

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
7	DE	1	2	This publication takes into account developments, experience and practices in integrating human factors engineering such as: (i) Human factors engineering shall be integrated into the design of nuclear facilities throughout the (iterative) design lifecycle, incl. requirements acquisition and analysis, design, and design evaluation (ii) Human factors engineering shall be integrated into plant operation, maintenance, administration, etc. throughout the plant lifecycle. into the design of nuclear facilities throughout the plant lifecycle.	Clarification			x	Firstly, we do not have shall statements in this document. Secondly, it is implicit that plant life cycle covers the phases described in bullet one of the comment. Finally, this is also covered as a part of clause 1.3.
2	JP	1	2	This publication takes into account developments, experience and practices in integrating human factors engineering into the design of nuclear facilities throughout the plant lifecycle, <u>with due consideration to organizational factors</u> . It references and takes into account other IAEA Safety Standards that are relevant and relating to HFE design. Most notable among these are the Safety Requirements GSR Part 2 [4], Leadership and Management for Safety, <u>especially systemic approach</u> and its supporting Safety Guides GS-G-3.1 [5], Application of the Management System for Facilities and Activities, and GS-G-3.5 [6]. The Management System for Nuclear Installations. <u>* Systemic Approach is an approach relating to the system as a whole in which the interactions between technical, human and organizational factors are duly considered.</u>	Clarification. Organizational factors should be considered in this publication. The wording of "human, technology and organization factors", that is, "systemic approach" defined in GSR Part 2, appears frequently in section 2 and section 3. In addition, the definition should be described in a footnote.			x	Organizational factors is considered in this document. All factors should be given due consideration. We do not want to highlight just one set of factors. Systemic approach is covered in GSR Part 2, which is referenced in this safety guide. We do not believe that it is not highlighted here.
2	FI	1	3	The main topical areas for which this Safety Guide provides guidance are the following: — Considerations specific to HFE, including the human machine interface(s) for achieving compliance with the requirements established in Ref. [1]; — Competences needed for integrating human factors engineering into the design of nuclear facilities throughout the plant lifecycle for achieving compliance with the requirements established in Ref. [4]; — The HFE process to be considered in achieving human machine interface design across plant states.; — The HFE performance monitoring and integration of HFE into safety processes, applications and product selection.	Add: — The HFE performance monitoring and integration of HFE into safety processes, applications and product selection. The chapters 7 and 8 should also be covered.	x	Added: HFE performance monitoring, evaluation, and integration into safety processes, applications and product selection.		
1	IN	1	3	Clarification required: Please clarify which section addressed the guidance on 'Competences needed for integrating for human factor.....'	It appears such guidance is not covered in the document	x	Removed "Competences needed for".		
111	CAN	1	4	Question	Is the intent of this standard to have specific sections evaluated in respect to a PSR even though they are HF elements and not safety elements?	x	Yes, this is the general intent of this safety guide. However, we do not want intend to go beyond the guidance found in Section 8 of this safety guide (i.e. with respect to SSG-25)		

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2	ENIS	1	5	This Safety Guide provides a consideration of relevant HFE aspects for several important applications linked to design, such as: - Severe accident management ; - Plant modifications and modernizations for achieving compliance with the requirements established in Ref. [2]; - Development and use of operating computerized procedures (e.g. including computerized procedures the automatic sequence of steps in these procedures); - Automatic sequence of steps in computerized procedures. - Development and use of severe accident management guidelines.	The order of bullets should be modified for logic because severe accident management is not the top priority. Also the management of severe accident relies on guidelines in place of procedures for normal operations and accidents The section on p57 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.	x	Clauses 1.4 and 1.5 will be modified to align with the structure of sections in Chapter 8. We will not be removing Severe Accident Management bullet. The order of the section in Chapter 8 does not represent the order or priority of the topic.		
4	RF JSC Atomen ergopro ject	1	5	The list of applications is not complete and not structured. It would be useful to change the list in more structured manner, starting with : • Development of procedures (Emergency Operating, Abnormal Operating, Maintenance /test, etc.) An ending with: • Development of Design of Mitigation Strategies & Beyond Design Human factor issues	The current list is aimed to present applications, but some of them are not (e.g. "Automatic sequence of steps in computerized procedures")	x	Clauses 1.4 and 1.5 will be modified to align with the structure of sections in Chapter 8. The order of the section in Chapter 8 does not represent the order or priority of the topic. The intent of this clause is not provide all the applications possible, but simply to introduce special topics.		
8	DE	1	6	... Personal protective equipment (<u>used during</u> e.g. maintenance activities, ...	For better understanding.	x			
3	JP	1	6	Add a following bullet: - Non-permanent equipment for severe accident management	In existing plant, non-permanent equipment is essential to use in severe accident condition taking into account the human factor engineering in design as well as operation.			x	This clause is meant to introduce topics in Chapter 8, HFE integration of product selection. Non-permanent equipment that may be used in severe accident conditions could fall under the category of HFE review for commercial off the shelf equipment.
5	RF JSC Atomen ergopro ject	1	7	Propose to remove this para OR to provide list of recommended standards that can be used in conjunction with this SG	Para does not provide any valuable information. In the current form it is a kind of disclaimer.	x	Modified the clause by adding reference to Annex 1.		
9	DE	1	8	".guidance on HFE in the design and modification of human machine interface". Please note that the modification of human machine interface(s) normally follows modifications of the plant's I&C and potentially modifications of the plant's systems and equipment – all of which may impact the nature and performance of operators' tasks. To better understand which HMIs are modified, why, how – and be able to assess how these modifications' affect human performance – knowledge of the corresponding modifications of the I&C (incl. automation) is essential.				x	No recommendation provided. We agree with the note but also we think necessary changes to the HMI may require changes to I&C.
3	RF JSC Atomen ergopro ject	1	8	The objective to minimize risk stated in para 1.8 should be better elaborated in SG.	Para 1.8 states that objective of this Safety Guide (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). However, there is no paras in SG that suggest how the impact on risk can be evaluated and minimized.			x	Sufficiently acknowledged in the document references to safety analyses such as PRA and Deterministic analyses, which cover human reliability analysis.
4	JP	1	9	The Safety Guide identifies the input information needed to design and validate the human machine interface and the basis for human tasks and including decision making across plant states as defined in Ref. [1].	Editorial. "Decision making" is also one of the "human tasks."	x	Modified the clause as follows: The Safety Guide identifies the input information needed to design and validate the human machine interface and the basis for physical and cognitive human tasks.		

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5	JP	1	12	This Safety Guide is meant to be applied using the systemic approach defined in Ref. [4].	The approach other than the systemic approach is not defined in Ref [4]. Therefore, suggested to be described explicitly.			x	Organizational factors is considered in this document. All factors should be given due consideration. We do not want to highlight just one set of factors. Systemic approach is covered in GSR Part 2, which is referenced in this safety guide. We do not believe that it is not highlighted here.
6	JP	1	13	Delete this paragraph	Duplicated with para 1.8.	x	1.13 Deleted.		
6	RF JSC Atomen ergopro ject	1	13	Remove one of this paras as they duplicate each other	Ducation of information	x	1.13 Deleted.		
1	ENIS	1	14	"This safety guide applies to the implementation of the HFE aspects of HMI design, operation and maintenance for new plant designs as well as for modification of existing plants."	The scope of this standard needs to be clearer. It later asks for assessment of maintenance tasks for example. The scope appears much wider therefore than the HMI. It appears to include maintenance and test of the system that the HMI controls.	x			
128	CAN	1	15	Add "decommissioning" to list of life cycle.	Full life cycle of plant.	x	We agree it can be used by organizations involved in decommissioning. Please note however, we do not provide recommendations specific to decommissioning because it is provided in SSG XXX. Also we did originally have a section on decommissioning but we were asked to remove it because it overlapped with SSG XXX.		
3	FI	1	15	This Safety Guide is intended for use by organizations involved in design, manufacture, construction, modification, maintenance, and operation, for nuclear power plants, in analysis, design, verification and validation, , implementation, and monitoring and in the provision of technical support, as well as by regulatory bodies.	Replace review with: validation, , implementation, and monitoring and The whole design life cycle needs to be included	x			
112	CAN	1	16	Add, "For certainty, malicious acts and sabotage are beyond the scope of human factors engineering."	This is the mandate of the nuclear security regulations. Any such analysis would seek inputs from design and design-assist analysis such as HFE.			x	We agree with the rationale (i.e. design assistance would be provided to nuclear safety activities as required) provided by the comment. However, the terminology used in this clause complies with IAEA safety glossary.
127	CAN	1	17	Clarify.	Organization analysis needs to be defined further to understand and interpret how this analysis is performed.	x	We decided to modify the sentence as follows: Section 3 provides recommendations for HFE analyses of operating experience, functional requirements and allocation, tasks, staffing, organization, qualification and important human tasks. Section 4 provides recommendations for HFE design. Section 5 provides guidance on verification and validation of human factors in the design process.		
129	CAN	2	0	Clarify.	Some of the clauses imply the program is for the facility and some seem more appropriate for a project-specific program.			x	No recommendation provided. It is the intent of the safety guide to provide guidance for both the facility and for project specific programs as required in GSR Part 2.
12	DE	2	4	HFE should ensure successful integration of human characteristics and capabilities into nuclear power plant design <u>and plant operation, maintenance and administration.</u>	Clarification	x	Clause was modified as follows: "HFE should ensure successful integration of human characteristics and capabilities with nuclear power plant design, operation, and maintenance." This incorporates comments from multiple member states.		

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1	FR	2	4	To insert between §2.3 and §2.4 the following new paragraph : "HFE should ensure that the design takes into account all factors which may influence the human performance in all kind of situations people will encounter at work for operating the facility and that they will be able to operate in suitable conditions for ensuring safety."	In the objective of the document in 1.8 it is written: "... and optimize human performance to ensure safe operation of the nuclear power plant". The new paragraph provides in chapter 2 a requirement about optimization of human performance. It is consistent with the text of the TECDOC in progress on Oversight of HOF (cf. Jean-René Jubin).			x	Clause 2.4 was modified as follows: "HFE should ensure successful integration of human characteristics and capabilities with nuclear power plant design, operation, and maintenance." This incorporates comments from multiple member states. See also definition of HFE in the IAEA Safety Glossary, which is essentially what is suggested in the proposed text of the comment.
7	JP	2	4	Add underlined text in para 2.4 and delete 2.16. HFE should ensure successful integration of human characteristics and capabilities into nuclear power plant design <u>,duly considering organizational factors.</u>	Clear description by integrating two paragraphs. The same as comments #2.			x	We've modified Clause 2.4 as follows: "HFE should ensure successful integration of human characteristics and capabilities with nuclear power plant design, operation, and maintenance." This incorporates comments from multiple member states. We are retaining Clause 2.16 because we believe it stands on its own.
8	RF JSC Atomen ergoproj ect	2	4	HFE should ensure that human characteristics and capabilities are comprehensively accounted for in nuclear power plant design.	The current wording is unclear as it is impossible integrate human characteristics into plant design.	x	Clause was modified as follows: "HFE should ensure successful integration of human characteristics and capabilities with nuclear power plant design, operation, and maintenance." This incorporates comments from multiple member states.		
1	USA	2	4	HFE should ensure successful integration of human characteristics /capabilities and nuclear power plant design.	The current wording suggests that the design have human characteristics. The intent is to have the system accommodate human characteristics and therefore the alternative wording is proposed as more accurate to the intent.	x	Clause was modified as follows: "HFE should ensure successful integration of human characteristics and capabilities with nuclear power plant design, operation, and maintenance." This incorporates comments from multiple member states.		
4	CAN	2	6	HFE is an iterative rather than linear process because the diversity of human characteristics and the variability in human performance means that human interactions with systems and equipment cannot be totally predicted. Therefore an empirical and iterative approach must be applied to develop, test and specify the aspects of the design that underpin desirable human performance. HFE processes are also iterative because of the interactions and dependencies with other technical disciplines involved in plant design.	The main reason that HFE is iterative and not linear is because the diversity of humans and the variability in human performance means that human interactions with systems and equipment cannot be totally predicted. Therefore an empirical and iterative approach is applied, to develop, test and improve those aspects of the design that underpin human performance.	x	Paragraph deleted. It is informative and we don't see the value in explaining why HFE is iterative just that activities should be iterative as identified 2.27 and 5.3		
13	DE	2	6	HFE is an iterative ... process due to the highly dependent nature of HFE with other technical disciplines <u>and the tradeoffs among the solutions provided by these disciplines. In addition, following a top-down approach, as more detail becomes known, rethinking certain design decisions may be considered advantageous.</u>	Clarification.	x	Paragraph deleted. It is informative and we don't see the value in explaining why HFE is iterative just that activities should be iterative as identified 2.27 and 5.3		
5	CAN	2	7	A HFE program should be developed and available for review and reference by the design team and the customer.	Unclear who should review the HFE program.	x	Clause modified as follows: "A HFE programme should be developed and documented."		
3	ENSI	2	7		It is not clear to me what "available for review" means	x	Clause modified as follows: "A HFE programme should be developed and documented."		
7	CAN	2	8	-- Organizational factors (e.g., management system, organizational structure, governance, resources, staffing levels, the roles and responsibilities of managers and plant personnel).	Staffing levels is missing	x			
6	CAN	2	8	-- Technical factors (e.g., technology including controls and displays, software, hardware, tools, equipment, plant design and plant processes);	The definition of HMI on page 71 is broader than the hardware / technology and includes the management system (procedures) and organization (interfaces between staff).	x			
14	DE	2	8	knowledge and expertise, cognition, performance requirements <u>performance and behavior</u>	Clarification.	x	We decided to modify performance requirements to performance expectations.		
130	CAN	2	10	Remove clause 2.10.	This clause is very vague for a standard and more of a theoretical principle. It is also a duplicate of other management system requirements.			x	This is not a requirement. It is a guidance statement and represents good practice. The intent is that technology should not be introduced without considering the potential impact.
15	DE	2	10	taking newly developed information, analysis methods, knowledge and features of new technology into account <u>following the verification of their applicability</u>	Clarification.			x	Verification and validation is an integral part of HF in design and is addressed throughout the document.

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3	ENIS	2	11	"The HFE programme should follow the approach defined in Ref. [4] in order to identify the appropriate level of rigour, resources and detail to be applied on a risk informed basis."	The work scope would be risk informed with a graded approach to develop a proportionate work package (looking at the time, trouble and cost).			x	This is already covered in reference 4, which we've included in this paragraph.
8	CAN	2	12	Change evaluation to evaluations	editorial	x			
16	DE	2	12	design of human machine interfaces (<u>e. HMIs, procedures, other decision aids</u>)	Recall that NUREG's HSIs (Human System Interfaces) are believed to include all means of task support.			x	HMI is already defined in the Definitions section.
4	FI	2	12	The HFE programme should outline the HFE processes as well as inputs and outputs for these processes. The HFE processes include analyses, design of human machine interfaces, and evaluation such as verification and validation and monitoring of human performance.	Add: and monitoring of human performance. The HFE programme should not end in final validation. Often there are difficulties in maintaining the performance level achieved in final validations. It is typical for human practices to start drifting.	x	Clause modified as follows: "The HFE programme should outline the HFE processes as well as inputs and outputs for these processes. The HFE processes include analyses, design of human machine interfaces, evaluations such as verification and validation, and monitoring of human performance."		
113	CAN	2	14	Question: Identify as in roles and position of individuals? HF program or design program?	This is larger than the HFE program scope for coordination identification and should be identified in the management system program.	x	Clause modified as follows: The HFE programme should identify the coordination required between responsible personnel for the HFE programme, project and design authorities, and different disciplines in order to perform HFE activities.		
8	JP	2	14	The HFE programme should identify the coordination required between responsible personnel, <u>designated entity of</u> project and design <u>authorities</u> , and different disciplines in order to perform HFE activities.	Clear description using the terms defined in SSR 2/1 (Rev. 1) to avoid misunderstanding by using the term "authorities".	x	Clause modified as follows: The HFE programme should identify the coordination required between responsible personnel for the HFE programme, project and design authorities, and different disciplines in order to perform HFE activities.		
2	USA	2	14	...personnel responsible for the HFE programme, project and ...	Clarity, current wording not clear who responsible personnel are.	x	Clause modified as follows: The HFE programme should identify the coordination required between responsible personnel for the HFE programme, project and design authorities, and different disciplines in order to perform HFE activities.		
9	CAN	2	15	Add the following after clause 2.17: HFE should take an active role in the design as an integrated design team member, as opposed to acting as a remote advisor to the design team.	While there is nothing wrong with clause 2.15, this and the "general" section seems to indicate the role of HFE in the design process as advisor or analyst, instead of as an integrated team member in the design process. Some clarification of good practice is needed, as suggested.	x	Inserted ne 2.17a. "The HFE programme should specify that HFE has representation in the design team, as opposed to being remote to the design team."		
131	CAN	2	16	Clarify.	Competence requirements require further clarification. Is this design competence, HF analyst competence?	x	Clause modified as follows: "The HFE programme should identify the responsible organization and competence requirements (e.g. qualifications, skills, knowledge, and training) for personnel responsible performing human factors engineering."		
2	FR	2	16	To add at the end of the paragraph : "including cases where HFE competences are fully or partially supported by contractors."	Relations between the operator (licensee, owner) and contractors in the program management are important and have to be stated clearly.	x	Clause modified as follows: "The HFE programme should identify the responsible organization and competence requirements (e.g. qualifications, skills, knowledge, and training) for personnel responsible performing human factors engineering." This does not be specified by the SG and at the discretion of the member state.		
9	RF JSC Atomen ergoproject	2	16	To elaborate better what specific "organization and competence requirements" are needed.	SG should provide at least some guidance, but not only declarations.	x	Clause modified as follows: "The HFE programme should identify the responsible organization and competence requirements (e.g. qualifications, skills, knowledge, and training) for personnel responsible performing human factors engineering."		
17	DE	2	18	<u>the purchasers utility</u>	Clarification.	x			
2	IN	2	18	For the new plant design, it should be ensured during procurement the purchasers should assure themselves that the intended plant design has followed appropriate HFE standards and elements of this Safety Guide.	The term purchasers seems to be person centric rather than a stage of project for initiating purchase.	x	Removed "purchasers" and replaced with "utility"		

