DS488 Design of the Reactor Core for Nuclear Power Plants
Step 11: SSC comments and resolution

COMMENTS						RESOLUTION			
NO.	MS	Com. No.	Para/Line No.	Proposed new text	Reason	Accepted	Accepted, but modified as follows	Rejected	Reason for modification/rejection
1	Poland	1.	2.4 / page 4	For design basis accidents and design extension conditions without significant fuel degradation, the reactor core is required to be designed to maintain a configuration such that it can be shut down and remain coolable	Consistency in referring to core design.	X			
2	U.K	UK 1	2.4	*For design basis accidents it is required to ensure that any damage to fuel elements is kept to a minimum. Components of the reactor core and its associated structures should be designed with account taken of the safety functions to be achieved (Ref. [1], paras 2.9 and 4.12).* *In particular, where a protection system is provided to mitigate a design basis accident, the normal expectation is that protection setpoints and operating limits will be selected to ensure core components retain their safety function. Where this is not practical, for* design basis accidents and design extension conditions…	This draft omits a fundamental requirement to reduce risk as far as reasonably practical and therefore is not acceptable in the UK or consistent with Ref. 1. I think that the old text should be reintroduced and clarified as proposed.		The proposed sentences are modified to read as: “For design basis accidents, it is necessary to ensure that fuel cladding failure is kept to a minimum. Components of the reactor core and its associated structures should be designed with account taken of the safety functions to be achieved. From this perspective, the reactor core is required to be designed to maintain a configuration such that it can be shut down and remain coolable for design basis accidents and design extension conditions without significant fuel degradation.”		
3	South Africa	1	2.12 / 2	**Adherence** to these limits with appropriate provisions …	Editorial	X			
4	South	2	2.21(b) / 1	(e.g., introduction of mixed-	Editorial	X			

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	Africa			oxide or gadolinium fuel; …					
5	U.K	UK 4	3.4(h)	*(h) Adequate resistance to hydrogen-assisted and hydride-related cracking in normal operation and fuel storage*	This is particularly an issue for dry fuel storage and is omitted.	X			Added as a new bullet in para. 3.5.
6	Poland	2.	3.7 / page 9	~~(~~Fuel and core coolable geometry should be maintained and the reactor core should be designed to prevent or control flow instabilities and resultant fluctuations in core reactivity or power.~~)~~	Editorial remark – no need for the brackets, this is an important feature of the core design			X	This statement is directly related to RCS design, and thus, although it is important information, we were requested to put it in brackets.
7	South Africa	3	3.9 / 8	… and, **by means of controlled dilution,** to compensate the decrease in core reactivity …	Include for accuracy	X			
8	U.K	UK 6	3.15	…beginning of cycle, end of cycle and *key points relating to poison burnout*	The examples given are often not the most important times.	X			
9	U.K	UK 7	3.18	…shutdown at all times *to ensure satisfactory fault tolerance.*	Doesn't say what you are trying to achieve.	X			
10	France	1	3.23	Correlations for predicting critical heat flux are continually being generated as a result of additional experimental data, changes in fuel assembly design, and improved calculation techniques involving coolant mixing and the effect of axial power distributions. <u>Any change in an approved correlation has to be submitted for licensing and impact on thermalhydraulic design should be evaluated.</u>	The mention to continually generated correlations has to be associated with guidance regarding impact on safety evaluation.		The proposed addition is slightly modified to read as: "The impact of any change in an approved correlation on thermalhydraulic design should be evaluated."		Submission for licensing depends on MS practices.
11	France	2	3.24 (a) and (b)	Regarding departure from nucleate boiling ratio, critical heat flux ratio or critical power ratio ~~correlations~~, ~~there~~ the limiting (minimum) value	(b) may introduce some question – and is not acceptable for PWR It is better to include limiting		Reworded to read as: "Regarding departure from nucleate boiling ratio, critical heat flux ratio or critical power		Some MS do not use the minimum value of CHF (or DNBR, CPR) that complies with 95%/95% condition.

