SSC Members Comments on
DS407 Version 3
"Criticality Safety for Facilities and Activities Handling Fissionable Material"

CONTENTS

Notes:

1. Resolution of comments now shown in DS407 Version 4

TITLE: DS 407 CRITICALITY SAFETY FOR FACILITIES AND ACTIVITIES HANDLING FISSIONABLE MATERIAL (version 3 – Sept 2010)

COMMENTS BY REVIEWER Reviewer: Country/Organization: France			Page Date: 22 October 2010	RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1.	§1.1	This applies to large commercial facilities, e.g. ~~fuel cycle facilities~~ nuclear installations, that deal […]	More generic term in compliance with AIEA glossary	Y			
2.	§1.3	The objective of this Safety guide […] for ensuring sub-criticality when dealing with fissionable material and for planning the responses to criticality accident.	Section 6 of the guide deals with Planned response to criticality accident	Y			
3.	§1.4	"… e.g a nuclear reactor unless when it is in function"	Except when the reactor is in function. Indeed all the other operation involving fissionable materials must be treated		Reference to "at power" added. Note, Criticality control of a reactor is not within the scope of the safety guide, see approved DPP.		
4.	§1.4	It encompasses […] Ref.[6]. ~~does not cover any activities on defence related facilities.~~	Why to exclude defence facilities ?			Y	Military or defence programmes are excluded from the scope of the safety guide, see approved DPP.

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
5.	§1.4	If applicable the recommendations of this guide should be applied ~~for storage and transportation of fresh an spent fuel~~ to operations that should remain sub-critical in nuclear power plants.	More generic term		Specific reference to storage and transport retained, but moved to the end of the sentence as an example.		
6.	§2.2/3	After "vicinity", add "Note that the criticality accident is detected when it happen, thus importance of the margins taking into account in the assessment and the respect of the procedures (cliff edge effect)."	To insist on cliff edge effect		Agreed. The following text was added: "A criticality is only detected when it has occurred, this emphasises the importance of safety margins in the criticality safety assessment and compliance with operating procedures to avoid this cliff edge effect."		
7.	2.3 (and 2.12 point 2, 2.15, 4.15)	" …such as mass, isotopic vector, moderator… » "capture, scatter, etc… taking into account the environment of the fissionable materials and the interaction between fissionable materials."	Enrichment is only for uranium. For taking into account the reflexion and the interactions. This should also be so introduced in 4.15 point.	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
8.	§2.6/1st bullet	At the end, add "To ensure appropriate implementation of procedure ensuring sub-criticality, it is recommended to involve staff handling fissionable materials in their writing."	The best way to write clear and comprehensive procedures is to write them with the people handling fissionable materials.		Agree with the need for staff to be involved. The following text was added as a new 2nd bullet, recognizing that the section is providing recommendations for management: "To ensure correct implementation of operating procedures for ensuring sub-criticality, management should ensure that staff involved in handling fissionable materials are involved in writing them."		

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
9.	§2.6/4th bullet	"…new activity and changes of activities, including exceptional operations, undergo…	Operating experience shows that exceptional operations or unprepared operations often reduce margins			Y	Text refers to changes of activities and therefore by default covers changes due to exceptional operations.
10.	§2.7/3	After "multiplication is increasing.", add "People handling fissionable materials should be encouraged to inform their supervisors in case of difficulties"	It is important that operators understand why they have to respect procedures. This is why people handling of fissionable materials should be encouraged to inform the supervisors in case of difficulties. It can be an informative tool.	Y			
11.	§2.13	This implies notably a value of keff somewhat less than unity and/or a controlled parameter value below its critical value.	Safety margins rely not only on keff values or critical values	Y			

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12.	§2.14	In defining safety ~~margins~~ criteria on keff (relative to 1) and/or on the value…(in the first case), and/or the critical value…	"Safety criteria" is defined in §2.12			Y	Agreed that the types of safety criteria to ne employed are defined in para 2.12. Para 2.14 is retained as it is required to provide recommendations for determining the adequacy of the safety margin to be applied to whichever criteria has been chosen.
13.	§2.14	"the pessimism of the geometrical hypothesis for 3D configuration and the degree of uncertainty"	The way of considering the geometrical hypothesis for 3D configuration can lead to important margins.			Y	Too detailed. The para already recommends that uncertainty in estimating K_{eff} or a controlled parameter should be considered. This would include uncertainty associated with any computational model or modeling hypothesis.

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
14.	§3.15	[…] such as limiting: - the isotopic composition of the fissionable material present in the system; - the mass of the fissionable material present in the system; …	Isotopic composition is not only related to mass control; the text seems to imply that isotopic composition and mass are always treated together (limiting concentration and isotopic composition is also usual).	Y			
15.	§3.16	After "the application of controlled parameters", add "and the mix of them"	Association of several controlled parameter is not clear in the text, for example mass and moderation, concentration with geometry and so on		Agreed, the following text was used "and their combinations."		
16.	§3.17	The sub-criticality of the system can be demonstrated by calculating the […] (keff) and/or controlled […].	See comment n°6	Y			
17.	§3.17	- Limitation of the concentration of fissionable material within a solution ~~or suspension~~;	"suspension" is subject to interpretation	Y			
18.	§3.17	[…] - Ensuring the presence of neutron absorbers present in the system or between separate criticality safe systems - Limitation on distance […] - ~~Neutron absorbers between separate criticality safe systems~~	The 2 bullets deal with neutron absorbers: merge it.	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
19.	3.17		In France, for the mass, the common safety factor is 0,9 (when no risk of double batching) and 0,43 (when risk of double batching). For geometry, the safety factor depends of the type of geometry: 0,75 for sphere, 0,85 for cylinder (diameter), 0,75 for thickness). The slope of the criticality parameters in terms of the characteristic of the fissionable materials is important in the evaluation the margins. It may be useful to have an idea of the k_{eff} corresponding to the value obtained with safety factor.			Y	Noted. However, comment No 37 in Version 3 from the Japanese representative from NUSSC requested that the safety guide not make any reference to specific values, consequently, these values have been deleted.
20.	§3.21	"The presence of neutron moderating materials should be considered as they can significantly reduce the controlled parameters of fissionable materials"	It is true for the whole controlled parameters			Y	True, but this paragraph is only considering the effect on critical mass.

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
21.	§3.22	"… However, the availability of other reflector materials or several reflector materials in superposed thicknesses should be considered…"	In some configurations, it is necessary to take into account successive thicknesses of reflectors. For example 25 cm of lead and 20 cm of water.		Agreed, the following text was used: "or several reflector materials used in combination,…"		
22.	§3.23	(e.g. a change to plutonium containing fissionable material caused for instance by different irradiated fuel)	Sentence to be clarified		Example deleted.		
23.	§3.26	"…, (or in some cases, maximum distances, for example to limit interstitial moderation between fissionable materials or introducing absorbed neutron screen)."	Use absorbed neutron screen to limit interaction between units of fissionable materials is also possible.		New text added after the last ")".		
24.	§3.27	Heterogeneity of materials […] particularly for low enriched uranium systems or for mixed uranium and plutonium […]	This phenomena exists also for mixed UPu medium	Y			
25.	§3.29 Bullets 1 & 2	Add a definition of a "criticality controlled area"	A criticality controlled area is defined both by the characteristic of the fissionable materials and the controlled parameters		The definition provided was included in Para 3.39, bullet 2.		
26.	§3.43 bullet list	Add a bullet: "The ability of personnel to manage abnormal situation"	Some criticality accidents had been avoided by the personnel itself	Y			

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27.	§4.10	Use computational models <u>respecting a process of</u> o Verification o Validation	To provide an explanation (the assessment and the verification / validation are usually performed by different persons; assessment only checks that the model has been V&V)	Y			

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28.	§4.10		Giving the definition of the criticality controlled area at the beginning would be useful (see comment 25) It is also important to identify clearly the reference fissionable material (the materials the more pessimistic material as regard to the criticality risk) and the controlled parameters. A criticality controlled area is defined by a reference fissionable material and a (or several) controlled parameter(s). All binding between controlled areas with different reference fissionable material and/or different controlled parameters must be particularly analysed		Definition of controlled area given in comment 25 was added to para 3.29.		

