NRC Responses to Public Comments

Japan Lessons-Learned Project Directorate Interim Staff Guidance

JLD-ISG-2013-01: Guidance for Assessment of Flooding Hazards Due to Dam Failure

(Docket ID NRC-2013-0073)

ADAMS Accession No. ML13151A161

July 2013

I. Introduction

This document presents the U.S. Nuclear Regulatory Commission (NRC) staff's responses to comments received on the Draft interim staff guidance (ISG) document, "JLD-ISG-2013-01: Guidance for Assessment of Flooding Hazards Due to Dam Failure." The draft ISG was published in the *Federal Register* on April 25, 2013 (78 FR 24439). The public comment period closed on May 28, 2013; there were no late comments received.

Comment submissions on the draft document are available electronically at the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/adams.html. From this page, the public can gain entry into the Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents.

This comment resolution document is also available electronically at the NRC's Electronic Reading Room under ADAMS Accession No. ML13151A161.

The final ISG can be found in ADAMS at Accession No. ML13151A153.

II. Comment submissions

The NRC responded to 105 comments received in six submissions. The NRC-designated identifier for each unique comment submission, the name of the submitter, the submitter's affiliation (if any), and the ADAMS Accession No. is provided below.

Summary Table		
Name	**Affiliation**	**ADAMS Accession No.**
Karin M. Hollister	Sargent & Lundy, LLC	ML13150A154
Mark Moenssens	Westinghouse Electric Company	ML13149A007
James H. Riley	Nuclear Energy Institute	ML13193A302
J. W. Shea	Tennessee Valley Authority	ML13150A155
K. Canavan	Electric Power Research Institute	ML13157A265
Michael L. Conner	U.S. Bureau of Reclamation	ML13163A074

III. Public Comments and NRC Response

Table 1: Comments

Comment No.	Comment	NRC Response
1. *[K. Hollister]*	***Location:*** Various ***Comment:*** In the Terms and Definitions section, provide a definition for each reservoir/pool level discussed in the document. For example, Section 4.2.2.2 discusses the "maximum normal pool elevation," Section 5.6 discusses "maximum normal operating ("full-pool") and average reservoir levels," and Section 6.2.2 discusses "normal pool elevation (invert of the highest outlet or spillway)" and "top of dam/maximum high pool." Please include a definition for these levels and any others that are included in the final version of the Dam Failure ISG.	***Response:*** Maximum normal pool elevation is defined as the elevation corresponding to the top of the active storage. The average reservoir level (average pool elevation) is the 50% exceedance duration pool level calculated using average daily water levels for the period of record. "full pool", "normal pool", "maximum high pool" are no longer used in the document. ***Action:*** 1) definitions added to appropriate sections to the Terms and definitions section (under storage) 2) "full pool" is no longer used in the document
2. *[M. Moenssens]*	***Location: General*** ***Comment:*** In general, it does not appear that there is a direct off ramp or reduced path for the instance where a dam, levee, embankment, etc. is owner controlled and licensed by the NRC as a seismic category I structure. These structures were originally qualified in the safety analysis report submitted with the licensee's application and verified by the NRC safety evaluation report. A direct statement(s) should be included in the ISG to	***Response:*** For onsite water control structures such as dams, levees, impoundments, etc. (including seismic category I, but excluding tanks), failure due to hydrologic or sunny-day mechanisms are to be evaluated as part of the R2.1 Flooding Reevaluation. Methods acceptable to the staff for this purpose are described in this ISG. Seismic failure of such

Comment No.	Comment	NRC Response
	clearly state what is required for seismic category I structures. Currently, the ISG does not make any direction mention to the term seismic category I.	structures falls under the scope of the R2.1 Seismic Reevaluation. ***Action:*** Text added to Section 2.1 (scope) to clarify this position.
3. *[M. Moenssens]*	***Location:*** Page 1, Section 1 ***Comment:*** Add "of' after the word "combination" in the second paragraph	***Response:*** Cannot find this word in 2nd paragraph. Combination is used in 3rd paragraph, but is already followed by "of". **Action:** No change to text
4. *[M. Moenssens]*	***Location:*** Page 1, Section 1.1 ***Comment:*** Is not it more realistic to only utilize this ISG rather than referring back to Reg. 1.59 which is very much outdated?	***Response:*** This ISG supplements and clarifies other NRC guidance that discusses dam failure such as RG-1.59. ***Action:*** No change to text
5. *[M. Moenssens]*	***Location:*** Page 2, Section 1.1 ***Comment:*** If there are differences on a certain issue between the different guidance, which guidance should be followed? The most stringent? Moreover, if the Licensee also owns a dam, does it need to be in compliance with all regulations or only the nuclear ones?	***Response:*** In general, this ISG should be followed if there are differences in NRC guidance. However, licensees are not required to follow NRC guidance. As stated in section 1.1, this guidance should in no way supersede or be used in lieu of guidance developed by any agency that owns, operates or regulates the dam(s) of interest. The purpose of this ISG is to provide guidance in estimating the consequences of potential dam

Comment No.	Comment	NRC Response
		failures in terms of flood hazards at the NPP. ***Action:*** No change to text
6. *[M. Moenssens]*	***Location:*** Page 4, Section 1.3.2 ***Comment:*** Does NRC require a P.E engineer certification for breach analysis (but not the screening and simplified analyses)? If so, does he/she need to have the P.E from the state where the dam is located?	***Response:*** Since the flood hazard reevaluation reports are to be submitted under "Oath and Affirmation," it is expected that the technical work be performed by competent professionals. However NRC does not have explicit requirements regarding licensure. Other state or federal agencies with jurisdiction for dam safety may have such requirements. ***Action:*** No change to text
7. *[M. Moenssens]*	***Location:*** Page 4, Section 1.3.2 ***Comment:*** Second paragraph, does this ISG recommend using the current NOAA hydrometeorological reports for dam failure analysis, some of which date back to the late 1970's but are still the "current" report for a region?	***Response:*** The NOAA/NWS hydrometeorological reports (HMRs) are the most comprehensive information on extreme rainfall estimate available at this time. However, due to the age of these reports (e.g. HMR-51 was published in 1978), the licensee should exercise due diligence and examine the record of extreme storms in the region of interest to provide assurance that the HMR estimates are still valid. ***Action:*** Following text added to Section 1.3.2: Existing estimates for design storms and floods (e.g., PMP and PMF) in the region of interest developed by federal, state or other agencies may be used. However, some of these reports may be quite old

Comment No.	Comment	NRC Response
		(e.g. the NOAA/NWS Hydrometeorological Report 51 for the Eastern U.S. was published in 1978). The licensee should exercise due diligence and examine the record of extreme storms and floods in the region of interest to provide assurance that the existing estimates are still valid.
8. *[M. Moenssens]*	***Location:*** Page 4, Section 1.3.2 ***Comment:*** If flood levels do not reach the site, does the licensee still need to evaluate the transport of sediments and debris?	***Response:*** Sediment transport should be considered in the analysis. Ignoring sediment deposition may result in underestimates of water level elevations. Conversely, ignoring sediment erosion may mean that potentially dangerous scouring around structures is ignored. If flood levels do not reach the site, then waterborne debris impacts would not need to be considered at the site. However, waterborne debris impacts on an upstream dam may still be germane. Section 4.2.8 of the revised ISG provides more detail on estimating waterborne debris impacts. Detailed guidance on sediment transport modeling is beyond the scope of this ISG, but Section 9.3 of the revised guide proved references. In many cases, simplified conservative estimates for erosion and sedimentation may be used in lieu of detailed analysis. ***Action:*** Section 9.3 of has been added to the revised guide.

Comment No.	Comment	NRC Response
9. *[M. Moenssens]*	***Location:*** *Page 8, Section 1.4.2* ***Comment:*** Add "is" after "it" to read "it is acceptable"	***Response:*** Section 1.4 has been reorganized and this phrase is no longer used. ***Action:*** No change to text.
10. *[M. Moenssens]*	***Location:*** *Page 10, Section 1.5.3* ***Comment:*** On the sixth line of the first bullet, "developi" is misspelled	***Response:*** ***Action:*** Spelling corrected.
11. *[M. Moenssens]*	***Location:*** *Page 11, Section 1.6* ***Comment:*** The section states that, "Details of dam breach modeling are discussed in ISG Section 7." This should be Section 8	***Response:*** ***Action:*** Section cross reference corrected,
12. *[M. Moenssens]*	***Location:*** *Page 11, Section 1.6* ***Comment:*** The section states that, "Details of flood routing are discussed in ISG Section 9." This should be Section 10	***Response:*** ***Action:*** Section cross reference corrected
13. *[M. Moenssens]*	***Location:*** *Page 11, Section 1.6* ***Comment:*** The section describes the organization of the guidance but does not describe Section 7, "Operational Failures and Controlled Releases."	***Response:*** In the revised ISG, operational failures and controlled releases are discussed in section 4.2.7 ***Action:***

Comment No.	Comment	NRC Response
		No changes to text in section 1.6
14. *[M. Moenssens]*	***Location:*** *Page 24, Section 3.2* ***Comment:*** Do you include "all" dams (items 1.a and 2.b) or only "all" dams that are consequential (i.e., after screening)? The text contradicts what is on Figure 10.	***Response:*** The figure 10 is correct. Inconsequential dams may be excluded before implementing the screening procedures discussed. ***Action:*** Clarification added to text for screening steps 1.a and 2.b and 3.b
15. *[M. Moenssens]*	***Location:*** *Pages 33,38,81; Sections 4.2.2.1,4.2.7,10* ***Comment:*** Does NRC recommend the utilization of 2D / 3D modeling software package such as FLO-2D or Delft3D instead of HEC-RAS to account for sediment production and transport, mud flows, and debris transport?	***Response:*** The need to address mud flows has been removed from the ISG. Certain widely-used modeling software packages are mentioned in the ISG for illustrative purposes, but the NRC does not recommend specific software packages. In general, hydrologic and hydraulic simulation models accepted in standard engineering practice by Federal agencies and other authorities responsible for similar design considerations may be used. ***Action:*** Language similar to the preceding paragraph has been added to the revised ISG section 1.1 (Purpose)
16. *[M. Moenssens]*	***Location:*** *Page 37, Section 4.2.4* ***Comment:***	***Response:*** There is an extra bullet.

