both qualitative and quantitative is often useful as well.	x			
137	13	DE	4	12	<del>Cognitive limitations and strengths of the users.</del>	The aspect of human cognition-skills should be considered as an important input in HMI design.	x			
138	14	DE	4	13	The HMI design should support the roles of operators as in the plant	This statement is nondescript in our view. The sentence could explicitly state which role of operators is to support: role as competent actor in the sociotechnical system, role as decision-maker, role as administrator of the technical components, etc.	x	4.13. The HMI design should support the roles of operators in the plant, considering levels of automation identified in the processes of functional requirements analysis and function allocation		
139	15	DE	4	26	<del>i) Should reflect consideration of human physiological characteristics, characteristics of human cognition, characteristics of human motor control and anthropometry.</del>	Interaction processes are affected also by the characteristics of human cognition.	x			
140	16	DE	4	125	<del>HMI should be user friendly, without requiring the operator to memorize special additional and varying complex codes or sequences to ...</del>	We suggest to be more specific since "special codes" are likely part of daily work.	x			
141	17	DE	4	157	<del>Communication between the supplementary control room and local control points, with the plant management, with external crisis management groups and the technical support centre should be provided.</del>	The Fukushima-incident shows that communication with external crisis management groups is important.	x			
142	18	DE	4	160	<del>Alarms should be defined primarily from an operational perspective considering an individual system designer's point of view and, based on that, they should be developed consistently by a system designer.</del>	Do you mean that it should possibly be done by one individual "as if made from one piece"?	x	Alarms should be defined primarily from an operational perspective considering system designer's point of view.		
143	19	DE	4	235	<del>The training programme for operating personnel should be consistent with HMI design, the way the systems function, current plant configuration and the operating and emergency procedures.</del>	Emergency procedures are also important for training programs.	x			

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
144	20	DE	5	7	The resources for crisis management and coordination between <u>among</u> the team members involved in the management of an accident.	It is not clear if you refer to the coordination between teams or among members of one team.	x			
145	21	DE	5	25	<del>Use of (group-) decision-making methods;</del>	The use of methods to improve decision-making processes is an important human performance measure.	x			
146	22	DE	6	5	The implemented HFE design has not generated any issues or conflicts (e.g. safety, operability or <u>cultural</u> ) to personnel, <u>safety culture</u> , safety management systems,	Because cultural aspects are connected to the safety management system and the whole organisation not only to the personnel.			x	In this very case we mean "culture" as such.
147	23	DE	7	2	The monitoring of human performance only functions effectively in a culture of open and honest reporting (e.g. a just culture has to be implemented);	The term just culture (from Reason) describes in addition to the existing argumentation more detailed what is needed	x	Modified with Canada comment #85.		
148	24	DE	8	26	HFE should consider the range of <u>internal and external</u> interaction of individuals and interested parties at all levels with the emergency organization for severe accidents.	The Fukushima-Incident shows that interaction with external emergency organizations can be very important.	x			
149	25	DE	8	98	Selection of mobile devices should be based upon analyses that reveal the mobile device is appropriate for the task and the length of time that users should be able to hold, interact with, transport, or wear the device. <u>The mobile device should be also appropriate for the task if the personnel is wearing personal protective equipment.</u>	It is important to add that the mobile devices should be able to be used also in cases where protective equipment is worn.	x			
150	1	EC	1	6	integration and use of several products in existing plant systems,	integration and use of several products into existing plant systems,	x			
151	2	EC	2	8	the elements Human, Technology and Organization	the elements human, technology and organization – Proposal to use capitals to make sure you do not mean "human elements, ..."			x	We have to follow the IAEA 'style guide'
152	3	EC	3	3	?	experience with candidate approaches to system and HMI - candidate approaches to system? Which system is referred to?	x	...candidate approaches to instrumentation and control systems and ...		
153	4	EC	3	5	Present 3.5 directly after 3.3 or combine; in particular experience from other industries.				x	We prefer keeping current sequence.
154	5	EC	3	11	Relationships between high level functions and the plant systems	Relationships between high level functions and the plant's systems			x	This report will be comprehensively edited in line with the IAEA style guide.
155	6	EC	3	16	The allocation of a function (functions) makes use of ...	The allocation of function makes use of ...The nature and scope of human tasks across functions... - How should "human tasks across functions" be understood?	x			
156	7	EC	3	29	Tasks that raise safety issues, e.g. latent errors or initiators, should be xanalysed ...				x	what is the comment?
157	8	EC	3	38		... can be directly used to inform the human error assessment and probabilities used within the probabilistic safety assessment. - Consider reformulation			x	Leave for the final editing.
158	9	EC	3	45		Consider to combine these two paragraphs.			x	This is a writing style, keeping short paras, not mixing informative and normative para.
159	10	EC	3	45	The ability to synchronize the contribution of each team member to the task;	The ability to synchronize the contribution each team member to the task;	x			
160	11	EC	4	18	It should be <i>tailor</i> made to reflect	It should be tailored made to reflect ...	x			
161	12	EC	4	50	4.50-4.63 4.65-4.84 4.132, 4.133, 4.134, 4.146, 4.148, 4.154, 4.155, 4.193, 4.194, 4.202, 4.205, 8.92 to 8.104	Most of these paragraphs include very technical information and should be best placed in an appendix or in some cases to an annex to improve readability of the Safety Guide.			x	This is a design safety guide. We tried to provide reasonable technical guidance, although I share your view that for some readers it may be too detailed..
162	13	EC	4	137	... which the main control room <i>staff is</i> able to perform	... which the main control room staffs are able to perform	x			
163	14	EC	4	159		Consider placing 4.164 after 4.159.	x			
164	15	EC	4	193	Reference should be made to international guidelines for more information about alarm coding techniques.	Refers to international guidelines for more information about alarm coding techniques.			x	References to each DS492 section are provided in Annex I.
165	16	EC	8	4	whenever manual actions <i>are</i> credited	... considered whenever manual actions is credited ...	x			
166	17	EC	8	9	HFE review should be conducted whenever	HFE should be conducted whenever ... - Is a review to be conducted?	x			
167	18	EC	8	13	at nuclear power plants are provided in	at nuclear power plants are provide in ...	x			
168	19	EC	8	41	The following interaction capabilities are ...	Following interaction capabilities are ...	x			

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	2	ENIS	1	5	This Safety Guide provides a consideration of relevant HFE aspects for several important applications linked to design, such as: — <del>Severe accident management</del> ; — Plant modifications and modernizations for achieving compliance with the requirements established in Ref. [2]; — <del>Design</del> -Development and use of operating computerized procedures (e.g. including computerized procedures the automatic sequence of steps in these procedures); — <del>Automatic sequence of steps in computerized procedures</del> ; — Development and use of severe accident management guidelines.	The term "development" is more appropriate for procedures. The order of bullets should be modified for logic (at least severe accident after procedures). The scope of the term "procedure" should be better indicated (is it only Emergency Operating Procedures ? or also Abnormal Operating Procedures or ...?). The section on p56 is only dedicated to computerized procedures (procedures in general have been dealt with in other sections). The bullet on automatic sequence for computerized procedure can be grouped with the previous one.	x	Accepted partially - "development".		Severe accident management is explicitly mention because we provide several specific recommendations in section 8 on that subject. All procedures are in the scope as described in 8.29-8.86.
