Resolution of Comments on IAEA Draft Safety Guide
[SPESS Step 11]
Design of Fuel Handling and Storage Systems for Nuclear Power Plants* (DS487) *Rev D9

	COMMENTS BY REVIEWER Reviewers: US Nuclear Regulatory Commission , STUK (NUSSC, WASSC members), Japan NUSSC member), SSTC NRS (Ukraine), USA (DOE/NNSA), ASN/IRSN (FRANCE) ENISS Country/Organization: United States of America/US NRC, Finland (STUK), (Japan NRA), Ukraine (SSTC NRS), USA (DOE/NNSA), FRANCE, ENISS Date: Oct 2018				RESOLUTION			
	Comment No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1.	France1	External hazards	Consideration of the fall of an aircraft may be more explicit	Suggestion			X	Already addressed in DS 487: Para. 3.35 refers to NS-G-1.5 that is a dedicated Safety Guide to external events. NS-G-1.5 includes aircraft collision in the list of external events. The other place in DS 487 that the external hazard including “the fall of an aircraft” is considered in “4.17. as well Protection of fuel handling systems against the effects of external hazards should be

								primarily ensured by the appropriate design of the building in which they are installed.”
2.	USA 9	General	We recommend addressing the issue of “Defense-in-Depth” analysis in order to have adequate safety feature performance for the spent fuel pool, in terms of integrity of its structure and having adequate means for monitoring potential leaks and plans for prompt mitigation during normal operation or after a natural event. We note that potential leaks may be caused by propagation of microstructures, particularly due to the influence of external events.	Completeness to address integrity of Spent Fuel Pool structures to prevent or minimize, releases from a spent fuel pool and establish prompt mitigation as necessary.				Already addressed in DS-487: The integrity of the SFP structure is covered by paras 3.81 and 3.85. Provisions to monitor and detect the leak through the liners of the pool is covered by paras. 3.67 and 3.80 bullet (e). Impact of external events on the integrity of the SFP structure is taking into account by considering design loads as appropriate, as listed in para. 3.85 bullet (a).
3.	USA 10	Several locations 2.1 3.52 3.108 3.127	“Error! Reference source not found.”	In several locations throughout the document the phrase: “Error! Reference source not	X	After final editorial check these cross-reference errors will be eliminated.		

				found.” is encountered.				
4.	FIN1	1.6(e)	Return or add “Shuffling”	Moving fuel from one position to another was removed with a reference to NS-G-2.5. But NS-G-2.5 is about operations, not about the design of fuel handling systems. Shuffling is relevant for the design of fuel handling systems (this guide). Regarding these systems there is no relevant difference between shuffling and moving fuel from other locations to the core.			X	The term ‘shuffling’ is used in some countries not in in many Member States. We were recommended to rephrase to read as “reinsertion of irradiated fuel …” as shown in para. 1.6 bullet (e).
5.	US NSGC 2	Para 1.8 Page 2	This Safety Guide is intended for application to UO2 fuels (natural, enriched or reprocessed uranium) and plutonium-blended UO2 fuel (mixed-oxide fuel) with metal cladding.	Why only UO2 fuels?		X For innovative fuel materials other than UO2 fuels (natural, enriched or reprocessed uranium) and plutonium-blended		

						UO2 fuel (mixed-oxide fuel) or cladding materials other than zirconium based alloys, this Safety Guide can be applied with judgment.”		
6.	US NSGC 1	Para 1.11 Page 2, bottom of	Handling and storage systems for spent fuel that does not remain part of the operational activities of a nuclear reactor (e.g. as needed for interim wet or dry storage) are addressed in IAEA Safety Standards Series No. SSG-15, Storage of Spent Nuclear Fuel [2].	Fragment – not sure the intent, so I can’t offer the suggested revision			X	The comment is for para. 1.6 (not 1.11). If spent fuel remains part of the operational activities of a reactor, DS487 is applied. Otherwise, SSG15 is applied. The existing statement in para. 1.6 was made to be comparable with the statement in SSG-15.
7.	US NSGC 3	Para 2.1 Page 3	Leadership and Management for Safety Error! Reference source not found.	Reference needs to be cleaned up.	X	After final editorial check these cross-reference errors will be eliminated.		
8.	US NSGC 4	Para 2.7 Page 4	the fuel handling and storage systems are required to be designed to maintain adequate fuel cooling capabilities for irradiated fuel. As such, these systems should be designed to ensure that the fuel cladding temperature limits and/or the coolant temperature limits, as defined for operational states and accident conditions, are not exceeded.	Fuel handling systems also need to ensure they handle the structural requirements for fuel, not just temperature/cooling requirements.			X	Para. 2.7 is to address ‘removal of the decay heat from irradiated fuel’ (title of the sub-section that governs para. 2.7) as one of three fundamental safety functions