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	There appears to be an extra bullet at the end of the Staff position in Section 4.2.4. Is this an extra bullet or was an additional staff position statement supposed to be located here?	***Action:*** Extra bullet removed.
17. *[M. Moenssens]*	***Location:*** *Page 38, Section 4.2.7* ***Comment:*** Can the licensee utilize the RUSLE method to identify the potential for erosion in the watershed?	***Response:*** The RUSLE method was developed to estimate erosion for agricultural applications. The database used to develop the method was based on agricultural plot-scale sites with disturbed soils. In general, it would not be applicable to the large watersheds of interest in this ISG without significant modification. However, the requirement to consider mud flows has been removed from the ISG, so this comment is no longer relevant. ***Action:*** The section on mud flows has been removed.
18. *[M. Moenssens]*	***Location:*** *Page 40, Section 4.2.7.2* ***Comment:*** The first paragraph after Table 3 references the 2005 version of ASCE/SEI 7-05. There is a more recent version, ASCE/SEI 7-10.	***Response:*** Reference Updated ***Action:*** Reference to ASCE/SEI 7-05 has been replaced with ASCE/SEI 7-10.
19. *[M. Moenssens]*	***Location:*** *Page 40, Section 4.2.7.2* ***Comment:*** USACE ERDC/CRREL TR-02-2 evaluated several different methods of estimating debris loading for logs. It concluded that "all three approaches can be derived from a single-degree-of-freedom model of	***Response:*** The USACE report shows that the methods are equivalent for a certain range of velocities and under certain assumptions regarding the stiffness of the debris and structure impacted. If the NASSTRA method (work energy method) or the AASHTO

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	the collision and are equivalent." Therefore, it is recommended that the NAASTRA *(Highway Bridge Design Specification)* and AASHTO *(LRFD Bridge Design Specifications)* methods also be referenced in Staff Position bullet 3.	method (contact stiffness method) are used, the licensee should justify that the results are equivalent or more conservative than the impulse momentum approach outlined in the ASCE standard. ***Action:*** No change to text.
20. *[M. Moenssens]*	***Location:*** *Page 43, Section 5* ***Comment:*** There is a section cross reference that appears to have been lost at the end of the last sentence in the third paragraph.	***Response:*** Cross reference is to section 5.6 ***Action:*** Added cross reference to section 5.6
21. *[M. Moenssens]*	***Location:*** *Page 43, Section 5.1.1* ***Comment:*** Will NRC accept a regional PSHA study or another study from a neighboring site or is it a "must" to conduct a site-specific PSHA as part of the dam failure analysis due to seismic event?	***Response:*** A site-specific analysis should be performed. The analysis may utilize the USGS 2008 seismic hazard tools, as discussed in ISG section 5.1. For the purposes of JLD-ISG-2013-01, it is not necessary to use the tools and methods being applied in the Recommendation 2.1 seismic reevaluations for NPP sites. ***Action:*** No change to text.
22. *[M. Moenssens]*	***Location:*** *Page 46, Section 5.2.1* ***Comment:*** In the last sentence of the **3rd** paragraph, "downstream" is repeated. One of the instances should probably be upstream.	***Response:*** ***Action:***

Comment No.	Comment	NRC Response
		Repeated word deleted.
23. *[M. Moenssens]*	***Location:*** *Page 52, Section 5.4.1* ***Comment:*** In staff position bullet 1, the term "UHRS" is used, but not previously defined. Should this term be UHS, as defined in Section 5.7.1.4?	***Response:*** Should be UHS ***Action:*** Text corrected.
24. *[M. Moenssens]*	***Location:*** *Page 52, Section 5.4.1* ***Comment:*** Staff position bullet 1 states that, "...(based on the UHRS and accounting for site amplification) as described in Section 5.4.1." The reference to Section 5.4.1 should probably be changed to Section 5.7.1.4.	***Response:*** Reference is to 5.3.1 ***Action:*** Reference corrected.
25. *[M. Moenssens]*	***Location:*** *Page 52, Section 5.4.1* ***Comment:*** In staff position bullet 2, the term "UHS" is used, but not previously defined. It is defined later in Section 5.7.1.4.	***Response:*** ***Action:*** UHS is now defined in Section 5.3.1
26. *[M. Moenssens]*	***Location:*** *Page 52, Section 5.4.1* ***Comment:*** The last sentence of Staff position bullet 1 states that, **"...in** light of the UHS developed in Section 5.4.1 including effects **of..."** The reference to Section 5.4.1 should probably be changed to Section 5.7.1.4.	***Response:*** Repeat of previous comment ***Action:*** No change
27. *[M. Moenssens]*	***Location:*** *Page 67, Section 6.1.3* ***Comment:***	***Response:***

Comment No.	Comment	NRC Response
	The text of the Levee section was removed based on past comments but the section header remains. It is recommended that a statement be added under the header that Sunny Day Failure is not applicable to levees since they are not normally loaded.	***Action:*** Section header removed.
28. *[M. Moenssens]*	***Location:*** *Page 68, Section 6.2 & 6.2.2* ***Comment:*** On Page 68 there are two instances of where Section 7 is referenced. These should be references to Section 8.	***Response:*** ***Action:*** Cross reference updated.
29. *[M. Moenssens]*	***Location:*** *Page 79, Section 9* ***Comment:*** The second word of the **3rd** paragraph should be "from," not "form."	***Response:*** ***Action:*** Text corrected.
30. *[M. Moenssens]*	***Location:*** *Page 82, Section 10.1.2* ***Comment:*** With respect to the last paragraph, there is a statement about the use of **1D** flood models in flat-lying topography. The paragraph does not directly state that **1D** modeling should not be used in this case. **1D** modeling tools are a poor choice of modeling tools for this scenario. Low relief areas where distributary flow may occur should rely on 2D (at minimum) models to deal with the complexity of non-channelized flow. There is a tremendous amount of academic research on this, and it isn't clear why 1 D models are still used in these areas. The ISG should take a firm position for the applicability of **1D** versus **2D** / 3D modeling.	***Response:*** Text states that, in this case, a 2D model will better simulate flows in flat topography. ***Action:*** No change to text.

Comment No.	Comment	NRC Response
31. *[M. Moenssens]*	***Location:*** *Page 83, Section 10.2* ***Comment:*** This section ambiguously references the models used in HEC-RAS. It is recommended to state directly that HEC-RAS is appropriate when it is determined that a one-dimensional flow model is suitable.	***Response:*** The discussion in question is aimed at the efficacy of 1D vs. 2D modeling approaches and applies to any hydraulic modeling package. The NRC does not recommend specific modeling software packages. ***Action:*** No change to text.
32 *[M. Moenssens]*	***Location:*** *Page 100, ASCE (2005b)* ***Comment:*** The reference should be updated to ASCE/SEI 7-10 since this is the most up-to-date reference for the standard.	***Response:*** Reference updated. ***Action:*** Reference to ASCE/SEI 7-05 has been replaced with ASCE/SEI 7-10.
33 *[J. Riley]*	***Location:*** *General* ***Comment:*** The ISG is not clear on how off-site temporary structures can be credited for flood protection ***Concern:*** Temporary off-site structures may already be in place for some plants. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	***Response:*** On-*site or off-site temporary structures can continue to be credited in the R2.1 flood hazard reevaluation if such credit has been evaluated and accepted by NRC staff* prior to the 50.54(f) information request (USNRC 2012). All other temporary structures, or measures (including mitigation or compensatory measures), should not be credited in the flood hazard reevaluation. Temporary structures or measures not credited in the hazard reevaluation may be proposed as interim actions and discussed in

Comment No.	Comment	NRC Response
		the appropriate section(s) of the hazard reevaluation response as described in the 50.54(f) information request letter (USNRC 2012). ***Action:*** The preceding text has been added to section 4.2.2
34 *[J. Riley]*	***Location: Sec. 1 / p. 1*** ***Comment:*** "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." ***Concern:*** *List should specifically exclude tanks.* *Note that the 50.54(f) letter only asks for external flood evaluations* ***Proposed Resolution:*** Specifically include "tanks" in the list. ***Understanding of Current Status:*** *We need to develop additional guidance on the scope of the ISG as well as the flooding reevaluations in general.*	***Response:*** Tanks are excluded. ***Action:*** Tank exclusion added to Section 1.1 (Scope)
35 *[J. Riley]*	***Location:*** Sec 1.3.1, p 2 ***Comment:*** Many sites have owner-controlled levees, embankments, dams, cooling ponds, etc. above power block grade that are licensed by the NRC as Seismic Category I. These structures were evaluated as Seismic	***Response:*** This ISG is applicable to estimating flood hazards due to failure of all offsite and some onsite water control structures and impoundments. For offsite structures, hydrologic, seismic and sunny-day failure

Comment No.	Comment	NRC Response
	Category I in the licensing basis / safety analysis report and affirmed as such by the NRC in a safety evaluation report. These structures are typically controlled via operating procedures, preventative maintenances, and surveillance tests. However, the Dam Failure ISG does not discuss an alternative, shortened assessment or screening path specifically for these types of structures, nor does the ISG make any reference to the term Seismic Category I. Do Seismic Category I water retention structures qualify for an abbreviated screening process that credits their NRC approved design and operation? ***Concern:*** *The ISG is not clear on how seismic category 1 structures are to be evaluated for flooding effects. Allowing for the analysis of these structures during the Fukushima 50.54(f) letter seismic reevaluations could lead to questions on the completeness of the Integrated Assessment which may have been completed prior to the seismic reevaluation.* ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	mechanisms are within the scope of the R2.1 Flooding Hazard Reevaluation and this ISG. This ISG provides guidance that is applicable to the evaluation of onsite dams and levees, including dam- or levee-like structures associated with onsite reservoirs (e.g., earthen cooling reservoir impoundments). Thus, while Section 2.4.4 of NUREG-0800 includes failure of all onsite water control or storage structures (e.g., levees, dikes, and any engineered water storage facilities that are located above site grade and may induce flooding at the site such as tanks and basins), this ISG provides guidance applicable to only a subset of those onsite structures. For example, even though the evaluation of site flooding from structures such as concrete cooling tower basins is within the scope of the NTTF Recommendation 2.1 flood hazard reevaluations, provision of guidance to support evaluation of such structures is not within the scope of this ISG. Moreover, evaluation of flooding from tanks is not within the scope of the NTTF Recommendation 2.1 flood hazard reevaluations and associated guidance is not provided in this ISG. Seismic failure of onsite structures may require input from the R2.1 Seismic Reevaluations. Seismic failure of onsite structures falls within the scope of the R2.1 Seismic Reevaluations and is not discussed in this ISG.