169	3	ENIS	1	6	1.6. This Safety Guide provides a consideration of relevant HFE aspects for selections, integration and use of several products into existing plant systems, such as: — Personal protective equipment (e.g. maintenance activities, inspections, accident monitoring and operation of severe accident mitigation equipment); — Commercial off the shelf software products1; — Mobile devices (e.g. hand held, portable, and wearable).	It is not needed to add the examples (moreover, there is no dedicated personal protective equipment for severe accident). The term "software" should be added if it is effectively what is meant for COTS for clarity (as in NUREG/CR-6421).			x	We prefer keeping the examples (result of internal review). SW COTS are not included, it is discussed in SSG-39.
170	6	ENIS	2	22	HFE analyzes should provide insights and consideration how operators should respond and control in usual operation and producing situations and how operators respond to and control system failures and HMI failures.	HFE analysis have to provide requirements for the both usual failures situations ...			x	Actually, the entire para is about insights on " how operators should respond and control in usual operation and producing situations and how operators respond to and control system failures and HMI failures"
171	9	ENIS	2	22	Insights into timeline constraints for significant situations-tasks	At this stage make reference to tasks is too detailed. Make reference to Control Command situations (full power, transient operations, Accident Conditions ...)			x	We do not use term 'situation' we use a term 'task' which is a standard expression in HFE.
172	7	ENIS	2	22	"Task analysis" must be defined, with details to precise the scale needed according to the phase.	It's not feasible to detail the requested items (alarms, information procedures and controls, possible sequence and flow of tasks) at this stage of the project. Make reference to Control Command situations (full power, transient operations, Accident Conditions ...) would be more efficient. Those situations would be detailed During detailed design. "			x	We follow the standard approach used for HFE analysis. Task analysis is address in greater detail in section 3.
173	8	ENIS	2	22	Safety significant complex tasks situations that warrant detailed analysis and HFE assessment	At this stage make reference to tasks is too detailed. Make reference to Control Command situations (full power, transient operations, Accident Conditions ...)			x	We use standard terminology - task. Term 'situation' is used in different context..
174	10	ENIS	3	23	The task analysis should consider a significant representative sample of all plant states, operating modes and all plant groups of operating personnel, e.g. reactor operator, operator turbine, shift supervisor, field operator, safety engineer, and operation and maintenance staff.	It is not feasible to provide a detailed task analysis of all plants, modes and operating personnel			x	Task analysis should be made considering all the task relevant with the design or the modification of the planned human machine interface. A task analysis is not to compare with a test, where a significant representative sample can be used to prove e.g. the usability of a product/system. Therefore 'significant representative sample' is an incorrect recommendation in the context of task analysis
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
176	11	ENIS	3	32	To conduct a task analysis, information from the following sources may be considered: — Documentation (supplier documentation, technical specifications, existing procedures, manuals, training materials); — Knowledgeable personnel from the design team, stakeholders and experts; — Walk-through and talk-through to analyse also previous activities and to analyse tasks from similar plants; — Data from the operating experience review (e.g. note differences from the reference design); — Data from the customer requirements; — Data from other analyses part of the HFE design process inputs (e.g. functional requirements analysis and allocation, human reliability analysis); — International HFE standards. -- analyzes of field activity from observations and interviews with staff.	Too documentary, add ground approach			x	We believe that little bit more details will certainly not harm, especially when discussing the input data for task analysis.
177	12	ENIS	3	40	A list of a significant representative sample of all tasks performed upon system hardware by operations, maintenance, and support personnel should be maintained.	It is not feasible to provide an exhaustive list of all tasks performed upon system hardware by operations, maintenance, and support personnel			x	Although we understand comment, using 'significant representative sample' is not in line with IAEA writing style. Moreover, it is a recommendation, but how it will be implemented depends on a member state.
178	13	ENIS	3	42	<del>Task analysis should contain an error taxonomy....</del> To remove 3.42	Too oriented on human error			x	This is the reason why this para is there.
179	14	ENIS	3	50	3.50. The following should be considered when assigning individual tasks to working group members: — The tasks assigned to each member are clearly described; — The basis for task distribution is determined and justified; — The workload of each team member is reasonable in all operational and accident scenarios; — The human performance impact is addressed when distributing the tasks between teams working day and night; — The tasks required in various operating situations are assigned to control room crew members in order to ensure continuity of responsibilities (excepted in case of severe accident).	In case of severe accident, the application of SAMG is performed by TSC staff.	x	— The tasks required in various operating situations are assigned to <b>working group members</b> in order to ensure continuity of responsibilities		
180	15	ENIS	3	51	Any reduction of staffing should be evaluate by ... in order to evaluate the consequences on safety	The reference to safety is needed	x	3.51. Any reduction of staffing should be evaluated for its potential impact on safety by simulations or full scope simulator tests		
181	16	ENIS	4	4	This is a Human Machine Interaction, not only HM Interface		x			
182	17	ENIS	4	6	Rephrase to present the characteristics of human centered design approach. Avoid the term "human component"	Present human centered design approach in the principles of the approach	x	deleted component.		

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	18	ENIS	4	9	<ul style="list-style-type: none"> <li>— Whether automatic actions are properly allocated to respond to a postulated initiating event;</li> <li>— Whether HMI can support anticipation and response to an unexpected event;</li> <li>— Whether HMI provides information on incremental changes in anticipation of sudden disruptions (e.g. predictive displays); IAEA HFE Safety Guide DRAFT F-2016-09-22 21</li> <li>— Whether provisions and locations for additional tools and equipment are available;</li> <li>— Whether implementation of 'stress tests' related to human and organizational factors to look at how equipment may be used in unexpected ways;</li> <li>— Whether implementation of different operational strategies may have to be adopted in order to achieve a safe state as an event unfolds;</li> <li>— Whether equipment could support a different strategy (e.g. use of fire protection system to provide cooling)</li> </ul>	Confusion and ambiguity			x	see comment #19
183	19	ENIS	4	9	<p>Design considerations should provide for operator and organizational resilience, for example:</p> <ul style="list-style-type: none"> <li>— Whether automatic actions are properly allocated to respond to a postulated initiating event;</li> <li>— Whether HMI can support anticipation and response to an unexpected event;</li> <li>— Whether HMI provides information on incremental changes in anticipation of sudden disruptions (e.g. predictive displays);</li> <li>— Whether provisions and locations for additional tools and equipment are available;</li> <li>— Whether implementation of 'stress tests' related to human and organizational factors to look at how equipment may be used in unexpected ways;</li> <li>— Whether implementation of different operational strategies may have to be adopted in order to achieve a safe state as an event unfolds;</li> <li>— Whether equipment could be used out of its design function support a different strategy (e.g. use of fire protection system to provide core cooling).</li> </ul>	<p>If comment above not accepted: Proposition of a wording improvement for better understanding.</p>	x			
184	20	ENIS	4	142	<p>The SPDS should provide information on the critical safety functions:</p> <ul style="list-style-type: none"> <li>— Reactivity control;</li> <li>— Reactor core cooling and heat removal from the reactor coolant system;</li> <li>— Integrity of the reactor coolant system;</li> <li>— Radioactivity surveillance;</li> <li>— Containment integrity;</li> <li>— Spent fuel pool heat removal and water inventory.</li> </ul>	The list of the critical safety function should be consistent with the requirements for SPDS in NUREG-0696. According to our present knowledge "spent fuel pool heat removal and water inventory" has not been added to the list of important functions for SPDS.			x	This is the Fukushima lesson. It is now included in SSR 2/1 rev.1. This safety guide should reflect it. Moreover, this safety guide will be valid for the next 10 years and NUREG-0696 may change as well.