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1	RF Rosatom	2	18	In the HFE program take into account the stressful condition of personnel in emergency situations and the corresponding adequacy of this state of personnel man-machine control panels of main control room and reserve control room in harsh environmental conditions.	The lessons learned from the accident at the Fukushima Daiichi nuclear power plant in 2011. (IAEA report on the accident at the nuclear power plant Fukushima Daiichi, volume 2, par. 2.6.8, p. 146-147)			x	This already addressed by other clauses throughout this guide. For example, Control room habitability is already considered in 3.28.
4	ENSI	2	19		What is the difference between "design implementation" and "implementation"? Does the term "implementation" mean the commissioning of a "HF engineered" product in the plant? Does the term "implementation" contain this message?	x	Replaced Design Implementation with just Design to be consistent with the example figure.		
3	IN	2	19	Add: - The term "Design Implementation" in 3rd bullet should be renamed as "Design". - The term "Implementation" in 5th bullet should be renamed as "Design Implementation".	To be consistent with Fig. 1.	x			
132	CAN	2	20	1. Merge first two columns in Fig 1 while keeping the titles. 2. Split verification & validation as separate activities (see Fig A1 of ANNEX A of CSA N290.12-14).	1. Consistent with the current design process. 2. It is not clear what is meant by "HFE Implementation" as actions listed in clause 2.24 are also validation and verification activities. Items listed in Section 6 are also mostly verification activities.			x	Figure 1 is simply an example. Also, often concepts are developed first as a part of an RFP for a project and requirements are developed once an option is chosen. Verification and validation are combined for simplification with the understanding that both can be performed iteratively. The clauses found in the Design Implementation here are consistent with the intent of NUREG 0711 section on Design Implementation but with consideration from other member states as well.
10	DE	2	20	Include a V Cycle into the figure.	HFE should as any other engineering discipline follow the required V cycle. The figure should show and explain this approach			x	This would complicate this example, which is meant to be a simple example. However, an iterative process is discussed several times in the document.
5	FI	2	20	(picture) HFE Design and V&V should start already in concept phase. It could be considered the division of the HFE Design phase into two phases the Conceptual Design phase and the HFE Design phase.	The intended concept should be validated from HFE perspective. If not the effectiveness of HFE is compromised. E.g. level of automation must be validated from HF perspective.			x	While we understand the concerns with starting verification and validation late, we would like to emphasize that this figure is an example and that member states can choose to perform V&V activities earlier depending on their circumstances. We advocate an iterative process. Many member states find it difficult to validate a concept design.
1	RF Atomstr ojexport	2	20	Modification of the Figure 1 The bar graph of "HFE Program Management" should end in the middle of "Design Support" stage.	It's necessary, because the results of the HPM analysis should be considered in HFE processes.			x	This figure provides an example, but the consensus from member states is that HF programme management should continue through to the end of design implementation in order to account for activities such as the resolution of issues found during design implementation.
11	CAN	2	21	-- HFE analyses should ..., and which support the developing concepts of operations and maintenance.	editorial	x			
10	CAN	2	21	-- HFE analyses should specify human factors-related requirements (such as the anticipated levels of operators' skills, training, numbers of personnel and tools or equipment needed) as inputs for defining and selecting appropriate design choices	Needs clarification			X	The proposed text does not change the intent of the clause and can complicate it.

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133	CAN	2	21	1. 2.21 -Bullets 2 and 6 should be addressed in management standards, not this guide. Clarify Clause 2.22 – intent, scope of design phase covered, position within the section. Clause 2.2.3- Given the issues raised within this comment, it is not clear that 2.23 is complete. It is not possible to comment comprehensively on 2.21, 2.22, and 2.23 until the basis of these clauses is clarified.	The second bullet is unclear and requires further explanation. Bullet 6 is beyond the scope human factors in design Clause 2.22 (which deals with HFE analyses goals) is positioned after Clause 2.21 (which deals with HFE inputs to be considered in concept design). Clause 2.23 deals with HFE inputs required for the design phase, and clause 2.24 deals with design implementation. Given that 2.21 covers conceptual design phase and 2.24 covers implementation, the implication is that 2.22 covers the preliminary and detailed design phases, although this is not stated explicitly. Also, 2.22 specifies that HFE inputs need to be considered in the functional requirements development phase. This may happen during conceptual design and preliminary design. The positioning of the topic of clause 2.22 implies the analyses and products are required for conceptual design. It is not possible to carry out all the HFE analyses and produce all the products in 2.22 during conceptual design (and perhaps during the functional definition activities – which may be during conceptual and preliminary design.)			x	Correct, 2.21 - 2.24 address activities that are performed during different engineering design phases described in the example Figure 1 and this has been explicitly stated in the introduction to the bullets. 2.22 was modified to say "requirements development" phase as opposed to functional requirements development based on another reviewer's comments. Agreed. It may not be possible to carry out all the activities in 2.22 during the conceptual design, which is why the clauses are framed as "should be considered". Finally, we believe that bullet 2 (consistent with CNSC 6.5) and 6 of 2.21 are valid and within the scope of HFE.
6	FI	2	21	- HFE validation should provide high level preliminary feedback to the intended concept from human factors perspective concerning the degree to which intended concept facilitates the achievement of safe operation of the plant	Add: HFE validation should provide high level preliminary feedback to the intended concept from human factors perspective concerning the degree to which intended concept facilitates the achievement of safe operation of the plant HFE validation should provide high level preliminary feedback to the intended concept from human factors perspective concerning the degree to which intended concept facilitates the achievement of safe operation of the plant The intended concept should be validated from HFE perspective. If not the effectiveness of HFE is compromised			x	Member states can choose to perform V&V activities earlier depending on their circumstances. We advocate an iterative process. Many member states find it difficult to validate a concept design.
3	USA	2	21	7th bullet. . . and support development of the concepts . . .	HFE analyses should be formative in the development of the concepts of operation and maintenance. As written, the analyses only support the developed concepts, implying that HFE does not have a role in developing the concepts.	x	Modified as per another member state comment as follows: HFE analyses should . . . , and which support the developing concepts of operations and maintenance.		
12	CAN	2	22	HFE analyses should provide insights and consideration of how operators should respond to and control system failures and HMI failures. The following HFE inputs should be considered in the Requirements Development phase: (1) Results of the function analysis that identify functional requirements for the system; (2) Specific HFE design principles and HMI design guidelines for the development of vendor technical specifications, and for their incorporation into design requirements	This clause uses the term "functional requirements development phase", whereas Fig 1. (more correctly) calls this phase "Requirements Development. The document should be scanned for this and the term "functional" removed. There is more to requirements development than just functional requirements. See also the comment and suggestion for clause 2.22 below	x			
13	CAN	2	22	Results from task analyses that provide insights into (a) the sequence and flow of tasks and (b) potential human errors, as well as considerations that impact human performance and provide error reducing and performance enhancing design features, (c) safety significant complex tasks that will require detailed analysis and HFE evaluation during the design process, (d) timeline constraints for significant tasks, (e) insight into specific knowledge, skills and abilities needed by personnel to perform their assigned tasks	Only one of the bullets indicates that items are the results of task analysis. This needs to be specified more broadly, as suggested.	x			
11	DE	2	22	Insight into specific knowledge, skills, and abilities needed by personnel in order to perform their assigned task(s) (<u>e.g., hard skills like technical knowledge and soft skills like communication and problem solving strategies</u>).	To highlight that insights into specific knowledge comprises hard and soft skill abilities.			x	Consensus is to refer to skills generally and not differentiate between hard and soft skills.

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18	DE	2	22	...how operators should detect, respond and control system failures... 1st bullet: ... functional requirements related to monitoring and control functions that are used ... 4th bullet: ...impact positively affect human performance... 6th bullet: ...timeline timing...	1st bullet: Please state that the "functional requirements" in question are related to monitoring and control functions (as opposed to other plant functions like the boration of water). 2nd bullet: Your notion of "functional requirements" seems to mean "required HMI functionalities" and as such their analysis and identification follows the Task Analysis . According to NUREG (and others), Task Analysis is normally done after the monitoring and control functional requirements have been analyzed and assessed, and those allocated to human operators (vs. I&C automation) are made subject to Task Analysis. Notwithstanding this, please note that task support (identified in the task analysis) may include collaboration among operators, field operators especially; or the shift supervisor. Please add. This will then be referenced in the HFE Program element "staffing". See 3.44 ff 6th bullet: referring to the time available for action, the required response time, etc.			x	The intent of functional requirements are furthered defined as a part of the Section 3. Modification to bullet 6 does not provide added clarity to the clause. Overall, we reject the proposed modifications outlined in the comment. However, based on the reasoning provided, we have added a bullet regarding coordination and collaboration among individuals or groups needed to support a task.
5	ENSI	2	22		This para. describes an aspect of the analysis phase. However, it is not clear whether the paragraph is referring to the phase "analysis" (see HFE generic process) or to a phase called "functional requirements development phase" which is not described in FIG. 1. As becomes clear later (3.9ff.) the functional requirements analysis is considered part of the analysis phase. As the para. contains specific and detailed requirements that need consideration in a functional analysis it probably should be moved to the chapter "functional requirements analysis".	x	Modified according to CAN comment to clarify that we mean Requirements Development phase and not functional requirements development.		
4	USA	2	22	2 and 3rd bullet: Change analysis to analyses	Multiple types of task analyses will be required	x			
4	IN	2	23	Suggestion:: Only three HFE Design Principles (redundancy, diversity and connectivity) are mentioned. Consistent HMI, Uniformity may also be added	Important HFE considerations	x	Decided to delete (i.e. redundancy, diversity, and connectivity)		
134	CAN	2	24	Add, "Verification of design implementation to ensure all information and controls required for carrying out tasks has been provided in the design."	This aspect of verification is missing. See NUREG 0711, Rev 3.	x			
5	USA	2	24	1st bullet: Verification against applicable HFE design principles, codes, standards, and guidelines.	Changed for accuracy. The relevant criteria for is whether a design principle is applicable, not whether it is identified.	x	Modified as follows: "...against previously identified HFE design principles and applicable HFE design codes, standards, and guidelines". The expectation is that the applicable HFE design principles etc. have been identified as a part of 2.21.		
135	CAN	2	26	Add reference to "maintenance" such as, "safe operation and maintenance of the plant is valid throughout the plant life time."	2.26 mentions "maintenance" at start of the clause.	x	Clarified based on several member state comments. The clause is meant to address the fact that engineering still supports operations and maintenance. Clause modified as follows: "Human performance monitoring in support of design should be conducted during operation and maintenance phases in order to verify that analyses and assumptions determined during the design phase remain valid throughout the plant life time."		

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
19	DE	2	26	Please rephrase "Design support during the operation and maintenance phase" as design (!) is already done by the time the plant is operated and maintained		x	Clarified based on several member state comments. The clause is meant to address the fact that engineering still supports operations and maintenance. Clause modified as follows: "Human performance monitoring in support of design should be conducted during operation and maintenance phases in order to verify that analyses and assumptions determined during the design phase remain valid throughout the plant life time."		
6	USA	2	26	... in order to follow up and verify that analyses and assumptions regarding human performance remain valid throughout the plant life time	Changed for accuracy. Current wording suggested that re-validation was to assure that safe operation remains valid. It is the continued validity of the analysis that is in question.	x	Clarified based on several member state comments. The clause is meant to address the fact that engineering still supports operations and maintenance. Clause modified as follows: "Human performance monitoring in support of design should be conducted during operation and maintenance phases in order to verify that analyses and assumptions determined during the design phase remain valid throughout the plant life time."		
14	CAN	2	27	2.27-2.29 Remove these clauses from HFE ACTIVITIES WITHIN ENGINEERING PHASES, and include them in the GENERAL section.	These clauses are general points, which do not seem to relate to the specific engineering phases, and seem to be better placed in the general section.			x	The clauses in the general section are related to the content and expectation for HFE programme development. Clauses in HFE Activities in Engineering Phases provide guidance for conducting HFE activities described in the HFE programme.
136	CAN	2	27	Amend to say, "HFE is iterative within the design process; or phases of an engineering process."	There is a degree of an iterative HFE process that can be limited in most utilities by cost, resourcing, scheduling and workplace realities.			x	The proposed amended text does not seem to address the reason for amendment provided by the reviewer. Furthermore, the amendment suggested is already covered by the clause as in "HFE iterative within a design process" is similar to "iterative manner consistent with the overall design project"
7	USA	2	28	... activities should be communicated to <u>other</u> disciplines participating in the design"	The phrase, as written, "activities should be communicated to the disciplines participating in the design" implies that the HFE team is not participating in the design, which would be counter to effective HFE integration.	x			
20	DE	2	29	...discrete controls, indicators, and systems alarm annunciators ...	Clarification.			x	The consensus is that the word "systems" was intended and that alarms are covered as a part of indications.
10	RF JSC Atomen ergopro ject	3	0	This section requires thorough review, restructuring and editing.	Many paras in this section are meaningless. The structure of the section and flow of information is inconsistent. The guide by definition should provide recommendations that helps to perform HFE design and assessment, but this section in many cases just contain evident statements with no added value.			x	No specific recommendation provided.
11	RF JSC Atomen ergopro ject	3	1	These paras should be rewritten to make them more focus on HFE.	Currently these paras provides generals statements on the use of operational experience that has limited connection to the HFE issues.			x	No specific recommendation provided.
180	CAN	3	2	Comment	While OPEX and conclusions from event analysis can -- at most -- impact the design basis, they should not be the basis.	x	We've replaced basis with input		
182	CAN	3	3	Add: (b) to evaluate operational problems and issues in current designs that may be addressed during plant modernization and modifications to plant components. Clarify: What is meant by "candidate approaches" in point (c).	Operational problems and issues in current designs can be changed and improved upon in the modification process.	x	We incorporated recommendation for bullet b) and replaced "candidate approaches" with "design options".		
21	DE	3	4	Operating experience review should analyse both positive and negative aspects of performance and design, <u>to be kept or avoided, respectively.</u>	Clarification.			x	Consensus is that the proposed text does not provide clarity.

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
15	CAN	3	5	4th bullet -- Operating experience from other nuclear power plants, process industries and high-reliability organizations.	High technology industries may not be focused on high-reliability, and reliability issues may be acceptable or tolerated. High-reliability operation does not necessitate high technology. Lessons can be learned from the range of process industries, such as chemical, oil and gas. In some cases these may not be considered as high-reliability organizations, although their OPEX may be relevant.	x	Modified as follows: "Operating experience from other nuclear power plants and industries."		
22	DE	3	5	4th bullet ...and high technology industries if considered applicable	Clarification.	x	Modified as follows: "Operating experience from other nuclear power plants and industries."		
137	CAN	3	6	Add: "- Use of "nuclear-related" products or tools within non-nuclear facilities."	Additional clarity and guidance.			x	This comment seems more appropriate for clause 3.5. The modification of 3.5 as "Operating experience from other nuclear power plants and industries." should address this comment.
16	CAN	3	7	Based on Member States' experience, effective HFE design requires involvement of HFE specialists during the concept development phase to consider human and organizational aspects of the concept options.	Unclear what "involvement of HFE" means here. It seems that HFE refers to the group or people who carry out HFE activities. The phase is called "concept development" in figure 1, and 2.21, so this term should be used for consistency.	x	The clause was deleted because as the reason identifies, HFE involvement is described in 2.21.		
138	CAN	3	7	Remove.	This requirement is not relevant to OPEX. It is concerned with integration of HF during conceptual design. The wording of the requirement is unclear and implies that involvement of HFE during conceptual design is optional, which contradicts information in Section 2.	x	The clause was deleted because as the reason identifies, HFE involvement is described in 2.21.		
23	DE	3	7	Based on Member States experience, effective HFE design requires involvement of HFE already at conceptual stage. Move para before 2.5.	The requirement is important but would better fit in relation to the presented process or 2.5.	x	Agreed. It is important but we felt that clause 2.21 implies that HFE involvement has started in concept development.		
46	USA	3	7	... at the conceptual stage. (Missing "the")	Editorial	x	The clause was deleted because as the reason identifies, HFE involvement is described in 2.21.		
17	CAN	3	9	Title before 3.9. Put the material into two sections, namely (a) FUNCTION ANALYSIS and (2) REQUIREMENTS ANALYSIS	The word "Functional" is not appropriate because requirements analysis, development and specification are largely not about system functions, in the technical sense. Function analysis could be considered as part of requirements analysis. The document is not clear about requirement analysis, development and specification and confuses this with function analysis. Clauses 3.9 to 3.23 relate to function analysis, not to the broader requirements analysis. The section on requirements analysis should be considered in a separate section, which could be placed after clause 3.59. (See https://en.wikipedia.org/wiki/Requirements_analysis as a starting point for material for this section, which covers eliciting requirements, analyzing requirements and recording/specifying requirement)	x			
18	CAN	3	9	Function analysis and allocation should be conducted to ensure that the functions necessary to accomplish safe operation of the nuclear power plant are sufficiently defined, analyzed and allocated.	Function analysis does not necessarily consider functions that are specified in the requirements specification. This should be called "function analysis", as opposed to "functional requirements analysis"	x			
139	CAN	3	9	The information/data to be covered by a successful function analysis should be specified.	The document appears to be providing guidance on how to conduct a function analysis & what is required for the function analysis to be successful, but the information/data requirements (in terms of outputs to feed into the design of the product/system/equipment) are missing.	x	A clause was added to include the identification of information needed. Clause added: Function analysis should help identify the information (e.g. the information when the function is needed, available, operating, achieving its purpose or terminating) and controls that personnel require to accomplish operational objectives.		
9	JP	3	9	FUNCTIONAL REQUIREMENTS ANALYSIS AND FUNCTION ALLOCATION Add some examples for functional requirements analysis and function allocation.	Some examples would be very useful for understanding in this sub-section.	x	New clause added to include examples of information expected from a Function Analysis: 3.9a "Functional analysis should help identifying the information (e.g. the information when the function is needed, available, operating, achieving its purpose or terminating) and controls that personnel require to accomplish operational objectives."		