Comment No.	Comment	NRC Response
		Action: Section 1.2 (Scope) has been updated to reflect the response.
36 *[J. Riley]*	***Location:*** Sec. 1.3.2 / p. 4 ***Comment:*** 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." ***Concern:*** 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? ***Proposed Resolution:*** 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. ***Understanding of Current Status:*** We understand that the details of sharing analysis results performed by other federal agencies is still being developed and that the intent of the ISG is to allow use of analyses prepared by other agencies as long as the analysis meets the guidance in the ISG.	***Response:*** The current staff position is that hydrologic failure and seismic failure can be ruled out with appropriate justification. For dams that are not screened out according to section 3 (i.e. the dam is "potentially critical"), this will require a detailed analysis. The detailed analysis can be from an existing study performed by the dam owner, if they meet the intent of the ISG. However, a sunny-day failure cannot be ruled out, even by detailed analysis, since there is no widely accepted methodology for estimating failure probabilities on the order of 1e-6 per year. A detailed analysis is generally one that takes into account specific characteristics of the watershed and the dam(s) and does so in a manner that incorporates more of the physics than the screening approaches. We do not provide a precise definition for detailed analysis since the components of a detailed analysis will vary on a case-by-case basis. Professional judgment is required. Studies by federal and state dam safety agencies, that meet the intent of the ISG, can be used to support a conclusion that hydrologic or seismic failure is not credible. However, existing (or new) studies cannot be used to "rule out" sunny-day

Comment No.	Comment	NRC Response
		failure. ***Action:*** No proposed changes to text.
37 *[J. Riley]*	***Location***: 1.3.2, p. 4 ***Comment:*** "Dam failure flood hazard estimation will require collecting data on the dam (s) to be analyzed (e.g., design documents, construction records, maintenance, and inspection program, planned modifications)" ***Concern:*** What can be done if records cannot be located? Are there any reasonable assumptions that can be made? Are there a minimum set of records needed. Note that the rigor of justification is going to be dependent on the availability of information. ***Proposed Resolution:*** If detailed historical information cannot be obtained, recent (last 5 years) inspection reports and evaluations by the dam regulator can be used to determine if there are flaws or vulnerabilities that should be evaluated for dam failure risk. ***Understanding of Current Status:*** *Not provided*	***Response:*** The screening methods described in Section 3 are intended to be performed using publicly available information (e.g. public NID fields). Detailed analyses will generally require the types of information referenced in the comment. The type and amount of information required to support a detailed analysis will vary on a case-by-case basis. In some cases conservative assumptions may be used in lieu of data. Professional judgment is needed. If sufficient information to support detailed analysis is not available, failure should be postulated and the consequences analyzed. ***Action:*** No text change.
38 *[J. Riley]*	***Location:*** 1.3.2, p. 4 ***Comment:*** "Transport of sediment and debris by flood waters should be considered."	***Response:*** Analysis methods for flood-born debris are discussed in section 4.2.8. The main concerns regarding sediment transport

Comment No.	Comment	NRC Response
	Concern: 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? The ISG leaves this evaluation up to the licensee and will probably result in large variation. Additional guidance on how to deal with debris and sediment in the dam break flood wave is needed. ***Proposed Resolution:*** 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. ***Understanding of Current Status:*** *Not provided*	include: 1) impacts to predicted water surface elevations (e.g. sediment deposition will result in higher water levels for a given discharge); 2) scour at SSC structures; and 3) sediment accumulation in UHS impoundment. However, detailed guidance on sediment transport modeling is beyond the scope this ISG. ***Action:*** Added section 9.3 which discusses general considerations for sediment transport modeling and provides references to the technical literature.
39 *[J. Riley]*	***Location:*** Sec. 1.4.2, p. 7 ***Comment:*** 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. ***Concern:*** 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	***Response:*** Due to the lack of widely accepted methods for estimating failure probabilities on the order of 1e-6 per year, this section has been revised. The revised approach for potentially critical/critical dams is as follows: (1) demonstrate that dam is capable of passing the PMF considering anticipated prevailing conditions as described section 4 of the ISG (2) demonstrate that the dam is capable of withstanding seismic load combinations as described in section 5 of the ISG

Comment No.	Comment	NRC Response
	without considering PMF? ***Proposed Resolution:*** 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 ***Understanding of Current Status:*** We understand that the 10-6 criteria will be removed.	(3) evaluate the flood height and associated effects of sunny day failure ***Action:*** This section has been revised to reflect the approach outlined above.
40 *[J. Riley]*	***Location:*** 1.4.2, p. 7 ***Comment:*** 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." ***Concern:*** • 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? ***Proposed Resolution:*** • Clarify how the two seismic criteria are to be used • Provide guidance on what amount of margin is sufficient.	***Response:*** It is recognized that the text in the draft ISG is confusing. ***Action:*** This section has been revised to eliminate reference to 1e-6 ground motion.

Comment No.	Comment	NRC Response
	Understanding of Current Status: We understand that the 10-6 criteria will be removed.	
41 *[J. Riley]*	***Location:*** *Sec 1.4.2, p. 8* ***Comment:*** 2nd bullet on p. 8, next to last sentence: "However, appropriate engineering justification must be provided to show that the dam has sufficient seismic margin." ***Concern:*** No quantitative criteria for "sufficient margin" are provided. ***Proposed Resolution:*** The 10-4 annual frequency ground motion is comparable to GMRS. Factor of safety in NRC regulatory guidance for liquefaction and slope stability for GMRS can be used to demonstrate "sufficient margin." ***Understanding of Current Status:*** We understand that the 10-6 criteria will be removed.	***Response:*** The discussion of margin is related to the 1e-6 criteria, which has been removed. ***Action:*** This section has been revised to reflect the approach outlined above (see response to comment 39).
42 *[J. Riley]*	**Location:** *Sec. 1.4.2, p.8* ***Comment:*** 2nd bullet on p. 8, last sentence: "Otherwise 10-6 ground motions should be used." ***Concern:*** The 10-6 ground motion criteria appears to be more conservative than NRC ISG-20, "PRA based Seismic Margins Analysis" where 1.67 *	***Response:*** The 1e-6 criteria has been removed. However, staff considers the current state of practice insufficient to reliably estimate failure at probabilities on the order of 1e-6. This informs the staff position to require that consequences of a sunny-day failure be analyzed. ***Action:*** This section has been revised to reflect the approach

Comment No.	Comment	NRC Response
	GMRS is used as a screening criteria. Comment also applies to Sec 5.3.1, p. 48, 1st paragraph. ***Proposed Resolution:*** "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." ***Understanding of Current Status:*** We understand that the 10-6 criteria will be removed.	outlined above.
43 *[J. Riley]*	***Location: Sec. 1.5.3, p. 10*** ***Comment:*** 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." ***Concern:*** • If information from a federal agency is considered classified, would this information be limited to the government agencies or would the licensee be involved? ***Proposed Resolution:*** 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.	***Response:*** Still working on the MOA. However, the details on the content of the MOA is not the subject of this ISG ***Action:*** No change to text.

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	Understanding of Current Status: *We understand that a Memorandum of Agreement is under development that will describe how information can be communicated and controlled.*	
45 *[J. Riley]*	***Location: Sec. 1.5.3 / p. 10*** ***Comment:*** 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 analyses are applicable, they should be used in the Recommendation 2.1 flooding reanalysis." ***Concern:*** Details of the agency's existing dam failure analyses may not be provided to the licensee or may be considered classified. If the full 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. ***Proposed Resolution:*** 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 the criteria for the Recommendation 2.1 flooding reanalysis, in the event that the details of these analyses are not provided to the licensee. ***Understanding of Current Status:*** *We understand that a Memorandum of Agreement is under development that will describe how information can be communicated*	***Response:*** Still working on the MOA, but the details of the MOA are beyond the scope of this ISG. ***Action:*** No Change to text.

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	and controlled	
46 *[J. Riley]*	***Location:*** Sec 1.5.3, p. 10 ***Comment:*** Staff Position, 1st bullet: "In the case of dams and levees owned or operated by U.S. federal agencies, the federal agency responsible (owner/operator) for the dam should be involved in any discussions, including possibly reviewing any analysis performed." ***Concern:*** It is unclear if this possible review is to occur as part of the evaluation or concurrently with NRC review. It is noted that the NRC-mandated schedule for evaluations may not permit such agencies to perform a review given their other commitments and responsibilities. This statement would appear to imply support for using previous analyses of upstream structures that have been reviewed and accepted by the federal owner/operators of such structures. FERC is a federal agency which does not own or operate dams, but directly regulates dam safety of licensed hydropower dams. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	***Response:*** The actions discussed here are envisioned as taking place during the evaluation. Use of existing studies, as applicable, is envisioned. ***Action:*** No change to text.
47 *[J. Riley]*	***Location: Sec 1.5.3, p. 10*** ***Comment:*** Staff Position, 3rd bullet: "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. The licensee should notify NRC if they encounter difficulties in obtaining	***Response:*** The licensee should notify NRC if they encounter difficulties in obtaining information ***Action:*** No change to text.

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	information. On a case-by-case basis, NRC may be able to provide some assistance in interfacing with state agencies." ***Concern:*** Based on experience, many dam owners consider dam safety-related information to be highly sensitive. Dissemination of information related to dam failure mechanisms, dam stability, and hydraulic capacity is likely to be restricted. FERC has a specific designation, "CEII," (Critical Energy Infrastructure Information) that is applied to "sensitive" information, thereby, labeled as non-public. The NRC should consider proactively reaching out to state dam safety regulatory agencies to inform them of forthcoming information requests from plant owners and to emphasize the importance of this information to support these evaluations. There can be hundreds or even thousands of dams in the watershed upstream of a nuclear facility; therefore, direct interaction with each owner would/could be cost and time prohibitive. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	
48 *[J. Riley]*	***Location: Sec. 2.2.3, p. 20*** ***Comment:*** Last bullet in list: "Inability to warn in advance…" ***Concern:*** Unlike the other bullets in the list, this bullet seems more like a consequence of failure rather than a causative failure mechanism, except possibly in the case of a cascading failure sequence, which is discussed in the next section. ***Proposed Resolution:***	***Response:*** Operational failures and controlled releases are of concern mainly in flooding scenarios. ***Action:*** Discussion of operational failures and controlled releases moved into section on hydrologic failures.

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	Suggest deleting bullet, or clarifying how it might apply as a failure mechanism. It is understood that the failure mechanism is associated with the failure of upstream dams ***Understanding of Current Status:*** *We understand that the text will be modified to indicate the concern with upstream dams and to focus on failures that my result in inability to warn in advance.*	
49 *[J. Riley]*	***Location: Sec 3.2, p. 23*** ***Comment:*** Why was 500-year flood data selected to be used for analyses rather than 100-year data? ***Concern:*** ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	***Response:*** The 500-year flood was selected to conservatively account for antecedent conditions. ***Action:*** No change text.
50 *[J. Riley]*	***Location: Sec. 3.2, p. 24*** ***Comment:*** Item 4: "Hydrologic Model Method (see Figure 13): Use an available rainfall-runoff-routing software package (e.g. HEC-HMS) to assess dam failure scenarios." ***Concern:*** Can HEC-1 be used as the hydrological model method? ***Proposed Resolution:*** *Not provided*	***Response:*** Choice of modeling package is up to licensee. The NRC does not endorse specific modeling software packages. ***Action:*** No change to text.

