August 3, 2011

Mr. Jim Kinsey
Director, Regulatory Affairs
Next Generation Nuclear Plant Project
Idaho National Laboratory
P.O. Box 1625
2525 North Fremont Ave
Idaho Falls, ID 83415

SUBJECT: NEXT GENERATION NUCLEAR PLANT - REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 005 REGARDING THE RISK-INFORMED, PERFORMANCE-BASED LICENSING APPROACH

Dear Mr. Kinsey:

This letter forwards requests for additional information regarding the proposed risk-informed, performance-based licensing approach for the Next Generation Nuclear Plant (NGNP). Aspects of the proposed approach have been described in three submittals from the Idaho National Laboratory (INL):

> INL/EXT-09-17139, "Next Generation Nuclear Plant Defense-in-Depth Approach," December 9, 2009, Agencywide Documents Access and Management System (ADAMS) Accession Number ML093480191,
>
> INL/EXT-10-19521, "Next Generation Nuclear Plant Licensing Basis Event Section White Paper," September 16, 2010, ADAMS Accession Number ML102630246, and
>
> INL/EXT-10-19509, "Next Generation Nuclear Plant Structures, Systems, and Components Safety-Classification White Paper," September 21, 2010, ADAMS Accession Number ML102660144.

The NRC staff has identified that additional information is needed to complete its assessment of these white papers. The enclosures to this letter provide requests for additional information addressing each of the major topic areas described in the white paper.

These topics are closely related to one another, so the NRC staff review will address all three topics in a single assessment report, making consistency between the three white papers an important consideration. As you develop revisions to the white papers in response to these questions or the staff's assessment, please ensure that you make conforming changes to pertinent text in all three white papers.

Should you have questions, please contact me at (301) 415-1470 or Joseph.Williams@nrc.gov.

Sincerely,

/RA/

Joseph F. Williams, Sr. Project Manager
Advanced Reactor Branch 1
Advanced Reactor Program
Office of New Reactors

Project No.: 0748

Enclosures:
1. Licensing basis event selection RAIs
2. Defense-in-depth RAIs
3. SSC classification and treatment RAIs

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Request for Additional Information No. 5903 Revision 0

8/2/2011

Next Generation Nuclear Plant Pre-Application Activities
Department of Energy - Idaho National Laboratory
Docket No. PROJ 0748
SRP Section: ARP LBE - Licensing Basis Events & Design Basis Accidents
Application Section: Licensing Basis Event White Paper

QUESTIONS for Advanced Reactor Branch 1 (ARB1)

ARP LBE-1

LBE-1. Section 2.1.3: The white paper states that "…accidents involving core damage in HTGRs are BDBE (based on the HTGR particle fuel's resistance to melting under high temperature conditions)…" While this statement may be an expected outcome, it has not yet been demonstrated by a thorough evaluation of reactor response to events, including conservatively modeled fuel performance. Such an evaluation would be an outcome of the LBE selection effort and evaluation of a completed design.

Provide a discussion of how the LBE process will ensure that such unconfirmed assumptions do not inappropriately influence decisions made as the process is implemented.

ARP LBE-2

LBE-2. Deleted.

ARP LBE-3

LBE-3. Section 3.1: The paper states that a deterministic approach is used to identify an initial set of events for LBE selection. Provide details regarding how this approach will be performed.

ARP LBE-4

LBE-4. Section 3.1: The paper briefly describes how PRA will be used as part of the LBE selection process, but does not address what guidelines for PRA quality will be applied. For example, "ASME-RA-XXX, Draft for Internal Review "Standard for Probabilistic Risk Assessment for Advanced Non-LWR Nuclear Power Plant Applications" is not cited in the white paper.

Compare the NGNP plant PRA development process with the process described in ASME-RA-XXX. The response should include a discussion of how uncertainties arising out of assumptions, incomplete models, and incomplete data are addressed by the event selection methodology.

ARP LBE-5

LBE-5. Section 3.3.3.2: The paper describes DBEs as events not expected during the lifetime of a single plant, but may occur during the lifetime of a fleet of similar facilities. The paper goes on to state that a frequency of 1E-4/plant year is defined as the lower bound for the DBE region.

Describe the number of facilities that is assumed to form the population used to determine the DBE frequency.

ARP LBE-6

LBE-6. Section 3.3.4.1: What is the practical effect of designating some events as AOOs and others as DBE? It appears that both sets of events are evaluated in a similar manner, and that their acceptance criteria are based upon the same F-C curve. From the SSC paper, it appears that the only distinction may be in treatment proposed for SSCs mitigating events within the categories.

ARP LBE-7

LBE-7. Section 3.3.4.1: How are frequency-consequence uncertainty distributions established? For example, do they represent 95% population boundaries?

ARP LBE-8

LBE-8 Deleted.

ARP LBE-9

LBE-9. Section 3.3.4.4: The paper states that DBAs corresponding to DBEs will be evaluated in Chapter 15 of the Safety Analysis Report. However, AOOs are also evaluated in LWR safety analyses, and may yield greater risk, as defined by the product of frequency and consequence.
Discuss the basis for excluding AOOs from the Safety Analysis Report.