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				should be such that the hot rod (see Annex II, Fuel, for terminology clarification) in the core does not experience any heat transfer deterioration during normal operation or anticipated operational occurrences with a 95-percent probability at the 95-percent confidence level. …	(minimum) value in (a)		ratio, the limiting (minimum) value should be established such that the hot rod (see Annex II, Fuel, for terminology clarification) in the core does not experience any heat transfer deterioration during normal operation or anticipated operational occurrences with a 95-percent probability at the 95-percent confidence level. Otherwise, in light water reactors, it should be demonstrated that the number of fuel rods that experience heat transfer deterioration does not exceed a very small fraction (e.g., at most 0.1%) of the total number of fuel rods in the core."		For these MS, current practice with a limited fraction (at most 0.1%) of fuel rods that experience heat transfer deterioration is still valid.
12	France	3	3.24 (b)	delete all (b) ~~For light water reactors, the limiting (minimum) value of departure from nucleate boiling ratio, critical heat flux ratio, or critical power ratio correlations should be established such that the number of fuel rods that experience a departure from nucleate boiling or boiling~~	in a PWR, there are more than 50000 rods; with the proposed limit "at most 1 fuel rod per 1000" in normal operation it can be allowed that "at most" 50 rods could experience DNB …. This is in contradiction with the general statement "Fuel damage is not expected during normal operation and operational transients	X			Close to Comment #11 (France #2).

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				~~transition during normal operation or in anticipated operational occurrence conditions does not exceed a specified limit, i.e., at most one fuel rod per thousand in the reactor core~~	(Condition I) or any transient conditions arising from faults of moderate frequency (Condition II)" Therefore, number of fuel rods experiencing boiling crisis is not a safety criteria in normal operation and AOO. Allowing boiling (as stated in reason for rejection of France comment 97) is not allowing Departure from Nucleate boiling.				
13	U.K	UK 8	3.25	*The design should achieve no fuel failures where this is reasonably practical, otherwise* only a limited	We don't set out with the intention of designing protection that will fail to achieve its safety function.	X			
14	Poland	3	3.25/ page 15	For accident conditions (design basis accidents and design extension conditions without significant fuel degradation) the possibility ~~only a limited number~~ of fuel failures should be ~~allowed~~ as low as reasonably achievable.	The design should be aiming to reduce the fuel failures to minimum, acceptance criteria should establish what is the acceptable level (eg. Number) of fuel failures.		Reworded as to read as: "For accident conditions (design basis accidents and design extension conditions without significant fuel degradation), the design should achieve no fuel failures where this is reasonably practical; otherwise, only a limited number of fuel failures should be allowed."		Close to Comment #13 (U.K Comment #8) immediately above.
15	South Africa	4	3.25 / 8	… fuel fragment dispersal in the coolant should be minimised.	Feasibility			X	Under the situation that the amount of fuel fragmentation

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									dispersal cannot be controlled by means of operational procedures or design measures, current MS practice is to "prevent" rather than "minimize".
16	South Africa	5	3.26 / 9	… irradiation and environmental **perspectives** are described in Annex I …	Editorial	X			
17	South Africa	6	3.33 / 3	… take into account the radial gap closure kinetics that **depend** on various parameters …	Editorial	X			
18	South Africa	7	3.36 / 1	… that the fuel rod can accommodate the effects …	Editorial	X			
19	Poland	4.	3.37 / page 18	Hydrogen pick-up correlation should be specified for each cladding type so that ~~some~~ appropriate fuel design limits,	Editorial comment	X			
20	France	4	3.42 (e)	Hydraulic forces, including cross-flows between distorted fuel assemblies or in mixed ~~fuel assembly~~ core configurations (i.e . with different fuel assemblies) ~~concepts~~;	Mixed fuel assembly concepts is not very clear, mixed core is generally used (e. g. para 3.126)	X			
21	South Africa	8	3.43(f) / 1	… (including those resulting from accidents …	Editorial	X			
22	South Africa	9	3.49(b) / 2	… no dryout condition for pressurized heavy water reactors);	Editorial	X			
23	France	5	3.49 (b)	no dryout condition for pressurized heavy water reactors)	typo	X			
24	U.K	UK 9	3.54(a)	(a) *For accident sequences where some fuel failures cannot reasonably be avoided,* the number.	Again, in most cases no failures are acceptable. For consistency with Ref. 1 etc.	X			

