From:	RILEY, Jim
To:	Cook, Christopher; Miller, Ed
Cc:	Attarian, George; Brunette, Pat; Buman, Dan; Burris, Ken ; Carrie L. Stokes (carrie.stokes@bwsc.net); Colin Keller; crharris@aep.com; Dave Bucheit; Dean Hubbard (dmhubbard@duke-energy.com); Don Bentley (DBENTLE@entergy.com); "Faller, Carl"; Gambrill, David; Gary W. Smith (gsmith@enercon.com); GASPER, JOSEPH K; Giddens, John; Glen D Ohlemacher (ohlemacherg@dteenergy.com); Hackerott, Alan; Hammons, Mark A.; Heather Smith Sawyer (heather.sawyer@bwsc.net); Heerman, John; Horstman, William R; "Huffman, Ken"; HYDE, KEVIN C; Jeff Brown (jeffrey.brown@aps.com); Jim Breunig (james.breunig@cengllc.com); Joe Bellini (joe.bellini@amec.com); John Lee (John.Lee@dom.com); Kit Ng (kyng@bechtel.com); LaBorde, Jamie; Larry Shorey (ShoreyLE@Inpo.org); Lorin.Young@CH2M.com; Maddox Jim (maddoxje@inpo.org); Mannai, David J; Matt Nienaber (mbniena@nppd.com); Maze, Scott; Michael Proctor (michael.proctor@urs.com); MICHAEL.J.MILLER@sargentlundy.com; Mike Annon - Home (ICENG2008@AOL.COM); Miller, Andrew; Murray, Mike; Parker, Thomas M.; Ray Schneider (schneire@westinghouse.com); RILEY, Jim; Robinson, Mike; Rogers, James G; Rudy Gil; Ruf, Gary (Gary.Ruf@pseg.com); Scarola, Jim; Selman, Penny; Shumaker, Dennis; Snyder, Kirk; Stapleton, Dan; Stone, Jeff; Terry Grebel (tlg1@pge.com); Thayer, Jay ; Vinod Aggarwal (Vinod.aggarwal@exeloncorp.com); Wrobel, George; Yale, Bob
Subject:	FW: Dam-Failure-ISG-Ind-Roll-up-Rev-4-NRC-Response-JFK-2013-04-10.docx
Date:	Wednesday, May 01, 2013 5:54:39 PM
Attachments:	Dam-Failure-ISG-Ind-Roll-up-Rev-4-NRC-Response-JFK-2013-04-10.docx

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And here are our comments on the dam failure ISG. The attachment is basically the comment document that resulted from our last meeting with comments that we would like to talk about during our Thursday meeting highlighted.

Jim Riley

NEI

(o) 202-739-8137

(c) 202-439-2459

From: Hubbard, Dean M [mailto:Dean.Hubbard@duke-energy.com]
Sent: Wednesday, May 01, 2013 5:30 PM
To: RILEY, Jim
Subject: Dam-Failure-ISG-Ind-Roll-up-Rev-4-NRC-Response-JFK-2013-04-10.docx

Dam Failure ISG Comments

Section / Page	Comment	Concern	Proposed Resolution	[Draft] NRC Response
Overall	Many licensees do not intend to perform the off-site dam failure evaluations in accordance with Appendix B		May want to specifically state the expectation	
Overall	Specify whenever a risk or frequency value is stated that it is the mean value. Can we use the USBR recommendations for event tree evaluations of dam failures to screen out events of very low probability?	Discussion in the document lists a number of considerations for different combinations of component failures and physical situations		
Sec. 1 / p. 1	1st paragraph, last sentence: "Therefore, in this ISG dam failure refers to flooding caused by any uncontrolled or controlled flow of water that threatens to impact structures, systems and components (SSCs) important to safety at the NPP site."	Definition of dam failure in the context of flooding usually refers to uncontrolled release of water from the reservoir. It is recognized that controlled releases from a reservoir may threaten SSCs at a site, and this potential should be investigated as part of the flood hazard reevaluation. However, flooding potential of controlled releases is never mentioned in the ISG except in this sentence. Also, the definition is imprecise in its wording because it refers to "any uncontrolled or controlled flow of water." Presumably, "flow of water" means reservoir releases, but the definition taken by itself could refer to any flooding mechanism.	The definition of dam failure should be revised to exclude controlled releases, or further discussion of the investigation of flooding potential of controlled releases should be added to the ISG (perhaps as a dedicated section). Also, suggest changing "flow of water" in the definition to "reservoir releases" to exclude other flooding mechanisms unrelated to dam failure.	Reword intro to discuss dam failure in the usual sense, as well as controlled releases. Add a section discussing controlled releases. - Gate discharge capacity - Check river op /dam procedures. - Communication w/ river/dam operator.
Sec. 1 / p. 1	2nd paragraph, 4th sentence: "NPPs may also use some combination the protection outlined above."	Typographical/editing error, missing word, "of"	Suggest change to: "NPPs may also use some combination of the protection outlined above."	Typo fixed. Changed to "NPPs may also use some combination of the protection outlined above."
Sec. 1 / p. 1	"Failures of water-storage or water-control structures (such as onsite cooling or auxiliary water reservoirs and onsite levees) that are located at or above the grade of safety-related equipment are potential flooding mechanisms."	List should specifically exclude tanks		Better for licensee to provide justification for excluding tanks? Note: Will check with scope of 2.1 with respect to internal/external flooding.

Dam Failure ISG Comments

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Sec. 1.2 / p. 2	Last sentence of paragraph: "This ISG is applicable to Tier 1 sites that have been granted an extension."	Application of the ISG to sites that have been granted an extension and whose bounding flood hazard does not include dam failure may present an unreasonable burden.	Suggest excluding Tier 1 sites who have been granted an extension and whose bounding flood hazard does not include dam failure. Consideration should also be given to tier 1 sites that did not receive an extension long enough to allow use of this new guidance.	Will provide clarification to: Exclude sites w/ short extensions Can exclude Tier 1 sites that are clearly not impacted by dam failure. But just because original design basis did not identify dam failure as bounding is not a reason to exclude.
Sec. 1.3.1 / p. 2	1st paragraph, 5th sentence: "…small/distant dams whose failure would like have negligible impacts…"	Typographical/editing error, "like" instead of "likely"	Suggest change to: "…small/distant dams whose failure would likely have negligible impacts…"	Typo fixed. Changed to "…small/distant dams whose failure would likely have negligible impacts…"
Sec. 1.3.2 / p. 4	2nd full paragraph of p. 4, last sentence: "The details of the screening process will vary according to the loading case being considered (e.g., hydrologic, seismic, other).	The screening process described in Section 3 does not distinguish among dam failure mechanisms. See Sec. 3.2, p. 23, 1st paragraph.	Make the guidance consistent.	OK. Can delete sentence.
1.3.2, p. 4	"In addition failure due to other (non-hydrologic, non-seismic) causes (e.g., geologic or structural defects, misoperation, etc.) under specific loading conditions must be considered."	This statement is too broad and could lead to an extensive search and justification for an endless list of potential failure mechanisms and combinations of failures beyond hydrologic and seismic.	Modify the statement to be specific on the scope of other failures by referencing Operation Failures which are described in section 2.2.3. The other failure modes are associated with Sunny Day failure as described in Section 6.	Can provide clarification, but if the aim is to credit non-failure, then comprehensive analysis is required.
Sec. 1.3.2 / p. 4	4th full paragraph of p. 4, last sentence: "In lieu of a detailed analysis, one can simply assume that the dam fails under appropriate loading and move on to estimation of the consequences."	In lieu of a detailed analysis, does the licensee have any alternate options to justify that a dam (which is not screened-out according to Section 3) will not fail, rather than simply assuming dam failure?	Explain what is meant by a detailed analysis – analyze non-failure or analyze how the failure would occur. Clarify if there are any alternative options to simply assuming dam failure in lieu of a detailed analysis. For example, if a federal agency can provide justification that the dams they own and operate will not fail under the scenarios described in this ISG, clarify if the licensee can rely on the assertion of a federal agency in lieu of a detailed analysis.	In general, comprehensive analysis, performed in accordance with standard engineering practice, is required to support determination of non-failure. Details of sharing analysis results performed by other federal agencies still being worked out.
1.3.2, p. 4	"Dam failure flood hazard estimation will require collecting data on the dam (s) to be analyzed (e.g., design documents,	What can be done if records cannot be located? Are there any reasonable assumptions that can	If detailed historical information cannot be obtained, recent (last 5 years) inspection reports and evaluations by the dam	All available information should be used to evaluate flood hazards and potential failure modes. Lack of information cannot be used