ARP LBE-10

LBE-10. Section 3.3.4.4: How will safety-related SSC performance be modeled in the Safety Analysis Report? For example, will they be modeled deterministically applying a single failure or some other scheme? Similarly, how will non-safety related, with special treatment (NSRST) SSC performance be modeled in safety analyses of AOOs?

ARP LBE-11

LBE-11. Section 3.3.5: The paper states that mechanistic source terms will be realistically calculated for each LBE and DBA. However, outcome objective 7 states that consequences will be conservatively calculated. How will the conservatism of these analyses be assured?

ARP LBE-12

LBE-12. Section 3.3.5: Figure 9 on page 27 shows an event tree where several DBEs are consolidated into a deterministic DBA. The AOO associated with this event is apparently not intended for evaluation. However, AOOs have more restrictive dose acceptance criteria, and so could possibly represent limiting events in terms of risk, as calculated by the product of probability and consequences. How does NGNP intend to evaluate AOO dose consequences?

ARP LBE-13

LBE-13. Section 3.3.6: Provide a basis for assuming the vicinity of a nuclear power plant is considered to be a distance of one mile from the site boundary.

ARP LBE-14

LBE-14. It appears that the paper does not address the role of plant personnel, including control room operators. Provide a discussion of the effect that plant personnel have on frequency and consequence of events, both favorable and unfavorable, and how those factors will be addressed in LBE selection.

ARP LBE-15

LBE-15. Section 1.4: Explain how SSC performance criteria for AOOs are conservatively established.

ARP LBE-16

LBE-16. Section 1.4: Discuss how the frequency of breaks in the reactor coolant system pressure boundary will be determined.

ARP LBE-17

LBE-17. Section 1.4: The design basis events for some SSCs are not necessarily based on an event in a specific frequency range. For example, the design basis for reactor coolant pressure boundary components are based on events associated with the application of the ASME BPV Code, including Section III. Discuss how design basis events needed for the application of codes and standards for the design of nuclear-grade (safety-related) components will be selected.

ARP LBE-18

LBE-18. Section 1.4: Describe how SSC performance characteristics will be determined by requirements for mitigation of accidents in the BDBE region.

ARP LBE-19

LBE-19. Section 1.4: Explain how natural phenomena such as seismic events will be selected in the AOO, DBE and BDBE regions in the risk-informed approach to the NGNP plant design.

ARP LBE-20

LBE-20. Section 2.1.1: Will ATWS and station blackout specifically be included as LBEs in the BDBE category?

ARP LBE-21

LBE-21. Section 2.1.2.1: In light of the expectation documented in the advanced reactor policy statement, and the recent work by the staff to risk inform 10 CFR 50.46 large break LOCA break size corresponding to 1E-5 per plant year, discuss the rationale for the proposed 1E-4/yr lower frequency bound for DBA s for the NGNP plant design.

ARP LBE-22

LBE-22. Section 2.1.3: To address uncertainties and unknowns in the risk informing of the 10 CFR 50.46 large break LOCA break size, the NRC applied deterministic judgment that a somewhat larger pipe (i.e., the largest pipe connected to the main reactor coolant system piping) should be used as the basis for the DBA LOCA break size for light water reactors. For the NGNP plant, how will deterministic judgment (versus the sequence frequency from the plant

PRA) enter into the decision process for the selection of LBEs (e.g., pipe break sizes) to be included as DBAs?

ARP LBE-23

LBE-23. Section 2.1.2.1: Explain how candidate LBEs will be deterministically identified and then assessed using risk insights for comparison to the TLRC.

ARP LBE-24

LBE-24. Deleted.

ARP LBE-25

LBE-25. Section 3.3.1: The paper states that PRA provides a rational approach for identifying, understanding, and addressing known uncertainties. However, this technique does not provide a rational approach for identifying and addressing unknown uncertainties, such as unknown or missing phenomena, or unrecognized initiating events.

Discuss how deterministic judgment is applied for the conservative selection of the NGNP initiating events and/or the selection of the NGNP event sequences and/or normal operating conditions as a defense-in-depth approach to address such unknown uncertainties.

ARP LBE-26

LBE-26. Section 3.3.7: Discuss how the NGNP event selection and categorization process conforms to the NGNP licensing strategy. Explain what is meant by the statement: “the initial set of LBEs will be risk-informed.”

ARP LBE-27

LBE-27. Section 3.3.1: Explain how deterministic engineering judgment will be used in the selection of LBEs to ensure adequate NGNP safety margins, compensate for an inadequate or an incomplete NGNP PRA (which might occur, in part, due to the use of new and innovative design features and/or technologies) and, to bound uncertainties.

ARP LBE-28

LBE-28. Section 3.3.3.2: The BDBE region is below the stated 1E-4 per plant-year lower frequency cutoff for the DBE region. Discuss whether the NGNP plant design will also include events selected from the BDBE region (i.e., 1E-4 to 5E-7 per plant-year) to demonstrate conformance with 10 CFR 50.34a.

