Attachment

Comments on the Draft
Standard for Probabilistic Risk Assessment for Nuclear Power Plants Applications
Revision 12

EXECUTIVE SUMMARY

ES-1 Attached with the subject standard was a "white paper and guidance to reviewers of the draft ASME standard...." It indicated that the changes in Revision 12 (from Revision 10) were based on public comments and that the majority of the comments (including the NRC) requested a need (1) for additional flexibility, (2) to distinguish among grades of applications, (3) to recognize the standard will be for determining how existing PRAs can be used to support risk-informed applications, and (4) to align with the industry peer review program. We disagree with these views and did not provide them in our comments on Revision 10. We offer the following:

(1) As noted in our comments on Revision 10 (Ref 1), "an appropriate balance between specificity and flexibility" had been achieved, and therefore, we disagree there was a "lack of flexibility" (although some commenters may have perceived a lack). The standard should be thorough and complete in defining technical quality with flexibility incorporated into the decision-making process for an application (the purpose of Chapter 3 in Revision 12 (Chapter 7 in Revision 10)). By introducing flexibility when defining the technical quality, Revision 12 has resulted in a disproportionate balance between flexibility and specificity that has resulted in unnecessary uncertainty in the definition of technical quality.

(2) While one mechanism to distinguish the PRA scope and level of detail needed for an application is to define PRA grades, the three-graded approach in Revision 12 for defining technical quality does not serve its purpose. The boundaries are ill-defined and appear to have an arbitrary separation. It is even stated in Section 1.5 that "the range of applications falls on a continuum..... The boundaries between these categories are arbitrary and .... judgment is needed to determine which category is to be applied." The standard should clearly define the categories such that a single category defines a technically acceptable PRA with a specified scope and level of detail, and such that any requirements for a given application should be contained within one category.

(3) The objective of the standard should be to define the technical quality needed to support risk-informed applications and a process for identifying weaknesses and strengths in the PRA that could be relevant to a decision. Therefore, the primary use of the standard is to provide a basis for determining confidence in the technical quality of the PRA results used to derive risk insights for use in a risk-informed activity. With the focus of Revision 12, as stated in the white paper, Revision 12 has resulted in a standard with no minimum definition of what constitutes a PRA of technical quality for any application.

(4) While the ASME standard and the industry peer review program are related, we disagree that the standard should be aligned to the industry program. The standard should be a stand alone document and not be dependent on a specific peer review program. In fact, any industry peer review program should align to the standard.

ES-2 The supporting requirements tend to be vaguely specified with insufficient explanation as to what they mean, thus leaving too much room for interpretation and inconsistent application (e.g., overuse of words such as "reasonable," "consider").

ES-3 There is a lack of technical completeness; essential technical requirements in Revision 10 were not incorporated in Revision 12. This problem is particularly evident for the data analysis requirements. Examples of just two requirements in Revision 10 not incorporated into Revision 12 are:

(1) 3.3.5.3 Equipment Independent Failure Data Attributes. Appropriate plant-specific estimates of equipment unreliability (i.e., equipment fails to function or fails to continue to function throughout its required mission time) shall be developed.

(2) 3.3.5.5.2 Out Of Service Data Test And Maintenance Criteria. Test rates (tests/yr) shall be based on plant surveillance requirements and actual practice.

ES-4 In the standard, undefined supplementary analyses are allowed in lieu of meeting the specified technical requirements for a given application. For example, it is stated in the standard, “if the affected SCCs.....are not modeled, then either enhance the PRA to include the SSCs in accordance with the Supporting Requirements.....or generate supplementary analyses.” However, these supplementary analyses can not be considered as meeting the requirements of the standard since there are no criteria as to what the supplementary analyses should include.

ES-5 The relationship of the technical elements, the high level requirements (HLR) and the supporting requirements is not always logical. For example, for the Quantification element, one HLR states “The Level 1 Quantification methodology shall quantify....in a way that captures plant specific and unique factors important to risk.” One supporting requirement (QU-A3) for this HLR states “Do not truncate cutsets based on the order of the cutset.” This supporting requirement has no relationship to its HLR, it does not provide a supporting requirement specifying “a way that captures plant specific and unique factors important to risk.”

ES-6 The HLRs themselves are also not always logical and do not represent a process and are not mutually exclusive. For example, for Quantification, HLR-QU-A is for “scope” and HLR-QU-E is for “model plant fidelity.” However, HLR-QU-A states “The Level 1 Quantification methodology shall quantify....in a way that captures plant specific and unique factors important to risk;” this HLR is related to fidelity and not scope. HLR-QU-E states “The Level 1 Quantification shall provide traceability with the LERF PRA analysis that is sufficient to identify the important contributors to LERF;” this HLR is not related to fidelity but to Level 2.

ES-7 The peer review is constructed more like a quality assurance review (e.g., a check of the completeness of the process used to develop the PRA) rather than a peer review to determine the reasonableness in the results (e.g., the validity of the key assumptions).

ES-8 There is a lack of consistency in the language of the standard in many places (e.g., words such as data, parameter, and parameter estimation are used interchangeably), and the definitions are not always correct.

General Comments and Observations

1. In order to increase public confidence in, and acceptability of, the use of PRA results, this Standard itself needs to be of high technical quality. As such, it needs to be clean of technical errors, and written logically. The current document falls far short of this "standard". Some of the high level requirements are characterized incorrectly (e.g., See Quantification section). There are several instances where the supporting requirements do not match up with the high level requirements (e.g., HR-A2 and A3 are not supporting requirements for HLR A). Many of the supporting requirements in Section 4 are imprecise or ambiguous (e.g., IE-B7, 8, and 9); there are many duplications or minor variations that could be rationalized (e.g., SY-B2 and SY-B4); the requirements are randomly ordered whereas they could be ordered logically, grouping related requirements (e.g., QU-D5 and 10) since some of the requirements are clarifications or expansions of others, or provide "escape clauses" (e.g., SY-B7 is an "escape clause" for SY-B9); and there are some requirements that are simply incorrectly characterized (e.g., AS-D4). There are many instances of imprecise language. A good example is the use of the word data, which is used to mean raw information, processed information, and estimates derived from "data". The chapter on definitions is full of other examples.

   A good example in Revision 12 where the HLR themselves are logical and properly organized and where the with supporting requirements logically match the HLRs is the internal flooding. The HLRs for other elements needs to be defined to provide a similar logical presentation of the supporting requirements.

2. Draft 12 added several new requirements, all of which are beneficial to the standard. However, there are numerous places where requirements in Revision 10 were not incorporated into Revision 12. This discrepancy is particularly evident for the Data Analysis requirements. See comments on data analysis, where a comparison between Revision 10 and Revision 12 is provided to illustrate this comment.

3. Event though the review of the entire standard was rather cursory, it did appear that the draft standard concentrates on the application of a set of procedures instead of emphasizing the technical quality of the product of the process specified.

4. The Standard needs to point out that more detailed analyses are always OK, e.g., a Category III analysis can be used for a Category I application.

5. In a recent ACRS hearing (July 12, 2000), Mr. Sid Bernsen stated that "this standard is really not a recipe for developing a PRA in a vacuum. This standard is really one that says how do you use an existing PRA of some value, of some significance, as your model, which is an iterative process. So we're not writing a standard that says here's how you write a PRA or you do a PRA." The purpose of the standard is not to provide requirements for constructing a PRA model per se, but more to assess the applicability of an existing PRA to various decisions. Chapter 3 has been specifically written with applications in mind.

   In a risk-informed regulatory environment, the PRA input is one input into a decision-making process (See for example, Reg Guide 1.174). This Standard does not, nor is it intended to, address the decision-making process, as such. The Standard is written to address the following question:

   - Is the PRA capable of providing risk insights related to the application?

   However, the more important question for the decision-maker is:

   - How much confidence can we have in the PRA results given the role they play in the decision?

While these two questions are not unrelated, posing the questions in different ways suggests a different emphasis on the way the Standard needs to be written. The focus on the first question, together with the objective of recognizing the work that has been done on the industry peer review process (NEI-00-02) has led to the development of the three PRA-grade format. Despite considerable energy having been spent on trying to make the distinction between the columns meaningful, it has proved difficult. In many cases the same language appears for all three columns (in the systems analysis, the majority read the same). This has been explained (ACRS meeting July 12, 2000 - Sid Bernsen "but I guess the main point is if you'll notice, in the three categories, the supporting requirements are to be interpreted in terms of the intent of the categories. So there is a difference, even though the words may be the same.") by saying the words have to be interpreted differently for the three grades. It is difficult to see how this can lead to an acceptable Standard. If the Standard had been written with a focus on characterizing the quality of the results rather than the quality of the PRA, i.e., instead of asking is the PRA good enough, ask, how much credence can be put on the results the particular PRA gives, there would have been no need for separate categories, but just one standard that defines what could be characterized as a PRA performed to good industry practices. Then, the role of the standard would be to help in the determination of the degree of confidence in the results; steps 7 and 11 in the process described in Chapter 3 would provide the filter to identify the significant differences from the standard. What is done with these differences is up to the decision-maker.