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	Understanding of Current Status: *Not provided*	
51 *[J. Riley]*	***Location: Sec 3.2.1, p. 28*** ***Comment:*** 2nd para. : "Topographic information from LiDAR or a DEM at the location of the hypothetical dam is used to develop a stage-storage function for the hypothetical dam. This stage storage function is used to determine the water surface elevation of the hypothetical dam." ***Concern:*** Grouping a large number of dams together would result in an unrealistically large reservoir volume. Applying actual topographic information to develop a stage-storage function for such a reservoir may result in very large water surface elevations and, thus, very large hydraulic head. The ISG should acknowledge (similar to the wording in the third paragraph) that the hypothetical dam should be representative of the collective dam heights of the individual structures it represents, while simultaneously representing an appropriately conservative scenario through the application of a hypothetical collective storage volume. In addition, selecting breach development parameters, such as breach development time, require engineering judgment in consideration of the fact that the dam in question is hypothetical and not an actual structure. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	***Response:*** The ISG states in the third paragraph that clustering of dams should make hydrologic sense. The point is that water volumes should be conserved, not heights of dams. If topographic information is not used to develop a stage-storage curve for the hypothetical dam, the stage-storage curve may be derived by summing the storage curves of the individual dams. The height of the hypothetical dam developed in this manner would be equal to the height of the tallest individual dam with a maximum storage equal to the summed storage of the individual dams. The invert elevation of the hypothetical dam would be derived from the topographic information. Breach models consistent with the screening level analysis in this section should require only basic information (height of dam and perhaps reservoir volume). More detailed breach models would not be appropriate for the screening analysis. ***Action:*** Paragraph added to describe alternative approach: As an alternative (if a DEM is not used to develop a stage-storage curve), the stage-storage curve for the hypothetical dam may be derived by summing the stage-storage curves of the individual dams. The height of the hypothetical dam developed in this

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		manner will be equal to the height of the tallest actual dam. The actual elevation of dam would be derived from the DEM. No change to text.
52 *[J. Riley]*	**Location:** *Sec 4.2.2.3, p. 34* ***Comment:*** 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." ***Concern:*** 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 ***Proposed Resolution:*** • 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?. ***Understanding of Current Status:*** We understand that the document may be revised to allow for justification of turbine availability in large river systems with multiple generating dams.	***Response:*** With regard to crediting release capacity through appurtenances other than the spillway (e.g., outlets, turbines), existing federal guidance is not consistent. For example, USACE engineering manual EM 1110-2-1603, "Hydraulic Design of Spillways" states that a powerhouse should not be considered as a reliable discharge facility when considering the safe conveyance of the spillway. Conversely, FERC Engineering Guidelines for the Evaluation of Hydropower Projects states that those release facilities which can be expected to operate reliably under the assumed flood condition can be credited for flood routing. USBR best practice guidelines (USBR 2011) suggest that at least one turbine should always be assumed to be down (e.g. for maintenance or other reasons) in performing flood routing. **Staff Positions:** • Release capacity through appurtenances other than the spillway (e.g., outlets, turbines) may be credited as part of the total available release capacity, with appropriate engineering justification that these

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		appurtenances will be available and remain operational during a flood event. Access to the site during a flood event should be considered. • The generators and transmission facilities to support the credited turbine(s) must be shown to be operational under concurrent flood and expected prevailing weather conditions if the turbines are credited as part of the total available release capacity. ***Action:*** ISG revised to include the text above,
53 *[J. Riley]*	***Location: 4.2.2.3, p. 34*** ***Comment:*** "The potential for flood-borne debris to reduce spillway capacity should be considered." ***Concern:*** 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 ***Proposed Resolution:*** If debris blockage is considered as a potential vulnerability of a spillway, clarify criteria regarding spillway capacity reduction.	***Response:*** The discussion of spillway blockage has been extended to provide additional guidance. Historical information and debris studies are proposed as the best sources of information. Guidance for spillway capacity reduction is provided for dams with debris management. ***Action:*** More detailed staff positions on spillway blockage have been added to this section: • The potential for flood-borne debris to reduce spillway capacity should be considered. Historical information on debris production in the watershed or similar watersheds should be used to assess the

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	Understanding of Current Status: We understand that this additional guidance is being developed.	potential debris volumes. • For dams that have debris management, a sensitivity study assuming a 5-10% reduction in capacity should be performed. Describe structures, equipment and procedures used to prevent spillway blockage by waterborne debris. • For dams that lack debris management greater capacity reductions should be considered. The appropriate capacity reduction will vary on a case-by-case basis. Justification for the reduction used should be provided (e.g., debris studies for the watershed or similar watersheds).
54 *[J. Riley]*	**Location:** *4.2.6, p 38* ***Comment:*** 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. ***Concern:*** There are infinite permutations for failure of gates given the information provided. The second staff position is incomplete ***Proposed Resolution:*** Clarify the guidance for gate failure. ***Understanding of Current Status:***	***Response:*** Difficult to provide detailed guidance on gate failure due to wide variety of gate types. The concern here is that reasonable allowance should be made for potential failures. If a gate failure can be handled (e.g., freeboard still adequate), good. If all gates available required to avoid overtopping (i.e., everything needs to work perfectly), then there should be some concern. Fuse plugs are generally considered to be reliable, but there is some inherent uncertainty about the exact depth and duration of overtopping needed to initiate breach. There is also uncertainty about the exact rate of breach development. Understanding the magnitude of these uncertainties is important

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	We understand that this additional guidance is being developed.	because delayed operation of the fuse plug to lead to failure of the dam. Staff position: • With regard to fuse plugs, one should show that flood routings are not sensitive to the depth and duration of overtopping needed to initiate breach so that delayed operation does not lead to failure of a main dam. ***Action:*** Text added for fuse plugs
55 *[J. Riley]*	***Location: 4.2.7.1, p 38*** ***Comment:*** Staff Position: The potential for basin to generate mud/debris flows should be considered. ***Concern:*** 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? ***Proposed Resolution:*** The purpose analyzing mud/debris needs to be described including the hazard/risk associated with mud flows. ***Understanding of Current Status:*** We understand that this section may be deleted or modified to address	***Response:*** Mud flows removed. ***Action:*** Section modified to address debris and sediment.

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	debris and sediment, not mud.	
56 *[J. Riley]*	**Location:** *4.2.7.2, p 39* ***Comment:*** 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 ***Concern:*** 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 ***Proposed Resolution:*** 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? ***Understanding of Current Status:*** We understand that the following two staff positions will be added to address this item: • Loads due to waterborne debris carried by flood waters should be considered with regard to impacts on the dam (i.e., gates and	***Response:*** Potential for waterborne debris impacts to damage embankment or key appurtenances should be considered. In the event that the dam fails, water borne debris impacts should be considered for SSCs important to safety. ***Action:*** No change to text.

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	associated mechanical equipment, appurtenances, parapets, etc.). • In the case of dam break flood waves, debris impacts to SSCs important to safety should be considered. Note that we believe that the second of the above bullets should be changed as follows to provided additional clarification: "…loads due to debris impact … should be determined."	
57 *[J. Riley]*	**Location:** *Sec 5.2.1, p. 46* ***Comment:*** 3rd para. : "This type of cracking eventually leads to isolated blocks within the dam that subsequently rotate and swing downstream or downstream, releasing the reservoir." ***Concern:*** Please reword this sentence to clarify the intent. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	***Response:*** The intent is to describe the conventional wisdom about how arch dams may fail in a seismic event. This information could be used to model a breach of the dam, if needed. ***Action:*** Text changed to: This type of cracking eventually leads to isolated blocks within the dam. The isolated blocks may subsequently rotate (swing downstream or upstream), catastrophically failing the dam and releasing the reservoir.
58 *[J. Riley]*	**Location:** *5.2.4, p 48* ***Comment:*** Staff position for levee failure during a seismic event - assumption of starting water level is not indicated ***Concern:*** ***Proposed Resolution:*** Starting water level should be consistent with that assumed for a	***Response:*** The modified approach to seismic failures states that the 500 year flood should be used when the dam fails under ½ of the 1e-4 seismic ground motion. So, when dam failure is assumed w/o any seismic analysis, the 500-year flood condition should be used. Levees are not designed to withstand significant

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	seismic dam failure evaluation ***Understanding of Current Status:*** *Not provided*	seismic loads, so the latter of the two cases in the preceding paragraph is more applicable. If the 500-year flood is in excess of the levee height, then the top of the levee is more appropriate. ***Action:*** Staff position modified to reflect the discussion above..
59 *[J. Riley]*	**Location: Sec .5.6, p.** *55* ***Comment:*** Staff Position, 1st bullet: "Dam failure due to an earthquake should be considered for both maximum normal operating ("full pool") and average reservoir levels." ***Concern:*** • 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 simulated in a continuous hydraulic model for cascading dam failures. ***Proposed Resolution:*** • 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	***Response:*** Use maximum normal pool elevation (i.e. top of active storage pool). Other starting water surface elevations may be used, with appropriate justification. Justification should be based on operating rules and operating history of the reservoir. Use hydrodynamically consistent headwater/tailwater relations for routing. But favorable headwater/tailwater relations (e.g., enhancing stability) should not be assumed in the seismic capacity analysis ***Action:*** Staff positions modified to clarify water surface elevation and headwater/tailwater positions.

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	Understanding of Current Status: *Not provided*	
60a *[J. Riley]*	**Location:** *Sec. 5.6, p. 55* ***Comment:*** "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." ***Concern:*** • 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 by 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 duration of most floods. • This paragraph is changed from previously expressed NRC positions as discuss in public meetings • What combination should be applied if seismic failure is just assumed? ***Proposed Resolution:***	***Response:*** The understanding of current status is correct. ISG will revert to modified ANS-2.8 approach in which SSE is replaced by 1e-4 seismic hazard ground motion and OBE is replaced by half of the 1e-4 ground motion. If the dam fails under the 1e-4 ground motion, it should also be checked for 1/2 of the 1e-4 ground motion. If seismic failure is just assumed, starting water surface elevations corresponding to the 500-year flood should be assumed. ***Action:*** Text modified to follow the modified ANS-2.8 approach.