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25	France	6	3.54 (b)	in the fuel enthalpy ris~~Ire~~	typo		Reworded to read as: ".. in the fuel enthalpy".		
26	South Africa	10	3.54(b) / 3	… caused by an increase in the fuel **enthalpy** are some of the failure mechanisms …	Editorial	X			
27	South Africa	11	3.84(d) / 3	… incorporation of **flexible** couplings …	Editorial	X			
28	South Africa	12	3.87 / 1	As indicated in Requirement 46, paras 6.9-6.10 …	Editorial	X			
29	South Africa	13	3.88(d) / 3	… two different and **independent** physical trip parameters …	Editorial	X			
30	South Africa	14	3.89 / 3	… and production of helium **gas.**	Editorial	X			
31	U.K	UK 10	3.108	Qualification of the system should be ensured *to a level consistent with the nuclear safety class of the functions performed.*	There is a more general requirement for qualification.	X			
32	South Africa	15	3.115 / 7	Unplanned power **manoeuvring** …	Editorial	X			
33	Finland	1	3.119.	The reactor core analysis should include fuel rod performance analyses based on average and local power levels and axial temperature distributions to demonstrate that the respective thermal and mechanical fuel design limits are met for all operational states. For light water reactors, the reactor core analysis should include peak channel power and peak linear power rates for normal full power operation and steady state radial power distribution at each assembly location and axial power distributions in each fuel assembly. Allowance should be	With the new modification the requirement is more demanding than the previous. Do you really require the power distribution to be given radially within the assembly and not at each assembly location?	X			Yes, we also need radial power distribution within the fuel assembly, as described in the last sentence of this paragraph.

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				made to account for the effects of changes in the geometry of the assembly on neutronic and thermalhydraulic performance (e.g., changes in the moderator gap thickness due to bowing of the assemblies). The reactor core analysis should also include the radial power distribution within a fuel assembly and the axial power distortion due to spacers, grids and other components in order to identify hot spots and to evaluate the local power levels.					
34	South Africa	16	3.128(b) / 3	… the reactor **shutdown** margin …	Editorial / consistency	X			
35	South Africa	17	3.128(d) / 4	Other consequences of the differences …	Editorial	X			
36	Finland	2	3.134.	The core design and operations program should establish procedures and limits for operating the core with defective fuel assemblies while assuring radioactive dose limits are not exceeded for plant personnel. In light water reactors, shutdown should be done if the operating radiochemical limits are exceeded, and all defective fuel assemblies are replaced according to procedures after the outage. In pressurized heavy water reactors, fission product release from defective fuel and subsequent secondary hydriding of the cladding can be minimized by reducing the power level of defective fuel rods. (See Annex II, Defective fuel, for supplementary	Please clarify, ” In light water reactors, shutdown should be done if the operating radiochemical limits are exceeded, and all defective fuel assemblies are replaced according to procedures after the outage.” This sentence is strange. How can assemblies be replaced after the outage?		Reworded “after the outage” to read as “during the outage”.		

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				information.)					
37	Finland	3	3.137.	Design limits are determined, based on the concept of defence in depth, to fulfill safety requirements for all applicable plant states. Fuel design limits described in paras 3.49–3.59 should be extended to assure that the fuel rods and fuel assemblies remain intact (when applicable) or do not degrade further (in case of leaking fuel rods) in the back-end phases after the assemblies are discharged from the core. Back-up phases include: handling, shipment, storage, reprocessing and disposal. The following key in-reactor safety parameters are among that may have an impact on the post irradiation behavior of the fuel rods and the fuel assemblies: (a) End-of-life fuel rod internal pressure Even though fuel rods can withstand some extent of over-pressurization exceeding the normal coolant pressure without failure in normal operation, such highly pressurized used fuel rods may not be acceptable to handle when coolant counter-pressure is diminished (e.g., in spent fuel storage facilities). This is particularly relevant for mixed-oxide fuels which remains higher temperature for a longer period of time and continue to	Please clarify, back-up phases or back-end phases include:…? (b) Sentence is strange: Localized hydriding (e.g…) may not hydride normal operation …		Corrected to: “Back-end phases include …”. The sentence in bullet (b) is corrected to read as: “Localized hydriding (e.g., due to corrosion layer spalling or due to axial pellet-pellet gaps) may take place during normal operation …..”.		