6. The three-tiered approach of Revision 12 does not appear to serve any useful purpose except to style the Standard to be consistent with the industry peer review process. Section 3 of the Standard clearly indicates that a process is used to determine the capability of a PRA to support a particular application of risk informed decision making. Thus, what is needed is a standard on what constitutes a good baseline PRA whose scope and level of detail of analysis can then either be reduced or enhanced to match the needs of the particular application. As is, the three-tiered approach requires the expenditure of significant resources to reach a consensus on the standards for three general categories, none of which may actually represent the standard needed for any particular application.

7. The supporting requirements are often vague. For example, in

   DA-B3: "USE an accepted generic data source such as NUREG/CR-4639."
   DA-B7: "USE accepted generic sources for common cause data, such as, NUREG/CR-5497."

   What does "accepted" mean? This standard needs to define what is accepted.

8. There are no acceptability criteria associated with the three PRA applications Categories I, II, and III, in the subsections of Section 4 which present the supporting requirements associated with each of the High Level Requirements for the PRA Elements.

9. As a generalization of the comments, the standard does not specify any set of minimum requirements, below which the applicable part of the PRA is considered unacceptable. For example, Section 6, Peer Review, does not address the situation when, for various reasons, either the technical qualifications or the number of available reviewers do not fully meet those specified in the draft standard.

10. The requirements for Category I Applications in general appear to be so loose that almost any risk assessment could meet them. Actually, some aren't event worded as requirements. They use verbs such as "consider."

11. For many SRs, Rev. 12 qualifies Category I requirements using phrases like "to the extent needed to support Category I applications", "to the extent that Category I applications are not distorted", etc. No criteria or guidance are provided to assist the reviewer to determine that the SR and the associated HLR has indeed been met. This is placing an extremely heavy and quite possibly unrealistic burden on the review process. In fact, the review burden may be heaviest for those applications which are intended to be the least effort intensive.

12. In addition, some Category II and III SRs also allow conservative methods "to the extent that realistic estimates of CDF and LERF are not distorted." Any such conservatisms must be addressed by the peer review team (Section 6) and in the application process described in Section 3.5. These links need to be explicitly stated in the Standard. Similarly, when a requirement states that alternate methods can be used but must be justified or show that something left out has no impact, the peer review must review the acceptability of those methods and conclusions.

13. These comments imply that the "typical applications" suggested for the different categories (section 1.5) are not very meaningful. Some of the examples, particularly for Category I, are inappropriate. For example, a PRA used for the maintenance rule (a)(4) and as part of Phase III of the significance determination process will need to be fairly detailed.

14. The standard, as written, is not a prescriptive standard; it specifies what needs to be done but not how. Therefore, compliance with the standard will not reduce variability between licensees' PRAs. This need not be a significant problem for use of PRA results in making decisions as long as the decision-making process makes use of sensitivity studies and uncertainty analysis that recognize acceptable and reasonable variations in assumptions and parameter values in the manner discussed in Reg Guide 1.174. However, it also implies that there will always be a need for some level of NRC review of a risk-informed submittal, if only to determine what the driving assumptions are, and whether the appropriate sensitivity studies have been performed.

15. Draft 12 does not lend itself to provide guidance about the process of doing the initial PRA or to using/updating an existing PRA. In other words, the supporting requirements do not provide an order or hierarchy of implementation. Thus, it would be a difficult standard to use for analysts with limited experience.

16. Revision 12 is written with emphasis of use by existing plants with PRAs and does not address the generation of a new PRA. This comment stems from the fact that the Standard does not state what the baseline requirements for a new PRA needs to be and by the observation that the three category descriptions for many elements presupposes that the dominant accident sequences are known for different plant types (this may not be the case for a new plant design). It is believed that anyone generating a new PRA, whether it is planned to be used in any applications or not, needs to strive to produce a good baseline PRA as exemplified by the Category III requirements, all of which are achievable by existing methods.

17. Application issues based on the current situation (e.g., what is the general level of quality needed to address recognized types of applications, what is the process for ensuring that a PRA has the analysis elements needed to address a given application) are important. The Standard may not be the right vehicle for addressing them (because, for instance, this limits the Standard's scope - does ASME care about applications to international plants without PRAs or new plants?), but they do need to be dealt with somewhere.

18. Some applications depend on the models underlying the basic events of the PRA model (an example is the use of the standby failure rate model for failures on demand to investigate the impact of changing testing intervals). This level of detail, i.e., modeling the cause-effect relationship (PSA Applications Guide), is outside the scope of this Standard. (Issues related to the cause-effect relationship are discussed in SRP Chapter 19.) This standard, and in particular, Section 3, will make most sense when fully integrated into a decision-making framework.

19. The draft standard does not explicitly address the question of who makes the determination that a given PRA is acceptable for use in a specific application category.

20. There is an opportunity to expand the stated purpose of the Standard to also be a means to improve existing PRAs. This could be accomplished by having a recommendation in Section 5 of the Standard that all PRA changes (maintenance or upgrades) be performed according to the SRs listed for Category III applications. Expressed in another way, PRA upgrades need to try to eliminate weaknesses identified by the peer review process. A link between the peer review results and upgrades needs to be made in the Standard. Currently there is no such link in either Section 5 or 6.

21. This Standard needs to be given a very thorough technical edit.

Section 1, INTRODUCTION

Overall Observations and Conclusions

- No specific application fits under a single category, therefore, in this regard, the different categories are not helpful.

- Some of the examples listed as "typical applications" within a category are inappropriate. For example, a PRA used for the maintenance rule (a)(4) and as part of Phase III of the Significance Determination Process will need to be detailed and would not fit in Category I.

- A discussion of what it takes to meet this standard is missing. Chapter 1 needs to include such a discussion that (1) the PRA is to be evaluated against the technical requirements with the difference documented, and (2) the evaluation is performed using the process in Chapter 3 with this process documented.

General Comments

Gen. 1-1 Rev. 12 lacks requirements concerning the "supplementary analyses" that it allows when the PRA does not meet the requirements spelled out in the Standard (other than a requirement that the supplementary analyses be documented). Examples can be found in Sections 1.3, 3.3.1, 3.3.2, and 3.5. The Standard needs to either provide requirements for the supplementary analyses, or specifically require that these analyses be acceptable to the authority having jurisdiction.

Specific Comments

1.3 This section refers to "Supporting Requirements" before the notion of High Level Requirements (HLR) and Supporting Requirements (SR) is discussed. Suggest revising text to ensure terms are defined before they are used.

1.4.1-1 The second sentence in this section uses the word "must." Following ASME procedure for writing standard, this word needs to be replaced with "shall."

1.4.2-1 This section clearly needs to state that the SRs identified in Section 4 "shall be met, if necessary, for an application" or as indicated in Section 3, supplementary analyses/measures must be applied if the SRs impact is significant (significant needs to be defined). Note that Section 4.4 just states that the SRs "shall be met using written guidance." Consistent language and logic between the Sections 1.4.2, 3.5, 4.2.3, and 4.4 needs to be adopted.

1.5.1-1 Section 1.5.1, in (b), "within a given Category" needs to be struck since the purpose of this consideration is to determine the appropriate category for the application.

1.5.1-2 Under Category I, (e), if a PRA application is not expected to impact safety-related SSCs, why would it necessarily be a Category I application? PRAs can contain non-safety related SSCs explicitly or implicitly (e.g., through initiating events). The modeling of non-safety related SSCs have to meet the same restrictions as safety-related SSCs.

1.5.1-3 The identification of the two Maintenance Rule applications as typical Category I applications seems incorrect considering that ISI, graded QA, and GL 96-05 are shown as typical applications under Category II. The requirements for all of these applications are similar (prioritize and rank SSCs) and belong under Category II or III.

1.5.1-4 It is unclear what the last typical application listed under Category I includes. Specific types of "prioritization of activities that must be done with or without the benefit of PRA insights" needs to be provided instead of this vague statement. Does this include on-line maintenance scheduling?