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
29.	4.18	Add another bullet: “Geometrical configurations retained for de 3D calculation, in particular the pessimism with regard to criticality risk”	Introduce the 3D geometrical configuration and not only standards, handbooks…			Y	Too detailed. The 4th bullet introduces methods other than standards and handbooks, e.g. validated calculation methods and techniques.
30.	§4.28	The criticality safety analysis should describe ~~the application of the double contingency principle, see 3.7 or the single failure criterion; see 3.9.~~ the demonstration of the fault tolerance of the system; see 3.7 to 3.10.	The double contingency principle and the single failure criterion are often combined	Y			
31.	§5.1	~~Facilities~~ nuclear installation	See comment n°1	Y			
32.	§5.20	[…] (e.g. gamma spectrometry ~~or employing the like ISOCS method~~)	ISOCS method is a gamma spectrometry	Y			

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33.	§5.20	… taking into account the contents and the densities of the materials. Considering the estimations of a criticality controlled area, the absolute values of uncertainties are systematically doubly added. These methods should take into account operating experiences, successive interventions, and recording of information. The notion of "mass reset" must be justified.	Taking into account the counting of the uncertainties in a criticality controlled area positively at the input and negatively at the output.			Y	This para is dealing with accumulations of fissile material (arising from machining, grinding and cutting. The recommendation to take account and control movements of materials into and out of criticality controlled areas is covered by the bullets in para 3.28.
34.	§5.22	It is noted that commercial fuel production relies heavily on limiting moderators as a primary control parameter. However, the implementation of the defence in depth principle should […]	The defence in depth principle is more general than the double contingency principle.	Y			
35.	§5.36		The lost of soluble or fixed absorbers concerns all operations involving fissionable materials, not only storage ponds		Agreed.		
36.	§5.51	- Plutonium oxalate or mixed uranium and plutonium oxalate	In PUREX in case of co-precipitation	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
37.	§5.51	Add bullets : "- uranium or plutonium metals ; - other compositions (e.g. minor actinides…)"	Broaden the potential fissile materials considered	Y			
38.	5.68		Plant laboratories are in the same case.		Agreed.		
39.	§5.70	At the end, add "It is worth noticing that wastes are commonly wrapped with vinyl, more moderated that water. Moreover, vinyl wraps with fissionable materials are placed together, so that the repartition of the fissionable material is heterogeneous."	Presence of vinyl, more moderated then water and heterogeneous repartition of fissionable materials and the vinyl in the packaging	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
40.	After §5.79 and before §5.80	Before beginning decommissioning operations, accumulations of fissionable materials should be identified in order to assess the recovery of these materials. A method for estimating and tracking accumulations of fissionable materials that are not readily visible should be developed to ensure that the work stations remain sub-critical during decommissioning operations. The methods to be used could be based on quantification using spectral measurements (e.g. gamma spectrometry) or by a structured evaluation, estimating the volume, taking into account the contents and the densities of the material. These methods should take into account operating experiences, successive interventions, and recording of information.	To introduce some recommendations about accumulations of fissionable material for decommissioning operations.	Y			
41.	§6.4	Of the 22 world-wide criticality accidents that have ~~occurred~~ been reported in process facilities	We are not sure that there were only 22 accidents	Y			
42.	§6.5	Ref. [~~22~~ 23]	Mistake of reference	Y			
43.	§6.15	- detail the actions to be taken on evacuation and the evacuation routes and control areas	To be consistent with §6.12	Y			

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44.	§6.20	During an ~~E~~emergency response […]	Error of typography	Y			
45.	§6.51	Invert the first and second bullets.	The second bullet is more general	Y			
46.	§6.51	Shielded facilities ~~where either the potential for a criticality accident is not foreseeable, or~~ in which the potential for a criticality…	The deleted sentence is covered by the second bullet	Y			
47.	Definitions	Delete the ISOCS definition	The ISOCS reference is removed from §5.20	Y			
48.	Bibliography	IRSN DSU/SEC/T/2010-334, Criticality risks and their prevention in plants and laboratories	Place this reference in the « Handbooks and guides » part	Y			
49.	Bibliography	CRISTAL (The French CRISTAL Criticality Safety Package), http://www.cristal-package.eu/GB/presentation.htm	Place this reference in the « Computational Methods » part	Y			
50.			The operations concerning the routine maintenance must be included in the criticality assessment		Maintenance is covered under the section dealing with the implementation and reliability of the safety measures.		

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51.			It is important to appeal to criticality expert from the beginning of all new projects. Indeed, it is a difficulty to adapt criticality assessment when the project is well advanced.		Agree. Paragraph 2.6 addresses this recommendation.		

COMMENTS BY REVIEWER Reviewer: **Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)** (with Comments by GRS) Page 1 of 7 Country/Organization: **Germany** Date: Oct.28th , 2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	2.11 (page 9)	last line: „Guidance and recommendations for establishing an operational feedback system ~~is~~ are contained in Ref. [33]."	typographic mistake	Y			
2	4.24 (page 26)	1st sentence: „… the computational model should be validated against selected benchmarks which are representative of the application case."	wording	Y			
3	4.29 (page 27)	2nd sentence: „A statement of compliance with these measures should be specified and incorporated into the design or operating procedures."	typographic mistake	Y			
4	5.24 (page 31)	- If possible, this Para should be formulated more understandable. -	Clarification. The context of the sentence does not make clear if the phrase „on completion of manufacture" refers to the fresh fuel assemblies or to the fresh fuel storage area.		Reference to fresh fuel assemblies added. Note that the paragraph covers storage as well.		
5	5.31 (page 32)	2nd sentence: „In contrast to criticality assessments for operations earlier in the fuel cycle, account ~~could~~ may now be taken for the effects of fuel	to express a higher degree of engagement	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		irradiation.“					
6	5.36 (page 33)	2nd sentence: „… further guidance is provided in Ref. [31]. In this case, the potential for accidental dilution of the soluble neutron absorber …“	Connection between first and second sentence with regard to content. If no soluble absorber is used in the storage pond water, it is not necessary to consider the potential for accidental dilution in the criticality safety assessment.	Y			
7	5.36 (page 33)	4th sentence: „For example, Boraflex sheets (a material ~~impregnated with boron~~ composed of boron carbide, silica, and polydimethyl siloxane polymer) used in some PWR and BWR spent fuel storage ponds have been found to shrink as a result of exposure to gamma radiation creating gaps in the material and reducing the effectiveness of the neutron absorbers.“	to provide a more precise description of chemical composition and physical properties of Boraflex	Y			
8	5.36 (page 33)	5th / 6th sentence: „In line with the recommended preference for engineered safety measures, the presence of a soluble neutron absorber in the storage pond water should not be taken into account in the criticality	Consistency to the recommendations in the IAEA DS371 „Storage of Spent Fuel“ (Para 6.34(e)): By virtue of the double contingency principle, two unlikely, independent and	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		safety demonstration for normal operation. For certain accident conditions such as drop of fuel assembly, limited credit for soluble boron may be allowed in view of the double contingency principle."	concurrent incidents are beyond the scope of the required criticality safety analysis. See also Appendix I.3 of DS371: Criticality safety of pool storage should not rely on the use of soluble neutron poison.				
9	5.37 (page 33)	add 4th sentence: „… across the pond. Where soluble boron is used for criticality control, operational controls should be implemented to maintain water conditions in accordance with specified values of temperature, pH, redox, activity, and other applicable chemical and physical characteristics so as to prevent boron dilution."	to establish and implement a good practice; consistency with the recommendations in Appendix I.23 of DS371	Y			
10	5.38 (page 33)	last but one line: „… tend to reduce the effectiveness of fixed absorbers, see Ref. [10]. These effects …"	omission of a word	Y			
11	5.39 (pages 33-34)	last sentence: „Safety measures associated with this type of fault may preferably include engineered features to preclude misloading (e.g. based on	Best practice: Engineered features should take precedence over administrative controls.	Y			

COMMENTS BY REVIEWER | RESOLUTION

Reviewer: **Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)** (with Comments by GRS) Page 1 of 7

Country/Organization: **Germany** Date: Oct.28th , 2010

Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		the physical differences in fuel assembly design), or otherwise administrative controls and checks on fuel identity.“					
12	5.43 (page 34)	2nd line: replace „keff“ by „k_{eff}“	typographic mistake	Y			
13	5.44 (pages 34-35)	6th line: replace „keff“ by „k_{eff}“	typographic mistake	Y			
14	5.88 (page 43)	last sentence: „… of these materials ~~(~~include Refs [21] and [22].“	typographic mistake	Y			
15	6.4 (page 45)	4th line: „… and one occurred with metal ingots, see Ref. [12]. In these …“	omission of a word	Y			
16	6.9 (page 46)	„The requirements for developing an adequate emergency response … are provided in Ref. [8].“	omission of a word	Y			
17	6.27 (page 49)	5th line: „… available from other criticality accidents, see Refs [12, 24 and 25]. This will help …“	omission of a word	Y			
18	Ref. [6] (page 56)	… IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2009). [DS437 will supersede]	DS437 will supersede the 2009 Edition of TS-R-1 (Link: http://www-ns.iaea.org/downloads/standards/drafts/ds437.pdf)	Y			
19	Ref. [10] (page 56)	UNITED STATES DEPART-MENT OF ENERGY, Anomalies	correct citation – Rev. 6 from February 2010 is now	Y			