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	construction records, maintenance, and inspection program, planned modifications)"	be made? Are there a minimum set of records needed.	regulator can be used to determine if there are flaws or vulnerabilities that should be evaluated for dam failure risk.	to rule out vulnerabilities.
1.3.2, p. 4	"Transport of sediment and debris by flood waters should be considered."	Not clear what this statement is requiring and how to perform a sediment and debris analysis beyond engineering judgment. Where is sediment a concern? What scale/type of debris is of concern?	If an analysis is required and expected to be part of the report, this statement would need to be expanded to further characterize when sediment and debris needs to be considered and the specific concerns that need to be addressed. If the concern is to consider sources of large debris in the routing path that could be transported to the nuclear site, it should be stated as such.	Debris is discussed in Section 4.2.7 Need to develop staff position on reservoir/river sedimentation.
1.3.2, p 4	"Comparison of the estimated capacities to the applied loads is used to assess the credibility of failure modes associated with those cases. The assessment may consider factors of safety incorporated into the dam design or dam capacity assessments, with appropriate justification. Likewise, uncertainties in capacity and loading estimates should be considered to arrive at an appropriately conservative decision. If it cannot be demonstrated that the dam-failure likelihood over the expected remaining life of the nuclear power plant is extremely low (or consequences of failure are negligible), failure should be postulated and the flooding consequences estimated."	How does this reconcile with paragraph 1.4.2 that describes risk criteria.	Clarify the relationship between the deterministic and risk based criteria.	This is intro/overview level discussion. This section is meant to convey, in general terms, two concepts that are discussed in more detail is later sections: 1) In certain cases we allow credit for margins 2) NRC risk tolerance is very low. Note: Will clarify that hydrologic need not be probabilistic, but can be.
Page 5	"credible failure modes/scenarios"	How will "credible" be defined?		Refer to section 1.4
1.3.2, p 5	"In summary, the dam-failure flood hazard analysis will comprise the following steps.."		Should include the works "potentially critical"	Will clean up wording.
Sec. 1.4.1 / p. 6	1st paragraph, 2nd sentence: "…little or no consequences (NRC, 2012)."	Ambiguous acronym reference. In this case, "NRC" refers to National Research Council, but the NRC acronym in the ISG usually refers to Nuclear Regulatory Commission. This comment applies each time	Clarify acronym.	Will fix this. Citation will become NAS (2012) (National Academy of Sciences)

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		this reference is cited (pp. 7, 8, 10, possibly others).		
Page 6, Figure 2	Decision diamond on Figure 2	What are the criteria for determining a yes or no outcome of the "Fail?" decision diamond?		This is overview. Refer to sections on detailed analysis (4,5,6,7,8,9,)
1.4.1, p. 7	"Historical rates for dam failure provide useful information about generic failure probabilities. However, each dam and its environment are unique and failure probability estimates, when used, should be developed based upon site and dam specific data and information."	The statement says "…failure probability estimates, when used…" which could imply that failure probability estimates are required.	Modify statement to say "…failure probability estimates, if used…". This would be consistent with the staff's position that a deterministic approach is preferred.	OK with this change in wording.
Sec. 1.4.2 / p. 7	General comment: This section states that the probability target for judging the likelihood of a particular failure mode/scenario (either from a single hazard or appropriate combination) is $1x10^{-6}$ annual probability. From the above statement it appears that dams which are safe for floods with a probability of 10^{-6} per year need not to be checked for failure during PMF.	If it can be demonstrated that a dam will not fail during a flood with probability of 10^{-6} per year, can hydrologic dam failure be excluded without considering PMF?	More clarification is required to clarify that dams not failing for 10^{-6} flooding can be considered as safe and potential failure during PMF does not need to be evaluated.	Staff discussion needed.
1.4.2, p. 8	Staff Positions Bullet 2 : "…on limited data will viewed with great skepticism."	Typo	…on limited data will *be* viewed with great skepticism."	Typo fixed. Changed to "on limited data will *be* viewed with great skepticism."
1.4.2, p. 8	Last bullet - staff position states "…acceptable to use the $1x10^{-4}$ annual frequency ground motions, at spectral frequencies important to the dam, for seismic evaluation of dams, instead of $1x10^{-6}$, as discussed above. However, appropriate engineering justification must be provided to show that the dam has sufficient seismic margin. Otherwise the $1x10^{-6}$ ground motions should be used."	• It is not clear how the 10^{-4} and 10^{-6} criteria should be used. If sufficient margin cannot be established with the 10^{-4} criteria, how could adequate justification be achieved with the 10^{-6} criteria when it is associated with a larger earthquake? • What constitutes sufficient margin if a 10-4 seismic hazard analysis is performed verses a 10-6 seismic hazard analysis?	• Clarify how the two seismic criteria are to be used • Provide guidance on what amount of margin is sufficient.	Staff discussion needed Interaction w/ ICODS needed
Sec 1.4.2 / p. 8	2nd bullet on p. 8, next to last sentence: "However, appropriate engineering	No quantitative criteria for "sufficient margin" are provided.	The 10^{-4} annual frequency ground motion is comparable to GMRS. Factor of safety in	Staff discussion needed