ARP LBE-29

LBE-29. Section 3.3.3.2: The NRC selected break sizes associated with a mean frequency of 1E-5 per plant year for risk-informing changes to LWR LOCA technical requirements; for LWRs, a LOCA is a DBA. Discuss the rationale for having a 1E-4 per plant-year lower frequency cutoff for NGNP design basis events, as compared to 1E-5 per plant-year initiation frequency for risk-informing the DBA LOCA for LWRs (see SECY-10-0161, "Final Rule: Risk-Informed Changes To Loss-Of-Coolant Accident Technical Requirements (10 CFR 50.46a) (RIN 3150-AH29)," December 10, 2010.

ARP LBE-30

LBE-30. Referring to the NGNP Defense-in-Depth (DID) white paper, Section 3.2.4.3: In Table 3-4, provide examples of accidents that will be considered to demonstrate that "there is a reasonable balance between the prevention and mitigation of accidents involving release of significant quantities of radioactive material (SRP principle 7 in table 3-3)" for establishing adequacy of NGNP DID.

ARP LBE-31

LBE-31. Referring to the DID paper, Appendix D: In the proposed application of the frequency-consequence curve described in Appendix D of the paper, LBEs are to be chosen by forming event families with similar common characteristics, i.e., initiating event challenge type, safety system response, and plant end state, and plotting the frequencies, doses, and uncertainty ranges on the Frequency-Consequence Curve. The robustness of this approach is highly dependent on the selection of top events in the event tree (system or function), and thus the degree to which sequences are or are not parsed into ever finer sub-sequences with lower frequencies of occurrence. Describe the measures to ensure that event families are appropriately defined and DID measures are conservatively prescribed.

ARP LBE-32

LBE-32. Section 3.3.3.1: The white paper derives the definition of anticipated operational occurences from teh approach used for operating reactors. For operating reactors, events in this category do not result in radiological releases; the normal consequence of any of these events is that safety limits are not exceeded and there is no release of radioactivity. In contrast, proposed NGNP frequency-consequence curve defines allowable radiological consequences, and

so appears to be inconsistent and less conservative than the regulatory approach for similar frequency events for LWRs.
Discuss why the proposed NGNP AOO consequence limits which are less restrictive than for LWR AOOs are acceptable.

ARP LBE-33

LBE-33. Deleted.

ARP LBE-34

LBE-34. Section 3.3.4.2 discusses the design basis event selection process. In this process the mean values for event sequence frequency is compared to with limits on the F-C curve to determine which event category it falls into. Why are mean values used? Uncertainty must be addressed in licensing analysis and this is often done by choosing bounding values or suitably conservative values.

ARP LBE-35

LBE-35. Question deleted.

ARP LBE-36

LBE-36. Section 3.3.5: Explain the meaning of the term “upper bound of the mean consequence for each DBE.”

ARP LBE-37

LBE-37. Describe what effect, if any, a revision to the frequency-consequence curve would have on the likely classification of equipment, related special treatment requirements, and overall design of the facility. Assume the following definition of an alternate F-C curve:

AOO Region: Frequency > 1E-2,Dose = 100mrem (point A)
DBE/DBA Region: Frequency <1E-2 and >1E-5, Dose = 25 Rem (point B)
BDBE Region: Frequency <1E-5 and >1E-7, Dose as defined by line

The boundary line between acceptable and unacceptable regions would be the straight line connecting points A and B (continuous through AOO and BDBE regions, i.e., allowable dose approaching 0 as frequency increases).

The handling of site integrated risk versus unit risk remains an outstanding policy issue, so your response should also discuss the sensitivity of the design to the use of the curve for events affecting multiple units.

Note that the above F-C graph does not represent an official NRC position. It was developed at the staff-level for the purpose of gaining an understanding of design sensitivities to the graph.

ARP LBE-38

LBE-38. Discuss whether the LBEs used to demonstrate fulfillment of dose criteria are also expected to adequately fully define the design specification of SSCs, or if there are additional scenarios which will be used in certain cases. For example, it is expected that safety relief valves will be required to protect the reactor coolant system from overpressurization, in accordance with ASME Code requirements, though overpressure transients are not expected to have significant dose consequences. How will LBEs be identified and evaluated to fulfill acceptance criteria other than dose? What is the role of PRA in identifying such events?

ARP LBE-39

LBE-39. Section 2.1.3: The risk-informed approach proposed for the NGNP includes consideration of events beyond the design basis (BDBE) down to 5E-7 per plant year. Although it is stated that external events below 1E-5 per year are screened out as design basis hazards, are external events with a mean frequency below 1E-5 still retained in the PRA as BDBEs?

ARP LBE-40

LBE-40. Section 3.3.4.3: It is stated that BDBEs assure that adequate emergency planning is in place. Events would be considered BDBEs if their mean probability is between 1E-4 and 5E-7 per year. However, current NRC policy and practice is to select a spectrum of event consequences (i.e., magnitude, timing, type of radionuclides) tempered by the event probability for establishing emergency planning requirements rather than using event probabilities as the basis for emergency planning. Discuss consistency of the proposed approach to selecting emergency planning basis events with the current NRC policy and practice in terms of a spectrum of event consequences (i.e., magnitude, timing, type of radionuclides).

