Resolution of NUSSC Members' Comments
Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants, (DS481)

COMMENTS BY REVIEWER Reviewer: Country: Cambodia, Czech Republic, Finland, Germany, Japan, United States, ENISS Date: 13/06/2018 Page: 1 of 5				IAEA RESOLUTION			
CMT No.	Para/ Line No	Proposed New Text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/ rejection
Finland 1	General	Observation to be considered in future development of safety guides DS481 and DS491 eg. new SSG and SSG-12. There is overlap between DS481 and new SSG-12 concerning the DS481 recommendations 3.27 – 3.42.			Accepted		The relationship, including the overlap between safety standards and the new drafts of safety standards are checked during the development process.
	Section 2						
Japan 1	2.7.	These systems are designed to accommodate slow reactivity changes (including control of the core power distribution) in power operation and to ~~control margins to recriticality~~ maintain subcriticality in shutdown condition.	Use a general wording. Reactivity control system is maintained sub-criticality in shutdown condition.	Accepted			
Japan 2	2.10./l2	The ultimate heat sink is usually a body of water~~, the groundwater~~ or the atmosphere.	Completeness. "Ground water" is one of the body of water and it is already including "water" as referred in para. 4.2. It should be deleted.		Accepted (including the ~~groundwater~~)		

	Section 3						
Czech 1	3.18, first line	Paragraphs 3.19–3.26 provide recommendations on meeting Requirement 17 in paras 5.17–5.21A of SSR-2/1 (Rev. 1) [1] in relation to external hazards.	Change of the clutch "and" to the prefix "in". A sentence with "and" coupling could mean that Request 17 is listed elsewhere than in paragraphs 5.17-5.21A.			Rejected	Requirement 17 and the relevant paras 5.17–5.21A of SSR-2/1 (Rev. 1) [1] to external hazards
Czech 2	3.18 2-4 lines	The recommendations provided in IAEA Safety Standards Series No. NS-G-2.13 Evaluation of Seismic Safety for Existing Nuclear Installations, No. NSG-1.5 […] and External Events Excluding Earthquakes in the Design of Nuclear Power Plants [10] should also be considered to understand the general concepts, to ensure identification of the relevant external hazards and to protect systems against the effects of these hazards.	There is no reference to any seismic hazard evaluation document. There is only mentions instructions deal with other than seismic hazard. Add particular IAEA documents regarding the seismic hazard.	Accepted			
Czech 3	3.22 3-5 lines	Components forming the reactor coolant pressure boundary, the secondary envelope of the steam generators (for PWRs and PHWRs), and the safety systems designed to mitigate the consequences of design basis accidents should be designed to withstand SL-2 seismic loads […]. No. SSG-9 Seismic Hazards in Site Evaluation for Nuclear Installations	There is no reference to the document that explains the SL-2 value determination. Add a reference to the IAEA document No. SSG-9 Seismic Hazards in Site Evaluation for Nuclear Installations	Accepted			

Germany 1	3.34	Design basis accidents should be identified and ~~calculated for~~ the behaviour of the reactor coolant system should be analysed in order to specify the adequate performance of the safety systems.	In this case analysis is important (more general term)	Accepted			
USA 1	Para 3.44/ Line 4	Revise to read: "… stresses and the cumulative usage factor to ensure…"	The design limits and acceptance criteria for the RCS and associated systems should include the cumulative usage factor. This proposed change is consistent with the descriptions included in Para 5.13, Para 5.80 and Para 5.93 of this draft safety guide DS 481.	Accepted			
USA 2	3.60	Revise the paragraph as follows: "The overall instrumentation and control architecture should provide measures to maintain the required independence between systems in the presence of undesired behaviors (e.g. common cause failure in support systems necessary for the actuation and operation of the instrumentation and control systems)."	As written, the paragraph is solely focused on common cause failure of the instrumentation and control equipment when it is just one example of an undesired behavior.		Accepted but modified: The independence implemented between instrumenta-tion and control systems or in their other support systems necessary for the actuation and operation of the instrumentation and control systems should not be compromised by common cause failure.		
USA 3	3.61	Revise the sentence as follows, which includes the addition of a new footnote "x": "The overall instrumentation[x] architecture supporting the actuation of the reactor coolant system and associated systems should promote independence	As written, 3.61 is unclear what requirement/principle the sentence is trying to convey.		Accepted but modified: The instrumenta-tion architecture supporting the actuation of the reactor coolant system and		