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
10	JP	3	9	Functional requirements analysis and allocation of functions should be conducted <u>for different operational and accident scenarios</u> to ensure that the functions necessary to accomplish safe operation of the nuclear power plant are sufficiently defined and analysed.	Clarification for the objective of "functional requirements analysis and allocation of functions".	x	Functional requirements analysis and allocation of functions should be conducted for all plant states to ensure that the functions necessary to accomplish safe operation of the nuclear power plant are sufficiently defined and analysed.		
19	CAN	3	12	3.12 - 3.22: Replace "functional requirements analysis" with "function analysis"	These clauses describes function analysis not requirements analysis, so this term should be used	x			
24	DE	3	14	...among plant functions and systems <u>and their support systems</u>	Clarification.	x			
6	ENSI	3	15	Consider adding a statement about the need for an approach to automation that aims at designing meaningful tasks for human operators that support him in controlling the technical system.	The "complementary system design approach" should be chosen.	x	The clause has been modified as follows: "The allocation of functions to human and machine should complement human capabilities (e.g. ability to improvise, flexibility, judgment, pattern detection) and machine strengths (e.g., rapidity, simultaneous processing of complex operations)."		
12	RF JSC Atomen ergopro ject	3	15	This para should be completely rewritten. It is would be also useful to define the term "allocation of functions"	The para has almost no sense. In particular second sentence: "Human limitations include cognitive factors as well as physical strengths and limitations".	x	The clause has been modified as follows: "The allocation of functions to human and machine should complement human capabilities (e.g. ability to improvise, flexibility, judgment, pattern detection) and machine strengths (e.g., rapidity, simultaneous processing of complex operations)."		
4	ENIS	3	16	"human performance strengths and weaknesses to assign allocate the functions to..."	Propose change to match usual nomenclature.	x			
13	RF JSC Atomen ergopro ject	3	17	Replace "regulatory requirements" with more general statements (safety margins, defense in depth principles, etc.)	Regulatory requirementen do not fit to this para	x	Clause modified as follows: "In addition to consideration of human capabilities, when allocating functions, designers should also include such factors as technology readiness, time requirements associated with systems response, and considerations for defence in depth."		
14	RF JSC Atomen ergopro ject	3	19	Instead of this para it is recommended to develop special section: "Documentation", where all aspects that require documentation will be listed.	It is not clear why only this specific aspect of overlapping should be documented. Generally the whole process requires documentation.			x	Too prescriptive; we leave on a Member State to decide what should be the content of associated documentation.
15	RF JSC Atomen ergopro ject	3	21	To rewrite the para to make it meaningful.	Currently the text seems meaningless: "Functional requirements analysesshould include consideration of functional requirements..."	x	Clause modified as follows: "Functional requirements analysis and allocation of functions should include requirements associated with the implementation of severe accident management guidelines."		
181	CAN	3	24	Delete the word "all" from the sentence to read, "The task analysis should consider relevant plant states, plant operating modes and end users of the tasks as determined by a graded approach " groups of operating personnel, e.g. reactor operator, turbine operator, shift supervisor, field operator, safety engineer, and operation and maintenance staff.	This should pertain to the end user in terms of modifications to existing plant equipment instead of a broad look at the control room. There isn't a delineation of a graded approach here.	x	Clause modified as follows: "The task analysis should consider plant states and groups of operating personnel, e.g. reactor operator, turbine operator, shift supervisor, field operator, safety engineer, and operation and maintenance staff that are relevant to the tasks being analysed.		
5	ENIS	3	24	"The task analysis should consider all plant states, all operating modes...."	In the IAEA Safety Glossary the definition of 'all plant states' includes all operation modes. Please consider deleting.	x			

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
20	CAN	3	25	Human, technology and organizational factors should be considered when performing task analyses.	There is likely to be more than one task analysis, and different analyses will usually be conducted to consider different aspects of the tasks performed.	x			
140	CAN	3	25	Clarify.	Organizational factors require further definition.	x	Clause modified to include examples of organizational factors.		
7	ENSI	3	25		What does it mean to consider H, T, O? Are the following points meant to explain this?			x	No specific recommendation provided. The definition of H,T,O is provided in the definition section. The definition is also provided in GSR Part 2. We provided examples of organizational factors as well in response to a comment by another reviewer.
21	CAN	3	27	Task analysis should include the context of the task (e.g., HMI, related tasks, procedures, organizational arrangements) in relation to the standpoints of people performing the tasks and of people who receive information or products of the task.	This clause is unclear because of the wording regarding the context of task performance that should be included in the analysis. Mainly editorial, with some clarification added	x	Clause modified as follows: "Task analysis should include the context of the task from the standpoint of its users in order to accomplish the task."		
16	RF JSC Atomen ergopro ject	3	27	1) It would be useful to present list of the most important tasks, but not the complete list of possible tasks. 2) To remove the following bullet: "Tasks which require individual work and/or co-operation/exchanges between different disciplines (e.g. operation, maintenance, procedure development, computer system engineering) and interested parties; 3) To remove the following bullet : Tasks which may or may not raise generic and/or specific risks	1) The essence of the statement is missing: what are the most important task that should be included in the analysis? 2) It means all possible tasks. What is the use of such statements? 3) It covers all possibilities. What is the use of such statements?	x	The introduction to the bullets in this clause was modified as: "The role and activities of human individual in a nuclear plant are wide-ranging, therefore the scope of analysis should include, as relevant, the following:"		
43	USA	3	27	Revise "individual" to "individuals"	Editorial	x			
44	USA	3	27	Revise "or extremely" to "or are extremely"	Editorial	x			
22	CAN	3	28	The roles and activities of individual humans in a nuclear plant...- Tasks that are performed...-- Tasks that vary...	editorial	x	Changed tasks which vary.		
23	CAN	3	28	TBD	The bullet "Tasks which may or may not raise generic and/or specific risks" needs clarification as currently it provides no additional information concerning how to identify tasks to be analysed.	x	Clause modified as follows: "Tasks which may raise generic and/or specific risks		
141	CAN	3	28	Remove 4th bullet.	The bullet, as written, is too vague.	x	Clause modified as follows: "Tasks which may raise generic and/or specific risks		
8	USA	3	28	... of individuals in nuclear	Delete "human" as it can be assumed and make individuals plural as required by context.	x			
45	USA	3	28	Tasks that are performed ... (Missing "that")	Editorial	x	Clause modified as follows: "Tasks which may raise generic and/or specific risks		
17	RF JSC Atomen ergopro ject	3	29	1) Task cannot raise safety issue (otherwise this task should not be considered). 2) Latent error or initiator is not a safety issues. It is just one of low probable outcomes of the task. 3) The logic should be completely changed: 1) All tasks should be analyzed 2) This analysis should identify task that has a potential to raise safety issues 3) to identify this potential analysis should take into account all aspects listed in bullets.	The logic presented in this para seems to be misleading or wrong	x	Agreed. Clause deleted as it was redundant with 3.28 and 3.30		
24	CAN	3	30	-- The task demands on plant personnel (operators or maintainers) who will have to perform the task, e.g., where the function analysis or task analysis indicates that the task is demanding for personnel, but which will not be automated.	Editorial, and clarification of the bullet is needed	x	Included a bullet as follows: Tasks identified as difficult by operating personnel where no plans have been made to automate the task.		
142	CAN	3	30	Remove "e.g., latent errors, initiators."	It is not clear why these are identified uniquely as examples.	x			
143	CAN	3	30	Provide a more comprehensive list or clarify why only these particular issues are mentioned.	It is unclear why the identified "bullets" are listed and other relevant considerations are not. Tasks should be analyzed with respect to: cognitive and physical requirements and capabilities of workers; information available; controls required/available; time required/available; - and many more.	x	We've modified this clause to address multiple comments.		

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Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
25	CAN	3	32	The results from Task Analysis should be used to identify the following: -- The expectations of how the task will be conducted, the expected task outcomes, and estimates of the reliability of human performance on the task	Editorial and clarification is needed.	x			
18	RF JSC Atomen ergoproject	3	32	1) This list under this para should be checked for consistency. The logic should be changed: It should start with identification of all tasks that include human interactions and then to identify aspect important from HFE point of view. The bullet "The expected human tasks and potential human errors which have an impact on safety demonstration" should be changed.	The logic of this para and content of some bullets misleading. For example, bullet "The expected human tasks and potential human errors which have an impact on safety demonstration". What does it mean? Do we have any human tasks and human errors that have NO impact on safety? Why "safety demonstration", but not just "safety"? What is the idea behind?	x	We deleted "demonstration". The identification of tasks to be analysed are covered under 3.38 with consideration to 3.30. The intent of the clause is to identify the expectations for the RESULTS of the analyses. We modified the order of the bullets such that there is a more logical flow.		
26	CAN	3	33	-- Walk-throughs and talk-throughs to analyze the predecessor system's task activities and tasks from similar plants, as well as the tasks related to the system being developed --Data from other analyses that are inputs to the HFE design process (e.g., function analysis, requirements analysis, human reliability analysis, training needs analysis)	Editorial and clarification is needed	x			
5	IN	3	33	Knowledgeable personnel from the design team, Operating personnel who have gained operating experience in similar plants , stakeholders and experts;	Including experienced operating personnel in task analysis adds significant value in task analysis and also ensures that due consideration is given as early as possible in the design process to the future operation and Maintenance of equipment.	x			
19	RF JSC Atomen ergoproject	3	33	Remove this para or provide details or references to the recommended techniques	The para is useless.			x	We believe this clause is useful for member states to understand where they may gather information in support of task analyses.
9	USA	3	33	Delete "also previous activities and"	The phrase "also previous activities" is problematic. The word also does not appear to fit in this context and previous activities is unclear and could benefit from specifying what previous activities.	x			
13	USA	3	33	Delete "also previous activities and"	The phrase "also previous activities" is problematic. The word also does not appear to fit in this context and previous activities is unclear and could benefit from specifying what previous activities.	x			
27	CAN	3	34	Add a new clause: The chosen scope and depth of the task analysis should be justified	3.34 covers justification of methods, but the scope and depth of the task analysis should also be justified.	x	Modified on 3.28		
147	CAN	3	34	The section should explain the range of goals that can be addressed via task analysis, which will impact on the methods chosen.	Clause 3.34 requires justification of the method. Maybe that clause could be modified. It is unlikely that the HFE Specialist will be looking at /analyzing ALL tasks carried out.	x	Modified 3.28		
20	RF JSC Atomen ergoproject	3	36	Remove this para	No added value to para 3.32.			x	It is guidance.
28	CAN	3	37	Change expertize to expertise	editorial	x			
10	USA	3	37	Replace "expertize" with "expertise"	Noun form is required in this context.	x			
144	CAN	3	38	Add other groups which may utilize the results of the Task Analysis, or add another clause relevant to this.	The results of the task analysis can be used during training/procedures, reactor safety analysis ...	x	Clause modified as follows: The results of the task analysis should be communicated to the others disciplines participating in the design for their consideration.		
11	USA	3	38	...other disciplines participating ..	The phrase, as written, implies that the HFE team is not participating in the design, which would be counter to effective HFE integration.	x	Clause modified as follows: The results of the task analysis should be communicated to the others disciplines participating in the design for their consideration.		
21	RF JSC Atomen ergoproject	3	39	To rewrite the para	The results of task analysis cannot "inform probabilities". They can be used to access probabilities.	x	Clause modified as follows: "The results of the task analysis can be directly used to support human error assessment."		
29	CAN	3	40	Task analysis should be performed where cognitive processes...	editorial	x			
114	CAN	3	41	Remove clause 3.41.	The scope of this clause is too broad. It is not within HFE scope to maintain a list of all tasks performed on system hardware. This is not realistic or achievable.	x			

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
148	CAN	3	41	Remove clause: A list of all tasks performed upon system hardware by operations, maintenance and support personnel should be maintained.	It is not the responsibility of the HFE "group" to maintain such a list.	x			
4	FR	3	41	To add at the end of the paragraph : "Methods used in HOF, such as interviews, observations, should be applied for collecting data useful for verifying that the human performance is good for performing the task as expected for safety."	Precision on methodological aspect on HOF	x	This comment does not seem to apply to 3.41.		
30	CAN	3	42	Add new clause: Where it is difficult or not feasible to simulate the tasks, tabletop walkthroughs of procedures and task descriptions, which can incorporate photographs, graphics, engineering drawings and aspects of the task analysis, can be used to obtain expert and stakeholder inputs.	Procedures do not include all aspects of the task and are often incomplete and idealistic. Table-top walkthroughs of procedures and task descriptions with experienced stakeholders (incorporating photographs, engineering drawings and task analysis results) can be a useful approach to obtain stakeholder inputs where it is difficult to simulate the tasks.	x	Clause modified as follows: "Table top analysis of documentation (e.g. procedures) alone may not be sufficient for determining that task can be performed. Stakeholder input and/or simulations by mockup, field walkdown, part task simulator, or full scope simulators may be performed to confirm feasibility in real scenarios."		
31	CAN	3	42	... with respect to the reference plant.	editorial			x	Adding this would preclude reviewing real scenarios for modifications or new design.
12	USA	3	42	... confirm the feasibility of the actions in real scenarios	The term "applicability" as used in this guideline is either incorrect or unclear. Applicability of what? Is the intent to confirm the feasibility of the action or the validity of the analysis?	x	Clause modified as follows: "Table top analysis of documentation (e.g. procedures) alone may not be sufficient for determining that task can be performed. Stakeholder input and/or simulations by mockup, field walkdown, part task simulator, or full scope simulators may be performed to confirm feasibility in real scenarios."		
145	CAN	3	43	Clarify.	For error taxonomy in particular equipment misalignments, actions omitted, wrong actions and failures in decision making should be removed. There are numerous error taxonomy schemes. Selection should be at the discretion of the HF analyst.	x	Clause simplified as follows: "Task analysis should contain an error classification that at a minimum captures the errors of omission, errors of commission, including decision errors."		
2	RF REA	3	43	3.43. Task analysis should contain an error taxonomy that at a minimum captures the following: — Equipment misalignments — Wrong interaction; — Actions taken too soon or too late; — Actions omitted; — Actions out of sequence; — Wrong actions; — Failures in communication; — Failures in decision making.	The error formulations seem to be neither distinct nor correct. "Equipment misalignments" is an error consequence rather than an error itself	x	First bullet deleted. Agree with reasoning but based on other reviewer's comment, we deleted entire list to simply as follows: "Task analysis should contain an error classification that at a minimum captures the errors of omission, errors of commission, including decision errors."		
146	CAN	3	44	Remove entire section.	While it is possible that some of the analysis and decisions listed in clauses 3.44 to 3.52 will be carried out, it is not clear that the HFE Specialist will be able to obtain agreement with the organization around assumptions (during design). Nor will it be the HFE Specialists' responsibility to assign job roles/tasks (which may be related to organizational design). The results of the HFE analysis may be inputs to such decisions – at a very detailed level. This entire section is unclear and its statements range considerably in terms of philosophy of what is covered. In 3.51, it is difficult to assess the impact between night and day shifts subjectively and objectively. HFE analysis should be looking at worst possible losses in prevention of the error.			x	Specific clauses may be modified for clarity but we cannot remove this section as it would pose as a gap in our safety guide around staffing, organization, and qualifications. The intent of this section is similar to that of Staffing Analysis in NUREG 0711 but with input from other member states with emphasis on organizational factors (fukushima lessons learned).
8	ENSI	3	44	Staffing, organization and qualification should be analysed for all tasks impacting safety in all plant states and operating modes to ensure that ...		x	Clause modified as follows: Staffing, organization and qualification should be analyzed for impacts on tasks important to safety to ensure that the required number of personnel, organizational interactions and qualification of personnel are sufficient for task performance.		
14	USA	3	44	Staffing, organization and qualification should be analyzed for impacts on tasks important to safety to ensure ...	The current wording limits the scope of the analysis to tasks impacting safety. Rather, the focus should be on safety impacts. Those impacts may come from other tasks that may not be important to safety, but could impact safety (e.g., through excessive workload).	x			