Request for Additional Information No. 5911 Revision 0

8/2/2011

Next Generation Nuclear Plant Pre-Application Activities
Department of Energy - Idaho National Laboratory
Docket No. PROJ 0748
SRP Section: ARP DD - Defense in Depth
Application Section: Defense in depth white paper

QUESTIONS for Advanced Reactor Branch 1 (ARB1)

ARP DD-8

DID-1. Conventional light water reactor risk metrics, such as core damage frequency, are not clearly applicable to NGNP. Describe the risk metrics which will be used to assess NGNP defense-in-depth, and justify their adequacy.

ARP DD-9

DID-2. White paper section 3.1.1 describes the risk-informed, performance-based design process, including the statement that this process "…is based on a foundation of deterministic requirements, decisions, and evaluations…" Provide a description and examples of deterministic decisions and evaluations involved in the decision process. The response should address how deterministic engineering judgment be will used to provide assurance that shortcomings and gaps in the PRA are addressed.

ARP DD-10

DID-3. White paper section 3.2: How are unknown uncertainties in event initiators, event sequences, event phenomena, or equipment performance addressed in the determination of defense-in-depth?

ARP DD-11

DID-4: Deleted

ARP DD-12

DID-5. Describe the numerical criteria for screening out (from consideration of DID measures) initiating events or event sequences based on low frequency (exclusive of catastrophic vessel failure). Describe how DID measures would be provided for low probability although not incredible, operational events such as station AC blackout, total loss of DC power, and loss of ultimate heat sink, based on, for example, light water reactor operating experience with similar precursors.

ARP DD-13

DID-6. Section 1.2: Describe how existing light water reactor regulatory requirements which contribute to DID will be identified and interpreted for application to NGNP.

ARP DD-14

DID-7. In Section 1.1, the set of criteria identified as the top level regulatory criteria (TLRC) do not address the all requirements that need to be met to attain adequate protection. However, it is not clear that the TLRC address all pertinent NRC safety standards which must be fulfilled to ensure adequate protection of the public and the environment.

Describe how all relevant regulatory requirements will be identified, the process to be used to determine their applicability to NGNP or the need for revising the requirements, and how those requirements will be addressed by the DID process.

ARP DD-15

DID-8. In section 1.2, there are two bullets that end with "(Refer to Sections 3.1 and)." What is the second section being referred to?

ARP DD-16

DID-9. Section 1.5 of the white paper states that "Programmatic Defense-in-Depth" will be used to address uncertainties not addressed by the plant capability. However, a robust defense-in-depth approach would require that uncertainties be addressed by both plant capability, as well as programmatic measures.

Explain why programmatic measures alone are adequate to address uncertainties.

Explain what approach, if any, will be used to ensure that there is enough margin in plant capability to assure that events of greater severity than identified by the PRA can be mitigated by the plant capability features. What are the conservative design strategies for plant capability DID to address such uncertainties?

ARP DD-17

DID-10. Figure 3-1 in Section 3.1.1 includes a footnote regarding consideration of non-nuclear hazards. Provide clarification of what non-nuclear hazards might be considered.

ARP DD-18

DID-11. Figure 3-2 of Section 3.1.1 is described as characterizing the NGNP risk-informed, performance-based design process. However, Figure D-1 of Appendix D is entitled “Risk-informed performance-based design process,” and does not resemble Figure 3-2. Provide a discussion and clarification of the relationship between these figures and the associated text.

ARP DD-19

DID-12. Section 3.2.1 and Figure 3-3 describes feedback loops incorporating risk insights into the development of plant capability and programs. However, to be a risk-informed process, it appears that the arrows between the lower portion of the center triangle and the lower left hand box and lower right hand box should point toward the boxes rather than away from the boxes. That is, a risk-informed approach to DID would involve deterministic evaluations or judgment directed at both Plant Capability DID and Programmatic DID. The plant PRA would then be used to evaluate the apparent risk importance of these DID measures.

Provide clarification of the expected process for incorporation of risk insights into Plant Capability and Programmatic DID.

ARP DD-20

DID-13. Section 3.2.1, Figure 3-4, describes detailed elements of the Plant Capability DID and Programmatic DID. However, some cross-cutting elements of DID, such as emergency planning or codes and standards, are not addressed by this figure, but are addressed in other parts of the white paper. Provide clarification of how these cross-cutting elements addressed in the overall DID approach. Describe white paper revisions which may be needed to ensure a consistent description of these topics throughout the paper.

ARP DD-21

DID-14. Section 3.2.2 states that Plant Capability DID will include “…conservative design margins to improve the capability of SSCs to withstand challenges that may exhibit uncertainties.” To what extent will Plant Capability DID include the capability of SSCs to withstand uncertain challenges (e.g., bounding event initiators)?

ARP DD-22

DID-15. Section 3.2.2 states that conservative design strategies include, amongst other items, “Robust design of each barrier to be capable of mitigating expected failure modes of other barriers" and "Application of conservative design margins to establish the capability and capacity of each barrier and to address uncertainties." Explain what is meant by these statements.

ARP DD-23

DID-16. Deleted.

ARP DD-24

DID-17. For Table 3-2 in Section 3.2.3, provide a discussion of the relevance of human factors engineering.