		among the different levels of defense in depth. [X] Such instrumentation would be designed as safety systems and for monitoring plant status."			associated systems, designed as safety systems should be independent as far as is practicable from instrumenta-tion for monitoring of plant status.		
USA 4	3.67	Seismic qualification should be added by referencing NS-G-1.6 for appropriate criteria.	Only environmental qualification is included. Equipment qualification includes both environmental and seismic qualifications.	Accepted			
USA 5	3.88/3	Revise to read: "…The materials should be appropriately homogeneous and should…"	"Homogeneous" is an undefined requirement, and is not always appropriate or achievable. It is, however, often important.	Accepted			
Germany 2	3.93	Materials should be highly resistant to all corrosion phenomena in operational states including any deterioration due to ~~chemical~~ corrosion by the fluid and the abrasive effects of suspended solids.	Corrosion is always a chemical process even if it may be accompanied by such processes as erosion, corrosion or fretting.	Accepted			
Germany 3	3.96	With regard to the risk of embrittlement of the reactor pressure vessel, a surveillance programme should be established on the basis of tests conducted on samples of the materials used for the manufacturing of the reactor pressure vessel. These samples should be installed in the reactor pressure vessel and removed on a scheduled basis.	We suggest to remove Para. 5.81, dealing with advanced materials, to the chapter "Material exposed to high neutron flux" (see also Comment No.12)			Rejected	Para. 5.81 gives slightly different design recommendation related to the "predictions to be made of the behaviour of the material in sufficient time"

		These samples should then be subjected to mechanical testing, including tensile strength and Charpy impact testing or fracture toughness testing. Other samples should be analysed to measure the irradiation fluence that the wall of the reactor pressure vessel and the samples are being exposed to. Acceptance criteria should be specified for all the tests performed. If advanced materials are to be used ~~in~~ for the reactor pressure vessel, samples of these materials should be subjected to a fast neutron flux with a high lead factor compared to the vessel wall to enable predictions to be made of the behaviour of the material in sufficient time to allow for corrective measures, if necessary					
Finland 2	3.102	”The design should incorporate provisions to facilitate examination, testing, in-service inspection, maintenance, repair and modifications to be carried out during the construction, commissioning and operation phases.” This is the only place where modifications are mentioned. The heading above this paragraph is “CALIBRATION, TESTING, MAINTENANCE,	Please check weather ” whether “monitoring” should be written instead of “modifications”.	Accepted			

		REPAIR, REPLACEMENT, INSPECTION AND MONITORING"					
USA 6	3.108/3	Revise to read: "…that no unacceptable damage…"	"Damage" is poorly defined. Some "damage" may acceptable and does not threaten operation, e.g., is neutron embrittlement considered "damage?"	Accepted			
Germany 4	3.111 a)	Hydrostatic pressure tests by the manufacturer of the reactor pressure vessel and all other vessels, valve bodies and casings prior to installation.	It is a good practice and is required by most of the regulations to carry out pressure tests not only for RPV, but for other vessels, for valve bodies and for casings as well, before installing them into the circuit.	Accepted			
USA 7	Para 3.121/ 2nd bullet	Revise to read: "…pipe whip, flooding, high pressure jet impingement including potential blast wave);"	Draft safety guide DS481 did not explicitly identify the potential blast wave load as a local effect resulting from postulated pipe failures. However, in the event of a high-pressure pipe rupture, the first significant fluid load on surrounding structures, systems, and components would be induced by a blast wave.	Accepted			
USA 8	3.133/ Item (a)	Replace: "…flow ratethat…" with "… flow rate) that…"	Editorial correction	Accepted			
USA 9	3.134 (a)	Revise to read: "…and for design basis accident monitoring…"	Sensors should not be required to not be shared for ALL accident monitoring and automatic actuation systems.			Rejected	The guide was technically approved in November 2017
USA 10	3.134/ Item (b)	Revise the beginning of the item to read as follows: "The same installed sensors should not be used…"	As written, it is unclear whether this item is referring to "the same sensors" technology or "the same [installed] sensors." Suggest clarifying it. Also, editorial correction by replacing "shoud" with "should".	Accepted	Changed back to "shared" (as it was in the version approved in November 2017) it means the same installed ones		