1.5.1-5 Both Category II and III have the same attribute (b), "PRA products are used to prioritize/catagorize/rank SSCs with respect to safety significance." Two of the examples applications listed under Category II (risk-monitoring and tech spec modifications) involve evaluation of changes in CDF/LERF – not risk ranking. Thus this attribute needs to be expanded to address these types of applications.

1.5.1-6 The wording for Category II attribute (c) is vague and inconsistent with the wording for the corresponding attributes for Categories I and III. It is suggested that a "sufficient characterization of PRA results to determine whether risk acceptance criteria for [the] applications have been achieved" is true for all categories. It seems more consistent to specify that the results of a Category II PRA must be better than an order of magnitude accuracy.

1.5.1-7 The definition of Category III appears to cover risk-based applications. Risk-based applications are not currently acceptable and thus the use of the Category III SRs is likely limited to providing the desirable attributes for a new PRA or for PRA updates. These need to be listed as example applications.

1.5.1-8 If Category III is considered a higher level risk-informed application and the previous comment related to Category II attribute (c) is incorporated, the difference with Category II will be in attribute (d). Since a Category III application requires a "high level characterization of PRA results," "a factor of 2 or 3 accuracy in the PRA results" may be a more appropriate attribute if this Category is retained in the Standard. Also, when discussing attribute (c) it is important to differentiate which PRA results you are talking about. Is an order of magnitude accuracy in importance measures used in risk ranking acceptable? It is believed that the attribute is referring to an order of magnitude accuracy in the mean CDF/LERF estimates. If this is not the case, what is the attribute referring to?

1.5.1-9 It seems that use of a risk monitor to replace Tech Specs AOTs would be a good example of a Category III application. Note that this is a risk-based PRA application. Decisions impacting safety-related SSCs are based on PRA results which must be reasonably accurate. Also, a PRA for a new plant is an example of a Category III application. If the Category III column is retained in the Standard, these examples need to be listed.

Section 2, DEFINITIONS

Overall Observations and Conclusions

- The definitions need to be accurate, well written and stand the test of time; this is not apparent with many of the definitions. Some are trivial and unnecessary, some are not written for the context in which they are used in the document, and others are simply incorrect.

General Comments

Gen. 2-1 Many of the definitions are written in a superficial, inaccurate way (e.g., pre- and post-initiator human failure events, uncertainty), often using grammatically incorrect English (e.g., available time); some are trivial and unnecessary (e.g., plant, dependency); some are not written for the context in which they are used in this document (e.g., diagnosis); and others are just wrong (e.g., availability). Furthermore, it's not clear that highly specialized terms are necessary in this chapter (e.g., all the ones that come out of the expert judgement section). In writing the Standard, care needs to be taken that the definitions are accurate and well written, and will stand the test of time.

Gen. 2-2 Some of the definitions are too restrictive (e.g., see HRA, PRA upgrade, and unavailability). Some definitions are not provided (e.g., SR SY-B2 refers to unreliability, SR QU-D2 refers to aleatory and epistemic uncertainty - note that the definitions implied in the SR are incorrect).

Specific Comments

The following provide comments on a sampling of the definitions. The lack of comment does not mean the definition could not be improved. However, the ones that are addressed are the more significant. Some of these comments are the same as were made for Rev. 10.

2-1 **Accident Class**: The definition is OK, some of the examples are not; the first is related to an initiating event. Perhaps a better example could be "accident initiated by a transient with loss of decay heat removal".

2-2 **Accident conditions**: Suggest deletion. This is a very convoluted and not very useful definition.

2-3 **Accident sequence**: This is badly written. Suggest: "A representation, in terms of an initiating event, followed by a combination of system, function and operator failures or successes, of an accident that can lead to undesired consequences, such as core damage or radioactive release." In the second sentence, "Cut set" needs to be "minimal cut set."

2-4 **Availability**: This is an incorrect definition of availability, which is a statement about the state of an SSC irrespective of cause. The standard textbook definition is something like "the probability that a component, system or function, is operable when required". It is a point wise concept whereas reliability is measured over a time period. The Rev 10 definition was closer.

2-5 **Available time**: Suggest deleting this definition, and let the context define it in the appropriate section.

2-6 **Birnbaum**: Importance Measure: Delete; this is best dealt with as a mathematical definition or reference when needed.

2-7 **Component**: As written this could include almost anything. The examples help, but the definition begs for some qualifying clauses, such as, "that performs a function associated with the operation of systems required to maintain ... , respond to ..." etc.. Suggest deleting "component." This is a common term that requires no definition

2-8 **Containment Analysis**: Containment analysis involve determining containment failure mechanisms in addition to their thresholds following a core damage accident. This includes containment leakage and bypass. This definition is too restrictive. In any case, why is it needed. If so, needs to be changed accordingly.

2-9 **Containment Bypass**: Delete "an event that opens". Bypass is a description of a condition not an event.

2-10 **Containment failure**: The definition needs to be enhanced to indicated the concern is leakage of radionuclides given a core damage accident.

2-11 **Core damage frequency (CDF)**: The use of "frequency" and "per unit time" is redundant. Suggest changing the definition to the "expected number of core damage events per unit time."

2-12 **Cumulative distribution function**: Since this is a common term in probability and statistics, it needs to be deleted.

2-13 **Dependency**: This has a pretty clear dictionary definition. Why not replace it with a definition of Dependent Event or Dependent Failure which are more specific to PRA?

2.14 **Diagnosis**: In the context of this standard, diagnosis is typically intended in relation to the determination of the interpretation of the plant condition, rather than the condition of an SSC.

2-15 **External event**: The standard has clearly stated that it covers internal events excluding fires. Internal fires need to be excluded from the external event definition.

2.16 **Event Tree**: Delete "a quantifiable logical network", and insert "an inductive logic model".

2.17 **Event Tree Top Event**: Title is singular, discussion is plural. An Event on an Event Tree is a representation of a condition or status of a system or function, or an operator action, that can be logically characterized in a binary way as being successful or failed.

2.18 **Failure mechanism**: Suggest replacement by "a physical explanation of why a failure occurred. It is characterized in many different ways, e.g., by the type of agent causing the failure, chemical, mechanical, physical, thermal, human error, or by the physical process resulting in failure (vibration, corrosion, etc.)."

2-19 **Failure mode**: Definition is incorrect, a mode is not a mechanism. Suggest replacement by "A specific functional manifestation or manner in which a failure occurs, i.e., the means by which an observer can determine a failure has occurred, e.g., fails to start, fails to run, leaking."

2-20 **Failure Probability**: The way it is used in PRAs this is better defined as "the probability that a component, system or function fails when demanded, which is often estimated as the ratio of the number of failures to the number of demands."

2-21 **Failure Rate**: "the probability of failure in a unit time, often estimated as the ratio etc."

2-22 **Figure of Merit**: Delete.

2-23 **Front line system**: Definition needs to be changed to reflect systems required for other functions beside core and containment cooling (e.g., reactivity control, pressure control).

2-24 **Fussell-Vesely (FV) importance measure**: Change "any figure of merit" to "a selected figure of merit" or delete. If changed, it needs to also be made in the definitions of the other importance measures in Section 2.

2-25 **Harsh environment**: Change the definition to "an abnormal environment (e.g., high or low temperature, humidity, corrosive) expected as a result of postulated accidents" or delete.

2-26 **Human Error Probability**: It's not a very good definition, but at least replace "the operator" by "plant personnel".

2-27 **Human Failure Event**: This definition is incorrect, or, at best, convoluted. A more concise definition is "A logic model event that represents a failure of a component, system, or function that is caused by a human action."

2-28 **Human Reliability Analysis**: This is a little restrictive, but, in the context of a PRA standard, it reads better if "human error" is replaced by "human failure event". This then links the HRA more clearly to the development and quantification of the logic model.

2-29 **Initiating Event Categories**: Suggest deletion. The two categories need to match anyway?

2-30 **Internal Event**: This needs to be Internal Initiating Event? If so, the definition only needs to relate back to the Initiating Event definition, and specify that it is an event that occurs internal to the plant.

2-31 **Large early release**: This definition is incomplete. While it provides a definition of "early," it does not define large, i.e., it makes no reference to the health effects, which are usually invoked for defining "large" release. An acceptable definition can be crafted by adapting the LERF definition in Reg Guide 1.1.74 to large early release.

2-31 **Large early release frequency (LERF)**: The use of "frequency" and "per unit time" is redundant. Suggest changing the definition to the "expected number of large early releases per unit time."