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
9	ENSI	3	46	3.44-3.46.	The difference between the two paragraphs is not clear.			x	3.44 discusses establishing a baseline for staffing and 3.46 considers the impact of a deviation from a referenced baseline.
32	CAN	3	49	-- Concept of operations in normal, incident and accident conditions	editorial	x			
33	CAN	3	49	Add design requirements to the list of items	Although task requirements and regulatory requirements are included in the list, the design requirements for the design being developed should be considered.	x			
25	DE	3	49	...plant operation...	Clarification.	x	Modified based on another reviewer's comment to say "Concept of Operation..."		
34	CAN	3	50	The task analysis results should be used to support defining roles, responsibilities and required outputs of the work groups.	"requirements" is unclear. Does this mean required outputs of the work group?	x			
26	DE	3	50	...working group operating crew...	Clarification.			x	We prefer to keep this broad to include maintenance crews etc.
35	CAN	3	51	The correct term is "work group"	Editorial. Ensure this is amended throughout the document	x			
27	DE	3	51	The human performance impact is assessed when distributing the tasks between teams working day and night (<u>considering the difference in day/night working conditions</u>)	Please identify in some word the differences (day/night work conditions) as the sentence can be confusing without this information.			x	Suggested edit does not improve clarity.
10	ENSI	3	51	Consider adding the following to the list: - The tasks allocation among team members ensures building and maintaining individual and collective situation awareness and developing and maintaining knowledge and skills		x	Modified the last bullet of the paragraph as follows: "The tasks required in various operating situations are assigned to work group members in order to ensure continuity of responsibilities and maintaining and individual collective situation awareness."		
36	CAN	3	52	Any reduction of staff numbers should be evaluated for potential impacts on safety, such as by modeling, analysis, simulation or full-scope simulator tests.	There are cases where staffing levels cannot be considered in full scope simulator tests, such as in emergency or accident-related activities that do not take place in the control room.	x	Modified based on reviewers comments as follows: "Any reduction of staff numbers should be evaluated for potential impacts on safety, such as by modeling, analysis, or full-scope simulator tests."		
11	ENSI	3	52	Any reduction of staffing or change in the organization of teams should be evaluated...	The impact of organisational changes in general, not only reduction of staffing, should be evaluated.	x	Modified based on reviewers comments as follows: "Any reduction of staff numbers should be evaluated for potential impacts on safety, such as by modeling, analysis, or full-scope simulator tests."		
15	USA	3	52	Delete "by simulations or"	The meaning of "by simulations" is open to wide interpretation and as such the validity of the approach is questionable.	x	Modified based on reviewers comments as follows: "Any reduction of staff numbers should be evaluated for potential impacts on safety, such as by modeling, analysis, or full-scope simulator tests."		
37	CAN	3	53	... responses during accident conditions.	editorial	x			
38	CAN	3	56	... should be analysed, and the ability for the design solution to achieve the necessary human performance related to safety requirements should be confirmed.	It is not clear why design criteria should be confirmed.	x			
149	CAN	3	56	Clarify.	Clarify that the reference to "safety analysis report" includes both deterministic and probabilistic safety analysis.	x			
47	USA	3	58	Revise "it should be assessed whether all these safety related tasks" to "it should be assessed whether all associated safety related tasks"	Editorial	x			
16	USA	3	59	"Determinations (e.g., feasibility, reliability) concerning important human tasks"	The wording of this guideline is vague and unclear. Is it intended to address determination of whether a task is important or determinations regarding important tasks? The list of considerations would seem to imply the latter. The guideline also does not specify what type of determinations.	x	We clarified that we mean identification of important human actions by rewriting this clause and moving it to the beginning of the section.		

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
150	CAN	4	0	Section 4 should be entirely re-written for clarity and several clauses deleted, as per the comments below.	For instance, 4.10 addresses the units of measurement of engineering variables while 4.11 discusses the design process inputs as being function and task requirement. If the document is meant to cover process, then the contents of 4.11 should be limited to that. It is not clear that details around design can be provided for all systems/equipment/ interfaces which exist in a NPP or related facilities. Some examples of documents which are more in this line are NUREG 0700 and MIL STD 1472. Both attempt to cover a wide range of design implementation requirements/guidelines – and both are enormous compared with this IAEA document. It is not clear what type of systems/devices etc. are intended to be covered and the philosophy for selecting what level of design guidance to include. Given the size of other documents, such as NUREG 00700 and MIL STD 1472, it is likely that this IAEA document has made some 'choices'. What is the philosophy? (Is it that the document focuses on Main Control Rooms and associated systems – Safety Parameter Display System? If so, why?). Since other IAEA documents exist which cover more details requirements for design, will the contents of the IAEA standard which results from DS-492 be entirely consistent with those other documents? It is not clear how the mixture of guidance /requirements can/will be tailored depending on the project.			x	This safety guide is intended to provide guidance to meet specific safety requirements of SSR 2/1. We will address comments regarding clarity and appropriate detail in this section with the understanding that the guidance is meant to provide high level guidance and not the kind of detail provided in NUREG 0700 and MIL-STD unless it is necessary address the requirements of SSR 2/1. In addition, the clauses found here also take into consideration guidance provided by other international standards guidance found with IEC, IEEE, EPRI etc. In response to the comment regarding other IAEA documents which cover more detailed requirements for design (our assumption is this means HFE related design), aside from possibly TEC DOCs, there is no safety guide that provides this kind of guidance.
12	ENSI	4	0	The operator of a nuclear installation commissioning a manufacturer with the design and production of systems/equipment should require the manufacturer to consider HFE throughout the project. The design specifications should include HFE related requirements both product as well as process related, including consideration of international standards as well as HFE related competences required/expected in the project or design team.	Should a recommendation be added concerning the inclusion of HFE related requirements in design specifications from the operator to the manufacturer? Product related specifications: requirements concerning the design of the system. Process related specifications: e.g. analyses to be performed such as task analysis, functional requirements analysis etc., iterative, human-centered design approach, HF V&V, etc.			x	Agreed. This is covered in Section 2.21 and 2.22 (relevant bullets). No modification necessary.
18	USA	4	5	The concept of defence in depth should be considered during HMI design to ensure that if a failure were to occur, it would be detected and compensated for or corrected by appropriate measures	It is not clear, as written, which phrases modify which subjects and thus how and when HMI design should implement defence in depth. The proposed rewrite is an attempt to interpret/clarify.	x			
39	CAN	4	6	Delete (human-centred design approach) and add (an integrated, systemic approach)	The first sentence describes an integrated, systemic approach. This is not the same thing as a human-centred design approach, which should be described separately	x			
40	CAN	4	6	Add before 4.6: HFE should consider the system or equipment being designed from the perspectives of the people who will carry out functions and tasks associated with the design (human-centred design approach).	Human-centred approach is cited in 4.6 in the wrong context and this needs to be described.	x			
151	CAN	4	6	Amend to say, "The human aspects, the machine (hardware and software), the work environment, and the control, operation and management should be harmoniously integrated during all phases of the design process (human-centred design approach).	"Harmoniously" is a subjective statement. As such, it is vague and difficult to provide direction for licensees to achieve a state of harmonious integration.	x	Replaced with harmoniously integrated with considered.		
22	RF JSC Atomen ergopro ject	4	6	The word "integrated" could be replaced with "considered"	Integration of "hardware" and "the work environment" during design process seems to be impossible.	x			
152	CAN	4	7	Remove.	This clause is vague for a standard and requires additional explanation to help users achieve its intent.			x	We've clarified the clause based on other reviewer comments and provided an example.
23	RF JSC Atomen ergopro ject	4	7	To define the term "organization" in the context of this para	Not clear term	x	Clause was modified as follows: Designers should consider how information relayed by the HMI will be communicated, exchanged and used by different work groups (e.g. main control room and emergency response facilities).		

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19	USA	4	7	...and used within and among organizations.	The concept of "an organization" is not clear in this context and could be interpreted in many ways to be as limiting as an operating crew or as broad as the entire operating company. The rewrite assumes the latter.	x	Clause was modified as follows: Designers should consider how information relayed by the HMI will be communicated, exchanged and used by different work groups (e.g. main control room and emergency response facilities).		
41	CAN	4	9	Whether equipment could be used outside of its designed function (e.g., use of a fire protection system to provide cooling)	editorial	x	Clause modified as follows: Whether utility implementation of 'stress tests' for plant systems in presence of severe accidents may provide insights on how operators and responders may use equipment may to achieve safety functions.		
153	CAN	4	9	5th bullet Remove.	"Stress testing" users and organizational structures with regard to unexpected uses of equipment beyond their design basis are not practical, realistic or achievable.			x	Clause modified as follows: Whether utility implementation of 'stress tests' for plant systems in presence of severe accidents may provide insights on how operators and responders may use equipment may to achieve safety functions.
24	RF JSC Atomen ergopro ject	4	9	1) The word "resilience" seems to be incorrect in light of bullets below. 2) To rewrite the highlighted bullet	1) Hard to connect the word "resilience" with bullets started with "Whether" 2) The meaning of the highlighted bullet is not clear.	x	Explanation provided.		
20	USA	4	9	.. how equipment may be used in unintended ways.	As written it is not clear if the intent is to identify creative solutions to unexpected events or adverse consequence from use of equipment in unintended ways. Stress tests would likely be useful for the latter but not the preferred/most effective approach for the former.	x	Clause modified as follows: Whether utility implementation of 'stress tests' for plant systems in presence of severe accidents may provide insights on how operators and responders may use equipment may to possibly achieve safety functions.		
62	USA	4	9	Replace "meets" with "meet"	Editorial	x			
115	CAN	4	10	Remove.	This is design-guide level input that needs to be in a lower-level document.	x			
13	ENSI	4	10		This is a very detailed recommendation. Is it well placed here? Shouldn't it rather be placed with 4.20ff.?	x			
42	CAN	4	11	Clarify what HMI characteristics are.	Unclear if the HMI characteristics are the HMI design specification, or intermediate deliverables.	x	Deleted clause because as suggested it is very similar to 4.12		
154	CAN	4	11	Change to HMI design requirements should be derived from HFE analysis.	The clause is vague and requires additional explanation to help users achieve its intent.	x	Deleted clause because as suggested it is very similar to 4.12		
43	CAN	4	12	Add "User characteristics analysis" as the second item in the list	User characteristics analysis and specification (known as Target Audience Description in other industries) is a fundamental early step in HFE, yet it is missing from this list			x	User characteristics are covered as a part of staffing, organization and qualifications.
14	ENSI	4	12	Add (cf. Chapter 3) after the first sentence	Reference to previous explanations about the analyses described in chapter 3	x			
15	ENSI	4	12		"Safety analysis" was not treated in chapter 3. What does it refer to?	x	Removed.		
25	RF JSC Atomen ergopro ject	4	12	Add more general "Defense in Depth principles"	Regulatory requirements in specific country might not be complete. More general guidance is needed.			x	Section 3, covers clauses associated with the consideration of Defense in Depth.
44	CAN	4	13	Add after Cognitive limitations and strengths of the users: -- Knowledge, skills and abilities of the user types	Specific knowledge skills and abilities of the user types/ populations is important and should be added.	x			
28	DE	4	13	...availability aswell as the indicators, controls, or alarms referenced in the corresponding Operating Procedure(s).	Clarification.			x	Only meant to provide an example. We cannot include all possible examples.
45	CAN	4	15	-- Task support requirements (e.g., lighting and ventilation requirements, or storage for paper procedures and surfaces for using them)	Add another example			x	Only meant to provide an example. We cannot include all possible examples.
46	CAN	4	17	A specific HFE design guide, referred to as a "style guide"...	editorial	x	Removed the term style guide based on other reviewer comments.		
155	CAN	4	17	The intent of these three clauses requires refinement.	A style guide is for a consistent look, which is different concept than a graphical user interface technical specification. The goal of HFE is human information needs and user requirements. This needs to be expanded with a separation between the two concepts.	x			
47	CAN	4	18	Should be "concept of operation"	Use the same term as in the glossary	x			

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16	ENSI	4	20		From here onwards until the end of chapter 4 most of the requirements concern the "product" (i.e. the design of interfaces, technical systems etc.), with some exceptions where the requirements concern the HFE process. Yet, the distinction between product and process related requirements is not made transparent in the document. I suggest to make the distinction clear to the reader. I wonder whether the product related aspects should be treated in this document at all: They are in part very detailed and specific (e.g. 4.46), but are probably still not comprehensive in order to give a manufacturer of operator all the information needed to specify its product. Wouldn't it be better to refer to international standards which explicitly address the specific design requirements in a comprehensive way? Are the product related requirements listed in this document drawn from international standards or was it made sure that they correspond to requirements of international standards?			x	We have addressed specific comments in this section to provide clarity. Clause 1.7 addresses the scope of this guide with respect to the level of detail and the intent that this guide be used in conjunction with other industry standards are decided by member states.
48	CAN	4	21	Add "high radiation levels" to the list of examples		x			
3	RF REA	4	21	4.21. The HMI design should support human performance under the full range of environmental conditions, ranging from normal operation to credible design extension conditions extreme conditions, such as loss of lighting, smoke, flooding, steam ingress and limited ventilation.	"From normal to extreme" would be incorrect. It is more reasonable to use the terms "from normal operation to design extension conditions"	x			
26	RF JSC Atomen ergopro ject	4	24	Suggest adding new para after 4.24 (or add to para 4.27) The HMI should be designed to reduce the operator errors in case of fault signal, indicators or alarms that might provide wrong understanding of the situation".	The recommendation for HMI design to be sustainable and provides enough information to operators to make correct decision even in case of wrong information.	x	We actually added a statement that resembles your reasoning for the comment and not the proposed text because we liked the intent. Clause added: HMI design should provide enough information to operators to support decision making in cases where wrong information may be presented.		
27	RF JSC Atomen ergopro ject	4	26	To remove the following bullets: f) Should be designed to minimize reliance on operator training; h) Should accommodate failure of analogue and video displays without significant interruption of control actions;	f) Recommendation seems to be wrong. Good HMI might require more training. h) more general para should be added (see Comment 25 above)			x	Consensus is that these are relevant guidance.
49	CAN	4	27	h) Should reflect consideration of human perception, physiology, characteristics of human cognition, characteristics of human motor control and anthropometry.	Human perception is missing. It is unclear why human physiology is cited, unless if is concerned with dose, toxicity, hearing damage etc.			x	Human cognition includes perception and yes, we included physiology for hearing and other body functions
29	DE	4	27	single failure of analogue and video display	A CCF of the displays will have an impact (change of interface... shut down after some time).			x	This safety guide addresses HFE desing; a consideration of CCF and SFC belongs to the I&C safety guide; please refer to SSG-39.
156	CAN	4	29	Remove or elaborate further.	This clause is very generic and theoretical with no defined method for achievement.	x	Clause modified as follows: The HMI, procedures and training programme should be designed and compared to ensure consistency with each other		
50	CAN	4	31	Add before 4.31: HFE should consider tasks concerning inspection, maintenance, test and repair of the hardware, software and HMI e.g., to ensure appropriate accessibility, lighting, training and procedures to support successful task performance.	The guide is not clear about good practices for the HFE design scope concerning maintenance etc.			x	The consideration for tasks and outputs from other analyse is covered in 4.12 and the need to consider inspection, testing, and repair is covered in 4.31.
52	CAN	4	32	Inclusion of maximum staffing needs to be explained	This requires some explanation, especially maximum staffing. Does this mean where there are observers or other stakeholders in the control room?	x	Agreed. Removed maximum.		
30	DE	4	33	...aswell as the interaction of the field operator (at the local control station) with the Main Control Room operator(s).	Clarification.			x	We deleted the clause as we felt it was already reflected in the section on habitability and working environment.
21	USA	4	36	...of control room with differences limited principally to those necessitated by environmental differences between the control room and local control stations."	Differences between MCR and local control stations environmental factors could warrant HMI differences.			x	Clause represents best practice and consistency to the extent possible and any differences should be explained and it could be justified.
31	DE	4	38	...reliable performance (<u>error free / availability / fidelity of present information</u>)	It is not clear what the definition of reliable is. Please describe it in more detail.	x	We mean the usual definition of reliable, which is correct, consistent performance. We've included "correct and reliable" for clarification.		