ARP DD-25

DID-18. One of the decision points described in Figure 3-7 of Section 3.2.4 is "Prevention and Mitigation Adequate?" If the answer is "no," then DID is supposed to be enhanced. Provide a discussion of how conservative judgment is applied to make this decision, including how deterministic elements are identified and addressed.

ARP DD-26

DID-19. Table 3-4 of section 3.2.4 states that "Adequate safety margins and conservative design approaches to address uncertainties in barrier and SSC performance (Use of SRP Principle 7 in Table 3-3)" will be part of the DID strategies to ensure adequate reliability and capability to fulfill TLRCs." Discuss the safety criteria and safety margins that will be used for the fission product barriers.

ARP DD-27

DID-20. Section 3.3.1 states that "The fuel has very large temperature margins to radioactivity release in normal and accident conditions." Provide additional justification for this claim, including description of the margin between peak fuel temperature and the temperature where there will be a large release of fission products from the fuel, and the means for determining peak fuel temperature (i.e., measurement or calculation), including uncertainties.

ARP DD-28

DID-21. Table 3-7 in Section 3.3.1.4 describes features for control of chemical attack. Describe how active and passive SSCs will provide defense-in-depth to control chemical attack due to water ingress.

ARP DD-29

DID-22. Table 3-7 in Section 3.3.1.4 describes various fission product barriers. The deterministic safety analysis takes credit for each of these barriers. Explain how these barriers can be considered redundant if all must be credited to demonstrate acceptable performance.

ARP DD-30

DID-23. Table 3-8 in Section 3.4 presents a number of important DID principles but does not provide a sufficient description to permit the NRC staff to assess the planned approach. For example, several items defer more substantial discussion to the license application. However, deferring a more complete description to that time does not give adequate opportunity to provide feedback on possible challenges in advance of the application. Provide additional discussion of the project approach for each of the plant capability DID principles to ensure their proper consideration as the design is developed.

ARP DD-31

DID-24. Appendix A, Section 5.2, outlines the approach to address uncertainties, and appears to emphasize the role of PRA in this effort. Deterministic approaches can also be used to give increased confidence that a design will be able to withstand unforeseen challenges. Explain the deterministic DID approaches or measures related to plant capability that will be used to address uncertainties or "unknown unknowns."

ARP DD-32

DID-25. In Appendix D, Figure D-1, the deterministic boxes 1-4 (in yellow) provide no indication that defense-in-depth will be considered at this stage in the NGNP design development process. To what extent do the passive and active SSCs enter into the DID design development process for Box 3?

ARP DD-33

DID-26. In many places to 10 CFR 50.34, which describes content required for construction permit and operating license applications submitted pursuant to 10

CFR 50. However, the licensing strategy intends to pursue a combined license per 10 CFR 52, so citing 10 CFR 52.79 regarding the content of combined license applications seems to be more appropriate. Explain this discrepancy, or propose changes to the paper to ensure consistency with licensing in accordance with 10 CFR 52.

ARP DD-34

DID-27. Section 3.3.1.2 cites maintenance of core geometry and the helium pressure boundary as required safety functions. However, Figure D-3 in Appendix D does not clearly recognize these functions. Explain this apparent discrepancy.

ARP DD-35

DID-28. The discussion in Appendix D, Section D.1.10 is confusing. According to the nomenclature in Figure D-1, it appears selection of initiating events (Box 4) is a deterministic process. However, text on page 89 states that PRA is used in event selection. What is the role of PRA in this process? If it is to refine the event selection, an adequate and reliable PRA is required.

It is stated that the tools and methods of PRA have been already exercised in the event selection (Box 4 in Figure D-1) which, according to the nomenclature, is a fully deterministic process. Please clarify the apparent inconsistency.

ARP DD-36

DID-29. Appendix D, Section D.1.10 states that "catastrophic vessel failures may be precluded." However, the NRC staff has not yet determined that design and fabrication of the cross vessel is adequate to support this claim, so it is premature for the DID methodology to assume to make this assumption. Therefore, the white paper should be revised to accurately characterize the status of this assumption.

ARP DD-37

DID-30. Appendix D: The F-C curve for the NGNP VHTR shows a significantly more restrictive design objective of 1 REM at the EAB. Discuss how targeting this more restrictive design objective would affect DID provisions described in the white paper. For example, in some design concepts, it is anticipated that the fission product retention capability associated with the reactor building barrier (in Fig 3-6) is not credited to meet the FC curve dose consequences. However, the fission product retention capability associated with the reactor building barrier might need to be credited to meet the 1 REM at the EAB. Discuss how applying the more restrictive 1 REM at the EAB would generally affect the DID features and approaches described in the DID white paper.

ARP DD-38

DID-31. Section 3.2.1: Discuss the extent to which design, analysis and testing (Programmatic DID) is implemented for the non-safety-related SSCs to ensure they have the capability to ensure that the F-C consequence limits are not exceeded without credit for safety-related SSCs for the range of safety-related design conditions at which they must perform their safety functions.

ARP DD-39

DID-32. Section 3.2.2: Discuss the extent to which the concentric fuel barriers may experience common mode degradation due to significantly higher than expected fuel operating temperatures or accident temperatures and the programmatic and plant capability DID measures associated to ensure that such common mode failure is extremely unlikely.