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	justification must be provided to show that the dam has sufficient seismic margin."		NRC regulatory guidance for liquefaction and slope stability for GMRS can be used to demonstrate "sufficient margin."	Interaction w/ ICODS needed
Sec. 1.4.2 / p.8	2nd bullet on p. 8, last sentence: "Otherwise 10^{-6} ground motions should be used."	The 10^{-6} ground motion criteria appears to be more conservative than NRC ISG-20, "PRA based Seismic Margins Analysis" where 1.67 * GMRS is used as a screening criteria. Comment also applies to Sec 5.3.1, p. 48, 1st paragraph.	"Otherwise 10^{-6} ground motions should be used." should be replaced by "Otherwise dam seismic capacity greater than 1.67*(10^{-4} ground motions) should be demonstrated."	1.67*GMRS is developed for NPPs. Staff discussion needed Interaction w/ ICODS needed
Sec 1.4.2 / p 8	Staff position bullet #1: USBR is referenced as being current best practice for determining probability of failure.	Can the staff be more specific on the section of the USFR manual that contains acceptable methods to prove the probability of failure is 1X 10^{-6} or less?		
1.5.2	TVA has more than 49 dams in the national inventory of dams.	Where was this data collected?	The National Inventory of Dams recognizes 155 dams owned by TVA.	Source was NAS report, that cited FEMA report. Will check this.
Sec. 1.5.2 / p. 9	4th full sentence: "Other federal agencies such as the USACE, the USDA Natural Resources Conservation Service and the UDOI Bureau of Reclamation…"	Typographical/editing error, "UDIO" instead of "USDOI" for US Dept. of Interior	Suggest change to: "Other federal agencies such as the USACE, the USDA Natural Resources Conservation Service and the USDOI Bureau of Reclamation…"	Typo fixed. Changed to "…USDOI…"
Sec. 1.5.3 / p. 11	Staff Position, 1st bullet: "If a federally owned dam is identified as critical to the flooding reanalysis, the licensee should contact NRC promptly. NRC will act as the interface between these agencies and licensees. Memoranda of Agreement or other mechanisms are being developed to facilitate sharing of data (including necessary safeguards to protect sensitive information) between NRC and the appropriate federal agencies."	If information from a federal agency is considered classified, would this information be limited to the government agencies or would the licensee be involved?	Following the development of the Memoranda of Agreement, include in this ISG information regarding how to handle requests for information that may be considered classified by a federal agency.	MoA still under development. Not yet addressed
Sec. 1.5.3 / p. 11	Staff Position, 1st bullet: "It is important to note that in many cases federal agencies that own or operate dams have a conducted detailed failure analysis. To the extent these	Details of the agency's existing dam failure analyses may not be provided to the licensee or may be considered classified. If the full	Clarify whether the onus is on the licensee or the federal agency to determine that the existing dam failure analyses performed by federal agencies are applicable and meet	MoA still under development. Not yet addressed

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	analyses are applicable, they should be used in the Recommendation 2.1 flooding reanalysis."	details of the agency's existing analyses are not available to the licensee, it may not be possible to determine that the analyses are applicable and meet the criteria for the Recommendation 2.1 flooding reanalysis.	the criteria for the Recommendation 2.1 flooding reanalysis, in the event that the details of these analyses are not provided to the licensee.	
1.5.3, p 11	"In most cases dams and levees will be owned and operated by private entities and regulated by a state agency. In this case, the licensee should interact directly with the owner and regulator."	NRC assistance may be important	Clarify NRC assistance in this situation	Will consider what form of assistance is appropriate and practical
Sec 1.5.3 / p 10	First Staff Position bullet: "If a federally owned dam is identified as critical to the flooding reanalysis, the licensee should contact NRC promptly. NRC will act as the interface between these agencies and licensees."	The criticality of the dam can't be determined without detailed information on the dam.	Reword statement "If a federally owned dam is identified as potentially critical to the flooding reanalysis, the licensee should contact NRC promptly. NRC will act as the interface between these agencies and licensees." :	
Sec 1.5.3 / p 10	Staff Positions. No guidance is offered on alternatives if the dam owner will not release technical information.	Without technical information it may not be possible to determine the failure mode and subsequent outflows.	Previous discussions indicated that the staff would consider examining the agencies information on the dams and the dam failure analysis on behalf of the licensee to determine adequacy and what outputs would be applicable.	
Sec. 2.2.1.2 / p. 20	2nd paragraph, 1st sentence: "…overtopping which initiates embankment erosion; and structural overstressing."	Typographical/editing error, number 3 is missing from the list.	Suggest change to: "…overtopping which initiates embankment erosion; and 3) structural overstressing."	Typo fixed. Added missing number 3.
Sec. 2.2.1.2 / p. 20	2nd paragraph, 3rd sentence: "For example, cohesionless soils are less able to withstand erosion from due to overtopping…"	Typographical/editing error, "from due to"	Suggest change to: "For example, cohesionless soils are less able to withstand erosion from overtopping…"	Typo fixed. Changed to For example, cohesionless soils are less able to withstand erosion from overtopping…"
Sec. 2.2.1.2 / p. 20	3rd paragraph, 1st sentence: "…without loss or strength or liquefaction…"	Typographical/editing error, "or" instead of "of"	Suggest change to: "…without loss of strength or liquefaction…"	Typo fixed. Changed "or" to "of"
Sec. 2.2.3 / p. 22	Last bullet in list: "Inability to warn in advance…"	Unlike the other bullets in the list, this bullet seems more like a consequence of failure rather than	Suggest deleting bullet, or clarifying how it might apply as a failure mechanism.	Will provide clarification

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		a causative failure mechanism, except possibly in the case of a cascading failure sequence, which is discussed in the next section.		
Sec. 3 / p. 23	General comment: There needs to be a clearer distinction between "inconsequential" dams, which are removed from consideration in the analysis, and "noncritical" dams, which are "screened out" (Figures 10-13) but whose postulated failure effects are carried forward in the analysis. The terminology used in the ISG seems to be inconsistent; e.g., the 1st sentence of Section 3 states "This section discusses screening criteria used to identify those dams that may be screened out and not given further consideration in the analysis." The term "screened out" as applied in this sentence and in Figures 10-13 clearly means something different.	Clarity of important subject.	According to the ISG, inconsequential and noncritical dams are not treated the same. Inconsequential dams are removed from consideration and no effects of their postulated failures are included in the final dam failure analysis. However, the cumulative, conservative effects of postulated failures of non-critical dams are carried forward in the analysis (e.g., last sentence of Item 1.d, p. 24). Further clarification on this topic near the beginning of the section would be helpful. Fig. 1 from Section 1 could be reproduced here, or at least referred to. The ISG needs to use precise terminology; the text should be revised to apply the terms "screened" and "screened out" consistently. A suggested change would be to use the term "removed" only for inconsequential dams and the term "screened out" only for noncritical dams. Also, a discussion of how the effects of noncritical dams are to be carried forward and used in the final analysis is needed.	Will review this section and tighten up wording. Note: Look at providing additional guidance on how to add in cumulative effects.
Sec. 3.1 / p. 23	1st paragraph, 2nd sentence: "The USACE states that is that there is…"	Typographical/editing error, "is that" should be deleted.	Suggest change to: "The USACE states that there is…"	Typo fixed. Changed to "The USACE states that there is…"
3.2 , p 23	Simplified Modeling Approaches: "…basis for simplified screening of upstream dams."	It appears the discussion is regarding simplified modeling, not screening in this instance.	"…basis for simplified modeling of upstream dams."	OK. Will adopt proposed change.
Sec 3.1 / p 22	Dams identified by federal or state agencies as having minimal or no adverse failure consequences beyond the owner's property may be removed from consideration. **Dams**	What is the basis of using ownership as a criteria to not being able to remove the dams from consideration	Remove statement in bold	