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
22	USA	4	38	A description should be provided of how the HMI presents controls, displays and alarms to ensure correct and reliable performance of actions necessary for maintaining plant safety.	Important human tasks are a small subset of tasks required for safe operation. Further, how the HMI supports these tasks should be consistent with how the HMI supports the other tasks necessary for safety, so it is not clear why this guideline is limited to important human tasks.			x	The intent is to provide a description for important human tasks with expectation that these would require regulatory review. It does not preclude descriptions provided for other tasks necessary for safety.
28	RF JSC Atomen ergopro ject	4	39	To add bullet: Risk indices associated with each HMI design option	One of the objectives of HFE (see para 1.8) is to minimize the risk.			x	There is no such para.
157	CAN	4	40	Replace these clauses with, "Usability tests may be utilized as required based upon a graded approach."	As written, this clause is vague and difficult to accomplish/validate in most business environments. Many utilities do not have access to the significant amount of funding needed to support this level of HFE-based trade-off evaluation and performance-based tests. This clause is more theoretical than practical.	x	Added: Usability tests...		
158	CAN	4	42	Remove.	Providing personnel based performance assessment cannot be achieved in the context of this part of design. How can licensees evaluate design options and acceptability if the user has not been fully-trained on a system to assess their performance while still considering options for HMI selection? Resource realities make it unlikely a utility will train several users on potential software and interfaces while trying to evaluate their performance to make a design decision. The cost and training/trial implications do not make this a practical, achievable task. There is no cost-benefit analysis to support this.			x	Modified to clarify as follows: Usability and performance tests involve assessing HMI performance, including user opinions, to evaluate design options and design acceptability.
159	CAN	4	43	Remove items 4.43 to 4.218.	This section does not really provide HMI design input. The requirements range from high-level principles (e.g., how the results of FA and TA feed into HMI design) to detailed guidelines (e.g., identify the units). The content of this section is very similar to the content in NuReg 0700 and does not seem to fit in a higher-level HF element document, which is more in line with NuReg 0711 and country standards. Specific design details should be documented in a lower-level document instead of one related to higher, programmatic methodology on how to execute HFE activities.	x	We cannot remove all clauses. However, we recognize that we can remove some clauses if we deem necessary. This document represents high level guidance not requirements. This is an important differentiation. The guidance is meant to address requirements from SSR 2/1 and align with guidance in SSG 39 and other relevant IAEA documents. To be clear, the IAEA cannot endorse to member states any one member state's guidelines (e.g. NUREG 0700) and we cannot endorse specifically IEEE or IEC or any other organizations guidelines for which member state membership to those organizations is required. Finally, these organizations have separate programmatic level document as well as design guidance document(s). The IAEA will only have one document that should have both programmatic level information and design guidance to support member states in meeting the requirements provided in relevant IAEA standards.		
53	CAN	4	45	Change "conventional" to "hardware".	All the control devices specified are hardware devices. Soft controls are not considered to be unconventional in 2017.	x	Replaced conventional with analogue.		
32	DE	4	47	...provide visual or auditory feedback within <u>adequate time</u> .	Otherwise an alternative indication shall be chosen	x			
54	CAN	4	48	Use of controls should be accompanied by feedback for the operators to indicate the process of data entry and to acknowledge the completion of data entry.	Punctuation and a word or two are missing	x			
33	DE	4	48	It is not clear what the use of "data entry" is.		x	Added an example, (e.g. set point adjustment)		
5	RF REA	4	51	4.51. To minimize operator errors, control movements should conform to population stereotypes and should be compatible with the controlled variable's attributes.	Exclusion of a subjective requirement. Proposal is either to specify what the "population stereotypes" comprises, or to exclude the reference	x	Added example (e.g. user expectations). Necessary to provide flexibility for member states or utilities to apply guidance specific to the population.		

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6	IN	4	52	Suggestion: The following may be added under this heading: a. Soft controls should be enabled / disabled as per plant status. b. The errors occurred during soft control operation should be indicated. c. There should be documented fixed timeout within which the command is declared failed or successful.	These are important considerations w.r.t to soft controls			x	a) Addressed by I&C. b) errors indicated are a part of alarms.c) too detailed for this guide.
55	CAN	4	60	If the system uses...	editorial	x	Deleted clause. Redundant with 4.77		
6	RF REA	4	60	4.60. If the system uses function keys, the function keys should be consistently assigned and properly grouped (see para 4.77) and labelled.	The term "properly grouped" needs to be defined. Proposal is either to specify criteria for "proper grouping" or to refer to para 4.77	x	Deleted clause. Redundant with 4.77		
35	DE	4	61	...navigation within the HMI...	Clarification.	x			
36	DE	4	62	Better explain the "modes" referred to. When is it preferable to have a set of controls rather than a multimodal one?		x	Deleted clause.		
48	USA	4	63	Revise "should offer to operator only available options" to "should offer to the operator only available options"	Editorial	x			
56	CAN	4	66	Add new clause before: Workstations may be in control rooms or in the plant	Field panels / control consoles do not seem to be included.			x	This proposed text is informative and also too general for this guide. Consensus also to delete 4.66 because we agree it was also too general.
37	DE	4	66	The text would benefit from a clear grouping of MCR, display and hardware requirements. In addition, some requirements are very specific for hardware of soft controls but are part of the chapter MCR (e.g. 4.105)				x	Deleted clause.
6	ENIS	4	66	4.66-4.96 Consider the value this section adds and its scope.	There are plenty of design guides and standards for workstations, which include a comprehensive list of items to consider. The level of detail here complicates the update and review process and is not aligned with other parts of the document.	x	We will only remove clauses that we believe are too general or too detailed for the intent of this guide.		
57	CAN	4	68	Change "visual acuity" to "size of text and graphics for legibility"	Visual acuity is a property of the human, while the other items listed are the properties of the workstation	x			
58	CAN	4	79	Remove one of the double periods/ full-stops	editorial	x	Deleted clause.		
49	USA	4	84	Revise "and group related." to "and related groups."	Editorial	x	4.86. Functionally related controls and displays should be distinguishable from other groups.		
7	IN	4	92	Suggestion: Hazards to be considered include radiation, smoke and toxic substances in the atmosphere. Considerations may be given to EMI, illumination levels, shielding of Control room				x	This is covered by 4.143
2	PL	4	94	Therefore, to minimize the risk of human errors because of stress and optimize human performance to ensure safe operation of the nuclear power plant main control room should have effective radiation shielding sufficient also in severe accident conditions.	supplement			x	This is a quote from requirement 65 of reference 1. It cannot be changed.
7	RF REA	4	94	To add a new para 4.94_A 4.94_A. Paragraph 6.39 of Ref. [1] states: "6.39. Appropriate measures shall be taken, including the provision of barriers between the control room at the nuclear power plant and the external environment, and adequate information shall be provided for the protection of occupants of the control room, for a protracted period of time, against hazards such as high radiation levels resulting from accident conditions, releases of radioactive material, fire, or explosive or toxic gases	Otherwise it is not obvious that these requirements of para 6.39 SSR 2/1 rev.1 follow from the Requirement 65 of SSR 2/1 rev.1	x			

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8	RF REA	4	94	To add a new para 4.94_B 4.94_B. Paragraph 6.40 of Ref. [1] states: "6.40 Special attention shall be paid to identifying those events, both internal and external to the control room, that could challenge its continued operation, and the design shall provide for reasonably practicable measures to minimize the consequences of such events."	Otherwise it is not obvious that these requirements of para 6.40 SSR 2/1 rev.1 follow from the Requirement 65 of SSR 2/1 rev.1			x	It is not within HFE scope to identify events affecting the MCR.
1	SWISS	4	96	These displays and controls should be separate from and independent of the normal I&C.	The wording "independent of, and different from" is ambiguous as to whether "different" refers to a) Presentation and coding of information (probably not the intent of the draft) b) Different physical implementation (this is addressed by the proposed "separate")	x	Agreed. Clause deleted.		
59	CAN	4	101	The HMI of displays should...	editorial	x			
38	DE	4	104	[...] maximum <u>task specific</u> viewing distance to [...]	Please indicate that viewing distances need to be based on the task.	x			
39	DE	4	106	...assess the status of individual HMI elements of the plant parameters or component's status indicated by the HMI element in question.	Clarification.	x			
23	USA	4	107	Numeric values should be displayed only to the level of significance required of the data for operation, regardless of higher levels of significance of individual input data	The position as written would not be supported if the level of significance of the input is not to the level required for the operation. I believe the intent is to only to display to the significance required regardless of whether the inputs are provided at a higher level of significance.	x			
60	CAN	4	108	...in a way that is salient and readily accessible.	Unclear why the word convenient is used.	x	Deleted clause.		
50	USA	4	113	Revise "in any operating conditions." to "in any operating condition."	Editorial	x			
2	RF Atomstr oexport	4	116	Hardware properties of display devices should be adequate to the operator's human factor needs for display, e.g. resolution, contrast, <u>color matching</u> , luminance, avoiding information distortion and flicker.	Design of display devices should abide by principles of color matching to prevent the situations, when it is enable to understand the displayed information.			x	Deleted clause.
2	SWISS	4	129	Suggest to delete "HMI procedure"	The term "HMI procedure" is not clear and may not be needed. Else, it requires clarification.	x	Deleted clause. Redundant with another clause.		
51	USA	4	131	Revise "of this Safety Guide provides" to "of this Safety Guide provide"	Editorial	x			
40	DE	4	132	Please include a list of staff including "field operators... It could be clearer what is meant with staff. E.g. a list of Qualifications required for the staff.				x	The section is about the control room. Not necessary to include a list of staff.
61	CAN	4	133	anthropometry is more straightforward than "anthropometrics"	Editorial.			x	Deleted clause. We have a general clause that addresses this.
9	RF REA	4	140	4.140. The main control room should provide an environment under which the main control room staff are able to perform their tasks without discomfort, excessive stress, or physical hazard. Also, para 5.61 of Ref. [1] states: "The design of workplaces and the working environment of the operating personnel shall be in accordance with ergonomic concepts"	Specification of the recommendation in para 4.140	x	Agreed. Clause deleted because the reference to requirement already provided.		
10	RF REA	4	142	4.142 The control room should contain sufficient facilities and supplies to ensure comfortable sustained occupancy (for at least X hours) during response to beyond-design-basis accident (including severe accident) design-extension conditions.	The term "sustained occupancy" is imprecise. To specify a period over which all necessary equipment and supplies shall be provided to personal under BDBA conditions, with reference to a supporting document			x	We cannot specify the duration of occupancy and design extension conditions is appropriate IAEA terminology.

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
8	IN	4	143	Clarification: The control room design should include assessment and protection against missiles originating from outside the control room. Please clarify whether considerations needs to be given to impact of human induced missiles (e.g. aircraft or missiles from outside)?				x	No, considerations does not need to be given to impact of human induced missiles. Clause 1.16 This Safety Guide does not address intentional unauthorized acts
4	RF REA	4	143	To add a new paragraph 4.143_A 4.143_A. The control room design should provide for protection against unfavorable external factors and should include relevant filter systems	To add a new paragraph. The ventilation and conditioning systems shall be equipped with independent power sources and filter systems.	x	We've added the example of filtered systems for 4.155. Otherwise, we believe 4.140 covers the intent of the proposed text.		
7	ENIS	4	145	"The SPDS should provide information on the fundamental critical safety functions: - Control of reactivity; - Removal of heat from the reactor and from the fuel store; - Confinement of radiative material, shielding against radiation and control of planned radioactive releases, as well as limitation of accidental radioactive releases. - Reactivity control; - Reactor core cooling and heat removal from the reactor coolant system; - Integrity of the reactor coolant system; - Radioactivity surveillance; - Containment integrity; - Spent fuel pool heat removal and water inventory. "The SPDS should provide information on the fundamental critical safety functions: - Control of reactivity; Removal of heat from the reactor and from the fuel store; Confinement of radiative material, shielding against radiation and control of planned radioactive releases, as well as limitation of accidental radioactive releases. Reactivity control; Reactor core cooling and heat removal from the reactor coolant system; Integrity of the reactor coolant system; Radioactivity surveillance; Containment integrity; Spent fuel pool heat removal and water inventory.	The proposed text ensures alignment with the definition of fundamental safety functions in SSR-2/1. Critical safety functions, as included currently, do not have an agreed definition and will depend on the precise safety case or reactor design.	x	Modified the clause as follows: 4.145. The SPDS should provide information on the critical safety functions associated with the reactor design		
17	ENSI	4	148		Shouldn't this statement come higher up in the list, i.e. after 4.144?	x			
9	IN	4	152	The following new clauses to be included: 1. The Supplementary Control Room should be conveniently located so that the operators abandoning the control room are able to move safely and easily to the Supplementary Control Room. Two diverse access routes may be provided, one of them for easy approach directly from the control room. 2. The design shall allow adequate time for the operator to reach the Supplementary Control Room and assess plant conditions for initiating necessary control actions timely.	Separate section on 'HFE DESIGN FOR ACCESSIBILITY AND THE WORKING ENVIRONMENT' covers access route related guidance. However, these two clauses as suggested would bring the clarity further.			x	This is quoted text that cannot be changed in this guide.
52	USA	4	152	Revise "in case that long term" to "in case long term"	Editorial			x	This is quoted text that cannot be changed.

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
34	DE	4	153	The HMI design of the supplementary control room should consider HFE principles and human characteristics of personnel under emergency conditions, particularly for immediate actions (e. g. <u>changed decision-making and changed information processing under time pressure</u>).	To highlight that especially the human characteristics of information- and decision-making processes under emergency conditions should be considered as important.			x	There may not be time pressure associated with using the supplementary control room. It's use is based on habitability of MCR as per your comment 41.
41	DE	4	155	[...] <u>In particular, habitability of the SCR shall be ensured when the habitability of the MCR is threatened or destroyed.</u>	Clarification.			x	The proposed text is a requirement already identified in SSR 2/1
62	CAN	4	161	Typo. Remove the "3"	Editorial	x			
17	USA	4	163	"The emergency response facilities technical staff should be trained on the notification and use of the instruments....."	Add the word "technical" to the requirement to ensure that non-technical staff are not tasked with learning about use of instruments to support implementation of severe accident management procedures.	x	We decided to remove the clause as it is outside the scope of this guide.		
11	RF REA	4	164	To add a new para 4.164_A 4.164_A. Paragraph 6.38 of Ref. [1] states: "6.38. If signals are used in common by both a protection system and any control system, separation (such as by adequate decoupling) shall be ensured and the signal system shall be classified as part of the protection system."	This is a mandatory requirement to a signal system with regard to separation principle, which is not mentioned in the text of the Safety Guide.			x	I&C principle on separation but not a HFE issue. It is addressed in SSG-39.
63	CAN	4	168	Unclear what is intended in this clause. Clarify what is intended.	Does this clause mean that since normal operations are the primary context of use, as opposed to accidents and emergencies, the alarms should be designed primarily from the perspective of normal operations?	x	Deleted clause.		
18	ENSI	4	168	Alarms should be defined primarily from an operational perspective considering the system user's point of view.	User-centered design.	x	Deleted clause. We've already said elsewhere that a user centred approach should be applied.		
53	USA	4	168	Revise "considering system designer's" to "considering the system designer's"	Editorial	x	Deleted clause.		
63	USA	4	168	Revise "considering system designer's" to "considering the system designer's"	Editorial	x	Deleted clause.		
29	RF JSC Atomen ergopro ject	4	169	To reformulate	Not clear what this para means	x	Modified as follows: All alarms should be documented and under configuration control.		
64	CAN	4	170	Unclear what is meant by "technically consistent"	This clause needs further explanation	x	Modified as follows: The system should have a sufficient coverage for operational states and accident conditions		
30	RF JSC Atomen ergopro ject	4	170	To reformulate	Not clear what this para means	x			
65	CAN	4	184	Omission, editorial	Add "the" after "masking"	x			
66	CAN	4	189	Guidance is not specific. What is meant by "low"? Provide a range of examples of what is meant by "low"	Unclear what is meant by "low". Further explanation is needed.	x	Clause deleted.		
10	IN	4	197	Suggestion: Explanation for Alarm dynamic priority can be provided in the standard		x	Deleted "dynamic"		
67	CAN	4	201	Should this be selected alarms vs. visible alarms?	Clarify the clause in relation to selected alarms.	x	Clause deleted.		
24	USA	4	203	4.203. The dark-board criterion consists of minimizing the number of alarms presented during normal operating conditions without challenging plant safety 4.204. Alarm processing should follow the dark-board criterion at full power and recommended at other normal operating conditions.	The sequence of guidelines as written provided the explanation of the dark board concept after its first use. The guidelines as written were also largely redundant and contained grammatical errors. Recommend reordering and rewording as shown.	x			
25	USA	4	206	Delete	The guideline is not needed given 4.205.	x	Deleted both clauses as covered in another general clause covering the use of analysis for HFE design.		
42	DE	4	212	The alarm hierarchy should always match the hierarchy of the graphical displays.	This needs further explanation. Displays are hierarchically ordered – by the level of detail - to allow to zoom in and zoom out. Alarms, however, are hierarchically ordered by priority.	x			