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	• 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 • 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. ***Understanding of Current Status:*** We understand that the ANS 2.8 seismic and flooding event combinations (modified with 10-4 ground motion) will be used in the final version of the ISG. i.e., • 10-4 ground motion with 25 year flood (Alt 1), • ½ of 10-4 ground motion with ½-PMF or 500 year flood, whichever is less (Alt 2)	
60b *[J. Riley]*	***Location: Sec. 6.1.3 / p. 67*** ***Comment:*** 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. ***Concern:***	***Response:*** Sunny-day failure of levee is not very likely to result in flooding. ***Action:*** Sunny-day failure of levees removed from ISG

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	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." ***Proposed Resolution:*** 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. ***Understanding of Current Status:*** The guidance on levees was moved from this section but the heading for the 6.1.3 still needs to be deleted.	
61 *[J. Riley]*	**Location:** *6.2, p 68* ***Comment:*** "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 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." ***Concern:*** 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.	***Response:*** Current staff position is that sunny-day failures of critical dams should be postulated and consequences analyzed. ***Action:*** ISG modified to remove probabilistic analysis for sunny-day failures.

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	Proposed Resolution: ***Understanding of Current Status:*** We understand that a probabilistic approach to sunny day dam failure exclusion will not be included in the document. Sunny day failures will need to be considered for all critical dams assuming the dams withstand hydrologic event	
62 *[J. Riley]*	***Location: Sec. 6.2.1 / p. 68*** ***Comment:*** Staff Position bullet: "Reasonable arguments justifying the case for a lower failure probability include but are not limited to…" ***Concern:*** It is unclear what "lower failure probability" means in this context. Does it mean lower than 10-6 failure probability? ***Proposed Resolution:*** 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. ***Understanding of Current Status:*** We understand that a probabilistic approach to sunny day dam failure exclusion will not be included in the document.	***Response:*** Current staff position is that sunny-day failures of critical dams should be postulated and consequences analyzed. ***Action:*** ISG modified to remove probabilistic analysis for sunny-day failures.
63 *[J. Riley]*	**Location:** *Sec. 6.2.1 / p. 68* ***Comment:*** 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	***Response:*** Current staff position is that sunny-day failures of critical dams should be postulated and consequences analyzed.

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	recurring dam inspection, monitoring program, expert assessments that the dam is in good condition and detailed inspection reports. ***Concern:*** 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. ***Proposed Resolution:*** 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. ***Understanding of Current Status:*** *Not provided* We understand that a probabilistic approach to sunny day dam failure exclusion will not be included in the document	***Action:*** ISG modified to remove probabilistic analysis for sunny-day failures.
64 *[J. Riley]*	***Location: Sec 6.2.2 / p. 68*** ***Comment:*** The Staff Position to use the maximum observed or maximum normal pool elevation for the sunny day breach analysis is excessive. ***Concern:*** • "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-	***Response:*** In view of the uncertainties involved in estimating reservoir levels that might reasonably be expected to prevail at the time of failure, the default starting water surface elevation used in flood routings for evaluation of overtopping should be the maximum normal pool elevation (i.e. top of active storage pool). Other starting water surface elevations may be used, with appropriate justification. Justification should be based on operating rules and operating history of the reservoir. The operating history used should be of sufficient length to support any conclusions drawn (e.g., 20 years or more). But consideration should be given to possible instances where the operating

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	flood conditions. Use of the maximum observed pool links it to the inflow of record for the dam. ***Proposed Resolution:*** • 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. ***Understanding of Current Status:*** We understand that the text will be modified to read: "…the default initial water level used in breach analysis and flood routings for evaluation of sunny-day failure should be the higher of the maximum observed pool elevation or the maximum normal pool elevation. Other water levels may be used with justification (e.g., records showing that water levels above max normal poll are infrequent and of short duration)." Note that it would be useful to describe the attributes of a justification of "infrequent" and "short duration".	history and/or rules have been influenced by anomalous conditions such as drought. ***Action:*** Preceding text used as staff position.
65 *[J. Riley]*	***Location: Sec 8.1, p. 72*** ***Comment:*** 2nd paragraph: "However, by using a dam-breach flood prediction model and making several applications of the model wherein the breach width parameter representing the combined lengths of assumed failed monoliths is varied in each application, the resulting reservoir water surface elevations can be used to indicate the extent of reduction of the loading pressures on the dam. Since the loading diminishes as the breach width increases, a limiting safe loading condition which would	***Response:*** The loading conditions on the remaining monoliths after one has failed will be significantly different than before failure (e.g. the monoliths on either side of the failed section will be subject to hydrodynamic forces of the water flowing through the breach). The stability of the dam under the modified loading condition is a point to consider. ***Action:***

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	not cause further failure may be estimated." ***Concern:*** The benefit of this process is unclear. The maximum loading condition during an overtopping event would be present at time zero for all monoliths. Since failure of a single monolith is assumed to be quite short (on the order of minutes), reductions in upstream water levels are likely to not be significant enough to reduce pressures on other monoliths. Sensitivity analyses incorporating peak downstream breach flows and water surface elevations should also be considered as appropriate approaches to estimating breach width. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	No change to text.
66 *[J. Riley]*	***Location: Sec 8.2.2, p 76*** ***Comment:*** "However, their paper does not provide clear criteria for selecting the erodibility index." ***Concern:*** 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. ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** We understand that the Xu and Zhang (2009) breach methodology alone is not recommended for the 2.1 hazard re-analysis and if used, would have to be bench-marked against another approach.	***Response:*** Xu & Zhang state that their erodibility index is based on the classifications presented in the Briaud paper. However, Briaud states in his paper that the classification system is meant as a preliminary design tool and that the error in his category assignments could as much as plus or minus one classification level. In addition, Briaud does not provide information regarding the number of soil tests that provide the basis for the classification system. It appears that the classification is based on samples tested in his EFA device at TAMU (e.g results from a single device/laboratory). Regardless of the level of experimental support for the Briaud classification system, Xu & Zhang also state that their erodibility index takes into account additional

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		factors such as dam cross-sectional geometry, slope surface protection, and compaction method. However, their paper does not provide any of this additional information for the dams examined in the study or provide insight into how these additional factors were used to determine their erodibility index. Thus, there is a lack of objective criteria for assigning the Xu & Zhang erodibility index to new dams. ***Action:*** No change to text.
67 *[J. Riley]*	**Location:** *Sec 8.2.2, p 76* ***Comment:*** "In addition, anecdotal evidence suggests that their relation for failure time may be biased in favor of longer times (Wahl, 2013)." ***Concern:*** 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 ***Proposed Resolution:*** Remove the statement	***Response:*** Definition of failure time in Xu & Zhang paper is the widely used definition. But Teton Dam example given in paper indicates that authors did not consistently apply the definition. Definition of failure time must be internally consistent within the regression analysis and between the regression analysis and the hydrologic/hydraulic model. ***Action:*** Additional text added to explain issues with Xu & Zhang paper 1) Inconsistent use of failure time definition 2) Lack of basis for erodilbility. Briaud's work focus is on measurement. Inappropriate for use w/ HEC-RAS

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	Understanding of Current Status: We understand that the Xu and Zhang (2009) breach methodology alone is not recommended for the 2.1 hazard re-analysis and if used, would have to be bench-marked against another approach.	
68 *[J. Riley]*	***Location:*** Sec 8.2.2.1, p 77 ***Comment:*** Uncertainty in Predicted Breach Parameters and Hydrographs ***Concern:*** It should be not necessary to cover the extreme values if there is a sound basis for limiting the range ***Proposed Resolution:*** 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). ***Understanding of Current Status:*** *Not provided*	***Response:*** Evaluating the applicability of the proposed resolution would require in-depth examination of the case studies that were used to develop the regression equation, in order to compare these dams (or some subset of them) to the dam being modeled. This does not appear to be a tractable approach in most cases. ***Action:*** No change to text.
69 *[J. Riley]*	***Location:*** Sec 10.2, p. 84 ***Comment:*** 2nd complete sentence : "Accurate estimates of flood elevation in areas of changing topography and near large objects in the flow field will	***Response:*** Comment accepted ***Action:*** Text modified to clarify that 2D analysis needed only

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	typically require two-dimensional analysis." ***Concern:*** Suggest adding "localized" to sentence, as it is typically not necessary to perform two-dimensional analysis of the entire inundation area, which may be hundreds of miles long: "….will typically require localized two-dimensional analysis." ***Proposed Resolution:*** *Not provided* ***Understanding of Current Status:*** *Not provided*	in regions where 2D effects are important.
70 *[J.W. Shea, TVA]*	***Location:*** *1.3.2/page 5* ***Comment:*** Step 5 -The reader is told to estimate the impacts of sediment and debris transport**.** ***Concern:*** The evaluation of debris and sediment transport and impacts to fluid dynamics requires extensive, complex analysis. ***Proposed Resolution:*** Clarify whether "impacts" refers to:(1) impacts on equipment for use during the integrated assessment; or (2) impacts on the fluid flow behavior itself (changes in fluid dynamics from additional sediment and debris in the flood routing).	***Response:*** With respect to debris, impact loads due to waterborne debris are the key issue. Impact loads on the dam and key appurtenances should be evaluated. In the event of dam failure, impact loads due to waterborne debris should be considered for exposed SSCs important to safety at the NPP site. The main concerns regarding sediment transport include: 1) impacts to predicted water surface elevations (e.g. sediment deposition will result in higher water levels for a given discharge); 2) scour at SSC structures; and 3) sediment accumulation in UHS impoundment. However, detailed guidance on sediment transport modeling is beyond the scope this ISG. With respect to equipment for use in the integrated assessment, impact loads and sediment transport

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		would be included in the "associated effects" of flooding that should be included in the hazard reevaluation. The impact that these associated effects have on the effectiveness of equipment and/or procedures relied upon for mitigation would be evaluated in the integrated assessment, if one is required. ***Action:*** Added section 9.3 which discusses general considerations for sediment transport modeling and provides references to the technical literature.
71 *[J.W. Shea, TVA]*	***Location:*** *1.4.2/page 8* ***Comment:*** Last bullet -Requires seismic analysis of 1 x 10^{-4} with sufficient margin or seismic analysis to I x 10^{-6} ***Concern:*** The term 'sufficient margin" is not defined. As used, the term 'sufficient margin" seems to imply more than meeting required factor of safety. ***Proposed Resolution:*** Define "sufficient margin" to be the required factor of safety per Federal Dam Safety Regulator's guidance. This term occurs in several places throughout the document.	***Response:*** This section was modified to remove requirement to evaluate seismic hazards at the 1e-6 annual exceedance level. 1) For hydrologic failure analysis, the dam should be able to pass the PMF via the spillway and other discharge outlets. The structural loads/demands are hydrostatic and hydrodynamic loads of the reservoir level associated with the PMF as well as associated effects such as wind waves and debris loads. Headwater/tailwater levels will be governed by inflow and the spillway conveyance relationships (and possibly backwater effects). Headwater/tailwater elevations will be calculated by the hydrologic or hydraulic

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		routing model used. The combination referred to in the comment is one alternative for deriving the PMF. PMF estimates typically include assumptions regarding antecedent base flow, soil moisture and rainfall conditions. Factors of safety used in stability analysis should be consistent with accepted engineering practice and standards for the structure(s) in question. 2) For seismic failure, the load/demand are those effects (vibratory ground motion, displacement, liquefaction) associated with either the 1e-4 seismic hazard ground motion (or half of the 1e-4 hazard) For the seismic stability calculation, default headwater elevation should be max normal pool level. Other levels can be used with justification. Tailwater should be average, nonflood levels. Flooding conditions should not be assumed to increase the stability of the dam. Factors of safety used in stability analysis should be consistent with accepted engineering practice and standards for the structure(s) in question.