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	owned by licensees may not be removed.			
Sec. 3.2 / p. 24	Item 1.b: "…from available hydraulic models of the watershed…"	Hydrologic (not hydraulic) models are generally associated with watersheds. The presumed intent was to refer to an available hydraulic model of the floodplain. Comment also applies to Item 2.c, p. 24.	Suggest change to: "from available hydraulic models of the floodplain…"	OK. Will re-word this.
Sec. 3.2 / p. 24	Item 1.b, general question: Rather than using a stage-discharge function, would it be acceptable to use an established 500-year WSEL at the site, such as from a FEMA FIS, USACE flood study, or other appropriate source?	It might be more precise to use an established 500-year WSEL from an existing, credible study than estimating the stage from a rating curve. Comment also applies to Item 2.c, p. 24.	Suggest adding text to allow use of an established 500-year WSEL at the site from an existing, credible flood study.	OK to leverage existing current and credible information.
Sec. 3.2 / p. 24	Item 1.d, general question: The goal of this step seems to be "to segregate potentially critical dams from dams with negligible cumulative effect of failure at the site. However, the last sentence states, "The cumulative effect of the 'noncritical' dams will be carried forward and eventually added to refined estimates for the critical dams." If the cumulative effect of failure of noncritical dams is negligible, why should it be carried forward and added to the effects of the critical dams?	The problem seems to be with the word "negligible." Comment also applies to Item 2.e, p. 24.	Suggest revising to replace the word "negligible."	OK. Will replaced negligible with more suitable term.
Sec. 3.2, / p. 24	Item 2.a, 2nd sentence: "Due to the potentially large numbers of at this stage of the analysis…"	It appears there is a word missing between "of" and "at"	Provide missing word to clarify the intent of the sentence.	Typo fixed. Dams is the missing word.
Sec. 3.2 / p. 25	Item 4, 1st paragraph: "unit hydrographs, design storms, , antecedent conditions…	It is unclear how design storms would apply to this screening method. Also, there is an extra comma in the sentence.	Suggest deleting reference to design storms, or clarifying how the use of design storms would apply to this screening method. Also delete the extra comma.	OK. Will remove reference to design storm.
Sec 3.2.1 / p. 28	Topographic information from LiDAR or a DEM at the location of the hypothetical dam is used to develop a stage-storage function	This approach appears arbitrary and may not be representative as intended	Revise to use the total volume of all dams being clustered into the hypothetical dam and assume a simplified staged/stored	

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	for the hypothetical dam. This stage storage function is used to determine the water surface elevation of the hypothetical dam.		relationship	
Chapter 4		Flood hazard analysis in general and Probabilistic Flood Hazard Analysis in particular are not covered to the same degree that PSHA is covered.		True. We don't have specific guidance on PFHA at this time.
4.1.1, p. 31	4.1.1 Concrete Dams	Failure conditions and modes are discussed in this section but there is no discussion on how much of the dam must be assumed to fail. Partial failure should be discussed	Include discussion of partial failure that recognizes that sections of the dam may fail without the loss of the entire dam. An engineering analysis would be required to justify the assumed failure based on the dam design and specific "weakness" leading to the assumed failure.	Discussed in Section 7.1 on Breach Modeling
4.1.1, p 30	Staff Positions	The staff is silent on acceptable methods to evaluate potential failure modes, design, and existing configuration such as taking credit for existing analysis for the dam.	Either add a bullet here in section 1.3.2 that discusses acceptable use of existing analysis to support dam failure analysis. This may be implied but it is not stated in the ISG	
Sec. 4.1.3 / p. 32	Staff Position bullet: "…should include consider the potential for loss…	Typographical/editing error, "should include consider"	Suggest change to "…should consider the potential for loss…" or "should include consideration of the potential for loss…"	Type fixed. Changed to ".. should consider.."
4.1.3, p. 32	"Analysis of hydrologic failure modes should include consider the potential for loss or degraded function of spillways, gates, outlet works and other appurtenances."	The statement could be read that the analysis must assume that the appurtenances fail.	Modify wording to state: "Analysis of hydrologic failure modes should include consideration of the potential for loss or degraded function of spillways, gates, outlet works and other appurtenances. If failure is not assumed, provide an engineering justification."	OK with proposed wording.
Sec. 4.1.3 / p. 32	General question: If an owner/operator of dams upstream of a NPP is not agreeable to providing information that would allow the licensee to evaluate of the operability and continued functionality of spillway gates and other appurtenances during an extreme flood, is it necessary to assume failure of	Information may not be available to the licensee to evaluate the continued functionality of spillway gates and other appurtenances during an extreme flood.	Clarify if the licensee may justify the operability of spillway gates and other appurtenances in the absence of information from the dam owner/operator, or if it is necessary to assume failure of these appurtenances.	Lack of information is not sufficient justification to assume non-failure. As discussed in section 1.5, NRC will, to the extent practical, interface with dam owners/operators/regulators to obtain information needed for analysis.

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	these appurtenances?			
Sec. 4.1.4 / p. 32	1st paragraph, 2nd sentence: "…rocks or concrete to minimize prevent erosion and failure."	Typographical/editing error. The presumed intent was "minimize."	Suggest change to "…rocks or concrete to minimize erosion and failure."	Typo fixed. Changed to "…minimize erosion and prevent failure."
4.2 , p 33	General Comment: Recognizing that there is a section devoted to Multiple Dam Failure due to Single Storm Scenario, the guidance appears to apply primarily to single dam failures. It does not seem to be fully developed to address cascading failures or failure of multiple dams on adjacent tributaries (either from seismic or precipitation event).	Extrapolation of the current guidance to cascading failures or failure of multiple dams on adjacent tributaries is excessively conservative in most cases.	Revise guidance to include cascading failures or failure of multiple dams on adjacent tributaries.	Refer to section 4.2.8 on multiple dam failures.
4.2.1.p. 33	"Embankment dams should be evaluated for potential failures due to internal pressures from a hydrologic inflow event (flood). Potential failure modes that should be evaluated include deterioration or plugging of drains and internal erosion mechanisms."	Since drains and internal erosion are not visible, an acceptable method to evaluate for potential failures should be offered here.	Evaluation would include reviewing the dam design to assure that appropriate filters, drains, and monitoring points are included. Seepage monitoring, piezometers, observation wells and visual observations of the seepage points over the life of the dam does not indicated deterioration of the dam.	OK, with proposed wording. Add requirement that there be no unremeditated deficiencies
4.2.2, p 34	Staff Position-First Bullet/First Sub-bullet: It was expected that the ISG would address the depth and duration of embankment overtopping in greater detail.	The decision not to fail should be based on the severity (depth and duration) of overtopping, characteristic of failure (overtopping from precipitation or cascading dam failures), in addition to the physical properties of the embankment.	Revise discussion to address depth and duration of overtopping.	Requires dam-specific engineering analysis.
4.2.2, p 34	Staff Position-Second Bullet: "The potential for overtopping due to nonfunctioning gates, outlets and other appurtenances should be considered."	This statement could be read that the failure of the appurtenances must be assumed versus being evaluated to determine if the failures should be assumed.	Modify the wording to state, "The potential for overtopping due to nonfunctioning gates, outlets and other appurtenances should be evaluated to determine the appropriate failure assumptions with appropriate engineering justification."	OK. See page 35.
Sec. 4.2.2.1 / p. 33	"Dams unable to pass their individual PMF should be considered for failure."	"Individual PMF" needs to be defined.	Add "individual PMF" to the definition section and define as PMF based on specific PMP for the dam location and does not include combined effects such as	