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		of Nuclear Criticality, Rep. PNNL-19176 Rev. 6, USDOE, Washington, DC (2010).	publicly available (Link: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-19176.pdf				
20	References: ANSI/ANS Standards (pages 59-60)	5th bullet: ANSI/ANS-8.7-1998;R2007 (R = Reaffirmed): Guide for Nuclear Criticality Safety in the Storage of Fissile Materials	complete citation – the 1998 standard was reaffirmed in 2007 (Link: http://www.new.ans.org/store/i_240234)	Y			
21	References: ANSI/ANS Standards (pages 59-60)	11th bullet: ANSI/ANS-8.17-2004;R2009 (R = Reaffirmed): Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors	complete citation – the 2004 standard was reaffirmed in 2009 (Link: http://www.new.ans.org/store/i_240254)	Y			
22	References: ANSI/ANS Standards (pages 59-60)	last but one bullet: ANSI/ANS-8.27-2008: Burnup Credit for LWR Fuel	correct citation – the standard was issued in 2008 (Link: http://www.new.ans.org/store/i_240273)	Y			
23	References: Government standards (page 60)	1st bullet: DOE-STD-1173-2009, Criticality Safety Functional Area Qualification Standard	DOE-STD-1173-2003 has been replaced by DOE-STD-1173-2009 (Link: http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/archive.html)	Y			
24	References: Governmen	3rd bullet: DOE-STD-1158-2010,	DOE-STD-1158-2002 has been replaced by DOE-	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
	t standards (page 60)	Self-Assessment Standard for DOE Contractor Criticality Safety Programs	STD-1158-2010 (Link: http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/archive.html)				
25	References: Handbooks and guides (pages 60-61)	3rd bullet: DOE-STD-3011-2002, Guidance for Preparation of Basis for Interim Operation (BIO) Documents	DOE-STD-3011-94 has been replaced by DOE-STD-3011-2002 (Link: http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std3011/std301120 02.pdf)	Y			
26	References: Handbooks and guides (pages 60-61)	12th bullet: TID-7016-Rev. ~~1~~2 (NUREG-CR-0095), ~~The~~ Nuclear Safety Guide, June 1978	correct citation (Link: http://www.csirc.net/docs/technical/12808/ref_002.pdf) TID-7016-Rev. 1 was published in 1957 and 1961 (corrected version)	Y			
27	References: Management (pages 62-63)	5th bullet: DOE-STD-3007-2007, Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Non-Reactor Nuclear Facilities	DOE-STD-3007-93, CN1 has been replaced by DOE-STD-3007-2007 (Link: http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/archive.html)	Y			
28	References: Management (pages 62-63)	6th bullet: DOE-STD-3009-94, CN3 Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented	DOE-STD-3009-94, CN2 has been replaced by DOE-STD-3009-94, CN3 in March 2006 (Link: http://www.hss.energy.gov	Y			

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Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		Safety Analysis ~~Reports~~	/nuclearsafety/ns/techstds/standard/archive.html)				
29	References: Management (pages 62-63)	last bullet: DOE-STD-1158-2010, Self-Assessment Standard for DOE Contractor Criticality Safety Programs	DOE-STD-1158-2002 has been replaced by DOE-STD-1158-2010 (Link: http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/archive.html)	Y			

ISO TC85/SC5/WG8 Comments on DS407, CRITICALITY SAFETY FOR FACILITIES AND ACTIVITIES HANDLING FISSIONABLE MATERIAL

ISO Participating Member: Country/Organization: Date:				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	§ 1.3	The objective of this Safety guide […] for ensuring sub-criticality when dealing with fissionable material and for planning the responses to criticality accident.	Section 6 of the guide deals with Planned response to criticality accident	Y			
2	§ 2.17	In some facilities or activities the amount of fissionable material may be so low or the isotopic composition may be such (e.g. $^{235}U/U \leq 1\%$) that a full criticality safety assessment would not be justified.	See § 672 (exceptions) of ref [6] (AIEA Safety Standard on Transport), where mass exception is (a) and (b); exception for uranium enriched in ^{235}U to a maximum of 1% by mass is (b); and exception for uranyl nitrate enriched to a maximum of 2% by mass is (c)	Y			
3	§ 3.5	The design of the facility or activity is such that the system will remain sub-critical without the need for active engineered or operator based safety	It cannot really be said that no operator based safety measure is used, even with intrinsically safe material. The consistency of the received material with	Y			

ISO Participating Member: Country/Organization: Date:				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		measures (other than verifying that the received fissile material properties are covered by the design).	the safe material should still be checked.				
4	§ 3.15	[…] such as limiting: - the isotopic composition of the fissionable material present in the system; - the mass of the fissionable material present in the system; …	Isotopic composition is not only related to mass control; the text seems to imply that isotopic composition and mass are always treated together (limiting concentration and isotopic composition is also usual).	Y			
5	§ 3.17	[…] - Ensuring the presence of neutron absorbers present in the system or between separate criticality safe systems - Limitation on distance […] - ~~Neutron absorbers between separate criticality safe systems~~	Or, if you prefer to separate the 2 points, the last item should be, for consistency: "Ensuring the presence of neutrons absorbers between separate criticality safe systems	Y			
6	§ 4.10	Use computational models respecting a process of o Verification o Validation	To provide an explanation (the assessment and the verification / validation are usually performed	Y			

ISO Participating Member: Country/Organization: Date:				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			by different persons; assessment only checks that the model has been V&V)				
7	§ 5.22	It is noted that commercial fuel production relies heavily on limiting moderators as a primary control parameter. However, ~~the preferred use of the double contingency principle~~ the implementation of the defence in depth principle should.lead to incorporation of control by other parameters in preference to multiple defences against moderator ingress to a system	The double contingency principle mentioned in this § 5.22 is not the one presented in § 3.7 but the "US DOE" preferred approach. Delete this reference to a DCP interpreted in this way. See previous comment 35 by USA (C.S. Tripp) on this topic	Y			
8	§ 5.51	"Plutonium or mixed uranium/plutonium oxalate"		Y			
9	§ 5.88	Closing ")" missing at the end.			First "(" now deleted.		
10	§ 6.4	"Of the 22 world-wide criticality accidents that have ~~occurred~~ been		Y			

ISO Participating Member: Country/Organization: Date:				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		reported in process facilities”					
11	§ 6.23	“the dose from ~~m~~an unplanned”		Y			

DS 407 Criticality Safety for Facilities and Activities Handling Fissionable Material

COMMENTS BY REVIEWER Reviewer: P. Malesys Country/Organisation: ISO (TRANSSC) comments for DS 407 Date: 27/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	5.86	My message is about the Draft Specific Safety Guide (SSG) DS 407 dealing with "criticality safety for facilities and activities handling fissionable material". More precisely, it is about paragraph 5.86 of this document. In this paragraph, it is stated that "fissile material should be transported so as to maintain subcriticality ...". In the previous round of comments, I suggested to replace "should" by "shall", with the reason that this paragraph 5.86 is essentially a copy of the IAEA Transport Regulations, where the verb "shall" is used. My comment was rejected, on the basis that DS407 will be a guide, and consequently the only verb which can be used is "should".	I would like to ask you to reconsider this issue, or to develop your reasoning. While I duly recognize that DS407 will be a guide, I think that it cannot modify the Regulations which exist. Whilst it is recognized that a guide cannot over regulate an activity, I also think that a guide cannot deregulate an activity. Therefore, I still think that "shall" would be more appropriate.		The Safety Guide can include "shall" statements providing it is quoting a safety requirement. I therefore propose to use "shall" by quoting TS-R-1. I believe that the appropriate TS-R-1 paragraph is 671 part (a).		

Title: Criticality Safety for Facilities and Activities Handling Fissionable Material DS407 Version 3 (2010-09)

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modif./rejection
Note: **Underlined** **means insertion of ward(s) and** **~~delete~~** **means deletion.**							
1	1.4/3	from initial design, through operation, ~~and~~ decommissioning and disposal.	In paragraph 5.8, it says "Criticality safety should be taken into account at various stages of the life cycle of the facilities: design, commissioning, operation (including modifications), decommissioning, and disposal".	Y			
2	2.16/1	In defining ~~normal~~ operational limits	No normal operational limits or abnormal operational limits. Just operational limits.	Y			
3	3.5/1	The passive safety design of the facility or activity is such that the system will remain sub-critical without the need for active engineered or operator based safety measures.	For clarity. The meaning of original sentence is unclear whether it is recommendation or explanation for passive safety.	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modif./rejection
Note: **Underlined** means insertion of ward(s) and **~~delete~~** means deletion.							
4	3.17 /bullet 2	• Limitation of the mass of fissionable material within a system to the safe mass~~: The safe mass should be obtained by multiplying the critical mass determined by the system conditions with a safety factor. For example, to~~ To meet the single failure criterion the safe mass may be specified to be less than half the minimum critical mass (incorporating a suitable safety factor) so that inadvertent double batching of the system does not lead to criticality;	Clarification Methods to evaluate the safe criteria should not be limited only to using safety factor. The method based on k_{eff} should be described.	Y			
5	3.17 /bullet 3	•Limitation of the geometry of the system to safe geometry~~: For simple geometries (sphere, cylinder, slab) the safe geometry is sometimes derived by multiplying the critical dimension determined by the system conditions with a safety factor;~~	Clarification Methods to evaluate the safe criteria should not be limited only to using safety factor. The method based on k_{eff} should be described.	Y			
6	3.17 /new bullet	Just after bullet7, insert the following bullet; ● Safe limits such as safe mass, safe geometry can be evaluated either by multiplying the critical value determined by the system	Clarification Methods to evaluate the safe criteria should not be limited only to using safety factor. The method based on k_{eff} should be	Y			