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		If the dam fails, the dam break flood wave should be combined with the 25 or 500 year flood (depending upon whether dam failed under the 1e-4 seismic hazard ground motion or ½ of the 1e-4 seismic hazard ground motion). When routing the flood wave, hydrologically consistent headwater/tailwater relationships, as calculated by the hydrologic or hydraulic routing model, should be used. 3) For sunny-day failure, the failure is simply assumed to occur. There is no specific load or demand. However, a breach scenario should be postulated. For sunny-day failure flood routing, the default headwater elevation should be the max normal pool level. Other levels can be used with justification. Tailwater elevations will be calculated by hydrologic or hydraulic routing. ***Action:*** Section 1.4.2 modified to reflect the approaches for hazard evaluation described above.
72 *[J.W. Shea, TVA]*	***Location:*** *3.1/page 22* ***Comment:***	***Response:*** Removal of dams based only upon damage being

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	Staff position says 'dams owned by licensees may not be removed" ***Concern:*** There are licensee-owned dams that have minimal or no adverse failure consequences beyond the owner's property. For example, there are holding ponds that are on the National Inventory of Dams that are owned by TVA. These are low hazard dams where failure under normal (non-flood) conditions would result in environmental permit compliance issues with the state and is therefore deemed as a failure consequence to the owner's property. For flood analysis, these holding ponds would not increase the flood elevations at the sites and are inconsequential. ***Proposed Resolution:*** Given the situation described in the concern field and the fact that this document is guidance, the proposed change to the statement is that the "licensee owned dams should not be removed from consideration without justification."	limited to the owner's property does not apply to licensee owned dams (or onsite water control structures). In this situation additional analysis would be needed to justify that the dam or water control structure meets the intent of the "inconsequential" category and may be removed from further consideration. ***Action:*** Section 3.1 modified to now read: Removal of dams based only upon damage being limited to the owner's property does not apply to licensee owned dams (or onsite water control structures). In this situation additional analysis would be needed to justify that the dam or water control structure meets the intent of the "inconsequential" category and may be removed from further consideration.
73 *[J.W. Shea, TVA]*	***Location:*** 4.1.3/page 31 ***Comment:*** The staff position requires engineering justification if failure of spillway gates and outlet works is not considered for hydrologic failure modes. ***Concern:*** With a complex river system with multiple dams and many hydro units (IVA has 109 hydro units), the staff position is very difficult to implement without extensive analysis, such as an extensive uncertainty analysis with Monte Carlo simulations or other such analyses. The schedule for the flood hazard reevaluation doesn't support this type of analysis.	***Response:*** The staff position is only meant to convey the general requirement for consideration of reduced conveyance capacity due to such failures. More details are provided in subsequent sections of the ISG. ***Action:*** The presumption of failure has been removed from the staff position.

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	Proposed Resolution: Recommend adding to the staff position, a third option, which would be a simplified system approach that allows probability of failure of gates and generating units to operate during flood events or application of an availability factor based on historical floods.	
74 *[J.W. Shea, TVA]*	***Location:*** 4.2/page 32, 5.2/page 45, & 6.1.1/page 66 ***Comment:*** The guidance is not clear on the establishment of loads/demands for detailed analysis. ***Concern:*** There is no separate section in the guidance for establishing the demands/loads for the detailed analysis as outlined in the flowchart in Figure 2 of Section 1.3. The demands/loads are addressed in the overtopping section of the document but only briefly. It is not clear to the reader if these loads are to include the combined effects from Appendix H of NUREG/CR-7046, e.g., Alternative 1 combination of mean monthly base flow, median soil moisture, an antecedent or subsequent rain that is the lesser of 40% PMP or 500 year rainfall, the PMP and waves induced by 2-yearwind speed applied along the critical direction. ***Proposed Resolution:*** Provide clear guidance on the establishment of the demands/loads which are to be used for the detailed analysis of the dams. This same comment also applies to seismic load/demands for detailed analysis and for sunny day loads/demands for detailed analysis. Guidance should include such specifics as the following: (1) headwater and tailwater levels to be used in stability analysis; (2) whether antecedent or subsequent rainfall must be combined with PMP; (3) whether or not	***Response:*** 1) For hydrologic failure analysis, the dam should be able to pass the PMF via the spillway and other discharge outlets. The structural loads/demands are hydrostatic and hydrodynamic loads of the reservoir level associated with the PMF as well as associated effects such as wind waves and debris loads. Headwater/tailwater levels will be governed by inflow and the spillway conveyance relationships (and possibly backwater effects). Headwater/tailwater elevations will be calculated by hydrologic or hydraulic routing. The combination referred to in the comment is one alternative for deriving the PMF. PMF estimates typically include assumptions regarding antecedent base flow, soil moisture and rainfall conditions.

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	to include 2-year wind speeds in the analysis; and (4) adequate factors of safety.	Factors of safety used in stability analysis should be consistent with accepted engineering practice and standards for the structure(s) in question. 2) For seismic failure, the load/demand are those effects (vibratory ground motion, displacement, liquefaction) associated with either the 1e-4 seismic hazard ground motion (or half of the 1e-4 hazard) For the seismic stability calculation, default headwater elevation should be max normal pool level. Other levels can be used with justification. Tailwater should be average, nonflood levels. Flooding conditions should not be assumed to increase the stability of the dam. Factors of safety used in stability analysis should be consistent with accepted engineering practice and standards for the structure(s) in question. If the dam fails, the dam break flood wave should be combined with the 25 or 500 year flood (depending upon whether dam failed under the 1e-4 seismic hazard ground motion or ½ of the 1e04 seismic hazard ground motion). When routing the flood wave, hydrologically consistent

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		headwater/tailwater relationships, as calculated by the hydrologic or hydraulic routing model, should be used. 3) For sunny-day failure, the failure is simply assumed to occur. There is no specific load or demand. However, a breach scenario should be postulated. For sunny-day failure flood routing, the default headwater elevation should be max normal pool level. Other levels can be used with justification. Tailwater elevations will be calculated by the hydrologic or hydraulic routing model used. ***Action:*** Figure 2 has been changed to clarify the relevant chapters that provide detailed information regarding the demands / loads.
75 *[J.W. Shea, TVA]*	***Location:*** 4.2.21page 33 ***Comment:*** In many cases the IDF is the probable maximum flood (PMF) developed by analyzing the impacts of the probable maximum precipitation (PMP)	***Response:*** NUREG-0800 states that dam failure should be evaluated using appropriate combination of antecedent flows as described by ANSI/ANS-2.8-1992. ANS-2.8-1992 states that each potentially

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	event over the dams upstream watershed. ***Concern:*** The guidance seems to imply that the dams be evaluated for project specific PMFs and if they are not able to pass the project specific PMFs then they should be considered to fail without consideration for other events. With a complex river system with multiple dams, the staff position is unrealistic and overly conservative. The nuclear power plant PMP which produces the PMF is over a large watershed with smaller amounts of rainfall compared to the project specific PMFs which have very high amounts of PMP over a smaller watershed. ***Proposed Resolution:*** In addition to the evaluation of the dams for the IDF, allow the large watershed PMP and associated PMF to be used to evaluate the stability of the dams when there is a large watershed with many upstream dams. This would be a further refinement in the hierarchical hazard analysis (HHA) process.	critical dam should be subjected analytically to the PMF from their own contributing watershed. ANS-2.8-1992 further states that if an upstream dam would likely fail in the probable maximum flood from its own watershed, it shall also be tested in the probable maximum flood applicable to the total plant site watershed. If judged likely to fail in either case, the resulting flood wave shall be carried downstream to the plant site for comparison and selection of the critical case. ***Action:*** Add the following text: to the section 4.2.9 Multiple Dam Failure due to Single Storm Scenario Operational rules may be considered but the starting water surface elevation at the most upstream dam under evaluation should be as specified in Section 4.2.2.1. River flows downstream of this dam should be based on the precipitation / runoff from the basin encompassing the multiple dam scenario(s) under consideration.
76 *[J.W. Shea, TVA]*	***Location:*** 4.2.2.2/page 34 ***Comment:*** Staff position talks about "maximum normal pool elevation" ***Concern:*** Maximum normal pool elevation term is not defined. ***Proposed Resolution:*** Define what °maximum normal" is, and/or provide examples for different	Maximum normal pool elevation is defined as the elevation corresponding to the top of the active storage. ***Action:*** Added a figure to Section 2.1.3 to clarify water levels and storage volume definitions. Definitions are also provided in the Terms and Definitions section (under storage)

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	kinds of reservoirs. TVA defines maximum normal as the normal summer pool.	
77 *[J.W. Shea, TVA]*	***Location:*** 4.2.2.4/page 35 ***Comment:*** Consideration of debris blockage of spillway gates. ***Concern:*** With a complex river system with multiple dams and many hydro units (TVA has 109 hydro units), the staff position is very difficult to implement without extensive analysis. The schedule for the flood hazard reevaluation doesn't support this level of analysis. ***Proposed Resolution:*** Recommend guidance provide percentage for spillway gate blockage. TVA's position that performance of sensitivity analyses on 5 percent and 10 percent spillway gate blockage is appropriate.	***Response:*** 5-10% capacity reduction is reasonable for dams with debris management. For dams that lack debris management, greater reductions may be appropriate. Capacity reductions as large as 35% have been observed. This determination needs to be made on a case-by-case basis. ***Action:*** Modified text to include description of Lake Lynn Dam debris blockage. Modified staff position to include sensitively study using 5-10% capacity reduction for dams with debris management. Dams without debris management should consider greater reductions on a case-by-case basis.
78 *[J.W. Shea, TVA]*	***Location:*** 4.2.2.4/page 35 ***Comment:*** Last bullet -At least one turbine should always be assumed to be down in performing flood routings. ***Concern:*** Dam operators typically perform their maintenance activities outside of the flood season and the assumption that one unit is out of service for every hydro dam in a large system may be overly conservative. TVA has completed the hazard reevaluation input work for the darns (the	***Response:*** Review of federal guidance on crediting discharge capacity through shows that different agencies take different approaches. Therefore, turbine flows can be credited, if engineering justification is provided. ***Action:*** Last bullet removed. Discussion of various federal guidelines on crediting turbine/powerhouse flows is added.