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			antecedent rain.	
Sec. 4.2.2.1 / p. 33	"Consideration should be given to the potential for reductions in reservoir capacity over the life of nuclear power plant."	It is not clear what the concern is with sedimentation in the reservoir and what must be evaluated. If the sedimentation is below normal full pool, it would not have any impact on the available storage for the PMF	Delete or be more specific on the potential impacts of sediment in the reservoir	
Sec. 4.2.2.1 / p. 34	Staff Position bullet: "The default starting water surface elevation used in flood routings for evaluation of overtopping is the higher of the maximum observed or the maximum normal pool elevation."	• The requirement of using the maximum observed reservoir elevation may be too conservative if the maximum observed reservoir elevation is the result of a large (e.g. 10^{-3}) flood event. Conceptually, this requirement implies the PMF event would occur immediately after a large antecedent flood event, effectively resulting in a "super PMF" and violating the definition of the PMF. A significant flood event may also be required to reach the maximum normal pool, depending on the amount of flood control storage in the reservoir. Comment also applies to Section 4.2.8, Staff Position, 1st bullet. • Since the maximum observed water level is likely the result of an extreme precipitation event, using maximum observed water level as a starting point is equivalent to assuming two concurrent floods. • "the maximum observed pool elevation" may be a very extreme	• For the hydrologic dam failure evaluation, suggest changing default starting reservoir water surface elevation requirement to maximum normal pool or other elevation with appropriate justification. Flood inflow hydrographs normally start from some base flow. The reservoir pool would be at normal levels at the beginning of such an event. An average pool level for the month in which the flood is anticipated to occur could be used. For example, for a plains snowmelt flood in the central US, an average pool for the month of March or April could be used. • . The default starting water surface elevation used in flood routings for evaluation of overtopping or sunny day failure is the maximum normal pool elevation. Other starting water surface elevations may be used with appropriate justification.	Max normal pool elevation is OK. Will consider other levels with sufficient justification. NRC will consider additional wording to clarify the level of justification needed for other levels.

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		event, which if considered in conjunction with runoff from a PMP could result in an unreasonable predicted maximum pool elevation. • The "highest observed" starting water surface referenced here would likely be from an extreme event, to which the analyst would be adding another hypothetical extreme even • Use of the maximum observed or full pool reservoir elevations is overly conservative in combination with an antecedent storm. Antecedent storms surcharge reservoirs and in combination with the maximum observed full pool (which may have resulted from an event close to the antecedent) or full pool is extremely conservative.		
Sec. 4.2.2.2 / p. 35	Staff Position bullet: "Reservoir surcharge capacity can be credited in used in flood routings…"	Typographical/editing error, "credited in used in"	Suggest change to "Reservoir surcharge capacity can be credited in flood routings…"	Typo fixed. Changed to "Reservoir surcharge capacity can be credited in flood routings…"
Sec 4.2.2.3 / p. 35.	Staff Position, 2nd bullet: "…at least one turbine should always be assumed to be down (e.g., for maintenance or other reasons) in performing flood routings."	• Dam operators typically perform their maintenance activities outside of the flood season. Assumption that one unit is out of service is excessive. • Overly conservative assumption	• Assume all units are usable, use full power plant discharge capacity. • In large river systems with multiple generating dams does each generating dam have to consider one turbine out of service?.	**Scheduled** maintenance occurs outside flood season. "one turbine" rule from USBR training manual Need to think about the multiple dam questions. Capacity factor info available??
4.2.2.3	"The potential for flood-borne debris to reduce spillway capacity should be	There is no industry standard on how to address debris. Additional		Staff discussion needed

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	considered."	guidance should be provided on how to address flood-borne debris blockage.		
Sec. 4.2.2.3 / p. 35	3rd sentence under Potential for Reservoir Debris to Block Spillway: "As a rule of thumb, spillway bays with a clear distance less than 40 feet (less than 60 feet in the Pacific Northwest) are vulnerable to debris plugging."	• The criteria for considering potential debris blockage at a spillway are not clear. If a spillway is gated with 40-foot wide gates, are there criteria for how much blockage should be considered or how the spillway capacity may be reduced by flood-borne debris? • "This statement needs a reference." Could not find the source	• If debris blockage is considered as a potential vulnerability of a spillway, clarify criteria regarding spillway capacity reduction.	Will provide reference. Staff discussion needed on capacity reduction.
Sec. 4.2.2.4 / p. 36	Staff Position bullet: "[NEED position regarding winds]"	It is recognized that this text was added as a placeholder.	Suggest adopting the criteria from ANS 2.8 Section 5.5.4.2.3, p. 12, which specifies the following event combination of wind and PMF: "Probable maximum flood surcharge level plus maximum (1%) wave height resulting from the sustained 2-yr wind speed applied in the critical direction." Although this combination is specified in the context of investigating the potential for overtopping of earth and rockfill embankments, it would also seem applicable in the generic sense for PMF evaluation of any type of dam.	Addressed. Used 2-yr wind. Section is not specific to dam type.
4.2.3, p 36	"Static stability of the dam and key appurtenances under hydrologic loads associated with the dam's PMF should be demonstrated. Otherwise the dam should be assumed to fail."	Failure of an appurtenance does not automatically result in a subsequent dam failure. What needs to be demonstrated to show stability, a new structural analysis or qualitative judgment?	Modify the wording to state: "Static stability of the dam and key appurtenances under hydrologic loads associated with the dam's PMF should be demonstrated. Otherwise the appurtenance should be assumed to fail and the impact on the dam determined." Clarify what is needed to demonstrate stability.	If dam cannot withstand load, fail the dam. If appurtenance cannot withstand load, fail the appurtenance and estimate impact of its failure on stability of the dam. If dam stability not impacted, still must consider downstream impact of uncontrolled release (if any) associated with appurtenance failure.
Sec 4.2.2.4 /	"However, at least one turbine should always	The Staff Position does not offer	Expand staff position to recognize alternate	