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				release helium gases from the fuel material. (b) Massive cladding hydriding and cladding mechanical properties Localized hydriding (e.g., due to corrosion layer spalling or due to axial pellet-pellet gaps) may not hydride normal operation or be of consequence in accident conditions, but such a condition may lead to delayed hydride cracking of zirconium-based alloy cladding in post-irradiation handling or storage, or undesired failures in the event of a shipment accident. (c) Grid-to- rod fretting wear Localized…					
38	South Africa	18	3.137 / 6	… safety parameters are among those that may have an impact …	Editorial	X			
39	South Africa	19	3.137(a) / 2	… normal operation, handling of such highly pressurized used fuel rods may not be acceptable when coolant counter-pressure is diminished …	Editorial	X			
40	South Africa	20	3.137(a) / 4	… mixed-oxide fuels **that** remain at higher temperature for a longer period of time …	Editorial	X			
41	South Africa	21	3.137(a) / 5	… continue to release helium **gas** from the fuel material.	Editorial	X			
42	South Africa	22	3.137(b) / 2	… may not hydride **during** normal operation …	Editorial		Reworded to read as: "… may take place during normal operation …"		
43	South Africa	23	I-2 / 1	… **guide** tubes, …	Editorial	X			

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44	South Africa	24	I-3(a) / 1	Rod **internal** pressure …	Editorial	X			
45	South Africa	25	Annex II header	SUPPLEMENTARY **TECHNICAL** INFORMATION	Editorial	X			
46	South Africa	26	II-2 *Cladding* / 4	… under development for use in **applications** such as …	Editorial	X			
47	Finland	4	Annex II-2 "Margin" supplement to 3.18:	The term "shutdown margin" is not defined in the IAEA Safety Glossary [9]; however, it is generally accepted as the instantaneous amount of reactivity by which a reactor remains subcritical from its present conditions assuming all full -length control rods rod assemblies are fully inserted except for the one exhibiting the highest reactivity worth that is assumed to be fully withdrawn.	Please modify the definition suitable for PWRs and BWRs. Control rod assembly still refers to PWR, in BWRs there are no such thing as control rod assembly as they use blade-type control rods. However, the term shutdown margin is used for BWRs too		Reworded "full-length control rod cluster assemblies" with "full-length control rod cluster assemblies (pressurized water reactors) or control rods (for pressurized heavy water reactors and boiling water reactors)".		
48	France	7	I-2 (c) (c) (d) (e)	(c) (d)(e) (f)	(c) appears twice	X			
49	U.K	UK 11	II-2 cladding	and cladding structural integrity is required *to maintain a coolable geometry and to permit core offload using normal refueling equipment.*	Structural integrity limits do not prevent fuel dispersal. If a pin bursts much of the pellet material is blown out into the coolant.	X			
50	France	8	II-2 Fuel	The fuel rod ~~is interchangeably called~~ refers to either fuel element, fuel pin or any structure containing fuel pellet.	Fuel pin is not used in the document, fuel element appear once in 3.24 (c) for PHWR	X			
51	Japan	1	Annex II II-2.	Annex II: Supplementary Technicial Information **Topics** : Reactivity feedbacks	Completeness. Boron reactivity feedback should be added.	X			

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				Clarification (d) Reactivity feedback due to changes of boron concentration in the coolant/moderator (i.e., boron coefficients of reactivity for the coolant and the moderator);					