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68	CAN	4	219	Reference [16] is duplicated, and order the references numerically	Editorial.	x			
116	CAN	4	219	Procedure writing and document control are broader than the mandate of this guide and should be addressed in a separate IAEA document.	Procedure writing and document control is beyond the scope of HFE. The clauses are applicable to the utility in general but guidance, procedural development and management is handled by organizations outside of HFE. HFE's role should be an input into the procedures in terms of HF identified issues and recommendations requiring input or change in procedures. However, to have HF in control of development and authoring procedures, is not a reality due to the limitations of HF resources and staffing levels in the utilities which already have procedure departments.			x	Procedures developed and implemented should use accepted human factors engineering principles. We have not suggested that HFE be in control of authoring procedures. As has been suggested by reviewer, the intent is for HFE to provide input.
43	DE	4	219	Guidance in this section provides recommendations on human factors aspects of procedure development in support of Refs. [8], [7], [12] and [16][46].	Reference [16] is double and grammar	x			
19	ENSI	4	219		In my opinion something should also be said about the philosophy of use of procedures. It should be decided on the type and aim of procedures: what should be regulated and in which detail? (cf. research about types of procedures e.g. by Hale & Swuste, G. Grote etc.). Also a statement about the binding character of procedures and the possibility of deviations from procedures could be sensible.			x	The philosophy on use of procedures is provided in references identified in 2.19
160	CAN	4	220	Clarify.	Define hazard analysis.	x	Clause modified as follows: Important human tasks identified by safety analyses should be covered in procedures.		
3	SWISS	4	220	Human tasks important to safety as identified for example, [to replace] Human tasks needed for safe operation as identified for example,	The term "safe operation" is not defined and may be ambiguous as to whether it includes tasks required in accident conditions. The proposed "important to safety" is used in para. 2.24 of this document.	x	Clause modified as follows: Important human tasks identified by safety analyses should be covered in procedures.		
117	CAN	4	225	225-226: Remove.	This is not within HFE scope and very difficult to trace and maintain. The keeper of this information should not be HFE, but the holders of the design basis and procedure.	x			
20	ENSI	4	225		This statement seems very important and sensible, but I am not sure it is clear to all readers what the term "assumptions" means in this context. Some explanation would be useful. Can it be compared to the bases of technical specifications that document the rationale behind a specific content/requirement or the reason for a change?			x	We agree but not HFE related so we decided to delete this clause.
54	USA	4	225	Revise "The bases for the procedure does not" to "The bases for the procedure do not"	Editorial			x	Deleted clause.
64	USA	4	225	Revise "The bases for the procedure does not" to "The bases for the procedure do not"	Editorial			x	Deleted clause.
69	CAN	4	226	Change "does" to "do"	Editorial			x	Deleted clause.
118	CAN	4	228	Change to, "Human factors input should be provided to the development of procedures, as required, in accordance with the graded approach."	These clauses relate to document management and procedure writing, which are not within HFE scope. Instead, they reside within a utility's procedural departments. HFE should input recommendations but not be responsible for development, management and tracking of procedures.			x	Deleted clause.
26	USA	4	228	4.228. Procedure development should be assisted by a writer's guide that provides guidelines for the development and revision of procedures so as to achieve clarity and consistency across various categories of procedures.	4.229 is not a stand-alone guideline but rather an explanatory statement of a technical term. Recommend combining 4.228 and 4.229. This will also resolve explaining a term after its use.			x	Deleted clauses 2.28 and 2.29.
119	CAN	4	236	Change to, "Human factors input should be provided to the development of training, as required, in accordance with the graded approach."	Industry sees how the results of HFE analysis can feed into training, but there will be many other items driving the training program. Are the requirements to be tailored depending on the criticality of the training content? It is not clear how this can be done.			x	Clause deleted.

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21	ENSI	4	239	241, 244	Why are these statements restricted to operating personnel? It should be generalized to any personnel working with the equipment (e.g. maintenance personnel).			x	Operating personnel is defined in the safety glossary. Includes individual workers engaged in the operation of an authorized facility or the conduct of an authorized activity.
161	CAN	5	0	The clauses in section 5 should be reviewed and revised with more precise wording to address the difference between user reviews/trials and verification/validation. If user trials/reviews are to be included in the document, then a separate section may be useful.	Verification and validation is usually carried out in the Product Realization phase of the System Engineering model (INCOSE model). This is after design is done. Human Factors Integration (HFI) models usually include Verification and Validation in the Testing and Evaluation phase of the model – after the design process. Verification and validation are usually on final systems/equipment. While licensees can appreciate conducting user trials/reviews at design milestones during the design process, care should be taken when using the terminology (V&V). Validation, in particular, includes measures of performance and criteria for success and failure (pass/fail). Verification should be carried out before validation. It is not clear whether this is in contravention with clause 5.3. If the term "iterative" is meant to imply incorporation of user trials/reviews during the design process, this (User Trials/Reviews) should be separated from verification/validation. This may help with the concept that user trials/reviews during design phase of work usually are aimed at gathering input to use during the design process – and not with pass/fail of the design. It may also help because user reviews/trials may not be able to be based on all the inputs as identified in 5.11. This would be true for user review/trials carried out during conceptual/preliminary design. The focus of some clauses appears to be tasks carried out in Main Control Rooms (decision-making, controls, panels etc.). The focus of the clauses should be reviewed in light of the range of equipment/situations where this standard is expected to be applied. Are the requirements to be tailored depending on the criticality of the system/equipment? It is not clear how this can be done. There are clauses in 5.31 which specify that "ALL operating conditions", "ALL operating tasks..." should be included. ALL is likely not going to be feasible. This should be changed. Clause 5.35 specifies the need for objective and subjective measurements. This is not likely to be feasible for many situations. More generic requirements regarding design and implementation of a validation exercise may be beneficial: System Representation Validity; Test Design Validity; Performance Representation Validity; Statistical Conclusion Validity. It may help to limit the specifics which need to be mentioned. While the document uses "should" statements, the number of clauses will make the task of tailoring the clauses difficult. Also, it may not be advantageous for design organizations to adopt this standard.			x	Section 5 has been revisited and revised to make the flow better as well as to address some of the concerns mentioned. The section objective is to provide recommendations on V&V to follow of the HFE desing process in general. Member States may wish to implementat cluses in this section in a way that is it better represents thier national framework. The IAEA safety guide is a consensus document from its nature, and thus cannot address all diffrenet approche that may apply.
183	CAN	5	0	General comment.	The verification and validation section is good for a new-build nuclear power plant and aspects of control room modifications such as modernization but inappropriate for small plant modifications			x	We agree with the comment, but this is not role of the IAEA to prescribe the minimum V&V activities to be applied for a specific modification. A graded approach can be applied which in our opinion very much depends on Member State regulatory framework.
70	CAN	5	1	Split this clause into two parts, to cover verification and validation, respectively. Verification asks "if the system has been built correctly" i.e., conforms to specifications and requirements. Validation asks "if the right system has been built" to produce the desired human performance and system performance, including safety considerations.	It is not clear what is meant by verification and what is meant by validation when these two activities are grouped together.			x	The definition section provides definitions of Verification and Validation terms. Originally, we have considered to split verification and validation into two parts, however later on we came up to a conclusion, that there are generally applicable recommendations for both parts, and in many cases it was simply difficult to make these two entities separate. Nevertheless we believe that we made clear in Section 5 what is applicable to verification and what to validation.

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44	DE	5	3	Please explain what is the base for iterations to support a planning of those in V&V method and the project schedule e.g., design progresses (1) more interfaces become available, (2) procedures are more detailed, (3) Operators are trained, (4) simulations are becoming realistic. In addition, early identification reduces the cost of changes to design.		x	Deleted 5.3 (as this was redundant with 2.27) but inserted new paragraph as recommended in proposed text (in V&V planning section) as we believe the examples provided adds value.		
162	CAN	5	4	Amend to say, "Verification and validation should be performed by users/subjects persons or parties independent of the design."	This clause should clarify the difference between performance of the validation team and performance of the subject team during the validation. While ideal and done for military, independence of HFE Specialists is not typically accomplished for nuclear power applications. It certainly would depend on the criticality of the system/equipment and would add significant time/cost.			x	Persons and parties include users too.
45	DE	5	4	The final <u>v</u> erification and validation should be...	An early design evaluation should be performed by people involved in the design to understand and implement changes as part of the design process (as performed during usability studies). Please open this requirement to allow best design implementation.			x	There should be independence ensured during different phases, not only during final stage.
71	CAN	5	6	Change "includes" to "include"	Editorial	x			
22	ENSI	5	6	Identification of correct and full implementation of HFE standards and guidelines				x	The use and implementation of the HFE standards and guidelines is determined by member state.
72	CAN	5	8	- The presentation and the organization of procedures to support task performance; The layout of the workspace to support task and system performance;	Procedures cannot be validated outside the context of task performance, neither can the workspace layout.	x			
163	CAN	5	8	Change 1st bullet to say: "- The ability of the crew to complete the required actions The crew performance in relevant all operating and accident scenarios."	This bullet needs to clarify the need to evaluate task completion, not crew performance.	x	— The ability of the crew to complete the required actions in operational states and accidents conditions		
164	CAN	5	8	2nd bullet: Remove.	Not HFE in design scope.			x	Modified along with Canada comment 163
165	CAN	5	8	5th bullet: Remove.	This bullet needs further defining and examples of resources for crisis management. How do you realistically evaluate coordination?			x	Modified along with Canada comment 163
46	DE	5	8	— The resources for crisis management and coordination among the team members involved in the management of an accident <u>including external organizations.</u>	The Fukushima-Incident shows that interaction with external emergency organizations can be very important.	x			
73	CAN	5	9	Amend the last bullet for clarity	Unclear what is intended by this statement.	x			
184	CAN	5	9	Remove.	Neither clause is clear. Nor do they adopt a graded approach.			x	Conflicting comments from Canada; modify or remove?
27	USA	5	10	A validation of the integrated system of hardware, software . . .	Clarified to ensure the validation is of the integrated system comprising these elements and not the individual systems.	x			
74	CAN	5	11	- data from previous human factors engineering reviews and analyses;	Editorial	x			
75	CAN	5	11	V&V: The concept of carrying out part-system or part-task validations during the design process should be highlighted. This approach enables design changes to be made earlier in the design process than when only one large integrated system validation is carried out at the end of the design. The concept of frequent and iterative part-task / part-system testing with users during the design is missing from this standard and needs to be included as a necessary good practice.	The standard does not consider the essential good practice of frequent, iterative test-redesign and test cycles during development.	X			
185	CAN	5	11	Refine list.	This requires specifics with regard to a graded approach to main control rooms, minor modifications, etc. - aside from new builds			x	Application of a graded approach is left on Member State; typically provided in the national regulatory framework.
47	DE	5	11	— Information on staffing, <u>organization</u> and qualifications;	The organizational factors are relevant in the HFE process implemented beforehand (see also 4.12).	x			

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76	CAN	5	12	Consider the use of the term "regulations" and add "design requirements" to the list.	While I understand that the IAEA considers that regulations are requirements, in the sense of design, there are design requirements that are not regulations in terms of the requirements of the regulatory body e.g., a style guide for the design project is a design requirement but not a regulation. This issue also needs to be considered in clause 5.15, for consistency.			x	Does the standard provide other than regulatory design requirements? In SG we have to use "requirements" with care.
186	CAN	5	13	Clarify.	Is this the HF evaluation team or the end user team to be evaluated? It is beyond the scope of HFE for the team to comprise members other than HF in an HFE evaluation for smaller modifications vs. new build plants.	x	The clause does not suggest evaluating either the HF team or the end user team. The clause suggests that the composition of the evaluation team should be specified in the plan. What comprises the team should be left to the member state. We've modified "Composition of the evaluation team" to "Participants involved in the evaluation"		
48	DE	5	14	Footnote 4. Materials are all the elements used by the validation team, e.g. audio, video, computer recording, questionnaires, etc.	Questionnaires are very often used.	x			
77	CAN	5	15	Add human factors standards and project requirements specifications concerning human factors, ergonomics and human performance to the examples in the first bullet.	The concept of including human factors/ ergonomics/ human performance requirements in the project's requirements specifications needs to be presented.			x	Conflicting comments from Canada; modify or remove?
166	CAN	5	15	Remove.	These bullets are already covered in the first bullet.			x	Conflicting comments from Canada; modify or remove?
167	CAN	5	16	Move to validation report section.	Verification of validation of changes to the design and evidence of mitigation of design deficiencies in HFVVP's does not belong in a plan, but can exist in the validation report	x	Clause final bullet modified as follows: The approach for resolving design deficiencies.		
78	CAN	5	17	Update this clause to include part task / part system validations, which may not require the same rigor.	This clause reads as if only one integrated system validation is conducted. The clause needs to consider the good practice of part task / part system validation earlier in the design process.			x	Conflicting comments from Canada; modify or remove?
187	CAN	5	17	Remove.	Is this for an HF validation of a design/system validation or modification of an existing design? This seems only applicable to a new build and is not practical for small modifications. This presents a level of resourcing that is not reasonable at an operating utility.			x	Conflicting comments from Canada; modify or remove?
188	CAN	5	20	Modify to read, "The test participants should be familiar with the relevant portions of the modifications beforehand."	How does this work on a graded approach for modifications? Wording regarding how much training is suitable needs to be defined. Are these participant primers? There is a desire to have a sample of new users and is not realistic to give extensive training prior to validation while still improving on design. In reality, it is hard to get resources and training time with a significant lead time prior to validation.	x	Incorporated and we moved it to test methods section.		
120	CAN	5	21	Remove.	This responsibility rests with a project or engineering design team, not HFE, especially with regard to monitoring the integration of the outputs. Outputs should be distributed to the design team and tracked to ensure they are considered and whether they are implemented or not.	x	Deleted. The intent of the clause is captured in 2.28.		
168	CAN	5	22	Modify to read, "The validation team should be trained in the data collection issues specific to the modification."	This ensures that the qualification of HF resources is trained in the appropriate techniques.	x	Clause modified as follows: The validation team should be trained in data collection techniques.		
49	DE	5	22	The members of the validation team should be trained in data collection post-test interviews and the post factum analysis of the collected data (e.g. statistical analysis).	Knowledge in statistical analysis methods are important to get the right information out of the data.	x	Clause modified as follows: The validation team should be trained in data collection techniques. Data analyses in another subsection of this section.		
79	CAN	5	23	"Walkthrough" needs further clarification	It is unclear what is meant by "walkthrough"			x	Consensus is that this is a commonly used term.
55	USA	5	23	Revise "in term of" to "in terms of"	Editorial	x			
65	USA	5	23	Revise "in term of" to "in terms of"	Editorial	x			
80	CAN	5	25	Remove "Type" from this clause. Remove "Expected" from this clauses	In the first bullet, it is not clear why the "type" of task is specified as a factor to measure. The type of task would be understood based on task analysis, and this should be an input to planning instead of a performance measure. In the second bullet, the workload is assessed, not the "expected" workload.	x			
169	CAN	5	25	Clarify.	Define what is meant by "required domain expertise."	x	Clause bullet modified as follows: Knowledge, skills, and abilities required on design.		
23	ENSI	5	25		It is not clear whether the "factors" (2nd sentence) are the "human performance measures" referred to in the 1st sentence. Because of the formulation used (to be performed, expected, required etc.), to me it seems rather that the factors define the basis or starting point from which the HP measures can be assessed.	x	Modified to "Examples of these measurements include..."		