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p 35	be assumed to be down (e.g. for maintenance or other reasons) in performing flood routings."	alternatives such using capacity factors and historical data to justify availability.	methods to justify availability	
Sec. 4.2.5 / p. 37	1st paragraph: "Both concrete-line spillways and unlined and grass-lined earthen spillways are subject to process that may lead to failure…"	Typographical/editing errors, "concrete-line spillways" and "are subject to process"	Suggest change to: "Both concrete-lined spillways and unlined and grass-lined earthen spillways are subject to processes that may lead to failure…"	Typo fixed. Changed to "Concrete-lined spillways, as well as unlined or grass-lined earthen spillways, are subject to process that may lead to failure during high flows associated with flooding."
4.2.6, p 38	Staff Position: As written, the guidance is ambiguous as to the evaluation(s) that should be conducted for gate failure. Further, it does not address gate failure for multiple upstream dams.	There are infinite permutations for failure of gates given the information provided.	Clarify the guidance for gate failure.	Staff discussion needed.
4.2.6 / p38	"Dams should be evaluated for potential failure due to spillway failure."	Staff position could be read that failure must be assumed	Reword Spillway statement similar to staff position statement for Gates: "The evaluation should consider the potential for spillway failure under flooding conditions to lead to an uncontrolled release of the reservoir."	
4.2.6/ p38	"There is also the potential for actual gate operations to differ from planned operations (e.g., inability of an operator to access gate controls or an operator decision to delay opening the gates due to downstream flooding concerns)."	Not sure how the analyst would evaluate the human factors that would apply to reluctance to follow policy to open the gate when told to do so.	Add statement: Justification for ability to operate the gates can be provided by documenting that procedures are in place and training provided personnel performing gate operation..	
4.2.6 /p39	With regard to fuse plugs, one should considershow that routing"	Staff Position statement is incomplete		
4.2.7.1, p 38	Staff Position: The potential for basin to generate mud/debris flows should be considered.	What is the significance and concern with mud/debris as it relates to dam failure analysis or impact to the reservoir? Are basin specific studies being recommended or required?	The purpose analyzing mud/debris needs to be described including the hazard/risk associated with mud flows.	Considering removing this section. Still in the document. Not sure when to apply and what the hazard of concern is.
4.2.7.2 / p 39	Equations and symbols missing	Section 10 is also missing	Update with missing info	

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		equations and symbols.		
4.2.7.2, p 39	Staff Position: Impact loads on structures due to waterborne debris should be considered. In general, methods outlines in the FEMA Coastal Construction Manual and average size/weight for objects specified in ASCE Standards are acceptable.	What structures need to be evaluated for impact loads for the HRR versus the IA? Does this apply only to the dams and appurtenances? If this analysis is intended for the NPP site, discrete velocities will be required at each structure being evaluated. The debris sources along with the size and depth of the flood will determine the volume	Clarify position on the conditions being used to generate the debris (PMF or dam failure, etc) and where impact loads must be evaluated. If IA assumes all flooded SSC's are lost, would debris dynamic load analysis would not be required, or is it only intended to determine if flood retaining structures survive the debris impacts?	Debris impact on dam is the concern here. Gates and associated mechanical equipment, appurtenances, parapets, etc.. Debris loading at the site due to the dam break flood wave should also be considered.
4.2.7.2, p 40	"In the case of dam break flood waves, debris impacts to SSCs important to safety should be considered."	Staff position could be read to evaluate the effect of the impacts	Reword: "In the case of dam break flood waves, determine debris impact loading <u>on</u> SSCs important to safety for use in the Integrated Assessment."	
4.2.8, p 40	Staff position: "Flood waves from multiple dam failures should be assumed to reach the NPP site simultaneously unless appropriate justification for differing flood arrival times is provided."	Clarify that the failures need not be forced to cause the flood waves to reach the site at the same time. This approach was meant for the high level evaluation. The models would work out the timing of the flood waves reaching the site.	Clarify that the failures need not be forced to cause the flood waves to reach the site at the same time. Hydrologic failure would be triggered based on peak water level, so the time of failure would be different.	Not meant to force flood waves to reach site at same time. The point is that differences in timing need to be supported with appropriate justification, not just assumed. Should not have to disprove simultaneous arrival times. Restate: Flood waves from multiple dam failures should be assumed to reach the NPP site at times determined by routing analysis. If different arrival times cannot be distinguished from the analysis, simultaneous arrival should be assumed.
5, p 42 to 61	The seismic chapter contains a number of acronyms and not all of them are defined (e.g., UHRS, GMPE, etc.)		Check acronyms to ensure all are explained	Will check
Sec 5 and fig 15, p 49	The document does not identify a starting water level or coincident rainfall if seismic failure is just assumed			
Sec. 5.1.1.1 /	Staff Position bullet: "… USGS maps… can	It is not clear what is meant by "very	Suggested change: "USGS maps can be	Plan is to remove this statement.

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p. 43	be used directly for very high-level screening level analysis…"	high-level screening level analysis."	used directly to screen out dams where site-specific seismic analysis is not required."	Rational: At his point in the analysis, dams under consideration are "potentially critical". UHRS should be used. Can be developed w/ existing tools with minimal effort.
Sec. 5.1.1.1 / p. 43 And Sec 5.3.1 / p. 49	Staff Position bullet, Sec. 5.1.1.1, p. 43: "… USGS maps… can be used directly for very high-level screening level analysis…" Staff Position, 1st sub-bullet, Sec. 5.3.1, p. 49: "The data and software tools available from USGS … are suitable for developing bedrock hazard curves and uniform hazard spectra at 10^{-4} annual frequency …"	For major rivers with multiple dams (e.g., Missouri River has 6 major dams), the CEUS SSC PSHA calculations and field geotechnical investigations for site response analyses will require an extremely large effort (cost and schedule) for a Utility to implement. Thus, the published USGS 2008 rock PGA for 2% chance of exceedance every 50-year ($4x10^{-4}$ /year probability of occurrence) should be acceptable to screen out dam failures in lieu of a site specific PSHA and GMRS (approximately $4x10^{-4}$ /year probability of occurrence) evaluations for low seismic regions of CEUS (2% exceedance every 50-year rock PGA <0.05g).	Suggested change: "USGS (2008) rock PGA maps for 2% exceedance every 50 year can be used directly to screen out seismic induced dam failures for CEUS regions with rock PGA of <0.05g."	Site-specific amplification functions not needed. EPRI generic site amplification OK.
5.2.3, p 47	"Gates *and may* fail…"	Typo	"Gates *may* fail…"	Type fixed. Changed to "Gates may fail…"
5.2.4, p 47	Staff position for levee failure during a seismic event – • assumption of starting water level is not indicated. • Also, failure should not have to be assumed if adequate justification of non-failure can be provided.		• Starting water level should be consistent with that assumed for a seismic dam failure evaluation • Change sentence to allow for adequate justification of non-failure in addition to specific performance criteria	Provisional answer – 100 yr flood or design level Seismic failure of levee only needs to be considered if levee failure could inundate site. Need to review for applicability…
Sec. 5.5, 5.6, and 5.7	General comment on NRC's approach for addressing dam failure hazards in the ISG.	The ISG appears to "resolve" the flooding due to dam failure primarily though a permutation of analyses by the plant owner either to show	For major dams where federal agencies (e.g., USACE) have the responsibility for dam design, dam safety, and controlling spillway flow for flood control, the ISG	