				These are related but separate.				defined in para. 2.2. Recommendation concerning the structures of spent fuels are in paras. 2.5, 2.6.
9.	France2	2.11	Design provisions should be provided to collect and filter radioactive materials released in case the event of handling accidents, and to prevent uncovering of irradiated fuel assemblies in the spent fuel storage in accident conditions, including the event of handling accident	Both parts of the recommendation are relevant for accidents: • Radioactive releases should be minimized in any accident situation (e.g. vaporization of water should also be considered if relevant) • Handled assemblies should not be uncovered.			X	In the proposed statement, the wordings "including the event of handling accident" is not taken because it may not directly cause the uncovering of irradiated fuel assemblies and it is part of accident conditions. Two bullets in the comment reason box are addressed by para. 2.14. Follow-up specific recommendations to address paras 2.11 and 2.14 are stated in Sections 3 and 4.
10.	US NSGC 5	Para 2.13 Page 5	Fuel handling equipment and fuel storage systems should include shielding as necessary to keep occupational doses as low as reasonably achievable in operational states.	Typically there are dose limits that you must meet and then ALARA is invoked to			X	The comment in the reason box is already addressed in para. 3.57 bullet (a).

				ensure efforts are maintained to additionally minimize dose were practicable.				Para. 2.13 is for normal operation and we know that for that condition the actual dose is quite lower than the limit. Therefore, we want to put emphasis on the ALARA.
11.	US NSGC 6	Para 3.1 Page 6	In the context of this Safety Guide, items important to safety include the pool structure, pool liner, pool cooling systems, pool purification systems, make-up systems, gates and fuel storage racks.	What about handling tools. These are typically considered to be important to safety as well.			X	Section 3 is for storage system and Section 4 is for handling system including handling tools; see para. 4.1(d).
12.	France3	3.2	c) Prevention of high radiation doses, practical elimination of plant states that could lead to early or large radioactive releases.	To be consistent with SSR-2/1 2.11, 4.3 and 6.68 Note that according to these articles, we should even add "PE of plant states that could lead to high radiation doses". But we can live with or without mentioning high radiation doses			X	Refer to IAEA-TECDOC-1791, page 34, for explanation of the term 'practical elimination' used in SSR-2/1 rev 1. It says that "the practical elimination is achieved by prevention of the conditions that could lead to an early radioactive release or large radioactive release.". In other words, practical elimination is done for the

								consequences by preventing plant states. This interpretation is also consistent with footnote 7 of SSR-2/1 Rev 1. Note IAEA-TECDOC-1971 was prepared for explanation of special terminologies used in SSR-2/1 rev 1, and was reviewed and accepted by NUSSC.
13.	FIN2	3.6	The design of spent fuel storage systems should include multiple means to remove decay heat from irradiated fuel and to maintain subcriticality margins in all the various plant states considered in the design.	Comment made also in previous step. Multiple means to maintain subcriticality should not be required if subcriticality is ensured (also in accident conditions) by fixed geometry of e.g. storage racks. Categorical requirement is a problem for BWR reactor building fuel			X	Subcriticality by geometry control is ensured for normal operation; however, the subcriticality margin may be reduced for accidents. Paras 3.101and 3.102 address this situation by adding additional means to ensure sufficient subcriticality margin mainly for accidents. This is the DiD design concept stated in para. 3.6.

				pools, which are connected to reactor vessel during refueling.				For BWRs, only para. 3.101 is applied.
14.	Japan1	3.7./ 2nd sentence	The combined application of redundancy, diversity and independency among the various cooling means should be adequate to demonstrate that the coolant temperature limits and/or fuel cladding temperature limits defined for operational states and for accident conditions are not exceeded and that the uncovering of the fuel assemblies is prevented for operational states and accident conditions with a high level of confidence.	Water covering is more conservative condition in term of fuel cooling and more important for radiation shielding purpose than keeping the coolant and fuel temperature. In addition, these conditions are already covered in para. 2.7.	X			Para. 2.7 is a general recommendation to address one of the fundamental safety functions defined in para. 2.2, which is removal of the decay heat from irradiated fuel. Para. 3.7 is to address the DiD design concept that is applied to the fuel storage system.
15.	USA 1	3.24/3-5	…be excluded from consideration as hazards in the fuel storage area through prevention, with a high level of confidence, by careful design of the handling equipment and by means of the layout of the refueling, fuel storage and cask loading areas. primarily by means of the layout of the refueling, fuel storage, and cask loading areas, and by careful design of the handling equipment.	Place emphasis on layout rather than design of handling equipment. Delete "with a high level of confidence" because that text from para. 3.7 refers to overall prevention of a substantial loss of coolant inventory	X	Reordered to read as: "….by means of the layout of the refuelling, fuel storage and cask loading areas and by careful design of the handling equipment."		