185	21	ENIS	4	218	Procedure development	The "Procedure development" section has to be checked for consistency with NS-G-2.15 "Severe Accident Management Programme for Nuclear Power Plants" currently revised under DS483 and should be limited to human factors considerations.	x	Checked and no contradiction was found.		
186	22	ENIS	4	218	Guidance in this section provides recommendations on human factors aspects of procedure development in support of Ref [15], Ref. [11] and Ref. [7].	Reference to NS-G-2.15 should be added for development of procedure.	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	23	ENIS	4	243	4.243. The development of a training programme should follow the guidance provided in Ref. [12] and in Ref. [15]. Propose criteria	The 4.243 should be moved at the beginning of the section on "Training programme development". In addition, reference to NS-G-2.15 could be added for training.		Reference 15 added.	x	We do not propose criteria in a safety guide which is consensus type document.
188	24	ENIS	5	26	Propose criteria	Too many expected, too detailed, it lacks guidelines			x	We typically do not provide criteria in IAEA safety standards (for a good reason); please refer to standards in Annex I.
189	26	ENIS	5	30	A significant representative sample of all operating tasks, including diagnosis, anticipation of exchange in parameters, monitoring, control, manual recovery of automatic control systems;	It is not feasible to provide scenario for all operating tasks			x	We do not use subjective clauses like "a significant representative sample" in safety guides. See answer to previous similar comments. Moreover para 5.28. reads: The test scenarios chosen to validate the installation should be realistic.
190	25	ENIS	5	30	A significant representative sample of all operating conditions, including events resulting and in safety-critical situations (e.g. the accumulation of thermal hydraulic events and the loss of sources of electric power, fire, flood);	It is not feasible to provide scenario for all operating requirements			x	We do not use subjective clauses like "a significant representative sample" in safety guides. See answer to previous similar comments. Moreover para 5.28. reads: The test scenarios chosen to validate the installation should be realistic.
191	27	ENIS	8	7	Indicate that a demarche redesign is required, with a control phase of change with the users. Making reference to INSAG 18.				x	This is a statement of SSR 2/1. No modification/addition is allowed.
192	28	ENIS	8	20	Development and use of severe accident management guidelines	As already mentioned, the section on "Severe accident management" should be moved to the end of the chapter on "HFE integration in safety applications". The title can be replaced as proposed for consistency with the one on computerized procedures.			x	No, severe accident management and computerized procedures are two separate and different topics.
193	29	ENIS	8	20	The likelihood of human error increases during severe accident situations because of the increased stress and harsh environmental and context conditions associated with the event. HFE should consider appropriately these situations. <del>8.27: HFE should consider the level of stress and burden that can exist during accident management situations.</del>	The two dispositions can be grouped.	x	See resolution to Canada comment #99		
194	30	ENIS	8	21	<del>8.21: Operating experience reviews, including emergency exercises combined with functional requirements analysis and task analysis should provide the bases for identifying the HMI requirements for accident monitoring and operation of severe accident mitigation equipment.</del> The design of equipment dedicated to mitigation should consider HFE for the use of this equipment. Return of experience, including from exercises, should be used for this consideration.	8.21 is not so clear. New sentence is proposed, hoping the meaning is well understood.	x	Modified according to Canada comment #100.		
195	31	ENIS	8	23	<del>8.23: HFE should be applied when designing technical support centres to provide for optimal layout of individual workplaces and data and information needed to perform the activities required for the implementation of accident management strategies.</del> <del>8.24: Accident monitoring displays supporting situation awareness should be designed through application of accepted human factor methods and principles. These include illumination, size, geometry, layout, available content, suitable format and standardization of the displays, and should consider the task to be performed with the information provided by the display.</del>	Technical support centres are not specific for severe accident management. The disposition should be moved at more general location on accident management (after control room). There are no dedicated displays for severe accident management. This should also be moved to more general location on accident management.	x	Added new subsection to Section 4, after supplementary control room entitled Emergency response facilities.		
196	32	ENIS	8	37	Design Development and use of computerized procedures	The term "development" is more appropriate for procedures.	x			
197	33	ENIS	8	37	Design guidelines for development of computerized procedures system's HMI	The term "development" is more appropriate for procedures.	x			
198	34	ENIS	8	37	Automatic sequence of steps in computerized procedures	This section should be included in the general section on computerized procedures			x	it follows logical order.
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
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200	35	ENIS	8	87	The following section provides a consideration of relevant HFE aspects for the selection, integration and use of several products, such as personal protective equipment (e.g. <del>for maintenance, inspections, accident monitoring and operation of severe accident mitigation equipment</del> ), commercial off the shelf products and mobile devices (e.g. <del>hand held, portable, and wearable</del> ).	It is not needed to explicit the examples for the use of personal protective equipment. Moreover, there is no dedicated personal protective equipment for severe accident.			x	This is the result of internal review process, these examples help understanding what products are in the scope. There is no 'dedicated' product mentioned.
201	36	ENIS	8	92	Commercial off the shelf software products	The term "software" should be added if it is effectively what is meant for clarity (as in NUREG/CR-6421).			x	We do not refer to any software in this section.
202	37	ENIS	8	97	Mobile devices	What is exactly included in mobile devices should be indicated. The section on "Mobile devices" might be divided in wearable devices and other devices. Some examples of wearable devices (which do not belong to personal protective equipment) might be added for clarity. Wearable devices might be grouped in a common section with personal protective equipment.			x	Para 8.97 specifies what is in the scope.
203	4	ENIS	Fig	1	The bar graph of "HFE Design" and "Verification and Validation" should start from middle of "Concept Development" stage	We have to start verification and validation of concept from "Concept Development" phase			x	Well, during the concept phase we do not know yet what HMI design there will be.
204	5	ENIS	Fig	1	Modification of the Figure 1 It needs a link with the products of the overall design demarche	Figure 1 shows that the overall process of consideration of FH design decision, but it does not make the iterative nature, neither the relationship between stages, or the contribution of "users".			x	It is a simplified, an example of HFE generic processes.