2-32 **Latent Human Error**: its relationship to pre-initiator human failure events needs to be made clear.

2-33 **Level of complexity**: Suggest deleting this term since the use of impact levels of complexity are not distinguished in the requirements in Section 4.6.

2-34 **Level of Detail**: Delete.

2-35 **Model**: Suggest deleting this common engineering term.

2-36 Is **operating time** related to **mission time** in the context used in the standard? If so, state what that relationship is.

2-37 **Plant**: Do we really need a definition for this? Please delete it.

2-38 **Pre- and Post- Initiator Human Failure Events**: The events are not errors, but representations of the impact of errors (see human failure event above). So the introductory phrase needs to read, "Human failure events that represent the impact of human errors committed ..." .

2-39 **Prior distribution (priors)**: The current definition does not explain what the prior is, it only describes how it is used. The definition needs to be changed to "in Bayesian analysis, the expression of an analysts's prior belief about the value of a parameter prior to obtaining sample data."

2-40 Since **recovery** and **recovery action** are the same thing, **recovery** needs to be deleted.

2-41 The term "release category" needs to be defined.

2-42 **Reliability** and **unreliability** need to be defined. These represent different parameters than **availability** and **unavailability**.

2-43 **Top event**: Top event is also used in describing the events in event trees. The definition of that event includes the descriptor "event tree." Why not use the descriptor "fault tree" when listing this event in Section 2?

2-44 **Uncertainty**: uncertainty is <u>not</u> a <u>representation</u> of anything. Uncertainty is better described as a lack of confidence in the state of knowledge about the parameter values and models used in constructing the PRA. In the context of the PRA standard the uncertainty is epistemic. Delete reference to random variability of a parameter. Random variability is an aleatory uncertainty which is built into the probabilistic structure of the logic model.

2-45 **Uncertainty Analysis**: This need not be restricted to <u>estimation</u> of uncertainties. Uncertainty analysis is performed to identify the sources of uncertainty in the PRA model and characterize their impact on the results of the PRA.

2-46 Delete the following: **Restore, Repair, Risk Achievement Worth, Required Time, Supplementary Analysis**.

2.47 Delete **May, Should and Shall**. These three terms are essentially standards language and not technical terms. They need to be defined up front in a more prominent place.

2-48 Check the use of **SORV** in the Standard. In PRA use, an **SORV** is usually a "stuck-open relief valve."

Section 3, RISK ASSESSMENT APPLICATION PROCESS

Overall Observations and Conclusions

- The needed flexibility is provided in this chapter; it is here that the user determines if a given technical requirement is needed with the ability to meet the standard. However, the application of the decision criteria is too cryptic and warrants better, more detailed explanation.

- In implementing the process described in this chapter, there are no minimum standards. This chapter needs to contain either requirements for the supplementary analyses, or state that where supplementary analyses are used, the standard has not been met.

- A requirement documenting the entire decision process is needed.

General Comments

Gen. 3-1 Despite its application focus, Rev. 12 provides guidance but no requirements (or even process description) concerning the selection of the Application Categories appropriate for the application (see Section 1.5, which uses such words as “generally” and “most”). Section 3.4 only states that the bases for categorization be documented. It isn’t clear that, for an arbitrary application, the selection of an Application Category is always non-controversial. The Standard needs to either provide such requirements or it needs to specifically require that the AHJ approve the categorization.

Gen. 3-2 Section 3 describes a process for applying risk assessment, but does not specifically identify any requirements. (See Section 3.1.) If the described process is intended to be required, this needs to be explicitly stated.

Gen. 3-3 The fundamental difficulty with this Chapter is that the process, as outlined in the flowchart and discussed in the text, does not distinguish between the PRA’s acceptability and the application’s acceptability. The supplementary analyses of boxes 12a and 12b, which are needed when the PRA is lacking in some necessary attribute, can be used to strengthen the case for an application, but they would not, in general, enhance the PRA to increase its acceptability. In the extreme case one could envision a PRA, which fails to meet the Standard in almost all respects, being categorized as acceptable based on supplementary analysis alone. In other words, the arrows of the flowchart do not all need to lead to Box 8, which states “PRA has sufficient capability” but instead the process needs to distinguish between the capability of a PRA and the validity of an application.

Gen. 3-4 Box 5 of the flowchart calls for determination of the category of the application. However, Boxes 3 and 4 deal with whether the PRA has the necessary scope and results needed to evaluate the contemplated change. These considerations already have some determination of the category of application. In addition, as acknowledged elsewhere in the Standard, it is unlikely any application will fit under one category for all technical elements. More likely, the category of the technical requirements will vary from element to element, depending on the application. (This relates to the fundamental problem of defining requirements for three distinct categories).

Gen. 3-5 Box 10 calls for development of supplementary Standard criteria when the existing detailed requirements of the Standard are insufficient for the application. While a mechanism to update and revise the Standard is needed, the mechanism of Box 10 appears to be aimed more at providing additional criteria for an application than for the PRA Standard. The

examples cited in the text bear this out. Again, a distinction needs to be made between the Standard and the application process.

Specific Comments

3.1-1 The types of supplementary analyses envisioned to address weaknesses in the PRA are deterministic analyses such as bounding or screening calculations, the use of expert panels, or perhaps simple risk calculations. Most of the examples of supplementary analyses provided in Section 3 involve the use of the existing PRA (e.g., using surrogate components for evaluating the importance of piping sections and using the interfacing system LOCA frequency to determine the importance of the interfacing valves). These simple manipulations of the PRA models are really examples of enhancements of the PRA necessary to meet the scope and modeling requirements needed for the application (suggest leaving them in but characterizing them as PRA enhancement examples). Better examples of supplementary analyses would enhance the understanding of the types of analyses that would be required.

3.1-2 In the process as written, Box A defines the application in terms of the impact on the plant, and the identification of the decision metrics. Box B addresses the issue characterized by the PSA Applications Guide as addressing the cause-effect relationship; i.e., the level of detail required to model the change. Since this Standard only covers internal events at full power, then the term scope can only refer to coverage of SSCs, appropriate models for the SSCs, and initiating events, etc.. This needs to be clarified in the write-up.

Fig. 3.1-1 The arrows from the boxes 12a, 12b, and 10 end up leading to Step 8 in Box E which says that the PRA has sufficient capability. This is misleading. The use of supplementary analyses and compensatory actions by the decision-making panel is by definition a response to not meeting the standard, i.e., insufficient capability. The conclusion of this process needs to be an appropriate characterization of the PRA results for the decision-makers. Boxes 12a and 12b need to lead to the decision-making process directly.

3.2-1 The reason for referencing EPRI TR-105396 in the second bullet is not clear. If it is because the PSA Applications Guide provides guidance on how to establish the cause-effect relationship between the plant change and the PRA model, then state so. Note that SRP Chapter 19 also provides the same guidance on how to establish the cause-effect relationship and thus also could be referenced.

3.3-1 Both Sections 3.3.1 and 3.3.2 indicate that if the PRA does not include the necessary aspects to assess a plant change, then one option is to update the PRA in accordance with the SRs in Section 4. Which application category SRs are to be used to update the PRA? The ones for the identified application category? The application category is not established until the next step in the process. This suggests that the flow of the process described in Section 3 is probably wrong and needs to be reworked. It needs to also be noted that the SRs for a specific application category are not necessarily the ones to be applied. At the very least, the SRs applied need to be those necessary for the application (e.g., some SRs more restrictive than those specified for a Category III application may have to be applied even though the application is generally classified as fitting under Category II and some SRs necessary for the application may not even be in the Standard). Thus, rather than referencing the SRs in Section 4, these two sections could state that the PRA needs to be updated according to the SRs that are required for the application as determined in Section 3.4.2.

3.4-1 The role of Step 6 in Box C is not clear. Its existence undermines the need for separate categories of applications. If the requirements identified for a category of application need to be reviewed for each application, what is the purpose of the category?

The examples given for this step are in fact category independent, and are more suitable to step 4. Pipes and snubbers are not modeled and are therefore out of the scope of the PRA. How they are dealt with is an issue related to modeling the cause-effect relationship and is outside the Standard.

3.4.2-1 Section 3.4.2 needs to be modified to indicate that any "additional requirements" beyond those specified for the Application Category that may be needed for an application may be requirements that are specified in a higher Application Category (or may not even be in the Standard). That is, the required SRs necessary for an application may exist in the Standard but some may exist under different categories than the selected category.