ARP DD-40

DID-33. Section 3.2.2: For LWRs, quantitative goals exists for accident prevention (i.e., a core damage frequency <10-4/reactor-year) and accident mitigation (i.e., large early release frequency <10-5/reactor-year). Discuss whether the NGNP safety design philosophy involves balancing accident prevention and mitigation using risk metrics with quantitative guidelines.

ARP DD-41

DID-34. Section 3.2.4.3, footnote h: The DID principles (i.e., statements) presented in Table 3.3 and derived from SRP Chapter 19 involve mostly subjective criteria (i.e., use of criteria such as “sufficiently,” “acceptably,” “sufficient,” “significant,” “provides for adequate”) without specific objective quantitative acceptance criteria. Discuss the quantitative objective criteria that will be used to determine when these qualitative principles are met.

ARP DD-42

DID-35. Section 3.3.1.2: Figure D-3 indicates that to meet 10 FR 50.34, no credit need be taken for control of fission product transport from the helium pressure boundary, control of fission product transport in the reactor building or from the site control fission transport from the site, or retention of radionuclides in fuel spheres. It is probable that crediting these fission product barriers will be required to meet the more restrictive dose limits associated with meeting the EPA

Protective Action Guidelines (PAGs) at the exclusion area boundary (EAB). If so, discuss the plant capability DID design aspects that would be available for meeting the EPA PAGs at the EAB.

ARP DD-43

DID-36. Section 3.3.1.4 states that "The response times of the reactor during transients are very long (days as opposed to seconds or minutes)." This would be true for delayed releases due to core heat-up events, but would not be true for prompt radionuclide releases associated with large breaks in the helium pressure boundary. Discuss how the NGNP DID approach addresses possible prompt release events, such as those resulting from breaks in the helium pressure boundary piping.

Request for Additional Information No. 5904 Revision 0

8/2/2011

Next Generation Nuclear Plant Pre-Application Activities
Department of Energy - Idaho National Laboratory
Docket No. PROJ 0748
SRP Section: ARP SSC - Safety Classification of SSCs
Application Section: SSC White Paper

QUESTIONS for Advanced Reactor Branch 1 (ARB1)

ARP SSC-1

SSC-1. Section 2.3.1.2: The regulations of 10 CFR 50.69 provide alternative special treatment for SSCs, and were developed as a risk-informed overlay to be applied to the existing deterministic design for operating LWRs.
Describe how NGNP intends to apply 10 CFR 50.69 to the design, operation, and maintenance of the proposed HTGR facility.

ARP SSC-2

SSC-2. Section 2.5: The description of the regulatory background of 10 CFR 50.69 is incomplete. For example, SECY-98-300 and SECY-99-256 describe important principles associated with development of this rule. Therefore, the white paper should be revised to provide complete references to these and other relevant regulatory background documents.

Describe the references which are added, and describe how incorporating that information affects the discussion in the white paper.

ARP SSC-3

SSC-3. Section 3.4.1: The paper states that risk informing SSC safety classification provides adequate protection of public health and safety. In fact, it is the performance of an SSC, assured by its adequate treatment, which provides adequate protection, rather than the safety classification itself.

Revise the white paper to more accurately characterize SSC performance and treatment.

ARP SSC-4

SSC-4

Section 3.4.1 states that:

> As discussed in the LBE white paper, the LBE frequencies are a function of the frequencies of initiating events from internal events, internal and external hazards, and the reliabilities and capabilities of the SSCs (including the operator)…

However, it appears that the LBE white paper does not address operator performance.

Provide revisions to the SSC and LBE white papers to which consistently describe the expected role of NGNP operators.

ARP SSC-5

SSC-5. Section 3.4.2: The white paper states that “The definition of safety-related includes application of deterministic engineering judgment and risk informed elements.”
Is the "definition of safety-related” in this sentence the NGNP project definition? If so, revise the text to make it clear this is the case. How is deterministic engineering judgment applied to safety-related SSCs for NGNP?

ARP SSC-6

SSC-6. Section 3.4.2 of the white paper states that:

> Risk-informed application of the safety classification process is applicable to SSCs of a facility or process that are relied upon to prevent or mitigate the consequences of accidents (LBEs) which could result in potential significant offsite exposures.

The definition of “significant” is not clear from this statement. Consequences for any event should not be in excess of regulatory limits. Small consequences (relative to more severe accidents) in excess of limits for AOOs cannot be permitted, for example.

The white paper also states that:

> The first step in the process of classifying SSCs as safety-related is to determine the required safety functions for DBEs.

The NGNP SSC classification and treatment must address all operating modes and off-normal conditions. For example, for operating LWRs, safety-related safety relief valves are required to mitigate anticipated transients which do not result in any dose consequences, and it is expected that there will be analogous relief capability for NGNP.

Discuss how the SSC classification and treatment methodology ensures operation remains within regulatory consequence limits over the full range of events evaluated for the facility.

ARP SSC-7

SSC-7. Section 3.4.2: The white paper states that SSC performance is "considered realistically" for BDBE. What treatment is envisioned for SSCs mitigating BDBE to keep dose consequences within limits and to avoid unexpectedly increasing the frequency of such events? That is, how are the PRA assumptions shown to be valid, both for the initial design, and on an ongoing basis during plant operation?