205	1	ENIS	Genera l		The proposed guide starts with interesting principles (human centered design approach, iterative approach ...), but doesn't fully implement them in the detailed content. It suggests a lot of expected items, but not an approach to coordinate operational work between designers and operators. It proposes a challenging approach in the general part, with objectives that we globally share: - An iterative & systemic HFE program, which suggests a contribution of experts in the project, with expected HF skills and HF deliverables to produced. - An HFE program which takes into account the most recent standards, sets up phases of verification and validation of HF aspects, with a demonstration of the feasibility of safety actions by deterministic and probabilistic approach. But this approach in detailed presentation remains very focused on the HMI and verification phases / validation, and very less on the general specifications of phases with operators. Requirements concerning operating experience feedback are very high, and very difficult to do systematically and ensure for all trades, from significant events to the minor findings, including also positive aspects to maintain the expression of functional and ergonomic needs of staff. A stage of task analysis is required with a focus on human errors, but and it remains a very documentary in nature. It lacks the use of analysis of field activity from observations and interviews with staff. In conclusion, it lacks a description of the principles of the approach itself step by step, in an iterative way and with the contribution of "users".			x	<b>The main objective of DS492 is to provide recommendations to meet SSR 2/1 Requirement 32 Design for optimal operator performance. As you may remember, CSS requested to include human and organizational factors too. When developing draft safety guide in this area, the consultants recognized that required task based human factors and situation awareness specific design should be included. This encompassed field operators, spent fuel pool, as well as other specific tasks outside the control room which impact on safety. Other IAEA guides require and effective use of the operating experience, both for lessons learned for events and the factors that are positive in maintaining safe operation. This recognized documentation expectation through experience has seemed to be essential to support HFE in different phases and in different part of the life cycle of the plant. As a general rule, the IAEA safety guide provides recommendations "what should be done" to meet specific safety requirements, not "how to do it". It is left on Member States to determine an appropriate process for their nuclear power plants.</b>	
206	1	FI	1	5	Consideration of relevant HFE aspects for several important applications linked to design, such as: — operation of the nuclear plant in operational states and accident conditions Severe accident management; — Plant modifications and modernizations for achieving compliance with the requirements established in Ref. [2]; — Design and use of procedures (e.g. computerized procedures); — Automatic sequence of steps in computerized procedures.	ADD: operation of the nuclear plant in operational states and accident conditions  Delete: Severe accident management;  The safety guide includes all the states of the NPP. Severe accident are covered by accident conditions.			x	operation of the nuclear plant in operational states and accident conditions are covered in 1.3 last bullet. Severe accident management is explicitly mention because we provide several specific recommendations in section 8 on that subject.

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	2	FI	1	15	This Safety Guide is intended for use by organizations involved in design, manufacture, construction, modification, maintenance and operation of nuclear power plants, in activities such as analysis, design, verification and review, validation, implementation, performance monitoring, HFE integration, and in the provision of technical support, as well as by regulatory bodies.	It seems that intended use is missing 1) modification organizations and 2) activities: design, validation, implementation, performance monitoring, and HFE integration which are all relevant uses considering the scope of HFE			x	We prefer keeping existing concise wording, which is a standard phrase in a safety guide.
207	3	FI	2	7	A HFE programme should be developed and available for review.	Please clarify the relation in between the HFE programme and HFE process. The recommendations for the programme in the safety guide could be recommendations for the process.			x	HFE programme involves different processes as described on Fig. 1.
208	4	FI	2	20	Stretch validation to cover late concept development in FIG 1.	Conceptual design should be validated from HFE perspective			x	During conceptual phase the design has not started yet. Our team has different opinion on that subject.
209	5	FI	2	21	... - early feedback on the concept from users - the constrains from the safety assessment	ADD:  - early feedback on the concept from users the constrains from the safety assessment  Conceptual design should be evaluated from end- user point of view. Any constrain coming from the safety assessment should be identified. so that the demonstration of the meeting the safety criteria can be made in later phases.			x	Based on a model on Fig. 1, it is still too early to provide a feedback from the concept phase; the design has not started yet.
210	6	FI	2	22	... the constrains from the safety assessment	ADD:  the constrains from the safety assessment  Any constrain coming from the safety assessment should be identified. so that the demonstration of the meeting the safety criteria can be made in later phases	x			
211	7	FI	2	23	... the constrains from the safety assessment	ADD:  the constrains from the safety assessment  Any constrain coming from the safety assessment should be identified. so that the demonstration of the meeting the safety criteria can be made in later phases.			x	We have address that in the Concept phase in 2.22.
212	8	FI	2	24	... <a href="#">the constrains from the safety assessment</a>	ADD:  the constrains from the safety assessment  Any constrain coming from the safety assessment should be identified. so that the demonstration of the meeting the safety criteria can be made in later phases.			x	We have address that in the Concept phase in 2.22.
213	9	FI	3	11	— Higher level functions should be decomposed into lower level functions that can be mapped to tasks to be performed by plant automation or the human, or human and automation jointly;	ADD:  — Higher level functions should be decomposed into lower level functions that can be mapped to tasks to be performed by plant automation or the human, or human and automation jointly;  It should be considered that many human tasks involve some automation and are thus joint between human and automation (this is treated in 3.16 but should not be omitted from 3.11 either)	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1										
215	10	FI	4	4	The HMI should be designed through a structured methodology, starting from conceptual design, that permits the identification and selection of candidate HMI approaches, the definition of a detailed design, and the performance of HMI tests and evaluations, when needed.	ADD:  starting from conceptual design  In the current version the systematic design of HMI starting with conceptual design and advancing to detailed design is not treated explicitly (although 4.38 assumes that conceptual design has been conducted).			x	This para reads "4.4. The HMI should be designed through a <b>structured methodology</b> that permits... This methodology follows HFE process as described on Fig.1.
216	11	FI	4	18	The style guide should be developed from generic HFE guidance and HMI design related analyses. It should be tailored made to reflect the design decisions in addressing specific aspects of the HMI design.	typo	x			
217	12	FI	4	26	...  b) Should be designed, in line with the safety assessment, with primary attention given to the role of the operator who is responsible for the safe operation of the equipment;  ...	ADD:  , in line with the safety assessment,  The safety assessment puts some constrains and this should be kept in mind all the time.			x	The intent of this para is ...should be designed with <b>primary attention given to the role of the operator</b> who is responsible for the safe operation of the equipment. Safety assessment has already been incorporated into Task analysis.
218	13	FI	4	160	Delete - Alarms should be defined primarily from an operational perspective considering an individual system designer's point of view.	Delete or re-phase.  The requirement is contradictory, if alarm is designed from an operational perspective it may contradict the individual system view, maybe there is misinterpret of the content, please consider re-phrasing			x	Our group spent quite some time to discuss this issue. Actually, both operational and design perspective should be considered.