3.5-1 The Standard makes it clear in several sections that the PRA capabilities for an application must be evaluated at the SR level. Section 1.3 states "PRA capabilities [for an application] are evaluated for each Supporting Requirement, rather than by specifying a "capability level" for the whole PRA." This statement is further reinforced in Section 3.1. These sections correctly imply that it may be possible that the SRs for a specific application can vary within an element from something less limiting than those represented in the selected category requirements to requirements substantially beyond those listed for the selected category. That is, all of the SRs for the selected application category may not be appropriate for the application.

The risk assessment application process described in Section 3 includes a step to identify the category for the application (see Section 3.4.1). Section 3.4.2 states that "For the Application Category determined in Subsection 3.4.1, it shall be determined if the scope and level of detail of the Supporting Requirements stated in Section 4 are sufficient to assess the application under consideration." This section also seems to support the concept that all of the SRs for the selected application category may not be sufficient (or could even be too rigorous) for the application. However, Section 3.5 indicates that the PRA is to be compared only against the SRs for the selected application category. It does not address comparing the PRA against more stringent SRs that may have been identified as necessary for the application. This is a fundamental flaw in the risk assessment application process described in Revision 12.

It is essential to remedy this flaw. It is recommended that the wording in the first paragraph of Section 3.5 be changed to the following or something similar: "Determine if the PRA satisfies the Supporting Requirements necessary for the application (Box7 of Figure 3.1-1). The results of the Peer Review (Section 6) may be used. The PRA is acceptable for the application if it meets the Supporting Requirements necessary for the application (Box 8 of Figure 3.1-1)." In addition, the first sentence in the second paragraph needs to also be changed to: "If the PRA does not satisfy a Supporting Requirement necessary for the application, then determine if the difference is significant (Box 11 of Figure 3.1-1)." Since all of the required SRs for an application may not be identified in Section 4 (this appears to be recognized in Section 3.4.2), it is recommended that the phrase "…stated in Section 4…." in the second to the last paragraph be deleted. Changes to the wording in some of the boxes in Figure 3.1-1 are also necessary to correspond to these suggested text changes.

3.5-2 Box D is where the comparison with the requirements is made. Steps 7 and 11 provide the filter to identify the significant differences from the standard. There is no need to discuss compensatory measures in this section since the Standard is not a standard for decision-making. That can be left to a document that describes the role of the integrated decision-making panel.

Section 4, RISK ASSESSMENT TECHNICAL REQUIREMENTS

Overall Observations and Conclusions

- There are flaws in the completeness, accuracy, logic, organization and structure of the technical requirements and the different categories. These flaws have fundamentally undermined the technical quality and acceptability of the standard.

- The supporting requirements of Category I do not define an acceptable PRA. Category III is devoid of value; it appears to be arbitrary with no purpose.

General Comments

Gen. 4-1 The supporting requirements need to be carefully edited so that they follow a logical flow that follows the analytical process. For example, SR QU-D10 needs to follow immediately after SR QU-D5. While this is not essential, it will make the Standard considerably more user friendly and give it the appearance of a well-organized logical document. In addition, the Quantification Section, 4.4.8, repeats many of the requirements from other sections. This is unnecessary duplication, and confusing when the words used are different.

Specific Comments

Section 4.1, Purpose

4.1-1 Suggest changing the first sentence to: "This Section provides the technical requirements for the three categories of PRAs identified in Section 1.5.1. Using the process discussed in Section 3, these requirements can be used to help identify the specific PRA requirements necessary for each risk-informed application."

Section 4.2, Derivation of PRA Requirements

4.2-1 Section 4.2 introduces the term "PRA quality level." Other sections have used the term "capability level" (Section 1.3) and "application categories" (e.g., Sections 1.5 and 3.4). Efforts needs to be made to use a consistent set of terms throughout the Standard.

4.2-2 Suggest changing the first sentence to: "The objective of this Section is to identify requirements for each PRA technical element to help determine the PRA quality necessary for risk-informed applications."

4.2-3 The wording in the forth sentence states that any PRA "ought to possess" the high level requirements in the Standard. This wording needs to be change to "shall possess" and made consistent with other Sections which include Sections 1.4.2 and 4.2.2.

4.2-4 Figure 4.2-1 lists the implied sub-tier criteria from 19 BWR certifications as an input in the definition of SRs. This essentially reflects the efforts of a few engineers involved in the BWR certification process to establish requirements for the certification process after they were completed. In the generation of Revision 10, the knowledge gained from the IPE review and subsequent publication of the IPE Insights report (NUREG-1560) and Draft NUREG-1602 was utilized in defining the requirements for a quality PRA. Since some of the Revision 10 requirements were incorporated in some fashion in Revision 12, these resources needs to also be listed as inputs in the definition of the SRs.

4.2.1-1 The HLRs in all sections are used to define and organize the subsequent detailed requirements. Poor definition and ordering of the HLRs have led to unorganized and disjunct sections that do not always make sense.

A proposed solution is to define and order the HLRs according to the major steps used to perform each PRA element. In doing so, the subsequent detailed requirements can be discussed in an order that matches the process typically used in a PRA. There are several examples of this in Revision 12. The Systems Analysis, HRA, and Internal Flooding sections have good HLR definition. For the Systems Analysis and Internal Flooding, the supporting requirements are presented such that the flow matches the general process for performing those elements. These sections seem to read more like Revision 10. The ordering of the HLRs in other sections of Revision 12 result in poor organization, redundancies, and contradictions in the supporting requirements (examples are provided in subsequent comments).

Using the above suggested approach, the definition of HLRs would vary significantly for each PRA element. There is no need to make them match and any effort to do so could negatively impact the organization and presentation of the detailed requirements.

4.2.2-1 The wording in this section needs to clearly indicate that the HLRs “shall” be applicable to PRAs that support all levels of applications.

4.2.2-2 It would be beneficial to define what is meant by “plant fidelity” (i.e, the PRA element represents the as-built, as-operated plant). Shouldn’t it be “model fidelity”?

4.2.3-1 The phrase “in the Standard” in the first sentence needs to be moved after “..were developed..” In addition, recommend changing “..at the various..” to “..for various…”

4.2.3-2 This section clearly needs to state that the SRs identified in Section 4 “shall be met if necessary for an application” or as indicated in Section 3, supplementary analyses/measures must be applied if the SRs impact is significant. Note that Section 4.4 just states that the SRs “shall be met using written guidance.” Consistent language and logic between the Sections 1.4.2, 3.5, 4.2.3, and 4.4 needs to be adopted.

Section 4.3, PRA Elements and Attributes

4.3-1 Table 4.3-1 presents the PRA attributes for each element appropriate for each application category. Unfortunately, it is difficult to link these element attributes to the overall application category attributes listed in Section 1.5.1 (relocating this table to Section 1.5.1 needs to also be considered in order to better define the three categories of applications). The table uses undefined words such as “dominant” and “risk-significant” to differentiate between the PRA attributes for the three application categories. The difference between these two terms is not clear. Furthermore, the use of these terms is inconsistent with the SRs listed for many of the PRA elements. For example, Table 4.3-1 states that only dominant initiating events need be identified and quantified for a Category I application (how do you know which initiating events are dominant or risk significant until after you do the analysis?). However, the SRs for identifying, grouping, and screening initiating events are essentially the same and needs to result in identification and quantification of dominant and risk significant initiating events for all three application categories as they should. The element attributes and the terms used in them need to be defined such that they provide

the link to the overall category attributes and are consistent with the category SRs. Otherwise, this table is meaningless and needs to be deleted.

Section 4.4, Requirements

4.4-1 This section indicates that the corresponding industry certification process requirement (NEI 00-02 uses the term criteria – not requirement) identifiers are provided in Tables 4.4-1 through 4.4-9. This presupposes that NEI 00-02 may be the only document that any one would use for a peer review of a PRA. Cross-referencing between the Standard and the industry peer review process more appropriately belongs in NEI 00-02. Currently, there appears to be a bias for styling the Standard to be consistent with industry references and needs rather than the other way which is more appropriate.

4.4-2 The one sentence Category definitions for each element PRA provided in the tables in Section 4.4 are not very useful. They are very broad definitions that use terms that are vague and undefined. For example, several of the elements use “dominant accident sequences” in the Category I definition and “risk-significant accident sequences” in the Category II definition. The difference between these two terms has not been defined anywhere. Does dominant refer to CDF, LERF, or both? Even more perplexing is the use of the term “modeled accident sequences” in some of the Category III element definitions. This definition implies that one could choose to only model one accident sequence that contributes to CDF and LERF and still meet the requirements for a Category III PRA. Expansion of the category definitions provided in Table 4.3-1 to include some key attributes needs to be performed. Specific comments for some of the element category definitions are provided in the comments submitted for that section.