Finland 3	3.136	"Potential leakage of radioactive material into the reactor coolant system and associated systems should be monitored	Please check the recommendation. Should "into" be replaced with "from"? Usually radioactive material does not leak into the reactor coolant system.	Accepted	From and into		
USA 11	3.138	Revise to add space between "3.139provides"	Editorial - Missing space between "3.139" and "provides"	Accepted			
Pakistan 1	Para 3.138 – 3.140 / Page 26	Refer to para 4.14 of SSR 2/1 4.14 Items important to safety for a nuclear power plant shall preferably be of a design that has previously been proven in equivalent applications, and if not, shall be items of high quality and of a technology that has been qualified and tested.	Use of codes and standards of a design that has previously not been proven may be elaborated in the guide	Accepted	The guide in this stage can not be extended as it was technically approved in November 2017.		
Pakistan 2	Para 3.138 – 3.140 / Page 26	Refer to para 4.16 of SSR 2/1 4.16. Where an unproven design or feature is introduced or where there is a departure from an established engineering practice, safety shall be demonstrated by means of appropriate supporting research programmes, performance tests with specific acceptance criteria or the examination of operating experience from other relevant applications. The new design or feature or new practice shall also be adequately tested to the extent practicable before being brought into service, and shall be monitored in service to verify that the behaviour of the plant is as expected.	Guidance of para 4.16 of SSR 2/1 may be added in this guide	Accepted	The guide in this stage can not be extended as it was technically approved in November 2017.		
Pakistan 3	Page-26/ Heading	USE OF PROBABILISTIC ANALYSES **AND**	Deterministic approach has been described in para 3.142, it should be reflected in heading of the section.			Rejected	Paragraphs give recommendations related to 5.76 of SSR-2/1 (Rev. 1)

		DETERMINISTIC APPROACH IN DESIGN					which is: Use of probabilistic analyses in design. The guide in this stage can not be extended as it was technically approved in November 2017.
Pakistan 4	Para 3.141 / Page 26	3.141. Paragraphs 3.142–-3.143 provide recommendations on meeting paras. 5.75 and 5.76 of SSR-2/1 (Rev. 1) [1]	Deterministic approach has been described in para 3.142, it should be reflected in opening para.			Rejected	See above
	Section 4						
ENISS 1	§4.8	Additional specific Heat Sink Hazards are: "Frazil ice, Ice cover, Clogging, Low water level, Sand and sludge silting and Hydrocarbons"	It might be useful to include this specific list in this part.	Accepted			
ENISS 2	§4.20 Para. 4.24	"the operation of components necessary to feed and bleed the steam generators should not be **directly** dependent on the heat transfer chain"	Indeed, a classical design of PWR is to have heat transfer chain cooling ventilation systems, and then ventilation systems cooling rooms of main components and electricity / I&C rooms.	Accepted	Para 4.24		
Japan 3	4.30.	The heat transfer should not be compromised by any ~~one~~ single failure postulated for any component necessary for transferring residual heat to the ultimate heat sink.	Clarification. To keep a consistence if "one failure" means single failures used in this draft.	Accepted			
ENISS 3	§4.45b	"The need to transfer residual heat… in the event of a loss of the cooling chain designed for design ~~extension~~ **basis** conditions…"	The event seems associated to the loss of cooling chain in case of a DBC, so an additional cooling chain robust to DBC (designed for DEC) could be necessary	Accepted	design basis accident condition		