				through defense-in-depth, and layout inherently provides high confidence of hazard avoidance.				
16.	US NSGC 7	3.24	prevention, , with a high level of confidence,with a high level of confidence, by careful	duplicate text	X			
17.	US NSGC 8	3.26	Internal flooding in fresh fueldry storage areas for fresh fuel	Duplicate text	X			
18.	US NSGC 9	3.31	fresh fueldry storage areas for fresh fuel	Duplicate text	X			
19.	Ukraine 1	3.32	3.32. The effects of firefighting agents on the subcriticality of fuel storage should be considered.	The effects of firefighting agents on the subcriticality of fuel storage should be considered for both fresh and irradiated fuel. For wet storage, the effects of firefighting agents on the subcriticality of the system should also be considered (for example, when	X			

				unborated water gets into borated water)				
20.	US NSGC 10	3.36	fuel storage, , items	Extra comma	X			
21.	US NSGC 11	Para 3.37 Page 11	The protection should primarily rely on an adequate layout and design of the buildings at the site.	This is not a complete thought/requirement. Protection of what? It should either be expanded in 3.37 here or appended to the most relevant requirement surrounding it.	X	Reworded to read as: "The protection of fuel storage systems against the effect of external hazards should…"		
22.	US NSGC 12	Para 3.42 Page 12	The methods of design, and the construction codes and standards used should provide adequate	"cliff edge effects" should be defined, or examples given.			X	The term "cliff edge effects" is defined in the IAEA Safety Glossary. Para. 1.10 states that "The terms used in this Safety Guide are to be understood as defined and explained in the IAEA Safety Glossary [3].".

23.	FIN3	3.50(a)/ 3.68		Failure of the cooling system used in normal operation as a DBA (req. 3.50(a)) and requirement of single failure tolerance of the systems necessary to remove decay heat in DBAs (req. 3.68) leads to requiring a 2 train accident system contrary to the example given in the reason for rejection column in the MS Comments resolution table for comment 31.				Th example provided was 2 normal cooling systems plus one additional system for DBA. The normal cooling system continues to be used during DBA, and thus for DBA single failure criterion is met.
24.	USA 3	3.50(e)/ Line 2	…fuel assembly (without cladding damage) in the fuel storage array.	Clarify that misplaced or dropped assembly is in a design storage location.	X			
25.	ENISS 1	3.50	Typical examples3 of postulated initiating events which are categorized as anticipated operational occurrences based on frequency of occurrence and radiological consequences, include: (a) Loss of off-site power; (b) Loss of coolant (small leaks) in the cooling and filtration/purification system or through the seals of gates;	For previous comment 29, the resolution is : "Bullet (d) is not removed as suggested. Instead,	X	Footnote 3 is come back to read as: "Typical examples are design dependent and may not be taken into account		

			(c) Loss of cooling water flow, or dilution of soluble neutron absorbers (only relevant to pressurized water reactors); (d) Malfunctioning of a normal operation fuel cooling system; (e) Abnormal fuel assembly configurations with single misplaced fuel assembly or dropped fuel assembly (without cladding damage) in the fuel storage	Footnote 3 modified in accordance with Comment #27 (ENISS Comment #2) is also applied to para. 3.50. " But there is no footnote in § 3.52 and the footnote 3 was removed from the §3.50 It is not possible to review the resolution. Therefore, the comments on § 3.50 are maintained with the same following reasons : There is no operational feedback to justify that dropped fuel assembly should be considered as an anticipated operational occurrence. For instance, French feedback shows that no event of		in certain Member States.".		