4.4-3 A number of the references cited in the tables in Section 4.4 are not identified (e.g., References 4.4.6-4 and -6 in Table 4.4.6c on page 95 of the draft standard).

4.4-4 Even given the Standard’s requirement that the PRA be peer reviewed, the HLRs need to avoid such vague terms as “reasonably” complete.

4.4.1, Initiating Events

Table 4.4-1-1 The current HLRs for the initiating event analysis are ill-suited for organizing the SRs and have resulted in redundancies and a poorly written section. The supporting requirements for the initiating event (IE) analysis would be better organized according to the major tasks that are required. These tasks involve identifying the IEs, grouping them, quantifying their frequency, and screening some out. The HLRs for this element need to coincide with these tasks (the fifth HLR being documentation). This logical structure is used in the organization of the documentation SRs so why not use it in organizing the rest of the SRs?

Using these tasks as HLRs, the order of HLR-IE-A and -B needs to be reversed (you need to identify individual initiators before you decide what the initiator groups or categories are), the treatment of dependencies needs to be addressed in the grouping HLR, plant fidelity (there are no SRs listed for this so why was it defined?) is reflected in the SRs for identifying plant-specific IEs and in their quantification using actual plant information, and screening-related SRs need to be separated into a screening HLR.

Table 4.4-1a-1 The definition of each of the application categories at the top of Tables 4.4-1a through 4.4-1f are not useful in deciding which category to follow. How does one decide which initiators are dominant or risk significant until they perform the PRA? Following the logical progression from dominant to risk significant, shouldn't the Category III definition state that dominant, risk-significant, and non-risk-significant initiating events are identified and quantified? These definitions need to be replaced with definitions that indicate that credible initiators are identified and quantified for all three categories, with any difference between the categories having to do with grouping.

Table 4.4-1a-2 The example methods for identifying initiators provided in SR IE-A1 need to be expanded to include the most common method used for existing reactor types - use of lists of known initiators. References to EPRI NP-2230 and NUREG/CR-3862 can be provided as sources of such lists.

Table 4.4-1a-3 SR IE-A2 distinguishes between two types of initiating event groups. It is not clear that this distinction is necessary. A single event tree can be constructed for all initiating events or categories (it could be a functional event tree or a systemic event tree). What is critical is that the effect of each initiator group on the accident response be accounted for in some fashion (e.g., explicitly in different events or by using flags or split fractions). These impacts, if not addressed in separate event tree structures, are addressed in the quantification. Usage of these two different IE category definitions in the Standard needs to be reviewed for consistency and clarity. It is not clear that "quantification initiating event categories" is used any where else.

Table 4.4-1a-4 Providing an example list of initiator groups in SR IE-A4 is a good idea. However, it needs to be expanded to show typical BOP transient groups. Typical BOP transient groups include loss of feedwater, transient with the PCS available, and transient with the PCS unavailable.

Table 4.4-1a-5 The requirements in SR IE-A6 for Categories II and III appear to be incomplete. In both categories, it is stated that to avoid excess conservatism, do not group initiators "unless the impacts are comparable to or less than those of the remaining events in the group." But in reality, the potential for conservatism is affected by the frequencies of each of the

initiators in a group, not just the impact on systems. This is somewhat reflected in the Category III requirement which includes the additional statement "or it is demonstrated that such grouping does not appreciably impact CDF or LERF." This is also true for Category II applications and needs to be added.

Table 4.4-1a-6 SR IE-A7 is the converse of SR IE-A6, and both could be subsumed in SR IE-A2.

SR IE-A3 could become SR IE-A1 if the word categories were removed. If the IEs themselves challenge normal operation etc., then the groups will.

Table 4.4-1b-1 The first sentence in SR IE-B1 is poorly written. In addition, the idea of including events that have occurred at low power, if applicable, seems to be a related idea. Consideration needs to be given to combining these requirements.

Table 4.4-1b-2 The Category II requirement in SR IE-B2 requires a systematic evaluation to determine if a systematic evaluation using a defined process is required for identifying support system initiating events. This is less of a requirement than that listed for Category I which actually requires an evaluation to determine if a support system [failure] can result in an initiating event. SR IE-C1 is a redundant requirement that also addresses identifying support system initiators. The wording and progression of requirements in IE-C1 make more sense. Thus it is recommended that SR IE-B2 be deleted (i.e., replace SR IE-B2 with SR IE-C1).

Table 4.4-1b-3 SR IE-B6 needs to be changed to indicate that low power events that are applicable to full power operation need to be included as potential initiating events. The actual shutdown event should not be used in quantifying the initiating event frequency. Unplanned controlled shutdowns need to also be included since they generally reflect a degraded plant condition (the reason for the shutdown) that may be risk significant.

Table 4.4-1b-4 SR IE-B7 needs to be mandatory for all three Categories. Whatever the application, there must be a reasonable assurance that all potential initiating events have been identified. The difference between the Categories needs to be in their grouping and screening.

Table 4.4-1b-5 SRs IE-B8 and IE-B9 need to be changed to indicate that identifying initiating event precursors and initiators resulting from multiple equipment failures is mandatory for all three application categories. How they are grouped can be Category specific. Further what do SRs IE-B8 and 9 mean? Are they a means of achieving the requirement SR IE-B2?

Table 4.4-1b-6 SR IE-B10: It is not clear what this means. It could mean "don't take credit for a cross-tie if that cross-tie is effectively removed by the initiating event", or it could mean "address the reduced availability of support systems when they have to be shared by two units". Whichever of these is implied, the evaluation would have to be done in the PRA model itself, not in this task. The accident sequence analysis, success criteria and systems analysis tasks, which is where this would be expected to be addresses, do not address this issue explicitly.

Table 4.4-1b-7 SR IE-B9 appears to contradict SR IE-A4, which requires the treatment of special initiators.

Table 4.4-1c-1 As mentioned previously, SR IE-C1 addresses the same subject matter as SR IE-B2 and is thus redundant.

Table 4.4-1c-2 What is the difference between SRs IE-C2 and IE-A6? The grouping of support system initiators with other initiators must follow the same guidelines as all other initiators.

Table 4.4.1c-3 SR IE-C2 could be deleted: the inclusion of support system initiators is already required by SR IE-A4.

Table 4.4.1c-4 SR IE-B10 allows support system initiators to be truncated or subsumed in other initiating event groups if it can be shown that this does not "distort" Category I applications. Presumably, determination of "distortion" requires a comparison of results with and without truncation/subsuming. In other words, it seems to require the quantitative analysis required for Categories II and III.

Table 4.4-1d-1 The wording of SR IE-D1 implies that screening of initiators is required. The wording needs to be changed to indicate that screening may be performed according to the three criteria listed. Also, since two of the screening criteria require calculation of the initiator frequency, it seems logical that this criterion follow the requirements in Table 4.4-1d that address quantification.

Table 4.4-1d-2 The purpose of SR IE-D9 is unclear. Shouldn't the calculated initiator frequencies be reflective of plant-specific data? This may result in frequencies that are inconsistent with industry experience. Also, why is recovery being addressed in this section?

Table 4.4-1d-3 Why is recovery actions being addressed in the initiating event element (SR IE-D10)? Any requirements dealing with the quantification of recovery actions belongs in the data analysis element for offsite AC power recovery or in the HRA element.

Table 4.4-1d-4 SR IE-D15. In category I, first sentence, what is it that is AUGMENT(ed) with a fault tree evaluation? For categories II and III it is clear that the generic estimates are the starting point.

Table 4.4-1d-5 Table 4.4-1d. It isn't clear why SRs IE-D11 and IE-D12 are separated, or why one states "COMPARE the results" and the other states "PERFORM a review/comparison." It also isn't clear why SR IE-D9 is separated; this would seem to be a natural consequence of the comparison.

Table 4.4-1d -6 The logic flow of the SRs is unclear. For example, SRs concerning the data to be used are mixed up with SRs concerning decomposition modeling of initiating events. A clear flow, perhaps augmented by sub-grouping, is useful especially when there is a long list of SRs. Not only will this help the reader understand, it will help a reviewer determine if all of the important requirements have been identified. Similar comments hold for many other HLRs.

Table 4.4-1d-7 It isn't clear why the quantification of initiating events is treated separately from the quantification of other PRA model events. Many of the same principles apply. There is no HLR tying the quantification of initiating events with the data analysis requirements of Tables 4.4-6. Such an explicit tie is needed to ensure consistency.