COMMENTS BY REVIEWER | RESOLUTION

Reviewer: Page 1 of

Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010

Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modif./rejection
Note: <u>**Underlined**</u> **means insertion of ward(s) and** ~~**delete**~~ **means deletion.**							
		<u>conditions with a safety factor or by calculation of the value which meets sub-critical keff criteria.</u>	described.				
7	3.25/L7 -8	Any materials included or omitted from the detailed assessment should be justified<u> by evaluating</u>~~ against their~~ <u>the</u> effect<u> of their treatment</u> on the neutron multiplication<u>.</u>	Clarity/completeness	Y			
8	3.31	~~3.31. Procedures for responding to criticality accidents should be prepared including the use of criticality detection and alarm systems and emergency procedures (Section 6)~~	This paragraph is not suitable in this section and is duplicated in Section 6. Therefore this paragraph should be deleted.	Y			
9	4.5-4.9	It is better to merge these sections after the next subsection "CRITICALITY SAFETY ASSESSMENT". **See attached sheet No.1**	4.1-4.4 sections are appropriate for GENERAL, but 4.5-4.9 sections explain more actual and detail. These explanations are suitable for next subsection.	Y			
10	4.10	~~The criticality safety assessment should analyse the hazards associated with an activity involving fissionable material and ultimately develop and document the~~	This section explains nearly same meaning as 4.6. If 4.5-4.9 sections are merged here, this part will overlap.	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: <u>**Underlined**</u> **means insertion of ward(s) and** ~~**delete**~~ **means deletion.**							
		~~safety measures (e.g. passive, active and administrative) required to prevent a criticality accident. To meet this objective~~ ~~a~~ <u>A</u> systematic approach to the assessment should be adopted as outlined below:					
11	4.10	~~• Use computational models;~~ ~~o Verification~~ ~~o Validation~~ ▪ Perform criticality safety analyses<u>;</u> • <u>Calculation methods;</u> • <u>Verification</u> • <u>Validation</u>	It is better to change subtitles. Usually criticality safety analyses include the preparation works of proper computational code, data, model et al.. V & V is a kind of these works.	Y			
12	Before 4.20	~~Computational models~~ <u>Calculation methods</u>	Usually "computational model" word impress more direct meaning.	Y			
13	4.20	~~Computational models, i.e. calculation methods or computer codes,~~ <u>Calculation methods, such as computer codes and nuclear data,</u> used in the criticality safety analysis should be verified and validated to ensure the accuracy of their	Recently computational code is used almost established and familiar one. So a basic verification process is already shown in the	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: **Underlined means insertion of ward(s) and ~~delete~~ means deletion.**							
		predicted values and to establish their limits of applicability, bias and level of uncertainty. Verification ~~relates to both the model and the system code. Model verification~~ is the process of determining that a computer code ~~computational model~~ correctly implements the intended conceptual model or mathematical model~~; that is, whether the controlling physical equations and data have been correctly translated into the computer code~~. System code verification is the review of source coding in relation to its description in the system code documentation, Ref. [2]. Validation relates to the process of determining whether the overall calculation method ~~computational model~~ is an adequate representation of the real system being modeled ~~modelled~~ and to quantify any calculation bias and uncertainty.	documents of code developer. Otherwise, modeling errors in calculation are strongly depending on a problem or object. Usually we validate computer code and nuclear data set by calculating a similar geometry or materials of benchmark problem. For these meaning, this sentence should be simplified.				

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: **Underlined means insertion of ward(s) and ~~delete~~ means deletion.**							
14	criticality safety analyses 4.28	Move after 4.19.	If 4.10 was changed, this sentence will move.	Y			
15	5.6	~~Operation of the organisation and~~ both human and hardware/software errors should be studied as possible initiating events for criticality accidents.	Clarity/completeness The meaning of “operation of the organization” is not clear.	Y			
16	5.44/3	The criticality analysis and supporting calculations now need to determine the change to the fuel composition during irradiation and cooling time after irradiation.	It is better to add these sentences from technical view point.	Y			
17	5.50, 3rd bullet	• Maintaining chemical control~~ during~~ in order to prevent:	Clarification	Y			
18	5.50, 3rd bullet/ Sub-bullet11	_ precipitation, colloid formation, concentration increases in solution, **de-nitrification**;	Question: Why ‘de-nitrification’ is addressed here? Do we need it?		Reference to de-nitrification deleted.		

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: **Underlined means insertion of ward(s) and ~~delete~~ means deletion.**							
19	5.50/ 3rd bullet/1 Sub- bullet2	_ unplanned separation and extraction ~~re-concentration~~ of fissionable material ~~(e.g. accidental solvent extraction);~~	Completeness and consistency with 5.57	Y			
20	5.50/ 3rd bullet/ sub- bullet3	~~_ Process control time lags;~~	"process control time lags" is a different topic from other bullets. This is explained at pala.5.59 and not needed to be here. See relevant comment No.28	Y			
21	5.51, 2nd bullet	・fuel rods; ・sheared fuel; ・fines or swarf;	Clarity/completeness (to add a condition in dissolver)	Y			
22	5.59/5	･･･criticality accident. The process control time lags should be considered in the maintaining chemical control.	Clarification		The following text was added: "The process control time lags should be considered in maintaining chemical control."		

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: **Underlined means insertion of ward(s) and ~~delete~~ means deletion.**							
23	5.63 3rd bullet	• passive filtration; ????	unclear. This is not familiar to us. Need explanation.		Reference to passive filtration deleted.		
24	6.2-6.13	**See attached sheet No.2**	para.6.2, 6.3 are appropriate for emergency preparedness and response" rather than for "cause and consequence of criticality accident". para.6.2, 6.10, 6.12 say about same issues redundantly. i.e. criticality alarm system (CAS) and evacuation. So, these paragraphs should be merged and rearranged. These paragraphs say that CAS should be provided. Therefore it could be read that all installations handling and use of fissionable material should provide CAS.	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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			However, para.6.51 explains about “exception criteria” for CAS. So, where CAS appear first, it is better to insert reference to 6.51. From the viewpoint of the above mentioned, para.6.2 to 6.13 are reorganized and revised.				
25	6.6/1	Typically criticality accidents in solution systems were characterised by one or several fission excursion spikes, particularly at the start of the transient,	Clarity/completeness	Y			
26	6.38/1	An assessment of the state of the facility should be ~~completed~~ conducted by nominated, suitably qualified and experienced criticality safety staff …	Original sentence means too strong responsibility on a criticality safety staff.	Y			
27	6.38/2	…by nominated, suitably qualified and experienced criticality safety staff with the support from operators, to determine the actions…	Without operators’ help, knowledge and experience, he cannot complete the task.	Y			
28	DEFINITIONS	**Irradiated material** material that has been exposed to	Generally it is not only exposed by a reactor.	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: Underlined **means insertion of ward(s) and** ~~**delete**~~ **means deletion.**							
		radiation ~~to a reactor flux~~.					
Editorial comments							
29	3.11	The safety measures for ensuring sufficient sub-criticality should be identified and their required safety functions should be defined.	Editorial	Y			
30	3.23	Neutron absorption should be considered. Neutron absorbers are mainly effective for thermal neutron and/or energy systems.	Editorial	Y			
31	3.24	Neutron absorbers that are homogeneously distributed in a thermal neutron and/or energy ~~fissile material~~ system are usually more effective than if they were heterogeneously distributed (although it should be noted that heterogeneous absorbers may be easier to administratively control). In a thermal neutron and/or energy system consisting of	Editorial	Y			
32	3.29 8th bullet	Transfer and control of materials to ~~from~~ areas without criticality safety control (e.g. waste water processing);	literal error ? The meaning of this sentence is not clear.		Text added to improve clarity of bullet		

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
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Note: <u>**Underlined**</u> **means insertion of ward(s) and** ~~**delete**~~ **means deletion.**							
33	5.2/4	fresh fuel storage (and ~~transportation~~ <u>transport</u>), spent fuel storage (and ~~transportation~~ <u>transport</u>)	Editorial	Y			
34	5.9/3	Periodic testing of material relied upon to maintain sub<u>-</u>criticality	Editorial	Y			
35	5.12/5	However, enrichment facilities have the potential for criticality accidents and should be protected from criticality <u>hazards</u> through the application of criticality safety measures	Editorial	Y			
36	5.22/5	In many cases it is possible to include passive safety engineering such as safe geometry or fixed neutron ~~absorption~~ <u>absorbers</u>, for example, for fuel pin/rod storage.	Editorial	Y			
37	5.43	and ~~this~~ <u>the application of burnup credit</u> may present several advantages as ~~highlighted~~ below:	As next sentence 5.44 started "On the other hand", "this" is not adequate.	Y			
38	5.44, 2nd bullet, L2	soluble poison → soluble absorber	In all other parts, "soluble neutron absorber" or "soluble absorber" are used.		Soluble absorbers used.		
39	5.58	monitoring of fissionable <u>material</u> concentration	Editorial	Y			
40	5.62	However, particular attention should be	Editorial	Y			