Finland 4	4.45 (b)	in the end of para "…heat transfer chain for design extension conditions with significant fuel damage."	Please clarify which one is meant "design extension conditions without significant fuel degradation" or "design extension conditions with core melting"?	Accepted	design basis accident condition		
	Section 5						
Japan 4	5.1.	The reactor coolant system includes the reactor pressure vessel, the pressurizer, the piping and pumps for the circulation of the coolant, and (for PWRs and PHWRs) the steam generators	Completeness. The pressurizer is one of the key components for both PWRs and PHWRs.	Accepted			
USA 12	5.1	Add period at end of paragraph	Editorial	Accepted			
Cambodia 8	5.3/12	In third bullet, replace a semicolon in place of a comma.	For consistency, editorial			NA	
Germany 5	5.9	The cyclic plant conditions that might cause the appearance of cracks due to fatigue should be identified for each reactor coolant system component. These plant conditions should be identified at the design stage in order to be monitored during the plant operation, and an admissible frequency of occurrence should be assigned to each condition according to the usage factor assessment of each component.	The assessment of the fatigue usage due to the dominant transients results in admissible numbers for these transients.	Accepted			
Germany 6	5.12	At low operating temperatures the ductility and fracture resistance of some materials might be significantly lower than at normal operating	It is more important to underline, which materials are used for the components rather than for manufacturing.	Accepted			

		temperatures. Where such materials are used for ~~manufacturing~~ pressure retaining components, the allowable loads at low operating temperatures should be defined, the permitted operational ranges for pressure and temperature should be determined and a protection system (e.g. the overpressure protection system) should be implemented to prevent brittle fracture of the material, taking into account the specified ranges of pressure and temperature established for the normal operation of the plant.					
Germany 7	5.13	Stresses caused by normal service conditions and upset conditions (see para. 3.79) should be less than the stress limits specified for these categories of loading conditions. The design temperature should not be exceeded, and it is good practice not to exceed the design pressure. The cumulative usage factor should be less than 1 for each component ~~subjected to such stresses~~.	Clarification. The cumulative usage factor should be less than 1 for any component. Besides, it is not clear what "such stress" means. We suggest to delete this part of the sentence.	Accepted			
Germany 8	5.14	For loading conditions assigned to the emergency conditions category, the design criteria should aim at preventing ~~the~~ fast fracture of the equipment ~~that is subjected to the primary loads~~, and at avoiding excessive	Fast fracture of all equipment of the reactor coolant system should be prevented.	Accepted			

		deformation or buckling. Stresses should be less than the stress limits specified for this category of loading conditions. The pressure reached during emergency conditions may be allowed to exceed the design pressure, provided that the excess is limited in magnitude and time (e.g. it should not exceed 110% of the design pressure).					
Cambodia 7	5.23/2	Delete one period (.)	Editorial	Accepted			All extra periods in the document were deleted.
Cambodia 9	5.25/1	The delete a period (.) in front of "should". Add a period (.) at end of sentence.	Editorial			NA	
Germany 9	5.32	The discharge capacity of the overpressure protection system should be designed to meet the pressure limits prescribed by proven industry codes ~~and should apply the design rules specified by these codes~~. The typical approach includes the following: … (c) The discharge capacity of the safety valves is determined on the basis of the applicable design standard.	The discharge capacity does not apply the design rules. Besides, the content is already addressed in (c).			Rejected	the design rules specified by these codes should be applied (technically approved text)
Cambodia 5	Section 5.35 to 5.39/ Page 57	The minimum net positive suction head (NPSH) for a normal operation of the REACTOR HEAT REMOVAL SYSTEM pumps should be ensured at any time during operation	Continuous operation Residual Heat Removal Pumps is required to operate during different plant modes to avoid fuel failure.			NA	Para 6.68 has a recommendation on "The minimum net positive suction head for the normal operation of the emergency core