				accidental fuel drop occurred and this event is considered as a design basis accident and not an AOO.				
26.	US NSGC 13	Para 3.52 Page 14	Single equipment failures and multiple equipment failures should be considered, in order to define design basis accident conditions and design extension conditions, respectively. Typical examplesError! Bookmark not defined.	Clean-up reference error	X			
27.	USA 2	3.52(a)/ 3rd bullet	Abnormal fuel assembly configurations (e.g., a fuel assembly ~~positioning error~~ not placed in a design storage location or a dropped fuel assembly with cladding damage)	Differentiate fuel assembly positioning error accident from the single misplaced fuel assembly listed as an Anticipated Operational Occurrence in paragraph 3.50(e).	X			
28.	ENISS 2	3.52	Single equipment failures and multiple equipment failures should be considered to define design basis accident conditions and design extension conditions, respectively. Typical examples3 of such failures to be considered include: Design basis accidents (a) Significant loss of coolant (e.g., breaks of piping connected to the spent fuel pool); (b) Failure of the normal operation cooling system operated in operational states;	See comment #1, the comments on § 3.52 are maintained with the same following reasons : Safety-criticality analysis follows	X	Footnote 3 is come back to read as: “Typical examples are design dependent and may not be taken into account in certain Member States.”.		

			(c) Abnormal fuel assembly configurations (e.g. fuel assembly positioning errors and dropped irradiated fuel assembly with cladding damage); (d) Significant Change of moderation conditions in fuel storage (e.g., large dilution of soluble neutron absorber (pressurized watwer reactor only) in wet storage area, or flooding of dry storage area).	a dedicated approach not to be put together with the DBC approach.				
29.	US NSGC 14	Para 3.56 Page 15	For dry storage of fresh fuel, the effective multiplication factor calculated for optimum moderation conditions should not exceed values specified in national regulations (e.g. 0.95–0.98, including uncertainties);	If you are going to provide an example limit (e.g. 0.95-0.98) with a generic reference to national regulations, you should cite an example of the regulations to draw from.		X The number rage is given as example. Footnote 4 is added to read as: "Examples are design dependent and may not be taken into account as stated in certain Member States."		
30.	USA 4	3.57	(b) In accident conditions, a sufficient ~~substantial~~ coolant inventory should be maintained to provide radiation shielding while operators are required in the pool deck area. - OR - (b) In accident conditions, plants with active systems ~~a substantial coolant inventory~~ should ~~be~~ maintain~~ed~~ a sufficient coolant inventory to provide radiation shielding. (c) In accident conditions, passive plants should maintain a sufficient coolant inventory to provide radiation shielding while operators are required in the pool deck area.	During accident conditions, the water level in the pool of plants with passive cooling systems are allowed to drop below minimum shielding level.			X	The wording "sufficient" is used in bullet (a). The additional comment "while operators are required in the pool deck area" is not taken because this phrase is related to operation.

31.	USA 5	3.58(a) 3.58(b)	Modify 3.58(a) as follows: Maintaining forced cooling in design basis accidents and in design extension conditions, or; Modify 3.58(b) as follows: Maintaining forced cooling for design basis accidents, and relying on ~~natural evaporation of coolant supplemented by makeup water~~ venting of evaporated coolant to the atmosphere for heat removal, supplemented by provisions for makeup water to compensate for coolant inventory loss in design extension conditions; or…	Modification to 3.58(a) allows plants to choose to maintain forced cooling in DECs or use other means as specified in 3.58(b). The proposed modification to 3.58(b) clarifies that passive measures are intended for design extension conditions only.	X	Bullet (b) is rephrased to reflect USA 5 and USA 6 comments to read as: "Maintaining forced cooling in design basis accidents, and relying on venting of evaporated coolant to the atmosphere for heat removal, supplemented by gravity driven flow of makeup water to compensate for the loss of coolant inventory due to evaporation in design extension conditions."		
32.	USA 6	3.58(c) [no content in Rev D9]	For passive designs, design features may be used to vent evaporating coolant to the atmosphere for heat removal and to provide gravity-driven flow of makeup water to compensate for coolant inventory loss due to evaporation, in both design basis	Insert suggested language, which is consistent with the licensed design	X	See resolution of USA 5 comment above.		Passive system is not considered for both DBA and DEC at the at-reactor SFP.