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7	FI	5	25	.. – requirements for collaboration and communication both within crew and outside of the crew	Add: requirements for collaboration and communication both within crew and outside of the crew Appropriateness of collaboration and communication reveals successfulness of design.	x			
81	CAN	5	26	Delete "time of day"	Unclear why "time of day" has been included as a human performance measure.	x			
82	CAN	5	26	Clarify what is meant by the last bullet.	Unclear what is meant by reliability. Is this the probability of successful task performance? Repeatability of results e.g., with multiple different test subjects of crews is not the same thing, and clarification is needed	x	Replaced with "probability of successful task performance".		
170	CAN	5	26	Remove the bullets:gaze and dwell time - biometricsfatigue and time of day	These items are too theoretical and impractical.	x	Kept gaze and dwell time (U.S. say they are using it for design). Bear in mind, the clause says "may"		
83	CAN	5	28	Add some examples for clarity.	Clarification is needed concerning what is meant by "task requirements" in relation to verification.	x	Examples provided.		
189	CAN	5	29	Remove the bulleted items and amend the text to read, "The test scenarios chosen to validate the design should be realistic and allow for appropriate HF analysis."	The list does not allow for a graded approach.	x	Added "realistic to the extent possible. Include..."		
84	CAN	5	29	The test scenarios selected to validate the design should be representative of all plant states and of sufficient fidelity to assess the human's tasks and the system support of these tasks. 2nd bullet: - The tested scenarios should be representative of the operating and accident conditions during all plant states, and should include events and their initiating conditions. 4th bullet:- The procedures used should match those that would be used in the relevant operating or accident conditions.	It is not clear what is being validated.	x	Replaced "installation" with "HFE Design"		
85	CAN	5	30	Add text to clarify what is meant in terms of "meaningful" lengths of time and numbers of scenarios.	Clarification is needed.	x			
190	CAN	5	30	Remove.	This is a theoretical statement which is good as a concept but difficult to determine what is meaningful in terms of practicality.	x			
28	USA	5	30	... meaningful number of scenarios considering potential variations in operating/accident conditions and variability in human performance.	"Meaningful" is quite vague. Addition proposed for clarification.	x			
191	CAN	5	31	Amend to say, "The test scenarios chosen to validate the design should be realistic and allow for appropriate HF analysis."	Enables a graded approach to be applied.	x	Deleted clause and combined relevant bullets to 5.29.		
56	USA	5	31	Revise "management of an anticipated" to "management of anticipated"	Editorial	x	Deleted clause and combined relevant bullets to 5.29.		
66	USA	5	31	Revise "management of an anticipated" to "management of anticipated"	Editorial	x	Deleted clause and combined relevant bullets to 5.29.		
72	USA	5	31	Revise "management of an anticipated" to "management of anticipated"	Editorial	x	Deleted clause and combined relevant bullets to 5.29.		
86	CAN	5	33	Mockups, and part-task simulators are mentioned, but the notion of part-task or part-system simulators has not been hitherto introduced.	See comment above on 5.17	x	Resolved as part of 5.17		
87	CAN	5	38	Consider verification and validation activities separately.	This clause is unclear because validation and verification are lumped into a single category, whereas in reality they are different activities with different objectives. See also the comment on clause 5.1 above.	x	Removed verification.		
171	CAN	5	38	Remove.	This is a theoretical statement. It is difficult to evaluate the efficiency of the system for use.			x	Efficiency was replaced with successfully. We are retaining this clause as we believe it is valid to provide expectations for how the results are discussed.
57	USA	5	39	Revise "into considerations;" to "into consideration;"	Editorial	x			
58	USA	5	39	Revise "which the control personnel" to "which the control room personnel"	Editorial	x			
67	USA	5	39	Revise "into considerations;" to "into consideration;"	Editorial	x			
68	USA	5	39	Revise "which the control personnel" to "which the control room personnel"	Editorial	x			

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73	USA	5	39	Revise "into considerations;" to "into consideration;"	Editorial	x			
74	USA	5	39	Revise "which the control personnel" to "which the control room personnel"	Editorial	x			
172	CAN	5	42	Requires refining.	This represents a significant amount of data. Is the intent for summary data, or raw collected data and notes?	x	Clause modified as follows: "The data collected in each test campaign and its analysis should be documented". We leave it up to the member state to decide how it should be summarized.		
88	CAN	6	0	General: Include a clause to explain that HFE design implementation is not a siloed / stove-piped activity and that it is very much integrated with the overall design implementation.	This section reads as if this HF in design activity is a stand-alone activity, which is misleading. This is important because integration with the rest of the design team and the organizational support such as training and procedures development is important for the success of the design.			x	A clause was added in section 2 to address integration as another comment.
5	DE	6	0	HF Team could instead be part of the configuration MM Team.		x	Yes, this is possible. No modification made to the		
173	CAN	6	4	Clarify why these specific issues need to be mentioned separately? Otherwise, these clauses should be removed.	The purpose of clause 6.4 is unclear. In clause 6.6, it is not clear that the HFE Specialist working on design will be involved at the level required to take into consideration all of these factors.	x	6.4 has been removed.		
174	CAN	6	5	Reconsider the word "assurance."	Assurance is not specific in intent. HF implementation phase should provide confirmation of the as-built design.	x			
24	ENSI	6	6	... impact of the HFE design process...	It is not clear to me what is requested here. Is it really the impact of the HFE design process on safety? Isn't the assessment concerning the elements	x			
25	ENSI	6	6		What is the meaning of "interfacing HMI"?	x			
59	USA	6	6	Revise "impact HFE design process" to "impact of the HFE design process"	Editorial	x			
69	USA	6	6	Revise "impact HFE design process" to "impact of the HFE design process"	Editorial	x			
75	USA	6	6	Revise "impact HFE design process" to "impact of the HFE design process"	Editorial	x			
175	CAN	6	7	Remove and replace with a statement that the HFE resources should be involved in verification that human factors aspects of the design have been implemented.	Provides a sensible role for HF resources. As currently written, the items in 6.7 seem highly theoretical. It is not clear how the HFE Specialist would accomplish them, what a workable organization might look like, etc.	x	First bullet of the clause in 6.7 deleted.		
89	CAN	6	7	last bullet: change "vent" to "event"	Editorial	x			
121	CAN	6	7	Remove all bullets.	Formalized plans for design implementation are project scope or organization scope and not HFE in design scope.			x	We have retained and revised the bullets but have deleted the reference to formalized plans.
26	ENSI	6	7	6.9	What would be "suitably qualified and experienced personnel"? Is the answer to this to be found in the last bullet point of 6.9?	x	Deleted.		
27	ENSI	6	7	6.7 b)	It seems as if the HFE design implementation is something separate from the overall implementation. In my opinion, HFE should rather be incorporated in the overall planning of the design implementation of the overall project. HFE should not be singled out but be considered as an integral part of any design process.	x			
29	USA	6	7	Delete "An assessment, which considers the consequences of the as-built HFE design on:"Keep - Actions to mitigate any undesirable consequences from implementing the HFE design. - The most suitable intervention point to implement the HFE design, e.g. an outage or maintenance period.	The lead sentence for items a and b does not appear necessary and rather creates confusing/circular logic, particularly for item a.	x	Clarified.		
60	USA	6	7	Revise "HFE design consist of" to "HFE design consists of"	Editorial	x			
70	USA	6	7	Revise "HFE design consist of" to "HFE design consists of"	Editorial	x			
71	USA	6	7	Revise "in the vent that" to "in the event that"	Editorial	x			
76	USA	6	7	Revise "HFE design consist of" to "HFE design consists of"	Editorial	x			
77	USA	6	7	Revise "in the vent that" to "in the event that"	Editorial	x			
61	USA	6	7	Revise "in the vent that" to "in the event that"	Editorial	x			
192	CAN	6	8	Delete text after "documented....." Amend to read, "The output of the HFE design implementation phase should be documented in a summary report that provides evidence that the as-built HFE design meets the original technical specification/design intent."	Enables a graded approach to be applied	x	Incorporated but also merged 6.8 with 6.9		
90	CAN	6	9	1st bullet: ...provisions (HMIs, procedures, training, initiatives etc.) meet...	Editorial Need to clarify what is meant by "initiatives"	x	removed initiatives.		

Resolution of Member States Comments:
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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
122	CAN	6	9	Change "report" to "documentation."	Human Factors implementation is under existing HF analysis documentation. A separate reports should not be required	x			
123	CAN	6	9	Remove.	This is configuration control and not within HFE scope. This is the responsibility of a utility's operations scope and engineering design basis and configuration control.			x	Merged 6.8 and 6.9. Identifying HFE issues and the resolution during design implementation is considered best practice by member states. How this is achieved within an organization is up to the member state.
124	CAN	6	9	Remove.	This is not practical for many utilities due to limitations on HFE staffing and resources to provide oversight and management of this action. This is beyond the scope of HFE work. The issue should be that the equipment and changes are properly implemented regardless of individual qualification.			x	The IAEA cannot comment on the limitations of HFE staffing for specific member states.
78	USA	6	9	Revise "etc.) meets the" to "etc.) meet the"	Editorial	x			
91	CAN	7	1	Add the following bullet: - Whether the system support such as supervision, training, staffing, procedures, personal protective equipment, tools and job aids are appropriate and sufficient to support the people performing their tasks.	System support is missing, and is an important aspect of monitoring, because it can degrade over time and this may not be noticed or considered appropriately.	x			
28	ENSI	7	2		What are "administrators of human performance monitoring"?	x	Administrator was removed and replaced with "those responsible"		
95	CAN	8	0	<i>Include SSG-25 as a reference.</i>	It is unclear why SSG-25 [8] is not referenced in this section	x	This has been corrected.		
176	CAN	8	0	Remove 81.-8.26	Are these clauses in the standard because it is felt they are not covered by other sections? Sections 8.01 to 8.6 are covered by NSG-G-4.1 Sections 8.7 to 8.19 are covered by the periodic review process in the relevant IAEA document - SSG25. Sections 8.20 to 8.26 are covered by NSG 2.15.			x	Paragraphs 8.1 to 8.6 addresses clauses to consider HFE in chapter in the revised IAEA guide on Format and content of Safety Analysis Report.
30	USA	8	0	HFE INTEGRATION IN SAFETY APPLICATIONS Severe Accident Management See items below for specific changes.	Guidance in this section is relevant for mitigation of beyond design basis events. Not evident why it is limited to severe accidents.			x	We do not use beyond design basis events any more in IAEA terminology. Design extension conditions is the terminology used now. Specific comments have been addressed.
79	USA	8	1	Revise "chapter in safety analysis" to "chapter in the safety analysis"	Editorial	x			
92	CAN	8	2	4th bullet: - Human factors verifications and ...	Editorial			x	Verification is generally not pluralised.
93	CAN	8	3	HFE reviews should be conducted to determine and verify that acceptable HFE practices and guidelines were incorporated into the design and in the safety analysis report.	Editorial	x			
80	USA	8	3	Revise "verify acceptable HFE practices and guidelines were incorporated into design" to "verify that acceptable HFE practices and guidelines were incorporated into the design"	Editorial	x			
94	CAN	8	5	... in the safety analysis report.	Editorial	x			
2	RF Rosatom	8	6	1. During the analysis of safety, it is necessary to take into account the psychological state of personnel in stressful emergencies in the human-machine interface. 2. In deterministic of safety assessments of nuclear installations in emergency modes should take into account failures of components of systems important for safety due to personnel errors. 3. In probabilistic of safety assessments of nuclear installations in emergency modes should take into account failures of components of systems important for safety due to personnel errors.	The lessons learned from the accident at the Fukushima Daiichi nuclear power plant in 2011. (IAEA report on the accident at the nuclear power plant Fukushima Daiichi, volume 2, par. 2.6.8, p. 146-147			x	The intent of this sectin is to provide a link between the IAEA safety guide on Format and content of Safety Analysis Report which is in revision.The HFE analysis is typically covered in Chapter 18 of safety analysis report.
29	ENSI	8	7		Why does this paragraph come so late in the document? In my opinion, particularly the statements 8.7 - 8.13 should come earlier. The impact analysis from a HF view point is the first and a very important activity at the very beginning of the HFE process in order to determine the need and depth of HFE activities.			x	We acknowledge this comment, however wwe found Section 8 most appropriate for making the link between HFE and plant modifications. Although there are severaal paras already mentioning modifications in previous sections.

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
30	ENSI	8	8	8.10 too	When does this review should be conducted? From the very beginning of the project.			x	The safety guide provide guidance what should be done to meet the requirements (e.g. SSR 2/2). "When" and "How" is left on member states
31	ENSI	8	10	8.8.	What is exactly the difference between these two statements? The difference between operator actions and human tasks should be made clear	x	Operator action replaced by human task to make it consistent.		
32	ENSI	8	11		The criteria to decide how to grade the HFE approach should be treated in more detail (e.g. changes to human actions and tasks, degree of novelty of the modification, safety relevance, new risks for humans, environment, equipment etc.)			x	The safety guide provide guidance what should be done to meet the requirements (e.g. GSR Part-2. Actual implementation how to do it is left oon Member States.
3	RF Rosatom	8	14	It is necessary to consider the psychological state of personnel in stressful emergencies when performing operations on safety functions in the human-machine interface in the control room and in the reserve control room in a harsh environment condition (earthquake, flood, fire, loss of ventilation). For such conditions, the level of competence, stress resistance, psychological stability, motivation, ability of thinking in stressful situations should be taken into account. The instrument park, tools, computer programs, communication equipment, emergency lighting, emergency ventilation and other means of emergency life support should be evaluated for the compliance of the emergency situation with the purpose of compensating the stressful condition of personnel.	The lessons learned from the accident at the Fukushima Daiichi nuclear power plant in 2011. (IAEA report on the accident at the nuclear power plant Fukushima Daiichi, volume 2, par. 2.6.8, p. 146-147)			x	We agree with the comments, but the ineten of this section is to make a link between HFE and PSR which provides detailed guidance on the evluation of safety factor 12.
3	PL	8	19	Editorial: repetition of words „in“.		x			
96	CAN	8	20	Delete extra period at the end of the clause.	Editorial	x			
4	PL	8	20	Editorial: double dot "." at the end of sentence.		x			
31	RF JSC Atomen ergoproject	8	20	To rewrite the statement in more practical form. This recommendation can be applied to many paras in SG. In this particular case the stamen can be reformulated: "The HFE and HMI design should take into account the fact that 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.". However, even in this formulation it is still useless as does not provide clear message how the mentioned aspects should impact HFE and HMI design.	This type of statement does not provide any valuable information for the HFE subject. There is no need to keep them in SG. They should be reformulated in the form useful for HFE subject.			x	This is is an informative para to provide an introdcution to section why HFE should be considered in severe accident management.
177	CAN	8	27	Remove.	This is not the appropriate document for specific requirements on computerized procedures. If computerized procedures are being implemented, it's as a design project which requires the same considerations as any other design project.			x	The computerized procedures are curnnelty developed and implemented by various vendors of nuclear power plants. We believe this is the new and important topic to be addressed in this safety guide (which will be in for for at least another 10 years)
33	ENSI	8	27		The relationship between computerized and paper based procedures should be treated in more detail. Should paper based procedures be used (and trained) as well? How to choose whether paper based or computerized procedures should be "leading"? (cf. 8.63 where paper based procedures are only seen as a backup)			x	We agree with the comments, but implementation of these clauses are left on Member State.
34	ENSI	8	27		Where does this requirement come from? Is this a requirement/ recommendation which reflects the state of the art today? Is the problem of qualification of the equipment solved? Does the statement also imply that full automation (type III procedures) should be aimed for? In this case the issues related to automation (e.g. ironies of automation) should be treated as well.			x	The computerized procedures are curnnelty developed and implemented by various vendors of nuclear power plants. We believe this is the new and important topic to be addressed in this safety guide (which will be in for for at least another 10 years)
31	USA	8	27	Replace with 8.30	8.27 is overly prescriptive by mandating the use of computer-based procedures and requiring a range of functionality. Guideline 8.30 provides a more defensible high level position.	x	should replaced by may.		
32	USA	8	28	Delete	Too prescriptive. Although computerized procedures can support all these activities other tools might be more appropriate.	x	should replaced by may.		

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
35	ENSI	8	29	... and shared situation awareness of the plant status.		x			
33	USA	8	29	Delete	This statement is written as a more detailed specification of the preceding guideline but refers to computerized operating system rather than procedures. As it seems to actually refer to the general design of a digital control room it is too broad and should be deleted.			x	By modifying clauses 8.27 and 8.28 with "may", if computerized procedures are used, then they should....
34	USA	8	31	The information needed for the operator to accomplish all the tasks defined in the computerized procedure being executed should be readily available to the operator.	Too prescriptive, as written it requires all needed information to be part of the computerized procedure system. The information needs to be available but need not be provided through the system.	x			
97	CAN	8	34	Delete extra period at the end of the clause.	Editorial	x			
5	PL	8	34	Editorial: double dot "." at the end of sentence.		x			
35	USA	8	35	8.35. Computerized procedure systems are of three types: — Type I systems represent an equivalent reproduction of paper based procedures and do not receive any processed or real-time information; — Type II systems augment procedures with dynamic embedded process data; — Type III systems provide the capabilities of Type II systems and included embedded soft controls to manipulate plant equipment. These systems may include the capability for automated sequences of steps that automatically carry out the described actions in the procedure.	The wording is inaccurate and requires restructuring to eliminate internal inconsistencies. Proposed revision is consistent with IEEE 1786 which is the computerized-procedure reference for this guide. Note that IEEE 1786 is written in terms of systems rather than procedures.	x			
36	USA	8	43	Status of the steps of a procedure (e.g. specifying whether the step is completed, in progress, checked and authorized where necessary, or failed) should be indicated. For Type 1 systems the capability to manually track the status of steps should be provided. Also an indication of alternative action where necessary should be included.	As written the guideline could only be implemented for Type II and III systems.	x			
37	USA	8	49	Data and logic rules evaluated by the computerized procedure system should be available to the operator.	Too prescriptive, operator assistance implies active engagement by the system which may not be warranted.	x			
81	USA	8	50	Revise "archived to may be later consulted" to "archived such that they may be consulted later."	Editorial	x			
38	USA	8	52	The computerized procedures system should notify the user when plant conditions necessitate proceeding to enter, exit or transition from one procedure to another	As written guidance would be interjecting non-essential notifications.	x			
82	USA	8	52	Revise "Computerized procedures system" to "The computerized procedures system"	Editorial	x			
39	USA	8	54	delete	No apparent basis for why the procedure system should be required to perform such calculations rather than obtain them from safety systems.	x			
98	CAN	8	55	... does not receive inappropriate information.	Editorial	x			
40	USA	8	56	delete	Too prescriptive. Automatic provision of step logic results can bias operator processing of step logic. Results available on demand should be an option.	x	should replaced by may.		
99	CAN	8	61	... backup procedures...	Editorial	x			
3	FR	8	61	To add at the end of the paragraph : "as well as for switching back from back-up procedure to the computerized procedure system when it works again."	After a failure of the computerized procedure system, it may be important to verify if it works safely again ... and specific actions may be needed for the operators to use again the computerized procedure system	x			
83	USA	8	62	Revise "backup procedure" to "backup procedures"	Editorial	x			
41	USA	8	64	The structure and format of information in the computerized procedures should be compatible with backup procedures.	Unless the computerized procedures are written with the usability of the paper-based back-up in mind this required consistency may not support usability of the back-up.	x			
84	USA	8	65	Revise "necessary, following" to "necessary, the following"	Editorial	x			
100	CAN	8	66	... backup procedures ...	Editorial	x			
42	USA	8	66	Time needed to transition to back up procedures should be validated as meeting system functional requirements.	Guideline could not be met as written. Procedures can't "guarantee" safe operation even without a failure of the primary procedure system.	x			
36	ENSI	8	67		Training for use of paper based procedures should be required as well (not only the transition).			x	The intent of this clause is defferent. Training is required when transtiotn from -to. Of course there is training on use of papare procedures too.
	USA	8	73	Automated steps sequences should be . .	Detailed and specific are unneeded modifiers.	x			
101	CAN	8	79	The computerized procedures system...	Editorial	x			