							cooling system pumps should…" but this is in the chapter of "Core cooling in accident conditions"
Cambodia 1	Section 5.35 to 5.39/ Page 57	the over pressure protection should be provided in Reactor heat removal system	the over pressure transient may occur in Reactor heat removal system because pressure surge in Reactor Coolant system in cold shutdown conditions and Back leakage of Reactor Coolant System to Reactor heat removal system through connecting vales.			NA	It does not exist in the document
Germany 10	5.44	The reactor coolant pressure boundary comprises pressure retaining components of the reactor coolant system that cannot be isolated from the reactor. The reactor coolant pressure boundary includes the following isolation valves: …..	The reactor coolant pressure boundary contains more components and as only valves are listed here, this should be specified.	Accepted			
USA 13	5.55 (a)	Add space between "between "leg" and "nor"	Editorial	Accepted			
USA 14	5.56	Move "External Hazards" to new line as a title.	Move "External Hazards" to own line	Accepted			
Cambodia 6	5.62/3	In first bullet, add a semicolon.	For consistency, editorial			NA	
USA 15	5.64, sixth bullet	Revise "systemsteam" to "system steam"	Editorial	Accepted			
USA 16	5.67	Seismic qualification should be added.	Only environmental qualification is included. Equipment qualification includes both environmental and seismic qualifications.			Rejected	Seismic qualification is provided in NS-G-1.6 Seismic design and Qualification for NPPs [11] (The guide was technically approved in Nov. 2017)

USA 17	5.67, 5th and 7th bullets	Revise “systemcomponents” to “system components”	Editorial	Accepted			
Germany 11	5.80 (d)	The choice of material, the structural design, the welding and the heat treatment should be such as to ensure a sufficiently ductile state of the pressure vessel material throughout the lifetime of the plant. The ductility of the pressure vessel wall facing the core should be ensured by limiting the maximum neutron flux and by the use of base ~~material~~ and weld metal of a chemical composition such as to keep radiation embrittlement at an acceptable level.	The proper terms are “base metal” and “weld metal”.	Accepted			
Germany 12	~~5.81~~	If advanced materials are to be used ~~in~~ <u>for</u> the reactor pressure vessel, samples of these materials should be subjected to a fast neutron flux with a high lead factor compared to the vessel wall~~, and exposed to the environmental conditions of the pressure vessel. The samples should be examined periodically throughout the lifetime of the plant to monitor changes in mechanical properties (in particular ductility and toughness), and~~ to enable predictions to be made of the behavio<u>u</u>r of the material in sufficient time to allow for	We suggest to delete Para. 5.81. Usage of advanced materials is a particular case of supplemental surveillance programme and less an issue of “Specific design aspects”. We suggest to move this statement to Para. 3.96 (see Comment No.3). Deleted sentences are already mentioned in Para. 3.96.	Accepted	“for” was modified	Rejected	Please see German 3 comment for para 3.96

		corrective measures, if necessary.					
Finland 5	5.106	"…with the recommendations in paras."	Please check the text. Numbers of paras are missing at the end of sentence.	Accepted			
USA 18	5.106	Define the "recommendations in paras"	The paragraph does not list the paragraphs.	Accepted			
Cambodia 3	Section 5.103to 5.117/Page 50-51	Specific design aspects of Steam Generators should include effective moisture separation means	Efficient moisture separation is necessary for Steam Turbine life. Moreover, it is helpful to enhancing plant thermal efficiency			Rejected	Para. 5.111. and para5.114 cover this design task.
Pakistan 5	Para5.106 to 5.120/ Page 47-48	Steam Generators (for PWRs and PHWRs) may include ***effective moisture separation means***	Efficient moisture separation is necessary for Steam Turbine life. Moreover, it is helpful in enhancing plant thermal efficiency.			Rejected	Para. 5.111. and para5.114 cover this design task.
Germany 13	5.107	The steam generator tubes and the~~ir~~ internal structures of the steam generators should be designed for the maximum stresses and most severe fatigue conditions expected to occur in operational states and in accident conditions without significant fuel degradation (e.g. should be designed to withstand loads from a loss of coolant accident and a main steam line break).	The tubes do not have any internal structures.	Accepted			
Germany 14	5.114	The design should allow for inspection of the steam generator tubes and the primary and secondary steam separators over their entire length. The equipment and procedures for examination of the tubes should be capable of detecting and locating significant ~~defects~~ degradation.	The tubes might also suffer wall thinning or denting which is generally not addressed as "defects", "degradation" is more general	Accepted			