219	14	FI	4	235	Training program should detail the learning goals related to safe operation of the plant	The section concerning training should also say something about how meeting the learning goals is evaluated and possible re-trainings designed	x			
220	15	FI	5	27	a. Verification of the HMI design should be preformed against the safety criteria of the nuclear power plant design.	ADD: new paragraph  Verification of the HMI design should be preformed against the safety criteria of the nuclear power plant design.  The compliance with the design should be ensured.			x	Is this surplus to task analysis? Task analysis already considered safety criteria of the plant design.
221	16	FI	5	31	a. Validation of the HMI design should be performed against the safety criteria of the nuclear power plant design.	ADD: new paragraph  Validation of the HMI design should be performed against the safety criteria of the nuclear power plant design.  The compliance with the design should be ensured.	x	Modified para 5.1. The human factors verification and validation should comprehensively determine that the HMI system conforms to specified HFE design requirements and that it enables personnel to successfully and safely perform the intended functions in order to ensure safe operation of the plant.		
222	18	FI	8	0	Severe accident management  And content	This heading is confusing, please clarify. In DEC conditions the mobile equipment can be used to prevent severe accident. On the other hand the stress and communication should be considered also during BDA and DEC conditions without severe core damage. Some of the recommendations are for the accident conditions and some for severe accident conditions. Please consider the scope of paragraphs 8.20 – 8.28.			x	Para 1.5 explains that HFE aspects need to be considered in several activities are important applications. According to SSR-2/1 rev.1 use of mobile devices as a preventive measures for new PPPs is not considered.

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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	17	FI	8	2	HFE considerations present in the safety analysis report should cover at minimum the following: . - Assumptions for the choice of design of HMI, Design choices, procedures, and training programs, taking into account HFE	ADD:  Assumptions for the choice of design of HMI, Design choices, procedures, and training programs, taking into account HFE  It should be detailed that at minimum HFE scope should cover design choice and issues related to HMI, operating procedures, and training programs	x	— Assumptions for the choice of HMI design taking into account HFE		
223	19	FI	8	26	HFE should consider the range of interaction of individuals and interested parties at all levels with the emergency organization for severe accidents.	Delete severe,  The interaction with other stakeholders is needed also during other accident states.			x	The whole section is related to severe accident.
224	20	FI	8	28	The technical support centre staff should be trained on the identification and use of the instruments to support implementation of severe accident management procedures or guidelines. More detailed IAEA HFE Safety Guide DRAFT F 2016-09-22 recommendations for the development and implementation of severe accident management guidelines are provided in Ref. [15].	ADD:  procedures o  If severe accident management systems are installed there should be procedures.	x	Moved as new para to 4.157 c.		
225	1	ROK	2	19	The HFE process can be grouped under the following: - Programme management; - ..... - Design Implementation - Human performance monitoring	Consistent expression is recommended with HFE 'Design Implementation', one of HFE activities on page 50 in this safety guide.	x			
226	4	ROK	3	5	The operating experience review provides the following: - ..... - Important human tasks in predecessor plant and system (add) - Related HMI technology (add)	One of objectives of operating experience is application of "important human tasks" in plant. So, adding this description would be better. Considering related HMI technology to operating experience review would be more comprehensive.			x	HMI technology is included in 3.3. Operating experience should identify all, not only important human tasks. We believe that existing wording is sufficient.
227	3	ROK	3	5	The operating experience review provides the following: - ..... - Issues identified from applicable predecessor related plants and systems - .....	Not only predecessor plants, considering "related plants and system" would be more comprehensive for operating experience.			x	We speak about predecessor (HMI) design in general; it also covers plants and system.
228	5	ROK	3	6	HFE should consider operating experience data... - ... - Evidence of organizational culture influences and trends that could prove problematic for future operations	The meaning of 'culture' is ambiguous. However, it is difficult to estimate the exact intention to use 'culture'. Therefore, the expression needs to be clarified. For example, 'organizational' or 'safety' can be used before 'culture'.			x	This is not only organizational culture, therefore we used broader expression.
229	6	ROK	3	7	Reference [8] provides recommendations on all the main components of systems for the feedback of operationaloperating experience, including gathering relevant information on events and abnormal conditions that have occurred at nuclear installations throughout the world.	Generally "operating experience review" is right description than "operational experience review".	x			
230	7	ROK	3	12	The functional requirements analysis..... and the human interaction required for success paths.	The meaning of 'success' is ambiguous. The functional requirements analysis should document the human interaction required for performing functions successfully. And success paths, the relationships between high level functions and the plant's systems, are responsible for that. Therefore, the expression needs to be replaced to 'success paths' instead of 'success' only.	x			
231	8	ROK	3	23	3.23 Functional requirement analysis and function allocation consider new/modified functions resulting from changes in the degree of integration between plants systems.  TASK ANALYSIS 3.23, 3.24 The task analysis should consider all plant states, all plant operating modes and all groups of operating personnel,...	If function is recently updated or supplemented, considering these changed function comparing to existing system and function would be more practical for FRA/FA			x	Comment is unclear; is it related to 3.23?
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1										
233	9	ROK	3	36	The task analysis is a collaborative activity and should involve a multidisciplinary team with HFE experts and operations expertize operation experts.	To provide clear understanding, the "HFE and operations expertize" should be replaced with "HFE experts and operation experts".			x	No change is needed, this para reads exactly what is your intent.
234	10	ROK	3	51	Any reduction of staffing should be evaluated by simulators or full scope simulator tests and justified against regulatory requirement.	For most of licenses on nuclear power plant (e.g., construction permit, operation license), the analysis of staffing, organization and qualification is required on regulatory basis. Therefore, it should be justified if the applicant requests to reduce the level of staff.			x	We only say that any staff reduction should be evaluated but justification to the regulator is different action.
235	11	ROK	4	5	The concept of defence in depth should be considered during HMI design, as applied to all safety activities, whether organizational, behavioural or design related activities should ensure that...	A noun is needed after 'whether organizational, behavioural or design related'. But, it is difficult to estimate the meaning of this sentence. So, it is possible to use another expression instead of 'organizational, behavioural or design related activities' if possible.	x	4.5. The concept of defence in depth should be considered during HMI design, as applied to all safety activities, whether organizational, behavioural or design related and should ensure that if a failure were to occur, it would be detected and compensated for or corrected by appropriate measures		We had a long discussion on that subject. This is a consensus. Please keep organizational aspects too.
236	12	ROK	4	11	The requirements to be considered in the HMI design should..... - <del>Operational</del> Operating experience review; - ..... - Staffing, organization and qualification; - Important human tasks;	In the analysis phase, HFE activities are composed of following: - review of operating experience - functional requirements analysis and function allocation - task analysis - staffing, organization and qualification - treatment of important human tasks Therefore, the element about staffing needs to be corrected and the element about important human tasks needs to be added. And in case of operational experience review in original sentence, Generally "operating experience review" is right description than "operational experience review".	x			
237	13	ROK	4	21	All aspects of the HMI (including controls and display arrangements, coding techniques, etc.) should be consistent with the mental models used by operators and with established conventions.	To provide clear understanding, some sentence should be modified. (mental models used by operators -> mental models of operators /understanding of operator of the status -> operator's understanding of the status)			x	We believe that current wording is correct.