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		dam will not fail in its current state or through measures to cope with the resulting flood. It fails to recognize that it is preferable, less disruptive, and less expensive to avert catastrophic dam failures through proper inspections, maintenance, and spillway flow control practices rather than to cope with the consequences of dam failures. The NRC approach to cope with consequences of hazards form natural phenomenon (seismic, snow melt, rainfall, hurricanes, etc.) is justified. However, for man-made hazards (dam failures, spillway gate failures, etc.) that can be greatly mitigated through good design and maintenance practices, the NRC approach should rely on prevention over measures to cope with the consequences to enhance public good and plant safety downstream.	should state that the NRC will, through inter agency agreement, determine the 10^{-6} probability "coping" flood levels for the downstream plants considering the critical parameters including dam design parameters, current condition of the dam, dam maintenance practices, seismic hazards at the dam site, spillway flow control practices, and river hydrographs because the downstream plant utility is not in a position to determine, or in future control, these critical parameters that greatly influence dam failure probabilities and dam failure flood wave levels at the plant site. The NRC specified 10^{-6} /year flood level at the plant site shall consider the joint probabilities of combined events (dam break with river flood, dam break with intense precipitation, etc.) that account for the limited duration of the maximum flood levels for these events.	
5.5 / pg. 52	Third paragraph: sources contributing to ground motion	The information in this paragraph is unclear. Need to revise to clarify wording.		Will clarify. Considering adding a figure.
Sec .5.6 / p. 53	Staff Position, 1st bullet: "Dam failure due to an earthquake should be considered for both maximum normal operating ("full pool") and average reservoir levels."	• The "maximum full pool level" generally corresponds to a 10%/year frequency. Thus, the joint event failure probability considering the maximum normal operating full pool level is conservative by an order of magnitude. • Head water/tail water relationship prescribed is not possible for multiple reservoirs being	• Suggested change: "Dam analysis to show sufficient margin for 10^{-4} ground motions should consider median (or average) reservoir levels. Maximum operating full pool level (10 percentile) should be considered with 10^{-3} ground motions." • Revise guidance for the head water/tail water relationship as applied to cascading dam failures.	SRP requires "full pool" Use 10-4 ground motions 2nd Comment OK for flood routing, but should not take credit for tail water in stability calculation. Structural calculations should not benefit from high water levels

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		simulated in a continuous hydraulic model for cascading dam failures.		
Sec 5.6, p 56	First bullet: • maximum normal operating level is not equal to "full pool" • standard practice does not combine non-flood tailwater with maximum normal operating level Also this information is in the wrong place in the document, it should be under the Detailed Analysis		• Delete the parenthetical term : "full pool" • Use standard tailwater assumptions (40% reduction, FERC)	
Sec. 5.6 / p. 53	"Given the hazard frequency target of $1x10^{-6}$ discussed in Section 1.4.2, the dam failure flood wave at the site should be combined with flows of a frequency that result in a combined annual probability of $1x10^{-6}$. For example, if the dam fails under a 10^{-4} ground motion, combine the dam break flood wave with a 100-year flood. If the dam fails under a 10^{-3} ground motion, combine the dam break flood wave it with a 1000-year flood."	• In the example, the combined event probability does not reasonably account for the fact that the 1000-year flood is a seasonal event and the maximum flood water level at the plant site for the 1000-year river flood is present for a limited part of the year only. The earthquake ground motion (and the resulting flood wave) and the 1000-year flood are independent events. Thus, the joint probability of occurrence of the combine event should consider the limited duration of the maximum flood level for a 1000-year flood. • The combining of an earthquake and a flood simply multiplying their annual probabilities of occurrence does not allow for the very small duration within a year for the earthquake to coincide with a longer but still only a fairly small fraction of a year for the	• Suggested change: "For example, if the dam fails under a 10^{-4} ground motion, combine the dam break flood wave with a 10-year flood. If the dam fails under a 10^{-3} ground motion, combine the dam break flood wave with a 100-year flood. This example assumes that the high flood level at the plant site for the 10-year and 100-year floods will last approximately 1-month (10% of one year) or less before receding." • See methodology in: Event Combination Analysis for Design and Rehabilitation of U.S. Army Corps of Engineers Navigation Structures by Bruce R. Ellingwood, Contract Report ITL-95-2, July 1995, US Army Corps of Engineers, Waterways Experiment Station	Open to considering 1st option. Will review USACE report. Note: Need to consider situation where failure is just assumed. The document still does not consider the probability of the events occurring simultaneously. This approach seems to nt be consistent with the direction in the 50.54 (f) letter and NUREG 7046. "Using guidance applicable to new plants" should result in the ANS 2.8 event combinations.

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		duration of most floods. • This paragraph is change from previously expressed NRC positions as discuss in public meetings • What combination should be applied if seismic failure is just assumed?	• Use event combinations as previously described in public meetings: 1. seismic hazard frequency target of $1x10^{-4}$ with 25 year flood, 2. 0.5 x seismic hazard frequency target of $1x10^{-4}$ with 500 year flood.	
5.8.2.1	"If the results of post-earthquake sliding stability analyses for critical failure surfaces indicate a safely factor well above 1.0 (e.g. 1.25 or greater)..."		Use governing/applicable dam safety criteria factors of safety as criteria for sufficient margin against sliding stability	Quoted factor of safety is from federal guidance document (FEMA). Will provide reference.
Sec. 6 / p. 62	6th bullet in list: "Erosion or cavitation in waterways and channels, including spillways." 8th bullet in list: "Failure of spillway gates or valves to operation during flood (e.g., mechanical or electrical breakdown or clogging with debris)"	Both of these mechanisms seem related to hydrologic dam failure rather than sunny day, and are specifically discussed in the context of hydrologic dam failure in Section 4 of the ISG.	Suggest deleting these two bullets from the list.	OK
Sec. 6.1.1 / p. 63	4th paragraph, 4th sentence: "For concrete buttress dams founded on alluvial soils, are subject to failure…"	Typographical/editing error, "For concrete buttress dams…"	Suggest change to: "Concrete buttress dams founded on alluvial soils are subject to failure…"	Typo fixed. Changed to "Concrete buttress dams founded on alluvial soils are subject to failure…"
Sec. 6.1.3 / p. 64	General comment: It is unclear whether the sunny day failure mechanism is applicable to levees, since levees are normally subject to water loading only during flooding events.	It is recognized that levee failure should be assumed if the levee is overtopped. Levee failure at elevations less than overtopping should be investigated; however, it is debatable whether these conditions can be considered "sunny day."	Suggest consideration be given to removing levees from the sunny day failure mechanism section, and adding the information about levee failures included here to the hydrologic failure mechanism, with additional information as needed.	Will remove. Some parts may be added to section 4.
6.2, P 65	"Sunny day failure may be excluded from further consideration if it can be shown by the licensee that the probability of failure is 10^{-6} per year or less. The 10^{-6} value is chosen since there is not sufficient data to allow for	What methodology for estimating a probability of failure is 10^{-6} per year or less would be acceptable to the NRC for sunny-day failure including piping or internal erosion failures.		Updated staff position provides criteria: Sunny day failure may be excluded from further consideration if it can be shown by a dam specific engineering assessment that

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	accurate calculations of this event. Reasonable arguments justifying the case for a lower failure probability include but are not limited to a recurring dam inspection and monitoring program, expert assessments that the dam is in good condition, and detailed inspection reports."			the probability of failure is $1x10^{-6}$ per year or less using current best practices. As of this writing, the methods discussed in the USBR Dam Safety Risk Analysis Best Practices Training Manual (USBR, 2011) are considered by the staff to represent current best practice. Therefore, the staff expects these risk results to be based on a thorough engineering analysis similar in scope and rigor to the comprehensive facility review process described in USBR (2011). Note: We will be reviewing the target and its appropriateness. We will also be reviewing the potential for extrapolating out to targets of 10-6.
6.2, p. 65	First sentence, "Analysis of sunny day failure can be organized in to three *basis* steps:"	Typo	First sentence, "Analysis of sunny day failure can be organized in to three *basic* steps:"	Typo fixed. Changed to "Analysis of sunny day failure can be organized into three basic steps:"
Sec. 6.2.1 / p. 65	Staff Position bullet: "Reasonable arguments justifying the case for a lower failure probability include but are not limited to…"	It is unclear what "lower failure probability" means in this context. Does it mean lower than 10^{-6} failure probability?	Additional description of how to apply probability to the sunny day failure mechanism and possible pathways to take credit for non-failure would be helpful.	See comment above (USBR approach)
Sec. 6.2.1 / p. 65	The Staff Position states that reasonable arguments for a lower than 10^{-6} per year risk of sunny day failure can be made using the existence of recurring dam inspection, monitoring program, expert assessments that the dam is in good condition and detailed inspection reports.	Federal agency dam owners generally have all of this information at hand. Utilities would have to request this data from the Federal agency dam owners.	Propose that the NRC ask the federal agency dam owners to agree via an MOU to provide this data to certify that their dams need not be analyzed in detail for a sunny day failure.	MoA process is TBD, but there is no expectation that such certification can be obtained.