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	dam rating curves) assuming that all the hydro units are available until the turbine deck, switchyard or powerhouse is flooded. ***Proposed Resolution:*** Recommend guidance allow a simplified system approach that considers probability of turbine outages or application of an availability factor based on maintenance data and/or historical floods.	Discussion on use of site-specific and generic information on generating unit availability has been added.
79 *[J.W. Shea, TVA]*	***Location: 4.2.6/page 39*** ***Comment:*** Staff position –"With regard to the fuse plugs, one should consider show that routing" ***Concern:*** The sentence is incomplete and TVA is unable to understand the staff position regarding fuse plugs. ***Proposed Resolution:*** Complete the sentence.	***Response:*** Text should have read: Fuse plugs are generally considered to be reliable, but there is some inherent uncertainty about the exact depth and duration of overtopping needed to initiate breach. There is also uncertainty about the exact rate of breach development. Understanding the magnitude of these uncertainties is important because delayed operation of the fuse plug to lead to failure of the dam. Staff position should have been: • With regard to fuse plugs, one should show that flood routings are not sensitive to the depth and duration of overtopping needed to initiate breach so that delayed operation does not lead to failure of a main dam. ***Action:*** Text corrected.
80	***Location:*** 4.2.7.2/page 39	***Response:***

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[J.W. Shea, TVA]	***Comment:*** No equation provided. ***Concern:*** Editorial; no equation and variables provided. ***Proposed Resolution:*** Provide equation and define variables.	Typographic error. ***Action:*** Equation and definition of variables provided.
81 *[J.W. Shea, TVA]*	***Location:*** 5/page 43 ***Comment:*** Last paragraph, last sentence calls out a Section 0. ***Concern:*** Editorial; user is not able to determine which section was meant to be referenced. ***Proposed Resolution:*** Provide the correct section reference.	***Response:*** Reference should be to Section 5.6 ***Action:*** Cross reference provided.
82 *[J.W. Shea, TVA]*	***Location:*** 5.1/page 43 ***Comment:*** When using the HHA process and assuming a seismic darn failure without a detailed analysis of the dam, there is no flood specified to use for hydrologic routing with the assumed failure. ***Concern:*** By not specifying to the user, the document seems to imply that a detailed seismic analysis is required to be performed which is contrary to NUREGICR-7046 HHA.	***Response:*** The modified approach to seismic states that the 500 year flood (or ½ PMF, whichever is less) should be used when the dam fails under ½ of the 1e-4 seismic hazard ground motion. So, when dam failure is assumed w/o any seismic analysis, the 500-year flood condition (or ½ PMF, whichever is less) should be used. ***Action:***

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	Proposed Resolution: Provide the flood which is to be used for hydrologic routing when there is an assumed failure of the dam under seismic loading.	Text in section modified to add staff position **Staff Position:** • If seismic failure is simply assumed without analysis, the seismic failure should be assumed to occur under 500-year flood conditions (or ½ PMF, whichever is less).
83 *[J.W. Shea, TVA]*	***Location:*** 5.2.3/page 48 ***Comment:*** Seismic analysis of appurtenant structures. ***Concern:*** This section implies the spillway gate system should be seismically analyzed. It is not common practice to perform detailed seismic analysis of dam appurtenances within the dam safety industry. This is an extensive amount of work for the amount of dams within TVA's watershed and very difficult for equipment installed 60-years ago. The documentation of material and installation details will be a challenge. The schedule for the flood hazard reevaluation doesn't support this type of analysis. ***Proposed Resolution:*** Recommend staff guidance provide an option to consider some conservative percentage of failure of spillway gates, outlet works and other appurtenances instead of comprehensive detailed analysis.	***Response:*** It is common practice to perform seismic analysis of spillway gates and other key appurtenances, because their failure can lead directly to overtopping and failure of the dam. However, the HHA approach includes the use of conservative assumptions in lieu of more detailed analysis. It would be the responsibility of the licensee to justify that some percentage of failure is conservative. ***Action:*** No change to text.
84 *[J.W. Shea, TVA]*	***Location:***5.3.3/page 51 ***Comment:***	***Response:*** Proposed revised text is the same as the existing

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	Detailed investigations would include surveys and undisturbed sampling borings. ***Concern:*** This section implies the use of undisturbed sampling for direct measurements of in situ densities and dynamic properties. However in situ testing is often preferred for performing liquefaction analysis. Undisturbed sampling for laboratory testing of potentially liquefiable soil often results in mixed results. ***Proposed Resolution:*** Recommend paragraph be revised to read: "Detailed investigations would include surveys and in situ field testing to (1) refine the preliminary interpretation of the stratigraphy and the extent of potentially liquefiable soils, and (2) measure in situ densities and dynamic properties for input to dynamic response analyses. Recover undisturbed samples for laboratory testing when site soils are not adequately represented in the available data base."	text in the document. ***Action:*** Revised text to read: "Detailed investigations would include surveys, in situ field testing, and laboratory testing, as appropriate, to (1) refine the preliminary interpretation of the stratigraphy and the extent of potentially liquefiable soils, and (2) measure in situ densities and dynamic properties for input to dynamic response analyses, (3) recover undisturbed samples for laboratory testing when site soils are not adequately represented in the available data base."
85 *[J.W. Shea, TVA]*	***Location:*** 5.3.3/page 51 ***Comment:*** Section 5.3.3 and Staff Position references NRC Regulatory Guide 1.198 'Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plants" as providing guidance and detailed procedures for evaluating liquefaction. ***Concern:*** The staff position reference to RG 1.198 could imply that Appendix B requirements are applicable to the ISG users in the future. These requirements are not applicable under this scope of work.	***Response:*** The point of referencing RG-1.198 was to provide guidance with respect technical methodology. The March 2012 Request for Information does not stipulate that Appendix B requirements apply to responses to the information request. However, if the analyses submitted in response to the request for information are later used for certain licensing purposes, Appendix B requirements may apply. ***Action:*** No change to text.

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	Proposed Resolution: Recommend that the ISG clearly state that the Appendix B requirements do not apply or remove the reference to RG 1.198 and reference the engineering methods for liquefaction analysis directly.	
86 *[J.W. Shea, TVA]*	***Location:*** 5.4.1/page 52 ***Comment:*** Staff position -Sufficient seismic margin in existing studies. ***Concern:*** Sufficient seismic margin is not defined. ***Proposed Resolution:*** Define 'sufficient margin" to be the required factor of safety per Federal Dam Safety Regulator's guidance. This term occurs in several places throughout the document.	***Response:*** Sufficient margin is usually defined in terms of a safety factor. ***Action:*** Provided reference to FEMA guidelines on earthquake analysis of dams, which discusses appropriate factors of safety.
88 *[J.W. Shea, TVA]*	***Location:*** 5.5/page 54 ***Comment:*** Figure 16 - appears to have a repeat in the last bullet ***Concern:*** Editorial ***Proposed Resolution:*** Remove the repeat bullet or correct the bullet if it was meant to be a 3rd point in the figure.	***Response:*** Third bullet in Figure 16 was meant to read: “Ground motions causing failure at Dam 3 cannot be excluded from causing failure at Dam 2” ***Action:*** Text corrected in Figure 16.
89 *[J.W. Shea, TVA]*	***Location:***5.6/page 56	***Response:*** In view of the uncertainties involved in estimating

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	Comment: Staff position -Dam failure due to an earthquake should be considered for both the maximum normal operating ('full-pool") and average reservoir levels. Normal, non-flood tailwater conditions should be used. ***Concern:*** It is not clear what is meant by "maximum normal pool'. The water elevation used in earthquake load case is generally the normal operating level. The highest normal operating level is used when there are seasonal fluctuations of the reservoir. ***Proposed Resolution:*** It is recommended that the normal pool level with normal tailwater levels is used rather than maximum and average pool. The use of these levels aligns with the TVA (and other federal dam regulators) dam safety guidance for seismic stability analysis.	reservoir levels that might reasonably be expected to prevail at the time of failure, the default starting water surface elevation used in flood routings for evaluation of seismic failure consequences should be the maximum normal pool elevation (i.e. top of active storage pool). Other starting water surface elevations may be used, with appropriate justification. Justification should be based on operating rules and operating history of the reservoir. The operating history used should be of sufficient length to support any conclusions drawn. But consideration should be given to possible instances where the operating history and/or rules have been influenced by anomalous conditions such as drought. ***Action:*** Staff position reflecting the preceding discussion inserted in this section.
90 *[J.W. Shea, TVA]*	***Location:*** 5.6/page 56 ***Comment:*** Staff position -The flood and seismic combinations to provide a $1x10^{-6}$ hazard frequency target. ***Concern:*** This implies that a seismic fragility analysis is required for each dam and then flood inflows be developed to route with the failure of the dam. This requires extensive analysis for a complex river system and is more difficult to implement than the two deterministic combinations that are defined in ANS 2.8. Modified ANS 2.8 combinations have been discussed with the staff for replacement of the deterministic earthquake	***Response:*** Staff position has been modified to reflect the modified ANS-2.8 approach.. ***Action:*** Staff position has been modified to reflect the modified ANS-2.8 approach.