238	14	ROK	4	22	The presentation of information should be integrated in a manner that optimizes the understanding of operators operator's understanding of the status of the plant and the activities necessary to control the plant.	To provide clear understanding, some sentence should be modified. (mental models used by operators -> mental models of operators /understanding of operator of the status -> operator's understanding of the status)			x	Please, leave it to editors
239	15	ROK	4	28	The HMI, procedures, <del>training systems and training</del> , training programme should be consistent with each other.	To provide clear understanding, the "training systems and training" should be replaced with "training programme".	x			
240	16	ROK	4	38	Tests and evaluations of <del>concepts</del> concept design and detailed design features should be conducted during the process of developing HMIs to support design decisions. Trade-off evaluations and performance-	To provide clear understanding, the "concepts and detailed design" should be replaced with "concept design and detailed design".			x	concepts include concept design but other elements as well. This is also related to concept of operation (see definition).
241	17	ROK	4	124	The HMI of display system should clearly indicate which items are selectable.	The meaning of 'system' is ambiguous. It is considered that selectable items mean soft control and soft controls are included in HMI of display system. Therefore, it will be more detailed expression if 'HMI of display system' is used.	x			
242	18	ROK	5	6	Verification may include users that are independent from the design team while validation should include them.	The meaning of 'users' written former in original sentence needs to be clarified if the meaning between former 'users' and latter 'users' is not different. So, it is recommended to use it as proposed text.			x	Modified with comment CA#56.
243	19	ROK	5	10	The inputs for verification and validation should originate from the HFE processes that are implemented beforehand, in particular: - ..... - Inputs from functional requirements analysis; - ..... - Data from human reliability analysis; - Data from deterministic analysis; (add) - Data on staffing and qualifications; - Data from HMI design;	Generally "functional requirements analysis" is right description than "functional analysis". According to 2.24 (page 11) in this safety guide, HMI design and human tasks important to safety in the deterministic analysis are HFE inputs for HFE verification and validation process (design implementation phase). Therefore these two inputs needs to be added for verification and validation.	x	Data from safety analysis added.		

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1	20	ROK	5	16	The validation should be defined and conducted by a multidisciplinary validation team (e.g. specialists in the operation of the installation, instructors, experts in operations in the event of incidents and accidents, HFE experts, etc.).	To provide clear understanding, the "validation team with different skill" should be replaced with "multidisciplinary validation team".	x			
244	21	ROK	5	23	The conformity and the limits of representativeness of the benches testbeds / models / simulators used in the verification and validation tests should be justified.	The description of "testbeds" is more frequently used than "test benches".	x			
245	22	ROK	6	6	The scope of the implementation phase should consider the impact on safety of the HFE design process on the following elements: - organization factors, Personnel Human factors	The correct expression is 'Human Factors', not 'Personnel Factors'. So, the expression needs to be replaced.			x	We believe that "personal" is correct here.
246	23	ROK	6	6	The scope of the implementation phase should consider the impact on safety of the HFE design process on the following elements: - ... - Probabilistic safety assessment / human reliability analysis; - Deterministic safety assessment; - HMI components; - .....	According to 2.24 (page 11) in this safety guide, human tasks important to safety in the deterministic analysis are HFE inputs for HFE design implementation process (design implementation phase). Therefore, this element needs to be considered for design implementation. HMI means human machine interface, so "Interfacing HMI" is incorrect expression. It is necessary to modify as "HMI components".			x	Probabilistic safety assessment is mentioned only because of human reliability analysis.
247	24	ROK	6	7	Confirmation that the team members implementing the HFE design are suitably qualified by experienced person;	To provide clear understanding, the "team" should be replaced with "team members".			x	team is correct.
248	2	ROK	Fig	1	HFE Design Implementation	Consistent expression is recommended with HFE 'Design Implementation', one of HFE activities on page 50 in this safety guide.	x			
249	3	SWE	4	0	Consider to delete some of the more detailed guidance of the section from this guide, e.g. the more detailed guidance on Alarm management	Even though aspects of alarm and alarm management could be recognized as an important part of a HMI design, this sections seems to be in much more detail than many other parts, e.g. procedure development and training programme development.  The guide could be seen as not being quite in balance on the level of detail of different aspects and activities of the HFE process.	x	We have proposed deleteing some paras in Alarm management.		
250	4	SWE	7	0	Consider to include paragraph about the timing of human performance monitoring, e.g. in relation to what is said about human factors for PSR in SSG-25 (5.130) and in the PSR section of chapter 8.	Even though human performance monitoring is something that should be part of the overall HFE programme and thereby managed during the operational phase of the NPP, it could be helpful to point out the link to the PSR and the possibility to, at least in time with the PSR, make an overall assessment of the design in terms of that the assumptions made about human performance are still valid, or if any changes are needed.	x	Modified according to Canada comment #82.		
251	1	SWE	Definiton		An approach relating to the system as a whole in which the interactions between technical, human and organizational factors are duly considered. (GSR Part 2, paragraph 1.2)  Alt. consider to delete these definitions and use paragraphs 2.8 and 2.9 as references if any explanations further in the guide are needed.	The two definitions are similarly named but not quite in line with the system view as it is presented in paragraphs 2.8 and 2.9 as well as in GSR Part 2 (e.g. paragapgh 1.2). Also, the definition is only used in chapter 2.8 and 2.9 to set the overall concept, so perhaps there is no need to define them further?	x	Aligned with GSR Part 2: System as a whole in which the interactions between technical, human and organizational factors are duly considered) are essential to the specification and application of adequate safety measures and the fostering of a strong safety culture.		
252	2	SWE	Table	I-1	Consider to include also ISO 11064:1-7	The standard ISO 11064 parts 1-7 have been widely used as a reference, both for the overall HFE approach (part 1) as well as for specific aspects of the design (parts 2-5) and its evaluation (part 7).	x			
253	5	USA	4	10	Suggest adding a new item before 4.10 "4.10 All physical variables must identify the units, for example, temperature in degrees C or in degrees F."	Units of physical variables in the engineering practice are VERY important and should be emphasized.	x			
254	6	USA	4	26	Delete item f)	Item f) states: The human machine interface "should be designed to minimize reliance on operator training". This can be misleading because as more necessary information is added into the interface, more training may be needed.	x			
255	8	USA	4	26	Add definition on "human motor control" used in item i)	Item i) uses the terminology of "human motor control" but the standard does not provide a definition of the terminology.	x			
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257	7	USA	4	26	Delete or modify item h)	Item h) is not clearly justified. Why do we consider only analogue and video displays, and how can we accommodate these display failures without significant interruption of control action?			x	If analogue and video displays fail, there still should be an opportunity to have control over the plant. We did not say "all" displays.
258	9	USA	4	33	Suggest adding one more item: "If the HMI is modified, any reduction of information displays should be justified, reviewed, and agreed upon among design engineers, human factor engineers, and operators."	The reviewer has seen reported accident caused by mistakes associated with a reduction of information displays.	x			
259	10	USA	4	169	Modify the sentence "Up to four high and four low deviation limits, and one positive and one negative rate limits could be used."	It is not clear to the reviewer.	x	Sentence deleted.		