COMMENTS BY REVIEWER Reviewer: Page 1 of Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modif./rejection
Note: **Underlined** **means insertion of ward(s) and** **~~delete~~** **means deletion.**							
		paid to the possibility of fissionable material accumulations in swarf,					
41	5.68	Add Further guidance on criticality safety at reprocessing facilities is provided in Ref. [XX] Reference XX. INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Reprocessing Facilities, IAEA Safety Standard Series DS360, IAEA, Vienna (in preparation)	Editorial	Y			
42	5.91	The management system should ensure that the combining of material from another criticality controlled ~~control~~ area or	Editorial	Y			
43	6.2/3	minimising the consequences of the accident ~~criticality~~ should be provided.	Editorial	Y			
44	6.3/2	in minimising the consequences of an accident ~~criticality~~.	Editorial		Now para 6.12		
45	6.4	20 have occurred in solutions, one involved a slurry and one occurred with metal ingots shown in Ref. [12].	Editorial	Y			

COMMENTS BY REVIEWER

Reviewer: Page 1 of

Country/Organization: Japan/ NISA, JNES Date: 29 Oct. 2010

RESOLUTION

Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modif./rejection
Note: **Underlined means insertion of ward(s) and ~~delete~~ means deletion.**							
46	6.4/bullet2	•Reactivity insertion mechanism and rate ~~mechanism/rate~~	Editorial	Y			
47	6.4/bullet5	o Duration time and time constant of reaction;	Editorial	Y			
48	6.5	in Ref.[~~22~~23 or 24?(perhaps 24)]	typo?		Ref 23		
49	6.8/2	there remains a possibility that a failure (i.e., Instrumentation and Controls ~~I&C~~, electrical, mechanical or operational	Editorial		Now para 6.2		
50	6.13/2	emergency response ~~preparedness~~ plan,	Editorial		Now para 6.8		
51	6.27/2	and should seek advice from other known experts ~~specialists~~ as necessary. A directory of such experts should be available with the emergency response plan.	Editorial	Y			

4. CRITICALITY SAFETY ASSESSMENT

GENERAL

4.1. Historically most criticality assessments have been based on a deterministic approach where a set of conservative rules and requirements concerning facilities or activities involving fissionable material are applied. In this approach the reliability of safety measures in successfully minimising, detecting and intercepting deviations in controlled parameters to prevent a criticality accident are judged mainly against a set of favourable characteristics such as independence, engineered versus administrative, passive versus active etc. Such considerations may also include a qualitative judgment of the likelihood of failure on demand of these safety measures. If these rules and requirements are met then it is inferred that the risk from criticality is acceptably low. This approach has been successfully applied over a very wide range of facilities and activities.

4.2. In more recent years it has been increasingly common to complement the deterministic approach to criticality assessment with probabilistic analyses. Probabilistic studies are usually based on realistic assumptions regarding operational conditions, rather than the conservative representation typically used in deterministic assessments. Part of the probabilistic approach is to make estimates of the frequency of the initiating event(s) which trigger the deviation from normal conditions and the probabilities of failure on demand of any safety measures. These may be combined to estimate the frequency of criticality. Using this value and combining it with the consequences (often assumed to be a single fatality per criticality accident for unshielded operations), an estimate of the criticality risk can be made and compared with risk targets or criteria if any for the facility or activity.

4.3. The probabilistic approach can be used to evaluate the extent to which the overall operations are well balanced and in some cases may provide additional insights into potential weaknesses in the design or operation which may be helpful in identifying ways of reducing risk further. Difficulties in applying the probabilistic approach are sometimes encountered in criticality assessment where one or more of the safety measures may include a significant component of operator action. The reliability of this type of safety measure can be very difficult to quantify. Also, in some cases for new types of equipment, hardware and software there may be a lack of reliability data. The uncertainties in the values of risk derived by these methods should be borne in mind before using them as the basis for significant modifications to a facility, plant, process or activity.

4.4. An increasing number of regulatory bodies now require that criticality assessment should form part of an integrated safety assessment for a facility or activity rather than as a 'stand-alone' assessment. In addition there may be increased emphasis on consideration of risks over the complete life-cycle of the facility and materials that arise, including their ultimate disposal. This leads to the need to weigh criticality risks relative to risks from other hazards such as routine dose uptake or non-nuclear risks from handling/transport activities for example. In making these types of 'risk-informed' judgments the levels of conservatism incorporated into estimates of risk from the different hazards should be broadly consistent. In these circumstances the more traditional deterministic approach to criticality assessment may need to be supplemented with a more realistic analysis of the type used in probabilistic assessment.

CRITICALITY SAFETY ASSESSMENT

4.5. A criticality safety assessment should be performed prior to the commencement of any new or modified activity involving fissionable material. The criticality safety assessment should be carried out during the design, construction, commissioning and operational phases of a facility or activity, during decommissioning and post-operational clean-out, during transport and during the storage of fissionable materials.

4.6. The objectives of the criticality safety assessment should be to determine whether an adequate level of safety has been achieved, to develop appropriate limits and controls, i.e. safety measures, to prevent a criticality and to demonstrate and document compliance with appropriate safety criteria and requirements as defined by the operating organization and regulatory body.

4.7. The criticality safety assessment should include a criticality safety analysis which should evaluate criticality safety in all operational states, i.e. normal operation, anticipated operational occurrences and design basis accidents. The criticality safety analysis should identify hazards, both internal and external, and fault scenarios and determine their consequences.

4.8. The criticality safety assessment and analysis should be carried out by suitably qualified and experienced criticality safety staffs who are knowledgeable in all aspects of criticality safety and familiar with the facility or activity concerned.

4.9. In the criticality safety assessment the criticality safety staff should consider the possibility of inappropriate (and unexpected) operator responses to incidents (i.e. off-normal conditions). For example, operators may automatically respond to leaks of fissionable solutions by catching the material in geometrically unsafe vessels.

4.10. A systematic approach to the assessment should be adopted as outlined below:

- Define the activity involving fissionable material;
- Define the methodology for criticality safety assessment;
- Perform criticality safety analyses;
  - Calculation methods;
  - Verification
  - Validation
- Identify any unique or special safety measures.

Activity involving fissionable material

4.11. The limits and extent of the activity involving fissionable material should be determined. This should be achieved by providing a description of the operations being assessed and should include all relevant systems, processes and interfaces. To provide clarity and understanding, the description of the operations should include relevant drawings, illustrations and/or graphics as well as operating procedures.

4.12. Any assumptions about the operations and assumptions about any associated systems and processes that could impact the assessment should be identified and justified. These include, but are not limited to, the administrative systems, e.g. non-destructive assay, materials control and accountability and combustible material control.

4.13. If the criticality safety assessment is limited to a particular aspect of a facility or activity, then the potential for interactions with other facilities, systems, processes and activities should be described as well as references to any related criticality safety assessments.

4.14. To ensure the accuracy of the criticality safety assessment, the criticality safety staff should, whenever possible, directly observe the activity, processes and equipment if they exist and encourage operators to provide operational feedback. The overall safety case for the facility should also be reviewed and used to identify and provide information on faults that should be considered as potential initiators of criticality accidents, e.g. sprinkler activation, glove box rupture, rack collapse, movement of fissionable material during package transport and natural phenomena.

Methodology for criticality safety assessment

4.15. The first step in the assessment should be to understand and analyze the range of normal processing conditions (i.e. normal operation). The fissionable material characteristics (e.g. mass, volume, enrichment, degree of fissionable material and burnable absorber depletion, degree of fission product production/in-growth and interaction) should be identified, justified and documented. Estimates of the normal range of operating parameters including conservative/bounding estimates of any anticipated variations in those parameters should be determined, justified, documented and shown to be sub-critical.

4.16. The next step in the assessment should be to identify all credible faults (i.e. incidents and accidents leading to anticipated operational occurrences and design basis accidents). These should then be analyzed and documented. The following should be considered when performing the fault analysis:

(1) All potential fault scenarios should be identified. A structured, disciplined and auditable approach should be used to identify potential faults. This approach should also include a review of available lessons learned from previous incidents and accidents and also the results of any physical testing. Typical techniques available to identify fault scenarios include:

- “What-If?” methods;
- Qualitative Event or Fault Trees;
- Hazard and Operability Analysis;
- Failure Modes and Effects Analysis.

(2) Input into the analysis should also be obtained from facility operations personnel and process specialists who are thoroughly familiar with the operations and potential fault conditions that could arise.

4.17. The assessment should be performed utilizing a verified and validated methodology. The assessment should provide the documented technical basis that demonstrates sub-criticality during operational states and design basis accidents in relation with the double contingency principle or the single failure approach (see paras 3.7 - 3.10). The criticality safety assessment should identify the safety measures, including any administrative safety measures, required to ensure sub-criticality, it should specify their safety functions and determine their reliability, redundancy, diversity, separation, system requirements and equipment qualification requirements.