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MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
85	USA	8	79	Revise "Computerized procedures" to "The computerized procedures"	Editorial	x			
86	USA	8	83	Revise "Computerized procedures" to "The computerized procedures"	Editorial	x			
94	USA	8	85	Revise "Computerized procedures" to "The computerized procedures"	Editorial	x			
87	USA	8	86	Revise "Computerized procedures" to "The computerized procedures"	Editorial	x			
125	CAN	8	87	87-90: Remove.	These clauses are not within HFE scope. Selection of PPE falls within the conventional safety scope for a utility. HFE needs to see if PPE impacts the ability and achievability to perform and complete the task, but is not responsible for the selection of utility PPE.			x	The intent of these clauses is whether personnel is able to use the protective equipment when performing the task.
102	CAN	8	88	... of the task performance.	Editorial	x			
37	ENSI	8	89		Shouldn't this be part of the task analysis?			x	We agree with the comment, but this sections makes a specific focus on HFE aspects when using protective equipment.
178	CAN	8	91	COTS should be addressed earlier in the document (i.e. sections 3 and/or 4).	Section 1 says COTS products are covered, but the clause appears to be orphaned.			x	Although we agree with this comment, we tried to group clauses on HFE intergration into product selection into section 8.
88	USA	8	92	Revise "selecting those ones that" to "selecting those that"	Editorial	x			
89	USA	8	93	Revise "selecting those ones that" to "selecting those that"	Editorial	x			
103	CAN	8	94	... work environment or in the way that tasks are performed.	Addition of changes to tasks	x			
104	CAN	8	97	... if the personnel are wearing personal protective equipment.	Editorial	x			
90	USA	8	98	Revise "for the task if the personnel is wearing" to "for the task if personnel are wearing"	Editorial	x			
105	CAN	8	99	Mobile devices...	Editorial	x			
91	USA	8	100	Revise "Mobile device" to "Mobile devices"	Editorial	x			
92	USA	8	101	Revise "HFE evaluation" to "HFE evaluations"	Editorial	x			
107	CAN	Definitons		A concept of operation describes the proposed design in terms of how it will be operated to perform its functions, which includes the various roles of personnel and how they will be organized, managed and supported.	The CONOPS is not just a HFE document, which is indicated by the current definition.	x			
108	CAN	Definitons		... The HMI comprises the interfaces between personnel and installation systems, including procedures, communication systems, displays, alarms, and controls.	Editorial. The term "installation" is preferred over "plant" in IAEA publications.			x	SSR 2/1, which is the main document that we have to align with, refers to the plant.
109	CAN	Definitons		Validation...can successfully perform that system's intended functions, goals and objectives in the anticipated range of operational environments.	Editorial and emphasis on functions being carried out.	x			
38	ENSI	Definitons			The definition of human-machine interface is narrower than the content treated in the guide under the same "label"			x	This terminology has been discussed in great, painful depth. We are forced to follow the established terminology in SSR 2/1. We tried our best to mitigate this by discussing HFE design where we meant HMI in a broader sense.
1	RF JSC Atomen ergopro ject	Definitons		To add definitions for the terms used in the documents (e.g. Human factor engineering, Human factors)	Many terms that are used in the documents are not common and self-explained. They should be defined.			x	We used definitions as per the IAEA safety glossary. Where we differed or where there was no definition available we either differed to associated documents such as SSR 2/1 or SSG-39, we provided our own to suit our intent in the safety guide.

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
1	RF REA	Definitions		To add the following text: Important human tasks - Safety significant complex tasks Minor problems – problems not related to safety, which could be precursors to, or contributors into, more significant problems. Supervisory control – a specialist’s control of automated system performance of its functions, with or without a possibility for intervention	Section DEFINITIONS does not comprise definitions for the following terms “important human tasks” (ref. to in . 1.15, 3.53-3.59); “minor problems” (ref. to in 3.6); “supervisory control” (ref. to in 3.19)	x	Important have been defined. The rest are in the IAEA glossary.		
7	RF JSC Atomen ergopro ject	Footnote	1	Remove item “b) used in applications other than nuclear facilities”	Para 1.13 states that this SG covers only NPPs.	x	Deleted footnote.		
3	CAN	Footnote		An item that is a) general purpose and ready-made, as opposed to custom-made for the specific nuclear application; b).....	a) is not necessarily true, because a generic, immediately usable COTS product may meet nuclear qualification specifications, even if it is a generic item. However, it may not meet the specific HFE requirements in terms of usability. The footnote does not indicate that COTS products are ready-made and not specifically custom-made for the individual application, although some reconfiguration may be possible. The “and” statements relating to points a) b) and c) should be removed because there are cases where not all of them will apply.	x	Deleted footnote.		
1	CAN	General		Ensure that the IAEA requirements documents have been fully considered, to highlight the requirements as opposed to guidance, e.g., by providing references, as in the section on procedure development.	Otherwise this document will specify IAEA requirements as guidance, which is misleading.	x	This has been done by providing requirements from references in advance of the design guidance where appropriate.		
2	CAN	General		The context in which HFE is conducted needs to be clearly described e.g., generic vendor design of a whole installation or of a system, specific design of a whole plant or of a system, modifications to an existing installation. These separate cases need to be considered throughout the document, because the HFE activities conducted will vary accordingly.	This document is written from the perspective of a vendor’s generic design for an installation, which is then implemented at a specific site for a specific operating organization. It is therefore not clear what HFE activities are appropriate for a modification to an existing installation, which is an important consideration, and in many nations this is more frequent than designing and implementing a new installation.			x	The IAEA does not distinguish between the users of this guide.
51	CAN	General		Clarify in the text	It is not clear if the HMI design includes the workspace i.e., the size and layout of the whole control room.			x	The intent is to provide general guidance.
110	CAN	General		THEME #1 – The document’s audience is unclear.(For clarity and ease of review, industry comments have been grouped in these themes below and supported by examples from the draft.)	The scope of human factors engineering in design is intended to address the human-machine interface and systems required for the safe operating envelope of the plant. The scope of additional complexity from human technology and organizational factors is broader than the engineering function, which is the subject of this document. For clarity, elements that do not apply to human factors in design should be removed from this guide.			x	This is identified in Clause 1.15.
126	CAN	General		THEME #2 -This guide does not provide a complete or consistent discussion within any of its sections.(For clarity and ease of review, industry comments have been grouped in these themes below and supported by examples from the draft.)	Much of its content does not seem to fit in a higher-level, HF element document. As a result, the philosophy of what type and level of guidance this document offers should be re-visited and clarified.	x	We revisited these sections and removed clauses as we deemed necessary where too much detail is provided.		

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
179	CAN	General		THEME #3 - The overall document seems tailored to the large-scale approach of a new build with minimal sections focusing on a graded approach for small modifications to operating plants. (For clarity and ease of review, industry comments have been grouped in these themes below and supported by examples from the draft.)	Although clause 1.14 says this draft "applies to implementation of the HFE aspects of the HMI design for new plant designs as well as for modifications of existing plants" its content does not support that statement. As currently written, it does not allow for a true, graded approach to cover different scales of changes dependent upon the equipment and circumstances. The validation section is heavily weighted on integrated control room testing and does not give a graded-guidance approach to validating small-modification replacements (i.e. single controller replacements). Nor does the validation section give enough guidance to out-of-control room modifications such as: in-field components; in-field systems that do not have direct main control room interactions; items such as reactor maintenance tooling systems.			x	As this is a guide, we leave it to the member state to determine the extent to which it is applicable to small scale modifications. In essence the member state in conjunction with national regulation determines the level of gradation in the use of this guideline.
1	DE	General		Please consider the addition of a chapter about HF on local control stations and components. The document is focusing mainly on HMI in the control center. A specific chapter about HF on components (e.g., maintenance on large pumps) and local control stations (e.g., Diesel) would create an understanding about the complete nuclear system and increase the focus on challenging interaction on components and about centralization of information. In addition, special requirements are needed for those parts of the HMI.				x	Although we agree with this comment, we cannot address everything in DS492. A DPP for this safety guide limited the scope to provide recommendations to meet SSR 2/1 requirement 32. Nevertheless, we believe that many clauses in DS492 are generally applicable to maintenance activities too.
2	DE	General		Please include more details about needed competences into the document. e.g. from NUREG 0711. To our understanding the "competences needed for integrating HFE into the design of ..." are not very detailed included in the document. A Matrix of minimum (appropriated) requirements for persons performing HFE would support the understanding of the safety guide.				x	This safety guide does not intend to provide recommendations on competences; this topic is generally addressed in another IAEA safety guides. Detail guidance on competences for HFE team goes beyond the scope of this safety guide.
3	DE	General		Please add some more details about the Styleguide (topics to be included). Many of the mentioned HMI design topics are very specific and could be summarized with bullets under Styleguide e.g., 4.10				x	We have deleted clauses on a style guide to satisfy another member state comments.
4	DE	General		We suggest to add Outage Control Center, and other rooms of the control center. It is highly important that HF personal takes all those rooms into consideration.				x	As we explained in section 1, this safety guide provides recommendations to meet specific safety requirement 32 from SSR 2/1, i.e. MCR, SCR, TSC.
6	DE	General		The requirements itself of a "graded approach" is mentioned in the document only for modernizations but should to our understanding be a driving factor for the intense of different analyses and V&V also for new plants using the reference plant as baseline.				x	Graded approach is generally mentioned, it is also part of GSR Part 2. However, how and to what extent to apply the graded approach is left on Member State.
1	ENSI	General		Substitute the term human-machine interface with human-machine interaction or system	Term human machine interface: It should be explained that the term is used in a broader sense. The term HMI limits the scope to a specific part of the human machine system. This way, important HF-issues are not considered, such as e.g. the automation philosophy with the corresponding function allocation (degree of automation) and the world view related to the role of the humans in fulfilling the task of the socio-technical system. The contents of the guide clearly go deeper into the HMS (e.g. by discussing issues of function allocation). The term human machine interaction is also used sometimes throughout the text (e.g. in 4.4).			x	This terminology has been discussed in great, painful depth. We are forced to follow the established terminology in SSR 2/1. We tried our best to mitigate this by discussing HFE design where we meant HMI in a broader sense.

Resolution of Member States Comments:
Human Factors Engineering in the Design of Nuclear Power Plants (DS492, Rev. "H")

MS No.	Member State	Sec.	Para	Proposed new text	Reason	Accept	Accepted, but modified as follows	Reject	Reason for modification/rejection
2	ENSI	General		The term "operator" should not be only used to refer to the operators in the control room, but to any human interacting with a technical system, including e.g. maintenance personnel. Therefore we suggest to use instead of "operator" the following description "all group of operating personnel e.g. reactor operator, turbine operator, shift supervisor, field operator, safety engineer and maintenance staff" (see para 3.24);				x	We use operating personnel (which includes operator) as defined by the IAEA Safety Glossary.
1	FI	General		The HFE issues are also meaningful in the context of decommissioning. IAEA should considered how the HFE issues could also be integrated into IAEA Safety Standards relevant to decommissioning of the nuclear facilities.				x	Agreed. However, a decommissioning guide is being produced with HFE included so guidance for decommissioning specifically has been excluded from this guide. This does not preclude using this guide.
1	JP	General		The concept of "fail-safe design" is not mentioned in this safety guide. What guides should deal with "fail-safe design" in accordance with the requirement 26 of SSR-2/1 (Rev. 1)? Human and organizational factor during DECs should be considered in the light of the Fukushima Daiichi NPPs accidents.	Clarification for the treatment of "fail-safe design".			x	This is a function of SSG-39 I&C. This safety guide does not address intentional, unauthorized acts. 4.25 addresses error tolerant design.
1	PL	General			A small section for newcomers would be useful taking into account the following points: a. At which stage shall a newcomer country create a HFE team ? b. Details about the composition of multidisciplinary HFE team. An example of HFE team with named specialists would be useful. c. At the stage of selecting plant vendor which documents concerning about HFE shall a newcomer country ask for ?			x	Well, the safety guides provides recommendations what should be done, not how to do it. Typically, we do not provide in a safety guide how to apply HFE in different (newcommer) countries., This is a topic for a TECDOC. If you descide to built a new NPP, the first document you will have available will, most likely, be a (preliminary) safety analaysis report. In Chapter 18 it provides details about how HFE principles were applied to desing HMI. The PSAR however does not provide full description how the actual HMI would look like. It is suggested to see a refernce plant design, if it is available.

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1	RF FSUE	General		<p>IAEA Safety Glossary (2016 edition) provides the following definition for "human factors engineering": "engineering in which factors that could influence human performance and that could affect safety are understood and are taken into account, especially in the design and operation of facilities". Therefore taking into consideration meaning of word "engineering" we must conclude that "human factors engineering" means all aspects of services influence on human factor for all services received by operating organization.</p> <p>Since such services cover the entire NPP life cycle, it is unclear why the standard draft title covers such services only for design stage, which is just one of the life cycle stages.</p> <p>As indicated in IAEA secretariat explanatory note to the standard draft, the objective of the draft is to provide a structured approach and guidance on human factor engineering in the design and modification of the human-machine interface to minimize the risk of human errors and optimize human performance to ensure safe operation of NPP. The actual content of the draft fully corresponds to this objective, i.e. the draft completely focuses on the problems of human-machine interaction.</p> <p>It seems obvious that this approach reflects only a small and not the main part of the human factor problems, the requirements for handling which are formulated in the GSR Part 2. Moreover, the problem of the human-machine interface is not new. It has always been considered in IAEA Safety Standards devoted to control (I&C) systems. In recently updated IAEA standard SSG-39 devoted to the designing of such systems, there is a special chapter covers human-machine interface.</p> <p>That topic seems appropriate to be covered in such safety standards like SSG-39. The duplication human-machine interface issues with even more details in the standard draft devoted to a wider coverage of human factor issues in all its manifestations at the NPP seems unnecessary. Moreover, it is completely unacceptable to focus such rather general standard on the human-machine interface.</p> <p>Thus we have no grounds for supporting DS492 standard draft. The standard draft should be revised to fully take into account the</p>	Revise title of the standard or its content			x	The scope of the safety guide has been endorsed in a DPP by NUSSC and CSS. As it is written in section 1, this safety guide provides recommendations to meet specific safety requirements of SSR 2/1, namely requirement 32. Therefore, your observation that "The actual content of the draft fully corresponds to this objective, i.e. the draft completely focuses on the problems of human-machine interaction" is correct. The SSG-39 provide several important recommendation on HFE consideration during the I ¹ C desing, however this safety guide did not provide details on how HFE should be applied to design HMI. The IAEA has published number of publications in operation section which addresses the human and organizational factors, included safety culture in greater detail.
2	RF JSC Atomen ergopro ject	General		The document does not provide any recommendations on the application of diversity in the HFE and HMI design. This aspect should be elaborated in the document	The use of computer based I&C may lead to common cause hardware and software failures. Therefore recommendations on the application of diverse I&C systems (on completely different principles) should be somewhere discussed in connection to HFE and HMI design (priorities, overlapping, etc.)			x	We believe that CCF in a programmable digital I&C system falls into the I&C domain. Please, refer to SSG-39 which address this topic in detail.
32	RF JSC Atomen ergopro ject	General		Technical meeting (TM) should be organized with the goal to perform final comprehensive review of the document by experts from Member States. The editorial work on the SG should be initiated only after TM with accept the draft.	The SG requires additional more thorough consideration. In the current form it cannot be published. Only editorial changes cannot improve the document significantly.			x	Although we agree with this comment; the technical meetings are no more organized to discuss draft safety guides. The draft safety guide is provided to member states for their comments anyway.
93	USA	Table	I-1	Delete "to the table" at the end of the IEEE Std 1707 title	Editorial	x			
106	CAN	Table		Add standards from nations other than the USA	NUREGs are not international standards. The US NRC uses specific terms and has specific approaches that do not always transfer well to other nations or which can be confusing in the context of this international document. Include documents / standards concerning HFE from other nations e.g., CSA N290.12-14	x	Added "and relevant guides" to the title. While we understand the desire to include the Canadian Standard, we have only included NUREGs here because of their long history and wide reference by other nations other than the U.S. Canadian was only released in 2014.		