Germany 15	5.118	Design provisions to perform ~~steam generator~~ sampling <u>in the steam generator</u> should be implemented.	The sampling may be done from the sludge or the tubes or internals, not from the steam generator itself.	Accepted			
Cambodia 4	Page 85/line 14	"Pressure Boundary" is modified to "pressure boundary"	For consistency, editorial			NA	
	Section 6						
Germany 16	6.6	~~The chemical and volume control system should be designed to adjust the boric acid concentration in the reactor coolant system in order to control the axial offset of the core during power operation.~~	The meaning is not clear as boric acid cannot compensate an axial offset. We suggest to delete			Rejected	The system is supporting the reactivity control function.
Germany 17	6.8	The chemical and volume control system should have capabilities to achieve the necessary boric acid concentration in the reactor coolant system for power operation for ~~fuel cycle~~ conditions <u>during the whole refuelling cycle</u>.	"Fuel cycle" rather refers to the processing of the fuel from the front to the back end.	Accepted			
Finland 6	6.35	"…with the recommendations provided in paras if they…"	Please check the text. Numbers of paras are missing at the end of sentence, same as for 5.106 numbers are missing.	Accepted			
USA 19	6.35	Define the "… recommendations provided in paras …"	The paragraph does not define the applicable recommendations. It "in paras."	Accepted			
Pakistan 6	Para6.36 to 6.40 / Page 53-54	***<u>Over pressure protection</u>*** may be considered in RHR Specific design aspects	Over pressure transient may occur in RHR System because of: a) Pressure surge in Reactor Coolant system in cold shutdown conditions b) Back leakage of Reactor Coolant System to RHR through connecting vales			Rejected	Over pressure protection was considered in sections 3 and 4.

Cambodia 2	Section 6.60 to 6.68/Page 60	The Flow requirements of EMERGENCY CORE COOLING SYSTEM Pumps for different modes should be defined	The EMERGENCY CORE COOLING SYSTEM System is required to operate during different pant modes with different flow requirements.			NA	
	Section 7						
Japan 5	7.4.	Use of the reactor water cleanup system as the ~~primary or~~ alternate means of residual heat removal during shut-down conditions should be considered.	Completeness. In BWRs, the reactor water cleanup system for residual heat removal during shutdown conditions is not a main function in operational states and it is used very specific purpose.	Accepted			
USA 20	7.19	Revise the sentence to read as follows: "Instrumentation should be provided to control the temperature and water level of the suppression pool during normal operations and accident conditions."	The instrumentation should be able to provide temperature and water level control during normal and accident conditions.	Accepted			
Japan 6	7.25.	It should be ensured that the valves expected to open to actuate ~~of~~ turbine driven water supply systems such as the reactor core isolation cooling system can be operated (by using compressed air, DC power or human power) in the event of station blackout (loss of all AC power).	Completeness. In case of SBO in BWR, some valves of RCICs inside the PCV can't be operated by means from the outside of the PCV. Actually, these valves are normally opened.	Accapted			
	Section 8						
USA 21	8.44	Revise to read: "The first and the second reactor shutdown systems should be fast acting, fully capable, diverse and functionally independent of each other. If part of the reactor	Because this safety guide is not created exclusively for passive plants, "passive" shutdown systems should not be required, but could be kept as optional.	Accepted			

		design, it should also be passive."					
USA 22	8.48 (a)	Change "an second reactor…" to "a second reactor…"	Editorial	Accepted			
USA 23	Para 8.70/ Line 1	Revise to read: "…jet impingement including potential blast wave, pipe whip) should…"	Draft safety guide DS 481 did not explicitly identify the potential blast wave load as a local effect resulting from postulated pipe failures. However, in the event of a high-pressure pipe rupture, the first significant fluid load on surrounding structures, systems, and components would be induced by a blast wave.	Accepted			