4.18. The criticality safety assessment should describe the methodology or methodologies used to establish the operational limits for the operation being evaluated. Methods that may be used for the establishment of these limits include, but may not be limited to:

- Reference to national consensus standards;
- Reference to accepted handbooks;
- Reference to experiments with appropriate adjustments to ensure sub-criticality when the uncertainties of parameters reported in the experiment documentation are considered; and/or;
- Use of validated calculation techniques.

4.19. The applicability of reference data to the fissionable material system being evaluated should be justified. When applicable, any nuclear cross-section data used should be identified (i.e. cross-section sets and release versions) along with any cross-section processing codes that were used.

Criticality safety analysis

4.28. The criticality safety analysis should demonstrate that operations are sub-critical under all operational states and that no incident or design basis accident can lead to a criticality. The criticality safety analysis should describe the application of the double contingency principle, see 3.7 or the single failure criterion; see 3.9.

Calculation methods

4.20. Calculation methods, such as computer codes and nuclear data, used in the criticality safety analysis should be verified and validated to ensure the accuracy of their predicted values and to establish their limits of applicability, bias and level of uncertainty. Verification is the process of determining that a computer code correctly implements the intended conceptual model or mathematical model. System code verification is the review of source coding in relation to its description in the system code documentation, Ref. [2].Validation relates to the process of determining whether the overall calculation method is an adequate representation of the real system being modeled and to quantify any calculation bias and uncertainty.

4.21. Once the calculation method has been verified and validated, it should be managed within a documented quality assurance programme as part of the overall management system. The quality assurance programme should ensure that a systematic approach is adopted in designing, coding, testing and documenting the calculation method.

4.22. When computer codes and nuclear data are used, the type of computing platform i.e. hardware and software, along with relevant code configuration control information should be documented.

Verification

4.23. Verification of the calculation method should be performed and periodically checked and should test the methods, mathematical or otherwise, used in the model.

Validation

4.24. After completing the verification of the calculation method and prior to its use in performing a criticality safety analysis, the calculation method should be validated against selected benchmarks which are representative of the activity being evaluated. The relevance of benchmarks used to perform the validation should be determined from comparisons of the benchmarks characteristics with those of the fissionable material system being evaluated.

4.25. The selection of the benchmarks should consider:

- Benchmarks that have relatively small uncertainties as compared to any arbitrary or administratively imposed margin of sub-criticality;
- Benchmark characteristics (e.g. all isotopic and chemical compositions, neutron spectra and geometry, etc) should be similar to the fissionable material system and its operating parameters as identified in the criticality safety assessment, i.e. all operational states, including normal operation, anticipated operational occurrences and design basis accidents;

- Benchmarks should be reviewed to ensure that their neutronic, geometric, physical and chemical characteristics encompass the operational states of the fissionable material system to be evaluated. Examples of neutronic, geometric, physical or chemical characteristics that should be reviewed for all materials include, but not limited to:
  - Neutron-energy spectra throughout the individual benchmarks relative to the neutron-energy spectra throughout the fissionable material system that is the subject of the safety analysis;
  - Molecular compounds, mixtures, alloys and their chemical formulae;
  - Isotopic proportions (Note: Calculated isotopic proportions used in "burnup" credit should be validated);
  - Material densities;
  - Relative proportions or concentrations of materials such as the moderator-to fissionable material ratio. Effective moderators are materials, typically of low atomic mass (i.e. < 17 amu). Common materials that are effective moderators include water (i.e. hydrogen, deuterium and oxygen), beryllium, beryllium oxide, graphite (i.e. carbon). In the presence of poorly absorbing materials, such as magnesium oxide, oxygen can be an effective moderator;
  - Degree of homogeneity or heterogeneity, including gradients of fissionable and non-fissionable materials;
  - Geometric arrangements and compositions of the fissionable materials relative to non-fissionable material such as neutron reflectors and scatterers but including materials that are effective for parasitic absorption of neutrons (e.g. common materials include cadmium, hafnium, and gadolinium but other materials, such as iron (Fe) also act as slow neutron absorbers);
  - The sensitivity of any geometry simplification should be checked, i.e. elimination of pipes, ducts, etc;
- Calculation methods should be reviewed periodically to determine if relevant new benchmark data has become available for further validation.

4.26. If no benchmark experiments exist that match the system being evaluated (e.g. low-moderated powders and waste), it may be possible to interpolate or extrapolate from other existing benchmark data to that system, by making use of trends in the bias. Where the extension is large, the method should be supplemented by other calculational methods to provide a better estimate of the bias, and especially of its uncertainty in the extended area (or areas), and to demonstrate consistency of computed results. Sensitivity and uncertainty analysis may be used to assess the applicability of benchmark problems to the system being analyzed and to ensure an acceptable margin of sub-criticality. An important aspect of this process should be the quality of the basic nuclear data and its uncertainties.

4.27. When available, the results of the calculations should be crosschecked using independent nuclear data or different computer codes.

Unique or special safety measures

4.29. Any unique or special safety measures resulting from the criticality safety analysis and assessment should be specifically highlighted to ensure their visibility and to ensure that they are complied with. A statement of compliance with these measures should be specified and incorporated in to the design or operating procedures. The requirements should be treated in accordance with a quality assurance programme, see Section 3.

Attached sheet No.2

6. PLANNED RESPONSE TO CRITICALITY ACCIDENTS

GENERAL

6.1. This section mainly deals with emergency response in stationary nuclear installations. Guidance on planning and preparing for an emergency response to a transport accident involving fissionable material can be found in Ref. [26].

6.2&6.8(merged). Priority should always be given to the prevention of criticality accidents through the provision of "defence in depth". Despite all the precautions that are taken in the handling and use of ***fissionable*** material there remains a possibility, while very small, that a failure (i.e., ~~I&C~~ ***Instrumentation and controls***, electrical, mechanical or operational errors) or an incident may give rise to a criticality accident. In some cases, this may give rise to exposure or the release of radioactive materials within the facility and/or into the environment, which may necessitate emergency response actions. Such emergencies may include transport accidents. Adequate preparations should be established and maintained at local and national levels and, where agreed between States, at the international level to respond to nuclear or radiological emergencies.

6.9(moved here). The requirements for developing an adequate emergency response to a nuclear or radiological emergency are provided in Ref. [8].

CAUSES AND CONSEQUENCES OF A CRITICALITY ACCIDENT

~~6.2. Priority should always be given to the prevention of criticality accidents through the provision of "defence in depth". However, in the event of a criticality accident, a means of minimising the consequences of the criticality should be provided. The consequences should be minimised by alerting personnel to the threat of high radiation intensity and providing a procedure for their safe evacuation.~~

~~6.3. The provision of shielding should also be considered in minimising the consequences of a criticality. In employing shielding as a protection measure, the implications on dose of penetrations through the shielding should be evaluated.~~

6.4. In demonstrating the adequacy of the emergency arrangements the expected external dose should be calculated. Of the 22 world-wide criticality accidents that have occurred in process facilities; 20 have occurred in solutions, one involved a slurry and one occurred with metal ingots shown in Ref. [12]. In these events, the key physical phenomena affecting the fission yield were:

- Volume of fissionable region (particularly for solution systems)
- Reactivity insertion mechanism~~/~~ and rate
- Reactivity feedback mechanisms, e.g.
  - Doppler feedback;
  - Duration and time constant of reaction;
  - Degree of confinement;
  - Neutron spectral shifts;
  - Voiding;

• Density changes.

6.5. Guidance for the estimation of fission yield magnitudes may be found in Ref. [~~22~~ 23 or 24 ?].

6.6. Typically criticality accidents in solution systems were characterised by one or several fission spikes, particularly at the start of the transient, followed by a 'quasi-steady state' or plateau phase where fission rates fluctuate much more slowly.

6.7. An analysis of the 22 process accidents identified a common theme in terms of the reactivity excursion mechanism; the majority being due to increase in concentration, movement of fissionable material/reflector by gravity or flow through pipework. A detailed description of the dynamic behaviour of these process based criticality accidents can be found in Ref. [12].

~~BASIC RESPONSIBILITIES~~

~~6.8. Despite all the precautions that are taken in the handling and use of fissile material there remains a possibility that a failure (i.e., I&C, electrical, mechanical or operational errors) or an incident may give rise to a criticality accident. In some cases, this may give rise to exposure or the release of radioactive materials within the facility and/or into the environment, which may necessitate emergency response actions. Such emergencies may include transport accidents. Adequate preparations should be established and maintained at local and national levels and, where agreed between States, at the international level to respond to nuclear or radiological emergencies.~~

~~6.9. The requirements for developing an adequate emergency response to a nuclear or radiological emergency are provided Ref. [8].~~

EMERGENCY PREPAREDNESS AND RESPONSE

6.13.(moved here) Each installation where criticality alarm systems (see para.6.51) are installed should have an emergency ~~preparedness~~ response plan, programme, and capabilities to respond to credible criticality accidents.