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	with a probabilistic earthquake. ***Proposed Resolution:*** Recommend guidance include use of the modified ANS 2.8 combinations that have previously been discussed with the staff. Those combinations are: 1) 1E-04 ground motion combined with 25 year flood and 2) 1/2 of IE-04 ground motion combined with lesser of 500 year flood or 1/2 PMF.	
91 *[J.W. Shea, TVA]*	***Location:*** 6.2.1/page 68 ***Comment:*** The ISG requires a comprehensive risk analysis to assess sunny day failure modes. ***Concern:*** Significant resources will be required to complete these analyses. All of TVA dams do not have existing Potential Failure Mode Analyses (PFMA) completed yet. The schedule for the flood hazard reevaluation doesn't support this type of analysis. ***Proposed Resolution:*** Allow use of simplified but conservative failure modes when there is a lack of an existing PFMA.	***Response:*** Staff position has changed to require analysis of sunny-day failure, so the comprehensive risk analysis to show nonfailure is no longer relevant. ***Action:*** The discussion of comprehensive risk analysis for sunny-day failure has been removed.
92 *[J.W. Shea, TVA]*	***Location***: 6.2.2/page 69 ***Comment:*** The normal pool elevation (invert of the highest outlet or spillway)	***Response:*** The staff position has been modified to be consistent with other statements about initial water levels. The default water level is maximum normal pool (top of

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	definition needs clarification. ***Concern:*** This is confusing as it could be defined as a spillway sill elevation which would be significantly lower than normal pool. ***Proposed Resolution:*** Suggest ISG document be revised to reflect a normal pool elevation where reservoir is maintained for normal operations.	active pool) or other level, with justification. ***Action:*** ***Staff position:*** In view of the uncertainties involved in estimating reservoir levels that might reasonably be expected to prevail at the time of failure, the default starting water surface elevation used in flood routings for evaluation of overtopping should be the maximum normal pool elevation (i.e. top of active storage pool). Other starting water surface elevations may be used, with appropriate justification. Justification should be based on operating rules and operating history of the reservoir. The operating history used should be of sufficient length to support any conclusions drawn (e.g., 20 years or more). But consideration should be given to possible instances where the operating history and/or rules have been influenced by anomalous conditions such as drought.
93 *[J.W. Shea, TVA]*	***Location:*** 6.2.2/page 69 ***Comment:*** Last bullet - maximum observed pool elevation and maximum normal pool elevation ***Concern:*** These terms are not defined in the document. ***Proposed Resolution:*** Suggest a definition be added to ISG document and/or provide examples.	***Response:*** Maximum normal pool elevation is defined as the top of active storage. Reference to maximum observed pool level is no longer used. ***Action:*** Staff position now reads: In view of the uncertainties involved in estimating reservoir levels that might reasonably be expected to prevail at the time of failure, the default starting water surface elevation used in flood routings for evaluation of overtopping should be the maximum

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		normal pool elevation (i.e. top of active storage pool). Other starting water surface elevations may be used, with appropriate justification. Justification should be based on operating rules and operating history of the reservoir. The operating history used should be of sufficient length to support any conclusions drawn (e.g., 20 years or more). But consideration should be given to possible instances where the operating history and/or rules have been influenced by anomalous conditions such as drought.
94 *[J.W. Shea, TVA]*	***Location:***7.1/page 70 ***Comment:*** 4th bullet – loss of generation by flooding of switchyard. ***Concern:*** In most cases the tail deck controls when generation is stopped. Switchyard is usually at a higher elevation than the tail deck (the point at which the powerhouse is flooded due to high tailwater). ***Proposed Resolution:*** Suggest incorporating the consideration of loss of the switchyard or the powerhouse due to flooding, whichever is at a lower elevation.	***Response:*** The observation is correct. ***Action:*** Modified statement to reflect loss of powerhouse, or switchyard. This discussion is now in Section 4.7.2.1.
95 *[J.W. Shea, TVA]*	***Location:*** 10.1.2 and 10.2 /pages 82-84 ***Comment:*** NRC prefers use of 2-D analysis over a 1-D analysis. ***Concern:*** Efforts to address the issues discussed in this section can have a significant impact on the time required to conduct the analyses. Effort	***Response:*** The ISG does not propose 2D analysis for the entire watershed or river system. 2D analysis is proposed for cases where it may have a significant effect on calculation of inundation water level and velocities at the NPP site. The NRC does not endorse specific modeling software. The use of a particular package

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	to develop and calibrate a 2-D model is well beyond that for a 1-D model and the current hazard reevaluation analysis schedule does not support a 2-D analysis for a large and complicated river system. ***Proposed Resolution:*** TVA intends to use a 1-D HECRAS analysis. Recommend guidance include a listing of 1-D and 2-D models for which appropriate analyses have been reviewed and approved by NRC staff.	should be justified by the licensee. ***Action:*** No change to text.
96 *[K. Canvan, EPRI]*	**Location: Section 1.4.2, from page 56** *Modeling Consequences of Seismic Dam Failure* "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 lx1 0-6. 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." ***Comment:*** The combining of an earthquake and a flood by 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 duration of most floods. ***Proposed Resolution:*** Recommend consideration of 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-	***Response:*** Section 1.4.2 has been revised to remove this approach of combining earthquake and flood. See response to comment 39 ***Action:*** See response to comment 39.

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	2, July 1995, US Army Corps of Engineers, Waterways Experiment Station.	
97 *[K. Canvan, EPRI]*	**Location:** Page 76 "However, their paper does not provide clear criteria for selecting the erodibility index." ***Comment:*** 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.	***Response:*** Same as comment 66 [J. Riley]. See response to comment 66 ***Action:*** See response to comment 66
98 *[K. Canvan, EPRI]*	**Location:** page 76 - "In addition, anecdotal evidence suggests that their relation for failure time may be biased in favor of longer times (Wahl, 2013)." ***Comment:*** 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.	***Response:*** Same as comment 67 [J. Riley]. See response to comment 67 ***Action:*** See response to comment 67
99 *[K. Canvan, EPRI]*	**Location:** pages 77 and 78 - Section 8.2.2.1, Uncertainty in Predicted Breach Parameters and Hydrographs and Section 8.2.2.2, Performing Sensitivity Analyses to Select Breach Parameters. ***Comment:*** 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	***Response:*** Same as comment 68 [J. Riley]. See response to comment 68 ***Action:*** No change to text.

Comment No.	Comment	NRC Response
	sensitivity analyses over the entire range of uncertainty on predicted breach parameters (or predicted peak breach flow rates).	
100. *[M.Conner]*	***Comment:*** NRC is to be commended for considering dam safety implications in light of the events that occurred during and following the Fukushima earthquake. This effort demonstrates a commitment to better understand dam safety risks as they relate to potential flood risks at downstream nuclear power plants.	***Response:*** Flood risks at nuclear power plants due to potential upstream dam failure has been considered by NRC in reactor siting and licensing decisions since the early days of the commercial nuclear power industry. In light of the events at Fukushima, the NRC has asked commercial reactor licensee to reevaluate their design basis flood estimates. This exercise includes consideration of flooding hazards due to potential upstream dam failure. ***Action:*** No change to text
101. *[M.Conner]*	***Comment:*** Reclamation and the Department of the Interior own, permit, operate and/or maintain many dams within the watersheds upstream of nuclear power plants. The, proposed guidance could lead to many requests for information about dams within our inventory. Given the difficult budget challenges we are currently facing, we must be sure that the efforts of our staff are focused on the highest priority dam safety risk issues. It is likely that prior studies performed for our dams will not meet the exact needs of NRC and would require considerable staff time to assure that any data and/or analysis results provided are being used and represented appropriately. We believe that the screening process needs to address an additional objective of limiting the impact of data	***Response:*** The screening process described in this ISG is intended to use readily available information from public sources such as the USACE National Inventory of Dams, and the USGS National Hydrography Dataset. In addition, due to the very small number of nuclear power plants downstream of large USBR dams, NRC does not anticipate that considerable staff time by USBR staff will be required. ***Action:*** No change to text

Comment No.	Comment	NRC Response
	collection efforts on dam owners to those dams that can be shown to have a reasonable likelihood of being significant contributors to the flood. risk at the nuclear power plants.	
102. *[M.Conner]*	***Comment:*** We suggest that NRC consider an alternative strategy for assessing flooding hazards. In most cases, the flooding hazard due to dam failure will be dominated by one or a few dams immediately upstream of the nuclear power plant. A much more efficient use of resources for making this assessment would be to start with an assessment of the dam immediately upstream of the plant and progressively add assessments of upstream dams until it is apparent that further assessments don't substantially alter the flooding hazard at the nuclear plant. This will minimize the investment of resources necessary for dams that will be found to make no substantial contribution to flooding hazards at the nuclear power plant.	***Response:*** The alternative strategy outlined relies on a number of plausible assumptions. However these assumptions are not a sufficient basis for demonstrating safety in the detailed manner required by the NRC staff. **Action:** No change to text
103. *[M.Conner]*	***Comment:*** The guidance indicates a double standard for assessing risk. Hydrologic loads appear to be required to meet a standard 100 times more conservative than acceptable seismic loads. While this may be commonly accepted practice in the nuclear industry, it leaves an avenue for questioning the credibility of the assessments when there is a systematic discounting of seismic loads.	***Response:*** The guidance has been revised to remove the 1e-6 annual exceedance probability target for hydrologic failure. The ability to pass the PMF is now used as the criteria for nonfailure under hydrologic loading conditions. See the response to Comment #39. ***Action:*** See response to Comment #39.
104. *[M.Conner]*	***Comment:*** Multiple dam failure scenarios are much more complex than portrayed in the guidelines: • The worst case scenarios described require a series of simultaneous events that would likely place most of them well	***Response:*** Multiple dam failures, either cascading failures or concurrent failure of dams on adjacent basins have been observed. The likelihood of such events must be considered on a case-by-case basis. General

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	below the 1e-7 risk objective • For hydrologic loads at dams large enough to be consequential, the likelihood of a storm of sufficient areal extent and intensity to fail multiple dams on adjacent basins is much less likely than a storm that would fail a single damn.	conclusions regarding the entire class of such events is not sufficient. ***Action:*** No change to text
105. *[M.Conner]*	***Comment:*** Communication of the flood hazard information is a significant concern. While the many conservative assumptions incorporated into the guidance provide a safety net for the assurance of nuclear safety, they could have an unintended consequence of unnecessarily raising concern in the public regarding the safety of dams in a watershed. If the goal is to provide assurance that the nuclear plants can accommodate a robust set of flood hazards, we recommend that communication of design loads be limited to conveying a series of one or more stage-discharge. relationships for which the nuclear plant has been evaluated. The basis for the stage-discharge relationships could be simply described as a combination of operational flood releases and potential dam failure scenarios at upstream dams. Such an approach could avoid costly, difficult and unnecessary public affairs issues associated with the dams.	***Response:*** Many assumptions go into assessing potential nuclear power plant flooding after dam failure. NRC's new guidance generally uses very conservative assumptions, leading to conservative results. This approach is appropriate given the potentially-severe and long-term consequences associated with nuclear power plant flooding. However, these assessments should in no way reflect on any dam being evaluated as part of the nuclear power plant licensee's evaluation. Questions about a particular dam should be sent to the dam owner, operator, or regulator. ***Action:*** No change to text
	****** END of COMMENTS ******	