Table 4.4-1d-8 SR IE-D15 allows the use of engineering judgment for "extremely rare" initiating events. "Extremely rare" is not defined. Furthermore, the SR does not require the use of "expert judgment," and so there is no requirement to follow the provisions of Section 4.6. If the initiating event is frequent enough to pass the screening criteria of SR IE-D1, and if it has significant consequences, some kind of analysis beyond ad hoc quantification needs to be required.

Table 4.4-1e-1 Since there are no supporting requirements for HLR-E (plant fidelity), it needs to be eliminated as an HLR. Plant fidelity is reflected in the SRs for identifying plant-specific IEs and in their quantification using actual plant information.

Section 4.4.2, Accident Sequence

Table 4.4-2-1 The defined HLRs for the accident sequence analysis appear to be some what arbitrary. In addition, the supporting requirements listed under each also are not organized in a concise fashion. Consideration needs to be given to defining the HLRs with the goal of organizing the SRs better. For example, HLRs could be established with regard to method selection, modeling mitigating functions, mitigating systems, operator and recovery actions, dependencies, and defining end states.

Table 4.4.2-2 High level Requirements A and B are essentially the same, or at least have a lot in common. They need to either be rationalized, or a clear distinction made, and any duplication of supporting requirements deleted.

Table 4.4-2a-1 The definition of each of the application categories at the top of Tables 4.4-2a through 4.4-2f are not useful in deciding which category to follow. How does one decide which accident sequences are dominant or risk significant until they perform the PRA? Following the logical progression from dominant to risk significant, shouldn't the Category III definition state that dominant, risk-significant, and non-risk-significant (credible) accident sequences are modeled? These definitions need to be replaced with definitions that indicate that the accident sequences for each initiator group are modeled, with any difference between the categories having to do with level of modeling (e.g., from conservative to realistic, from limited to complete). Since the Standard doesn't show any difference in the SRs between Category II and III, the definitions for these two could be the same.

Table 4.4-2a-2 It is noted that the major difference between the supporting requirements for Category I versus Categories II and III is that Category I allows the use of conservative methods "to the extent that Category I applications are not distorted." Some Category II and III SRs also allow conservative methods "to the extent that realistic estimates of CDF and LERF are not distorted." In the cases where both of these statements are made (e.g., SRs AS-B11, AS-C3, and AS-D10), there are no differences between the Categories and they need to be treated the same.

Table 4.4-2a-3 In SR AS-A2, (b) and (d) need to be combined. The plant response needs to be based on the initiating event category or individual initiating event dependent upon the resulting IE grouping that is performed. In addition, there needs to be no difference between the three categories, all three must model the different plant response for each initiator group. This doesn't necessarily mean that a different event tree is required. The same event tree could be used but flags could be used to turn events on or off for different groups (e.g., a functional event tree approach).

Table 4.4-2a-4 It is not clear how one addresses the level of discrimination in the event tree structure referred to in SR AS-A4 with out actually developing it. Suggest making the requirement the same of all three categories.

Table 4.4-2a-5 Suggest combining SRs AS-A1 and AS-A5. The event tree approach is an acceptable method for accident sequence analysis.

Table 4.4-2a-6 In SR AS-A12, how is the use of system dependency matrices a method for developing event sequence models? They can help in the development of accident sequences but they are not a method in themselves. They need to be deleted from this requirement

but retained in SR AS-D3 as a method for accounting for dependencies. Also, this requirement talks about methods for sequence analysis as does SR AS-A1. Consolidation of these requirements needs to be considered. For Category I, SR AS-A12 is currently inconsistent with SR AS-A5 (SR AS-A12 states that one needs to consider using event trees while SR AS-A5 says one should use event trees). The need for SR AS-A13 is questionable in light of these comments.

Table 4.4-2a-7 SR AS-A2 What is the difference between "reflects the initiating event categories" and "is explicitly traceable to the init..."? Similarly in SR AS-A4, what is the real difference between ADDRESS and DEVELOP? Since the logic structure has to be correct, the differences between the categories needs to somehow be related to level of detail, and the degree of approximation. This is not clear.

SRs AS-A1, 2 and 7 could easily be combined.

SR AS-A9 introduces the term event sequence. Is this the same as accident sequence or is it something new (assume not)? It is not clear what the word INCLUDE means in this context. A critical safety function could be used as an event in the event tree, or it might be expanded into several events representing the systems that can fulfil that function. Either way, the systems need to be included in the logic model; in the former case via a functional fault tree for the event, in the latter by events in their own right.

A new requirement needs to be included: "Define the success of each event tree event in functional terms as a link to the success criteria and systems analysis tasks." Or is this what is intended by SR AS-C4? If this is the case, then the Success Criteria task needs to be characterized as defining the system requirements, timing, etc. required to perform these functions.

Table 4.4-2b-1 In SR AS-B2, both success and failure paths in the accident sequence models must be consistent with the core damage definition.

Table 4.4-2b-2 SR AS-B12 states that a single fault tree model can be used for accident sequence analysis. What are the requirements for modeling system successes in this or any other alternate approach? Can you ignore them in Category I (consistent with a conservative approach) but not in the other two categories (consistent with a realistic model)?

Table 4.4-2b-3 SRs AS-B1, 2, and 3 are good examples of a distinction between Category I and higher category applications. However, what are the models and analysis in the context of accident sequence development? At this stage there are no models, only an identification of what functions are required and in what order. Similarly in SR AS-B3, the discussion of repair and recovery seems to be leaping ahead to quantification or other analyses. If this is to address the issues of repair and recovery in special cases such as the loss of offsite power initiator, it might be better to be more clear.

Isn't SR AS-B4 the same as SR AS-A4? In any case, it's covered by SR AS-B5.

Table 4.4-2c-1 SR AS-C1 refers to "functional success criteria" developed in Success Criteria. The term 'functional success criteria does not appear in Section 4.4.3. Since it is an important intermediate step, defining functional success criteria needs to be identified as a supporting requirement (see comment Table 4.4-2a-7 above).

Table 4.4-2d-1 SR AS-D1 refers to a dependency evaluation task of a PRA. Since this was removed as a separate PRA element in the Standard, this reference needs to be deleted. In addition, the reference to the interface between the sequence analysis and systems analysis elements in this requirement is redundant to SR AS-C4 and thus could be consolidated.

Table 4.4-2d-2 Consideration needs to be given to combining SRs AS-D2 and AS-D4, although SR AS-D2 is simply a restatement of the HLR. In SR AS-D4, what is the requirement for intrasystem dependencies? The second requirement listed under <u>Intra and Intersystem</u> does not make sense (identify dependency matrices and linked fault trees) and needs to be rewritten. In SR AS-D4, the description of human dependencies is incorrect. What needs to be included here is the dependency of the functions or systems modeled on operator actions. The impact of the plant conditions on the HEPs is discussed in the HRA section.

Table 4.4-2d-3 SRs AS-D13 and AS-D14 deal with transfers from one event tree to another and are redundant to SR AS-A10. Consolidation of these requirements is recommended.

Table 4.4-2d-4 SR AS-D1 refers to a "dependency evaluation task"; there is no corresponding section in the Standard.

The example in SR AS-D3 addresses hardwired inter-system dependencies only.

Table 4.4-2d-5 In SR AS-D5, the last sentence appears to state that dependencies between mitigating systems and operator actions need not be modeled. This is not correct; these dependencies need to be modeled in situations where they exist.

Table 4.4-2d-6 The SRs need to be revised to ensure that consistent terminology is used throughout. (For example, SR AS-D2 refers to "functional, phenomenological, and operational dependencies and interfaces", while SR AS-D4 refers to "functional, intra and intersystem, human, and spatial/environmental/phenomenological" dependencies.)

Table 4.4-2e-1 SR AS-E2 requires documentation of independent reviews of the accident sequence analysis and the qualifications of reviewers. The documentation of the peer review is addressed in Section 6. There are no requirements for other reviews. This requirement needs to be deleted.

Section 4.4.3, Success Criteria

4.4.3-1 This section needs to be edited to make it clear that what is being addressed is the definition of the system requirements to meet the functional level success criteria developed in the definition of the event sequences. It is confusing to have supporting requirements to develop success criteria in both the accident sequence analysis (SR AS-C4) and success criteria sections without making some distinctions.

4.4.3-2 Objectives of the success criteria technical element are provided as bullet items in Section 4.4.3. They don't seem to follow a particular order. It would be desirable to have them ordered consistently with the HLRs and the SRs in Tables 4.4-3a through 4.4.3d to show where these objectives are met and to provide additional information for a better understanding of the HLRs and SRs.