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Sec 6.2.2 / p. 66.	The Staff Position to use the maximum observed or maximum normal pool elevation for the sunny day breach analysis is excessive.	• "the maximum observed pool elevation" may be a very extreme event and not reflect sunny day conditions, which if considered in conjunction with runoff from a PMP could result in an unreasonable predicted maximum pool elevation. Such an extreme historical event may have a very low frequency and short duration relative to historical operation depending on the riverine system and the upstream watershed. • The implication of the term "sunny day" is that it occurs during non-flood conditions. Use of the maximum observed pool links it to the inflow of record for the dam.	• The default starting water surface elevation used in flood routings for evaluation of overtopping or sunny day failure is the maximum normal pool elevation. Other starting water surface elevations may be used with appropriate justification.	Default is maximum observed. Max normal pool can be used with justification. Examples of justification: Water levels above max normal pool are Infrequent, and duration is short.
Sec 7	Overall comment: Section 7 seems to depart from requirement s of NUREG CR/7046 and ANS 2.8 that would be expected for new plant evaluations as directed by the 50.54(f)	Guidance and methods to perform the evaluations listed under 7.1 are not available to consistently perform analysis.	Remove section 7 or narrow the scope of section 7 to specific areas that are called in out NUREG's for dam failure analysis. Any postulated failure from this section should be bounded by flooding levels caused by one of the other failure modes.	
Sec. 7, p. 67	General comment: Most of the introductory material in this section seems specific to embankment dams.	General organization of section.	It might be more appropriate to move the information that is specific to embankment dams to Section 7.2, since Section 7 is presumably meant to provide general introductory material for both concrete and embankment dams.	OK. Can reorganize in this way.
7, p 68	Earthen dams do not tend to fail completely, nor do they tend to fail instantaneously.	This statement applies to a non-cascading dam failure. Cascading failures can be very rapid due to high levels of overtopping over the entire crest of the dam with multiple	Discussion is needed to acknowledge the differences between a cascading dam failure and a non-cascading dam failure.	Statement as written is well supported. Can provide references. We have not seen references that discuss or examine the differences outlined here.

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		simultaneous breach points across the dam		
7., p.68	Last sentence, "Dam breach analysis of composite dams…should consider the failure portion or portions of the dam that would produce the largest peak outflow."	Largest Peak outflow in many instances would result from a total failure which, for embankments, would likely result from cascading dam failures.	Discussion should be included regarding cascading failure in the subsequent sections.	Please discuss available technical literature on cascading dam failures.
P 71	"However, their paper does not provide clear criteria for selecting the erodibility index."	Xu and Zhang (2009) do not provide detailed criteria for selecting the erodibility index because they state that they used definitions in a paper by Briaud, which provides detailed definitions.		Paper does not give any examples that would indicate how closely Briud definitions are followed.
p 71	"In addition, anecdotal evidence suggests that their relation for failure time may be biased in favor of longer times (Wahl, 2013)."	• Xu and Zhang define failure time differently than in other empirical breach parameter studies. This means that one must use their failure time estimates in a breach model (e.g. HEC-RAS) in a way that is consistent with their definition. It is not a fundamental deficiency or flaw in the method. • The difference in reported failure time is more appropriately characterized as a difference in how it is defined based on the starting and ending point. Not sure that anecdotal evidence is appropriate for an ISG document	• Remove the statement	Xu & Zhang definition of failure time is same as that used in some other studies. Not unique definition. However, their example of Teton dam does not seem to follow their own definition, so there is a question of consistency. NRC is working with ICODS to coordinate review of Xu & Zhang model.
7.2.2, p 71	Xu and Zhang – "However, their paper does not provide clear criteria for selecting the erodibility index."	Xu and Zhang do not provide detailed criteria for selecting the erodibility index because they state that they used the J. L. Briaud (2009) definitions which is the current state of practice.	Revise the statement to say "The paper references the J. L. Briaud (2009) criteria for selecting the erodibility index."	Paper provides no example to show how they implement Briuad criteria. Briaud criteria not developed specifically for dams.

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P 72	Uncertainty in Predicted Breach Parameters and Hydrographs		It is useful to recognize that "uncertainty" in regression equations is associated with "unexplained variance" and that physical arguments/engineering justifications can be made as to where in the range of "uncertainty" a particular dam would be expected to fit given its physical characteristics that are not specifically included in the "explained variance" represented by the mathematical form of the regression equation. Therefore it may not be appropriate to perform sensitivity analyses over the entire range of uncertainty on predicted breach parameters (or predicted peak breach flow rates).	Don't understand the comment. Please elaborate.
Sec. 7.2.3 / pp. 73-74	Staff Position bullet, last sentence: "Justification for the chosen mode and input parameter should be justified, including documentation of uncertainty and sensitivity studies."	Typographical/editing error, "Justification… should be justified…"	Suggest change to: "Justification for the chosen mode and input parameter should be provided, including documentation of uncertainty and sensitivity studies."	Typo fixed. Changed to "Justification for the selected model and input parameters should be provided, including documentation of uncertainty and sensitivity studies."
Sec. 9 / p. 79	"Tailwater rise has a similar effect on a riverine levee breach, but upstream river inflow (and hence catchment size) also affects the breach size and outflow by sustaining the water level in the river. **In addition,"**	Last sentence in second paragraph the first sentence in the fourth paragraph are incomplete.		
Sec. 9.1.6 / p. 78	General comment about calibration data sets.	Any available calibration data sets are likely to be for much smaller flood events than those considered in this flood hazard reevaluation, and therefore may have limited applicability.	Suggest adding discussion about the applicability of available calibration data sets to the large flood events considered in this flood hazard reevaluation.	True statement. Use large storms of record to calibrate (when available).
Sec 9.2 / p. 79	Staff Position, 1st bullet: "For inundation mapping of the NPP site, two-dimensional models should be used."	A 2-D analysis may theoretically be more accurate on the local scale but the variations seen would be minor and would be washed out in the big picture by the conservative	Suggest removing the requirement for a 2-D analysis with appropriate justification.	OK with this.

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		decisions made upstream and downstream. A 2-D analysis may benefit the accuracy of a small project or a varied landscape, but in the case of a riverside plant on flat ground, the benefits disappear.		