6.14.(moved here) Experience of criticality accidents shows that the main risk is to operators in the immediate vicinity of the event. Generally, radiation doses to personnel more than a few tens of metres away are not life-threatening. On the other hand it is common for some types of systems, particularly solutions, to display oscillatory behaviour with multiple bursts of radiation continuing over hours or even days. Bearing this in mind the key principle in emergency planning should be prompt evacuation to a safe distance followed by a period of information gathering ahead of initiating a planned re-entry.

6.12.(moved here) The radiation doses from criticality accidents may be significant, even for personnel located at some distance from the accident, and so a mechanism for identifying appropriate evacuation and control areas should be developed. ~~Alarms~~ Criticality alarm systems (see para.6.51) should be provided and appropriate safe evacuation routes and assembly areas defined.

~~6.10. It is acknowledged that in most operations with fissionable materials the risk of a criticality accident, while very small, cannot be eliminated. In such an event a means of alerting personnel to the threat of high radiation intensity, using a criticality alarm system and a procedure for their safe evacuation should be provided.~~

6.11. The design should provide a diversity of communication systems to ensure reliability of communication under different plant states and conditions.

<u>6.3.(moved here)</u> The provision of shielding should also be considered in minimising the consequences of a criticality <u>accident</u>. In employing shielding as a protection measure, the implications on dose of penetrations through the shielding should be evaluated.

~~6.13. Each installation where criticality alarm systems (see para.6.51) are installed should have an emergency preparedness plan, programme, and capabilities to respond to credible criticality accidents.~~

DS 407 – CRITICALITY SAFETY FOR FACILITIES AND ACTIVITIES HANDLING FISSIONABLE MATERIAL

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** Page-1 of 3 **Country/Organization: Pakistan / PNRA** Date: 29-10-2010				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
1	3.8 (New)	Independent monitoring systems should be available to monitor each parameter.	To avoid common cause failure.			Y	Recommendations covering the adequacy of safety measures, i.e. redundancy, diversity etc already covered in para 4.17 and the recommendation for compliance with single failure criterion covered in para 3.9
2	4.10 (New)	Define fissionable (most prominent) radio nuclides.	In the safety assessment, mention the type of radio nuclides after defining the activity of fissionable material.			Y	Fissionable defined in the IAEA Safety Glossary.
3	5.86 (New)	Temperature changes.	Temperature is the critical parameter which plays major	Y			

COMMENTS BY REVIEWER Reviewer: M. Anwar Habib Page-1 of 3 Country/Organization: Pakistan / PNRA Date: 29-10-2010				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
			role in reactivity changes.				
4	6.21	Management should ensure by emergency drills that workers are well aware of procedures during emergency and awareness program for local residents.	Emergency drills are only way to assure proper awareness of workers and residents.		New para 6.17 added as "Management should conduct emergency exercises to ensure that workers are well aware of the emergency procedures and an awareness program for local residents."		
5	References Page-56	Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (NS-G2.8)	Personnel training is discussed at page -8 but no reference is provide in the references section.			Y	NPP specific. However, management requirements and recommendations on training are covered by references: 3, 11 & 30.
6	References Page-56	Quality Assurance for Safety in Nuclear Power Plants and	Quality assurance is an important aspect in all nuclear and			Y	50-C/SQ-Q is no longer an IAEA Safety Standard and has been

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** **Page-1 of 3** **Country/Organization: Pakistan / PNRA** **Date: 29-10-2010**				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
		other installations (Safety Series No. 50-C/SG-Q	safety related activities. Operating procedures and Criticality Safety Assessment is discussed so reference of Quality Assurance Safety guide is necessary				superseded by GS-G-3.5, which is referenced in DS407.
7	2.6	Following may be added in context of criticality safety; a. Management should ensure that the corrective action plan has been updated and implemented. b. Management			a) Added new bullet to para 2.6 as: "Management should ensure that any corrective action plan is updated and implemented." b) Physical protection is not within scope of document c) Covered by para		

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** **Page-1 of 3** **Country/Organization: Pakistan / PNRA** **Date: 29-10-2010**				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
		should ensure that the physical protection program exists and implemented. c. Management should ensure arrangements for implementation of operational feedback experiences.			2.11		
8	3.3/3	The word “limiting consequences” may be replaced with “mitigating consequences”.	For clear understanding			Y	Reference to “limiting consequences” retained for consistency with the statement in NS-R-5.
9	3.29	Following may be				Y	a) Covered by para 2.6.

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** **Page-1 of 3** **Country/Organization: Pakistan / PNRA** **Date: 29-10-2010**				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
		added in administrative safety measures; a. Control of documentation and record keeping & retrieval. b. Implementation of radiation sign board display system. c. Demarcation of controlled access areas subject to the level of radiation d. Availability of means for handling of fissionable and					b) & c) Not within scope of document. d) Covered by para 2.6. e) Not with scope of document. f) Covered by para 2.6. g) Covered by para 2.6. h) Covered by 2.9. i) Not within scope of document.

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** **Page-1 of 3** **Country/Organization: Pakistan / PNRA** **Date: 29-10-2010**				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
		waste materials. e. Enhancing safety culture within the organization. f. Internal and external review and assessment periodically. g. Ensure coordination and clear understanding among different departments. h. Management and control of major non-conformances.					

COMMENTS BY REVIEWER **Reviewer: M. Anwar Habib** Page-1 of 3 **Country/Organization: Pakistan / PNRA** Date: 29-10-2010				RESOLUTION			
Comment No.	Para/Line No	Proposed new text	Reason	Accepted	Accepted but modified as follows	Rejected	Reason for modification/rejection
		i. Establish plan and procedures for implementation of industrial safety measures and practices.					
10	2.6	"Management must ensure adequate resources are available in case of any mishap/accident"	There is no description of available resources in case of accident.		Proposed text added as last bullet to para 2.6		

DS 407 Criticality Safety for Facilities and Activities Handling Fissionable Material
FOR SUBMISSION AT IAEA 30th Meeting of the NUCLEAR SAFETY STANDARDS COMMITTEE (NUSSC)

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	General		This draft is now well advanced and acceptable from a UK regulatory perspective. We have a few editorial comments detailed below.	Y			
2	Para 2.2, 1st sentence		In Line 1, consider mentioning that one of the main purposes/ outputs from a criticality safety assessment (safety case) is limits and conditions necessary for controlling criticality.	Y			
3	Para 2.17, 2nd	Modify to read: "….reviewed by management	Improve English.	Y			

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
	sentence	and **agreed with** the regulatory body as appropriate."					
4	Para 3.20, 1st bullet	Modify to read: "the isotopic composition limits **should be complied with**;"	Improve English.		"Should be" is replaced by "are" as introductory text to bullet list already uses the term "should".		
5	Para 3.20, 2nd bullet		It is difficult to understand what is meant here. Suggest replacing "disintegrated" to improve clarity.		Reference to disintegration deleted and text referring to a change to a more reactive compound retained.		
6	Para 3.24		For completeness. Other examples of a change in geometrical distribution could include slumping, evaporation, or compression.	Y			

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
7	Para 3.25, 3rd sentence	Modify to read: "Materials with low density (such as steam **or foam**) can cause a significant increase…."	For completeness.	Y			
8	Para 3.29	Consider adding new bullets to read: ▪ Appointment of suitably qualified and experienced persons; ▪ Staff training;	Omission.	Y			
9	Para 4.28	Consider including the following: "There is a need to identify limits and conditions necessary to control criticality risks."	For clarity (see also Comment 2).	Y			
10	Paras 5.8 to 5.10 (Life cycle issues)	Consider including the following: "There is a need to periodically review criticality safety cases (assessments)."	Omission. This point does not appear to be mentioned elsewhere in the draft safety guide.	Y			
11	Para 5.15, 1st bullet	Modify to read: "Buildings containing fissionable material should be	Improve English.		Text modified, using "inundations'		

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		protected from **the ingress** of water, …”			for internal sources and “ingress” for external sources.		
12	Para 5.20, 4th sentence	ISOCS should be defined here or reference should be made to the section *Definitions* where it is defined.	Improve clarity.		Agreed. However, reference to ISCOS has been deleted. See Comment No 32 France-NUSSC.		
13	Para 5.24 (and elsewhere)	Consider replacing “fresh fuel” with “unirradiated fuel”	The phrase “fresh fuel” is jargon; “unirradiated fuel” is probably more accurate and more readable.		Proposal was considered. It was found that the term “Fresh Fuel” was defined in the IAEA’s Safety Glossary and therefore there is an obligation to use it. The		

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
					IAEA's definition covers both new fuel and unirradiated fuel.		
14	Para 5.45, 2nd sentence	Refer to Reference 17 against the first mention of Safe Loading Curves.	Omission.	Y			
15	Para 5.66, 4th sentence	Modify to read: "…may include periodic inspections of the areas below vessels and pipework **and the review of operational records to identify chronic process loss**."	Omission.	Y			
16	Para 5.80, 1st sentence	Consider deleting the first sentence.	This sentence may be misleading as written, since it is not always the case the decommissioning operations tend to be characterised by low fissile inventory;	Y			