260	11	USA	4	235	The document did mention human training; however, "Simulator Training" is an important specific aspect in NPP operation. We recommend adding more guidance and emphasis in this regard.	Completeness to emphasize the need for simulator training to reduce the risk from human-machine interface errors.	x	Added new para: 4.242.a. Simulations by mock-up, field walk down, part task simulator, or full scope simulators should be used in the training programme for operating personnel.		
261	3	USA	7	0	The objective of this Safety Guide is to provide a structured approach and guidance on HFE in the design and modification of human machine interface (HMI) in order to minimize the risk of human errors, and optimize human performance to ensure safe operation of the nuclear power plant. The document provides information on human factors, such as training and qualification. However, the document lacks information on the Human Factors Information System (HFIS) database to be used as indicative of overall performance at an individual plant. The HFIS information is intended to provide a general overview of the types and approximate numbers of performance issues documented in these reports. The information from inspections is typically used as an indication of when a plant's human performance record varies from the record of the industry as a whole or from the plant's own history. Awareness of human performance records allows for informed decision making about any changes that may be needed in inspection of Human-Machine Interaction for corrective actions and updating guidance and inspection protocols	Completeness to address Human factor Information System (HFIS) database and use as such for assessment and update of HMI protocols. (We note that the NRC collects data from its own inspection reports and licensed operator examination reports and from Licensee Event Reports (LERs), which are submitted by licensees, as well).			x	Originally, this section on human performance monitoring was much more detailed, however during the internal review it was decided to make it shorter. The reason was that the IAEA have other safety guides which include human performance monitoring. Although I agree that the Human Factors Information System (HFIS) database is a useful tool, I am not certain whether we should provide guidance to member states that they should have it. We typically do not recommend any specific information system to the member states. This is left up to them on "how to do it".
262	12	USA	8	20	Suggest adding "8.20 HFE related accidents that trip reactors should be analyzed by HF engineers. Measures should be taken to minimize the possibility of reoccurrences under the similar scenarios."	Continuous improvement should be sought.			x	Does this belong to severe accident section?
263	13	USA	8	29	This part does not discuss where the computerized system should be executed: in a safety system or non-safety system.	If the computerized procedure is running on safety system, it allows type III procedure to issue safety related commands, such as tripping the reactor from the computerized procedure; but it makes the safety system unnecessarily more complex and may introduce safety system failure caused by the failure of the computerized procedure. If the computerized procedure is running in non-safety system, it may be problematic because tripping reactor from the computerized procedure means to send a safety command from a non-safety system. The standard has not addressed this detail yet.			x	According to IAEA safety classification items important to safety, which includes safety and safety related. Please, not that this is different classification than applied in US.
264	4	USA	Fig	1	Should be moved to Section 1, Introduction	Figure 1 gives HFE activities in basic phases of an engineering process. Each of these activities is a topic of the sections following the Introduction section. Therefore, this Figure should be in the Introduction rather than in Section 2, which discusses one of the activities, HFE program management.			x	Section 1 is a general section in a safety guide. We typically start with recommendation on a specific topic in section 2.



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1	1	USA	Genera I		The description of human performance criteria in the context of human-machine interface (HMI) to reduce risk from human errors are scattered within the text and may not be inclusive. We recommend using NRC descriptions of human performance using the following eight categories and coding them into sub-categories, if necessary: - Training - Procedures and Reference Documents - Fitness for Duty - Oversight - Problem Identification & Resolution - Communication - Human-System Interface and Environment - Work Planning and Practices  As indicated above, each category can be further divided into areas, and each area contains a series of details that describe the human performance issue as related to HMI.	Completeness to address HMI interface and performance criteria in an organized and complete fashion. .			x	In general, we followed structure as provided in NUREG 711. DS492 is a consensus international document, which has to respect other than US regulatory framework.
265	2	USA	Genera I		We recommend the guidance provide additional information pertaining to the following aspects as related to HME and HMI: • Emergency Operating Procedures (EOP), Emergency Response Procedures (ERP), and Abnormal Operating Procedure (AOP)/Alarm Response Procedure (ARP) • Mitigation Strategies & Beyond Design Human factor issues	The document should provide more elaboration on EOP, ERP, AOP, and ARP.			x	DS492 provides recommendations on HFE aspects of procedure development. DS492 does not repeat recommendations on all types of procedures rather than it provides reference to the IAEA safety guide NS-G-2.2. This is the Agency writing style.
266	18	USA	Genera I		SMRs (small modular reactors) control room and HMI designs may be considered differently from conventional nuclear reactors. For example, how to allocate displays/monitors among reactors (i.e., one display for one reactor or for multiple reactors or for all reactors, up to 12 in NuScale design). This standard has not explicitly discussed issues arising in SMRs. This may be still in the research stage, but the standard should be clear if SMRs are not included in this standard.				x	The main objective of DS492 is to provide recommendations to meet SSR 2/1 Requirement 32 Design for optimal operator performance's 2/1 is explicitly meant for nuclear power plants, not SMRs. However, we believe that many recommendations in DS492 can be applicable to SMRs too.
267	14	USA	Ref.		We recommend that the guidance cite NRC regulations under 10 CFR50.120. § 50.120 Training and qualification of nuclear power plant personnel. Please consult NRC Specific requirements for providing the training and qualification of the following categories of nuclear power plant personnel: (i) Non-licensed operator. (ii) Shift supervisor. (iii) Shift technical advisor. (iv) Instrument and control technician. (v) Electrical maintenance personnel. (vi) Mechanical maintenance personnel. (vii) Radiological protection technician. (viii) Chemistry technician. (ix) Engineering support personnel.	Completeness to address specifics of training and qualifications of NPPs personnel.			x	DS492 provides recommendations on HFE aspects of training and qualifications of NPPs personnel. DS492 does not repeat recommendations to address specifics of training and qualifications, general to NPPs personnel. It provides reference to the IAEA safety guide NS-G-2.8 Recruitment, qualification and training of NPP personnel.. This is the Agency writing style.
268	15	USA	Table	I-1	Remove the phrase "in revision" following IEEE Std 845	The standard is not currently under revision	x			
269	16	USA	Table	I-1	Add IEEE Std 1707-2015, "IEEE Recommended Practice for the Investigation of Events at Nuclear Facilities" to the table.	The standard is missing from the table and should be added because it has a strong relationship to the safety guide.	x			
270	17	USA	Table	I-1	Add IEEE Std 1786-2011, "IEEE Guide for Human Factors Applications of Computerized Operating Procedure Systems (COPS) at Nuclear Power Generating Stations and Other Nuclear Facilities" to the table.	The standard is missing from the table and should be added because it has a strong relationship to the safety guide	x			
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	MS No.	MS	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	1	ZA	1	7	Requirements on HFE design and development of human machine interface (HMI) may vary from country to country based on country specific regulations and practices. Thus additional guidance on HFE design and development of human machine interface (HMI) is available from Member States and from other organizations that develop industrial standards. Such standards give much greater detail than is appropriate for IAEA safety standards. It is expected that this Safety Guide will be used in conjunction with detailed industry standards.	This gives context as to why it is neither appropriate nor desirable for this IAEA document to contain detailed guidelines.			x	We cannot use "requirements on design" in a safety guide. Moreover, this para is an introduction to the fact that there are available detailed industrial standers which are used to design specific equipment. Also, we do not discuss appropriateness of IAEA safety standards; we do our best.