ARP SSC-8

SSC-8. Section 3.4.2: The white paper defines an SSC as non-safety-related with special treatment (NSRST), in part, as an SSC mitigating the consequences of AOOs. This definition is a departure from current practice, where such SSCs are considered safety-related. Given that the risk of AOOs, as defined by the permissible combination of event frequency and dose consequences proposed by NGNP, may be higher than for DBAs, it is not obvious why a lower classification is appropriate. In addition, SSCs mitigating AOOs for existing plants are classified as safety-related, so the NGNP proposal is inconsistent with current practice. Furthermore, the term "NSRST" is not presently part of the regulations, so it is not consistent with current NRC rules.

Provide additional justification of the proposed classification of SSCs mitigating the consequences of AOOs as NSRST, including justification for deviating from the precedent that such SSCs are classified as safety-related. Discuss how NGNP intends to implement the NSRST classification (i.e., by exemption or petition for rulemaking), given that the classification is not part of the current regulations.

ARP SSC-9

SSC-9. Section 3.6: The description of special treatment states that the reliability and capability of safety-related SSCs are derived from the frequency and consequences of the LBEs that those SSCs mitigate. This description is incomplete, because frequency and consequences do not address equipment capability to function adequately in the environmental conditions it may be subjected to in the event of an accident, capability of withstanding a seismic event, or other performance attributes unrelated to the frequency and consequences of the event. While Table 1 appears to recognize these additional factors, the white paper text is arguably misleading, because it implies a more limited set of special requirements.

Provide clarification of the full scope of special treatment requirements for safety-related SSCs.

ARP SSC-10

SSC-10. Section 3.6: The paper states that:

> The purpose of the special treatment is to increase the level of assurance that the SSCs will perform as predicted in the PRA under expected LBE conditions with the assessed uncertainties. As such, the special treatment requirements are an important element of defense-in-depth.

The paper also states that special treatment measures are established by:

> …establishing capabilities of the SSCs that are credited in the PRA with successful performance of safety functions during DBEs and the reliability requirements that are needed to prevent high consequence BDBEs.

SSCs will be relied upon to demonstrate compliance with regulatory requirements in the Safety Analysis Report, not just the PRA. According to the LBE white paper, the SAR analyses of DBAs will be deterministic, at least in part. SSC performance specifications which are defined deterministically may not be adequately reflected in the PRA, and may form an element of the overall defense-in-depth for the facility. Therefore, special treatment determined based only from PRA requirements may not adequately ensure SSC performance.

Provide a discussion of how deterministic SSC performance specifications will be identified and how special treatment will ensure those specifications will be satisfied.

ARP SSC-11

SSC-11. Section 3.6.2: The white paper claims that the level of uncertainty in predicting NSRST SSC performance for AOOs is less than that for safety-related SSCs, concluding that less special treatment is justified. However, it seems that such a claim relies on an assumption that other factors associated with SSCs are somewhat equivalent, which may not be the case if different controls are applied, making the two SSC populations fundamentally different.

In addition, special treatment is also needed to also address factors relevant to mitigation of AOOs which are not addressed by the PRA. For example, an anticipated transient can result in service conditions such as elevated temperatures which can challenge SSC performance, so equipment will still require qualification for those expected environments. However, Table 1 suggests that environmental qualification will not be required for NSRST components, which is inconsistent with the requirements of 10 CFR 50.49 and 10 CFR 50 Appendix A Criterion 4.

1. Provide justification for the claim that uncertainties for NSRST equipment are lower than that for safety-related SSCs.

2. Given that existing regulations may require more control of NSRST equipment than proposed, explain how NGNP intends to implement (e.g., via exemption) the proposed treatment of NSRST equipment.

ARP SSC-12

SSC-12. Section 3.6.2: The white paper claims that NSRST SSCs provide defense-in-depth for DBEs and BDBEs. Such a claim is only true to the extent that NSRST SSC functions are relevant to mitigation of DBEs and BDBEs, and to the extent that that equipment will be capable of performing under the service conditions characteristic of such events. For example, it is not reasonable to claim an NSRST SSC that is not qualified for the environment created by a DBE will have any capability to mitigate such an event.

Discuss the advantages and limitations of NSRST SSCs contribution to defense-in-depth for DBEs and BDBEs.

ARP SSC-13

SSC-13. Section 2.3.1.1: The white paper does not clearly state that SSCs described by this section (i.e., NSRST SSCs) will meet regulatory requirements, such as 10 CFR 50.55a(a)(1), which requires that SSCs be "…designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed."

Provide clarification of NGNP's intent for these SSCs.

ARP SSC-14

<u>SSC-14</u>

Sections 2.3.1: The white paper states that:

> NGNP anticipates utilizing the guidance provided in Regulatory Guide 1.201 for complying with the NRC's requirements in 10 CFR 50.69 to determine the safety significance of SSCs and place them into the appropriate RISC categories as described in Section 1.5 of this white paper.

1. The LWR risk importance measures associated with RG 1.201 (which involve the use of CDF and LERF risk metrics) are not applicable to the NGNP. Discuss the risk importance measures or other risk assessment techniques that will be used to evaluate risk significance of NGNP design features with respect to defense-in-depth, safety margin, or risk.