			accidents and design extension conditions. Makeup may be provided by portable systems for design extension conditions.	of passive reactors.				Makeup by portable systems is addressed in para.3.80.
33.	US NSGC 15	Para 3.58 Page 15	Maintaining forced cooling in design basis accidents, and relying on natural evaporation of coolant supplemented by makeup water to compensate for the loss of coolant inventory for design extension conditions, to provide for acceptable diversity in the removal of heat in accident conditions; or c.	Reference to a third example is given (i.e., bullet (c), but no example is included.	X	Bullet (c) is removed.		
34.	France4	3.64	Gates separating the spent fuel pools from other pools or compartments should be water-tight under normal operating conditions and during anticipated operational occurrences (i.e., gates with pneumatic seals should be provided with reliable back-up air supplies to maintain pressure following a loss of offsite power).	Pneumatic seals can burst therefore we suggest to delete the parentheses. Otherwise, additional features should be provided.	X	3.66. Deleted the sentence related to pneumatic seals as commented.		
35.	France4a	3.73	Water storage pools should not be designed with penetrations below the minimum water level required for shielding and cooling of stored and handled irradiated fuel in accident conditions.	This recommendation is also relevant for handled assemblies which should be cooled and should not be uncovered.			X	The comment is noted. The minimum water level for shielding is higher than that for cooling in accident conditions, thus we did not include “cooling”.
36.	US NSGC 16	Para 3.74 Page 18	The system necessary to remove decay heat in accident conditions should be designed so that it	Not sure what this means. I suggest being more specific in			X	It means that when the system can be restarted at water temperature

			can be restarted in conditions in which the subcooling function of the pool water is lost.	this requirement.				close to the boiling temperature.
37.	US NSGC 17	3.82	design loadsload	Duplicate word	X			
38.	US NSGC 18	3.89	considered.]	Stray mark	X			
39.	France5	3.91 and Referenc es	(see, for example, Refs. [17–19]). Delete references [17]-[19], which are national codes	Not favorable to give such a list of national codes: please stick to the generic expressions, without mentioning any particular country code or standard.			X	This is a common practice to provide available national codes.
40.	France6	3.96 and 3.99	New SSG-48 about ageing should be taken into account	Suggestion			X	Already addressed in DS487: Ref [20] has a note that NS-G-2.12 is under revision.
41.	US NSGC 19	Para 3.108 Page 24	3.108. In accordance with para. 6.48 and Requirement 81 of SSR-2/1 (Rev. 1) [1], suitable ventilation system(s) and shielding should be implemented to maintain the concentrations of airborne radioactive material and the direct radiation exposure of workers as low as reasonably achievable in operational statesError! Reference source not found.	Clean-up reference error	X			

42.	US NSGC 20	Para 3.127 Page 26	Environmental and Source Monitoring for Purposes of Radiation Protection [24]Error! Reference source not found..	Clean-up reference error	X			
43.	US NSGC 21	3.128	Design of water purification systems for the spent fuel pool. Start new heading: DESIGN OF WATER PURIFICATION SYSTEMS FOR THE SPENT FUEL POOL.	Move to next line to start section	X			
44.	ENISS 3	3.128	The design of fuel storage facilities should consider and facilitate the use of remote and robotic technology for monitoring and measurement of potentially very high dose rates, particularly in the event of an accident. Design of water purification systems for the spent fuel pool.	Editorial comment	X			
45.	USA 7	3.128/ Line 3	Design of water purification systems for the spent fuel pool.	Editorial: Move this sentence fragment: "Design of water purification system for the spent fuel pool" to the heading for next section beginning at Paragraph 3.129.	X			
46.	USA 8	4.12	Fuel misplacement during fuel movement activities within the reactor vessel should be prevented by ~~implementing~~ interlocks of suitable reliability and quality.	Requirements for interlocks should only apply within the reactor vessel where the fuel placement locations are sufficiently well	X			

				defined to permit interlocks.				
47.	US NSGC 22	Para 4.14 Page 30	4.14. To meet Requirement 17 of SSR-2/1 (Rev. 1) [1] in relation to internal hazards, protection of fuel handling systems should be primarily ensured by the layout of the building in which they are installed.	Define, reference or provide an example of "internal hazards"			X	Para. 3.21 already mentioned about typical examples of internal hazards that influxes on the design of fuel handling and storage systems.
48.	US NSGC 23	Para 4.15 Page 30	4.15. Paragraphs 4.16–4.18 provide recommendations on meeting Requirement 17 of SSR-2/1 (Rev. 1) [1] in relation to external hazards.	Define, reference or provide an example of "external hazards"	X	Added: "Identification of external hazards that affect the design of fuel handling system should be referenced to IAEA Safety Standard Series No. NS-G-1.5 [14] in addition to earthquake."		
49.	US NSGC 24	4.23	Two (a)'s in list, update to be a-d	typo	X			