COMMENTS BY REVIEWER Reviewer: Country/Organisation: UK(NUSSC)/HSE(ND) comments for DS 407 Date: 18/10/2010				RESOLUTION			
Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			sometimes the opposite is true.				
17	Para 6.15	Consider adding a new bullet to read: ▪ Include a requirement for individual personal dosemeters to be issued;	Omission.	Y			

Comments on IAEA Draft Safety Guide "Criticality Safety for Facilities and Activities Handling Fissionable Material" (DS407)

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	2.1	Combine first two sentences to "Criticality safety should be ensured for all operational states and accident conditions within design basis accidents"	First sentence as written should be obvious, and is redundant with 1.1.	Y			
2	2.1	Replace "within the defined safety limit" in the last sentence with "below the defined upper subcritical limit" or some other unambiguous term.	The term "safety limit" is used to mean different things in different countries (and even within the same country). In the US, this typically means an analytical limit on a controlled parameter, but here it appears it may mean a limit on k-effective.		Agreed. Reference to para 2.13, which includes a reference to safety limit, added. Note that the use of the term is consistent		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			This term is not defined in the Definitions section. This term needs to be defined, unless it is defined in some other IAEA document, or another suitable term should be used.		with the definition in the IAEA Safety Glossary 2007.		
3	2.2	Suggest moving the last 3 sentences of this section to the defense in depth discussion of chapter 3.	At this point in the document, the reader is not informed about what the levels of defense in depth mean, and thus this material seems out of place.		Moved to para 3.3.		
4	2.3	Replace "which are" in the second sentence with "such as."	The set of controlled parameters may not be complete according to all users. For example, it is unclear why "volume" has been removed from the list. Some have considered this to	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			be a form of geometry control, but in the US, it is typically treated separately. Not mentioned are such parameters as heterogeneity and the physico-chemical form. Changing to "such as" allows for such differences in taxonomy.				
5	3.8	Replace "simultaneous" with "concurrent" in the first sentence.	This will make the discussion consistent with the double contingency principle and discussion in Section 3.7.	Y			
6	3.12	Replace "manually initiated active engineered safety measures" in the third bullet with "enhanced administrative control."	Such systems are generally regarded, at least in the US, as enhanced administrative controls rather than active engineered controls. If any part of the control system is administrative in nature,		Para 3.12 redrafted. The original 3rd bullet has been incorporated into the bullet		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			requiring human intervention, it should be regarded as an administrative control.		on administrative safety measures. The two sub bullets provide the distinction between an operator initiating an automatic safety measure or the operator providing the safety measure, which was the intention of		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
					the original bullet listing.		
7	3.15	Replace “passive safety” in the first sentence with “passive geometry.”	This section starts out by talking about the control type hierarchy (i.e., passive, active, and administrative), but this was discussed in Section 3.12. The bullets then switch to talking about what parameters should be used. It is therefore unclear whether the intent is to say what control types or what parameters should be preferred. If the intent is to discuss controlled parameters, then this section should start by stating that passive geometry is the preferable means of preventing	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			criticality.				
8	3.17	See Comment 3.	Lists of controlled parameters throughout the safety guide should be consistent.		Agreed. Believe that this list is consistent with para 2.3 – see response to comment 4.		
9	3.19	Remove this section.	The statement is so broad and non-specific that it gives no useful guidance to the reader.	Y			
10	3.20	Move the fourth bullet, on heterogeneity, to another section.	While there is a strong connection between isotopics and heterogeneous reactivity effects (e.g., heterogeneity is significant at low enrichments), this connection is not clearly made here. The discussion of heterogeneity is good guidance, but doesn't		Agreed. Reference to heterogeneous effects removed and included in the paragraph dealing with these effects.		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			appear to be applicable to te discussion on isotopics, as currently worded.				
11	3.21	Add a sentence after the 2nd sentence: "Low-atomic mass, low-neutron absorption materials (e.g., deuterium, beryllium), known as "special moderators," are less common but very effective moderators.	This section should introduce the concept of special moderators	Y			
12	3.22	Replace "estimate" with "approach" in the 4th sentence.	The term "estimate" is not a good replacement for the term "reach." Calculations can be said to "estimate" the k-effective value, but the subject of this verb appears to be the reflector "thickness," and not the "criticality safety assessments." Perhaps this can be rectified by a slight	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			rewording of this sentence. What appears to be meant is that as reflector thickness is increased, it asymptotically approaches the maximum k-effective.				
13	3.24	Add a final sentence: "Solid, fixed neutron absorbers should be tested prior to first use in order to demonstrate the presence and uniformity of the absorber isotope (e.g. ^{10}B)."	Neutron absorber testing is an important part of the criticality safety design of a fissionable material system that uses fixed neutron absorbers, and should be referenced in this section.	Y			
14	3.25	Replace "increase" with "change" in the next-to-last sentence.	It appears that the intent of the changes to this section were to clarify that nearby materials can either increase or decrease k-effective. This change is appropriate, but	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			was made everywhere except in this sentence.				
15	3.30	Replace “independently reviewed” with “independently reviewed by staff knowledgeable in criticality safety.”	This new text is good, but is not clear on who has to do the review. The review should be by the criticality safety staff (as well as operations, etc.).	Y			
16	4.20	Rewrite the definition of verification (such as previously suggested).	The definition of model verification before the semicolon is good, but what follows the semicolon (following “that is”), does not match this. Validating the model seems to be model-specific; it is confirming that whatever is being modeled is modeled correctly. The analyst does not in general have time, or the necessary		As you state that it is not usual industry practice, the reference to system code verification has been deleted. Please note that the use of		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
			expertise, to delve into the numerical algorithms and equations underlying the code. Instead, verification is usually accomplished by re-running previously modeled benchmarks and checking if they give the same answers as previously. In addition, the discussion of "system code verification" refers to reviewing the source coding, but this is not typically done. Rather, these two types of verification are generally done together by the method described above. This does not reflect usual industry practice.		the terms: "Verification", "Validation" and "System code verification" and their descriptions are all consistent with the IAEA Safety Glossary 2007.		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
17	4.25	First bullet on page 27: Remove “(i.e., < 17 amu).”	Defining moderators as materials with A<17 seems to be arbitrary. This would limit it to isotopes that are lighter than oxygen. While the most common moderating elements are H, Be, and C, all lighter than oxygen, in some cases other materials (e.g., silicon (A=28) in a low-density waste application) could be a moderator.	Y			
18	5.41	Change 5^{th} sentence to “Taking credit for the burn-up of individual fuel assemblies *will* ~~may~~ increase the potential for misload accidents.”	Moving from a system where the fresh fuel assumption is employed (no loading curve) to one where burnup is credited (loading curve) introduces the possibility of misload where none existed before.	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
19	5.44	3rd bullet: "Note, the irradiation of fuel with burnable poisons ~~could~~ *will typically* result in increased reactivity early in its life.	This section should state this more definitively, as this effect is so common that criticality safety practitioners should expect increased reactivity with the use of burnable poisons.	Y			
20	5.94	2nd sentence: "Particular challenges will be encountered in determining safe sub-critical masses of the materials *cited in 5.88*, as there are frequently no critical experiment benchmarks to validate criticality computations *with these materials*.	Should clarify that this section is talking about difficulties with special fissionable and non-fissionable materials.	Y			
21	6.22	Suggest changing section heading to "*Evaluation of potential accidents*"	"*Pre-accident evaluation*" implies that we intend to have an accident.	Y			
22	REF	Review list of references for	While there are a large		Agreed.		

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		worldwide applicability and representativeness.	number of DOE standards and documents represented, NRC documents (NUREGs, ISGs, etc.) applicable to commercial fuel criticality safety are not represented. This provides a skewed view of the US criticality safety community. In addition, many of the included DOE standards are not of general interest to criticality safety practitioners world-wide, but are specific to DOE's regulatory environment. If these are to be included, then including a list of similar documents from many other nuclear		List reviewed and amended using the criterion recommended For the future development of the document please provide the list of USNRC references that have a general applicability to the technical aspects of		

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			countries would also need to be included, but this would be voluminous. Suggestion is to scrub the list of references to only those having general applicability to the technical aspects of criticality safety.		criticality safety.		
The remaining comments are editorial and are being provided for consideration only.							
23	1.2	Remove "moderation" from the first sentence.	Minor editorial comment—moderation is listed twice. It is more appropriate to include under "other materials" rather than parameters related to fissionable material.	Y			
24	5.13	Change to "… absorber material	Minor editorial change	Y			

COMMENTS BY REVIEWER Reviewer: United States of America Country/Organization: United States of America Date: Month Year				RESOLUTION			
Comment No. / Reviewer	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
		(e.g., 240Pu)."					
25	5.29	Change to "Fire risks in the fuel storage area should …"	Minor editorial change	Y			
26	5.35	Change last sentence to "… potential impact of such changes are considered in the criticality safety assessment."	Minor editorial change	Y			
27	5.40	Change to "… should also be considered in the criticality safety assessment."	Minor editorial change	Y			