2. The classification scheme described by the white paper section 1.5 does not match the 10 CFR 50.69 RISC categories. Furthermore, 10 CFR 50.69 was written to provide alternative treatment for SSCs while preserving the deterministic design basis for an existing light water reactor, and was not intended as a tool for initial design of a reactor, so its direct applicability to a risk-informed, performance-based design basis such as proposed for NGNP is not clear. Provide clarification of how 10 CFR 50.69 will be applied to NGNP.

ARP SSC-15

SSC-15. Section 2.3.1: It may be possible that a BDBE results in a very high (but not unacceptable) consequence near the high end of the BDBE frequency range and as such may be among the largest contributors to plant risk (i.e. located on the highest iso-risk contour in Figure 1). Will the NGNP SSC safety classification approach require that SSCs that mitigate such an event be classified as safety-related?

ARP SSC-16

SSC-16. Sections 1.5 and 4.2: The phrasing of the "Outcome Objectives" in these sections is not consistent. Provide revised text to clarify these sections.

ARP SSC-17

SSC-17. Section 1.5: List all criteria that can result in an SSC being designated as safety-related.

ARP SSC-18

SSC-18. Section 3.4.3: Regulations in 10 CFR 50.34 and 10 CFR 52.79 include requirements for consideration of a "major accident, hypothesized for the purposes of site analysis or postulated from considerations of possible accidental events." What is the safety classification and associated special treatment for SSCs which mitigate such a hypothetical accident?

ARP SSC-19

SSC-19. Section 3.5: It is understood that an LBE plotted on the F-C chart will depict both the mean values and uncertainty band for both event frequency and event consequences.

1. Discuss whether the events identified as “AS” and “AF” are the mean values or the upper range of the uncertainty bands.
2. Discuss whether the special treatment of the NSR SSCs are intended to reduce the mean values, the uncertainty bands, or both.

ARP SSC-20

SSC-20. Section 3.5: In a February 11, 2000, letter on “Importance Measures Derived From Probabilistic Risk Assessments,” the Advisory Committee on Reactor Safeguards stated:

> We believe that risk-informed decisions are best made using metrics, such as core damage frequency (CDF) or large, early release frequency (LERF), to evaluate the impact of decision options. There are, however, important situations in which this impact cannot be calculated easily. These include the risk-informed determination of special treatment requirements for structures, systems, and components (SSCs). The SSCs are first categorized according to their "importance," and then a decision is made regarding special treatment requirements for each category. The impact of these requirements on CDF and LERF is not quantified.

Discuss the role of importance measures in establishing special treatment of SSCs. The discussion should address the inherent difficulty in quantifying the benefits of special treatment in risk analyses.

ARP SSC-21

SSC-21. Section 3.5: The February 11, 2000, ACRS letter also stated:

> …what really matters is the robustness of the SSC categorization that the expert panel produces through its integrated decision making process that includes plant information in addition to the information provided by the importance measures.

Discuss whether (or to what extent) an “expert panel” will be used for classifying SSCs and/or establishing SSC special treatments for the NGNP.

ARP SSC-22

SSC-22. Section 3.6.1: How will SSCs which provide ,mitigation functions, such as steam generator depressurization to mitigate a tube rupture, be classified and treated?

ARP SSC-23

SSC-23. In the NGNP Defense-in-Depth white paper, Section 3.1.1, the footnote on page 19 states that "It is expected that intermediate design performance or reliability metrics will be used to establish the special treatment requirements." Clarify what is meant by this statement. What are "intermediate design performance or reliability metrics?" Why are intermediate metrics adequate for definition of special treatment, as opposed to final design parameters?

ARP SSC-24

SSC-24. Refering to the NGNP Defense-in-Depth white paper, Section 2.2.6: Discuss how functional performance capabilities of the non-safety-related SSCs for the LBEs relied upon for providing DID for the safety related SSCs will be established, including a description of separate effects tests and integral effects tests will be conducted to demonstrate the adequate performance of these SSCs.

ARP SSC-25

SSC-25. Referring to the NGNP Defense-in-Depth white paper, Appendix D.1.4: Does the NGNP DID strategy include a regulatory treatment of non-safety systems (RTNSS) type of approach that is currently used for advanced passive light-water reactor (LWR) designs? If so, please describe.

ARP SSC-26

SSC-26. Section 3.5: In regard to the design goal of maintaining the offsite exposure below 1 REM (consistent with EPA PAG criterion for offsite emergency planning), discuss the sensitivity of likely plant designs on the treatment of the 1 REM goal as a TLRC – which would translate into treating as safety related that equipment needed to keep the dose below 1 REM. If the 1 REM line remains a design goal and unrelated to SSC classification for the plant designer, would NGNP foresee a licensee wishing to propose changes in the EPZ needing to revise the SSC classification?

ARP SSC-27

SSC-27. Section 2.3.3: Discuss how beyond design basis events will be reviewed to determine what safety functions are required to prevent the consequences from increasing above the 10 CFR 50.34 dose limits for a major accident. Will SSCs required to mitigate such events be classified as safety-related?