272	2	ZA	2	19	Include "competence and training (or staffing and qualification)" as part of the list.	This is an important element that is reflected in almost all guidelines of member states on this subject.			x	We agree this is an important element, but it is covered in task analysis. Training is covered in different sections based on its specific purpose.
273	3	ZA	2	20	"Design Support during Operation, Maintenance and Decommissioning"	Consideration of a full systems lifecycle.			x	Well, originally, the decommissioning phase was included. However, it has been deleted because HFE related to decommissioning is already covered in DS-452 Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities. Per IAEA rule, we cannot provide recommendations on the same subject in two safety guides.
274	4	ZA	2	21	4th bullet: HFE analyses should identify relevant operating experience (both positive and negative) with a focus on human performance factors and potential human error and its mitigation;	Use of "human performance issues" followed by "potential human errors" is synonymous			x	I think we distinguish between human performance and human error. Nevertheless, this safety guide will be thoroughly edited before publication.
275	6	ZA	2	23	Security considerations - new	Not covered totally			x	It was agreed in DPP that security aspects will not be included in this safety guide. There is number of security publications developed or under the development that deal with security aspects.
276	7	ZA	3	27	Bullet 5: Tasks which must sometimes be performed under extreme time pressure, harsh environmental conditions and context or extremely vital and rare.	Low frequency, high consequence ...	x			
277	8	ZA	3	42	Actions omitted or skipped;	Comprehensiveness			x	Action omitted includes skipped too.
278	9	ZA	3	42	Actions out of sequence or sync;	Comprehensiveness			x	out of sequence - out of synchronism, is it the same meaning?
279	10	ZA	3	43	Staffing, organization and qualification should be analysed for all tasks impacting safety to ensure that the required number of personnel, organizational interactions and adequate qualification of personnel are sufficient for successful task performance.	Clarity of objective			x	Too many adjectives; we try to avoid terms adequate, sufficient, representative, etc. in safety guides. This is too subjective.
280	12	ZA	3	45	The perception of the task, its benefits, and its acceptability for the personnel	Align with general context	x			
281	11	ZA	3	45	The ability to synchronize the contribution of each team member to the task;	Missing article	x			
282	13	ZA	3	47	"reference plant"	Need to be defined			x	Term reference plant is widely used in the IAEA publications.
283	14	ZA	3	50	The human performance impact is assessed when distributing the tasks between teams.	It cannot be addressed but assessed Task duration is not a factor between the teams	x			
284	15	ZA	3	55	As a minimum, operator tasks and actions credited in the safety analysis report, including relevant performance shaping factors, should be analysed and design criteria confirmed	Resolution is untrue	x			
285	16	ZA	3	57	Plant modification may alter the manner by which safety related tasks are executed and it should be assessed whether all safety related tasks can still be reliably executed.	Improve clarity of the sentence	x			
286	17	ZA	3	58	Assessment of important human tasks and actions should take into account potential hazards faced by personnel such as radiological exposure and make use of information sources such as review of operating experience, industry notices, peer review, and comprehensive risk assessments methodologies.	Clarity of the statement	x	3.58. Determination of important human tasks and actions should take into account potential hazards faced by personnel such as radiological exposure and may consider the use of information sources e.g. review of operating experience, industry notices, and previous risk assessments.		It is a determination, not assessment.
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1	18	ZA	4	9	Whether HMI provides information on incremental changes in anticipation of sudden disruptions or fault conditions (e.g. predictive displays);	Clarity of the statement	x			
288	19	ZA	4	20	The HMI design should support human performance under the full range of environmental conditions, ranging from normal to credible extreme conditions, such as loss of lighting, smoke, flooding, steam ingress and limited ventilation.	Added additional potential risks	x			
289	20	ZA	4	47	HMI interface should reduce the likelihood of unintended actuation by requiring deliberate multirole (two or more wo/man rule) action for their execution for actions that can have negative consequences.	Minimize individual risks			x	This para is not about human risks. But about reducing the likelihood of unintended actuation...
290	21	ZA	4	66	New bullet: Visual acuity considerations	Clarity	x			
291	22	ZA	4	77	The layout of components within a functional group should follow the sequence of use: Left to right, top to bottom, or other natural flow or ordered pattern.	Clarity	x			
292	23	ZA	4	102	The display system should communicate the intended information to the operator without ambiguity, loss of meaning, unnecessary time delay or latency	Clarity	x			
293	24	ZA	4	107	When several operators are required to interact with the system simultaneously, control entries by one operator should not interfere with those of another of higher priority.	Graded approach applies	x			
294	25	ZA	4	111	The display format of visual display units, e.g. table, diagram, or flowchart, should be consistent with tasks that the operator performs with the displayed information	Clarity of intent	x			
295	26	ZA	4	136	A storage space of emergency equipment that control room personnel may require during accident conditions should be provided with ease of access.	Completeness	x			
296	27	ZA	4	138	Workspace design of the main control room should consider environmental factors that can have effect on personnel performance including designing for thermal comfort, illumination considering emergency situations, auditory environments that ensure verbal communications, and facility layout.	Completeness			x	What is recommended here?
297	28	ZA	4	159	Follow the course of the plant's behavior or response	Completeness	x			
298	29	ZA	5	15	The tracking of the HFE discrepancies as necessary;	Clarity	x	See Canada comment 61		
299	30	ZA	5	25	physiological factors	Addition			x	are biometrics, fatigue, reliability psychological factors?
300	31	ZA	5	25	workload	Addition			x	same as previous comment.
301	32	ZA	5	25	Delete "Reliability;" or clarify	Subtraction			x	Reliability is an important element.
302	33	ZA	6	9	Any new HFE design related issues have been captured and assessed, and a suitable route to resolve assigned;	Clarity	x			
303	34	ZA	8	79	1st bullet: Help the operator to recognize the progress of the automation and to make any relevant and necessary decision/adjustment for the procedure to continue;	Clarity	x			
304	35	ZA	8	79	Enable the operator to authorize the procedure to continue.	Clarity	x			
305	36	ZA	8	84	Information about the interruption such as why the sequence has been interrupted, what steps have been completed and which ones are still pending to be executed should be provided by the computerized procedures system.	Editorial	x			
306	5	ZA	Fig	1	The HFE program management block should also extend to the last column.	HFE program management is also important during the operation phase. The figure suggests that it ends during the design implementation phase			x	Well, in DS492 we use HFE programme management in the development and implementation process. We considered the design support to be outside HFE programme management.
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