Similarly, the items listed in the documentation requirements (Table 4.4.3d) could also be consistently ordered. It would make review easier if they were ordered consistently with the PRA report sections for success criteria.

4.4.3-3 Although important issues are covered in Table 4.4.3-3a for "Technical Basis", the SRs provided in this table are difficult to follow. They could be presented in a more logical order or structure, or, additional descriptions could be provided for a better understanding. For example, SC-A3 stated "SPECIFY the criteria and bases for reaching a safe, stable state with respect to the minimum set of mitigative systems/functions to prevent core damage or radioactivity release in the accident sequences." Does this mean that under the requirement of SC-A3 one only needs to check whether "criteria" and "bases" are provided? Should the SR not specify more than that? Such as that success criteria are provided for all the initiating event groups identified in HLR-IE-A. Otherwise, SC-A3 could easily combined with SC-A4.

(Although it seems that "criteria" used here means "success criteria", it would be better to use "success criteria" because the term "criteria" is used elsewhere in this table for different things.)

4.4.3-4 SC-A6 deals with the "grouping of initiating events or for accident sequences". The requirement for this SR for Categories II and III is "ASSIGN the success criteria for systems and human actions applicable to the most limiting element in the group of initiators or sequences". The use of the "most limiting element" may not be appropriate for Category III, which requires "realistic bases". The SR needs to also require that the grouping would not significantly affect analysis results (e.g., risk contributions).

4.4.3-5 SC-A8, SC-A9 and SC-A10 all deal with structural integrity. SC-A8 states "DEFINE the criteria used to determine structural integrity for piping, vessels, and structures important to the determination of CDF and LERF." This definition seems to cover the requirements of both SC-A9 ("EVALUATE reactor pressure vessel ultimate capacity") and SC-A10 ("DETERMINE the pipe ultimate capacity"). In fact, the requirements for SC-A9 and SC-A10 are for RPV failure and ISLOCA, respectively. The sources of these two requirements as stated in the table are from ST-4 and ST-9 of the Industry PRA Peer Review Criteria. The titles for ST-4 and ST-9 are "RPV CAPABILITY (ATWS)" and "PIPE OVERPRESSURE (ISLOCA)", respectively. It is suggested that these titles be used at the beginning of SC-A9 and SC-A10 to highlight the objectives of these requirements.

(It is not clear what “criteria” are looked for here. Are they structural failure criteria?)

Tables 4.4-3-1 And tables 4.4-3a through d - The V&V requirements for the codes used to develop success criteria are weak. They only require that the reasonableness of the results be checked (SR SC-B2), and that the ability of the codes to provide the required information be evaluated (to varying levels of detail) (SR SC-C2).

Section 4.4.4, Systems Analysis

4.4.4-1 This section is generally good. As a general observation, there are relatively few distinctions between the three categories of application, and those that exist are somewhat forced, concentrating on what are in some cases, minor differences (e.g., SRs SY-B3, SY-B13), and in other cases, inappropriate (e.g., SR SY-B16). There are many instances of "do X ... unless it does not affect the results". This can be a blanket statement for all applications, supporting the case that it is not necessary to have three columns. This reinforces the claim that it is superfluous to have the Standard address three grades of application.

Table 4.4-4-1 On a relative basis, the HLRs for the system analysis are defined such that the supporting requirements are presented in a logical fashion. The HLRs for other elements need to be defined to provide a similar logical presentation of the supporting requirements.

Table 4.4-4-2 The definition of each of the application categories at the top of Tables 4.4-4a through 4.4-4d are not useful in deciding which category to follow. How does one decide which accident sequences are dominant or risk significant until they perform the PRA? Furthermore, the Category III definition of "modeled sequences" leaves open the possibility of modeling one sequence meeting the Category III requirements. These definitions need to be replaced with definitions that indicate that system models for the three categories vary by their level of completeness and supporting analysis.

Table 4.4-4b-1 In SR SY-B3, Category I, what good does it do to only consider the effects of alternate system alignments. Those system alignments could be risk significant. The SR SY-B3 requirement needs to be the same for all three categories. Alternatively, Category I could consider alternative system alignments but only have to include them in a fault tree if they result in a more vulnerable state for a sufficient fraction of time.

Table 4.4-4b-2 SR SY-B11 needs to indicate that component failure modes that occur prior to an accident in addition to those that may occur during the accident must be included (unless of course they meet the screening criteria in SR SY-B12).

Table 4.4-4b-3 In SR SY-B13, coordination between the modeling of pre-accident human errors and their inclusion or exclusion from component failure rates needs to occur. The critical modeling element that needs to be addressed is the modeling of common cause pre-accident human errors which are generally not reflected in the component failure data. These common cause pre-action human error events need to be include in the fault trees used in all three levels of applications.

Table 4.4-4b-4 For Categories II and III, there are four modeling requirements that are not present in Category I. These four modeling requirements are redundant to the requirement to "MODEL the type of testing and maintenance consistent with the actual practices and history of the plant for removing equipment from service." Therefore, these four requirements can be deleted (or used to replace the other one) and the requirements for all three categories be made the same.

Table 4.4-4b-5 It is believed that SR SY-B17 is meant to refer to modeling degraded system conditions that, even though the system is functional, results in the system not meeting the required success criteria. The engineering calculations referred to in this requirement

are used to identify when these degraded conditions occur. The calculations are required for models in all three categories but if they are not performed, then the systems needs to be assumed to fail at some conservative level of operation.

Table 4.4-4b-6 In SR SY-B18, if the credit for system operation beyond design basis conditions is not based on the sources listed, then the system/component needs to be considered inoperable (i.e., assume the component/system fails with a probability of 1.0 once the design basis condition is reached).

Table 4.4-4b-7 SR SY-B4 is redundant to SR SY-A2.

Table 4.4-4c-1 In SR SY-C1, only intra-system common cause failures that are supported by generic or plant-specific data needs to be modeled.

Table 4.4-4c-2 In SR SY-C5, what is “this” referring to in the second sentence - modeling support systems or showing their omission is not important? It is believed it is the former. In addition, it is believed that the sentence under “dependency matrices” refers only to dependency matrices and not to fault tree linking. The wording of this requirement needs to be made clear.

Table 4.4-4c-3 The purpose of the engineering analyses referred to in SR SY-C6 is to determine if support systems are needed to support the operation of another system. The requirement needs to be changed to more clearly reflect this fact.

Table 4.4-4c-4 The exception identified in the requirement in SR SY-C9 needs to be clarified or eliminated. Support systems are eliminated when linking fault trees when necessary to break a logic loop. In general, all support systems need to be identified and included in the construction of fault tree.

Table 4.4-4c-5 The requirements in SR SY-C11 for Category I are internally inconsistent. How do you include the presence of the conditions needed for automatic actuation or address permissive and lockout signals if you don’t model the actuation signals? It is recommended that the requirements be the same for all three categories. However, if some difference is required for Category I, then specify that actuation signals only need be modeled if they actuate multiple components and/or share logic with actuation signals for other components.

Table 4.4-4c-6 It is believed that SR SY-C12 is addressing the same requirement as SR SY-B17. If so, these requirements need to be consolidated. If not, further clarification on each is needed.

Table 4.4-4c-7 SR SY-C1 If you could show that common cause failures do not impact the results, do you still have to model them for Categories II and III? Ditto for SR SY-C2.

Section 4.4.5, HRA

4.4.5-1 In the list of objectives:

Second bullet: Replace by “the methodologies for identification of human failure events and the estimation of their probabilities are consistently described and applied”.

Third bullet: The meaning is not at all clear; clarify or delete.

Fourth bullet: Replace “operator errors” by “human failure events”.

Seventh bullet: This is incomplete and looks as if it’s headed in the wrong direction - HRA does not address design and construction errors - delete.

Eighth bullet: Replace “human errors” by “human failure events”

Ninth bullet: The reference to quantitative errors is unclear. This should be clarified or deleted.

Eleventh bullet: Replace “operating crew errors” by “human failure events”.

Twelfth bullet: Add “definition of human failure events” before , and the resulting HEPs.

4.4.5-2 Given the potential impact of HRA on the overall PRA results, most if not all applications will probably require a reasonably close look at human error. Therefore, there are a number of SRs where the Category III requirement needs to probably be extended to Categories I and II. Examples include: SRs HR-A3, HR-E3 (elements referring to other relevant procedures, e.g., AOPs; note that SR HR-E6 refers to AOPs), SR HR E-6 (elements referring to cues and to complexity), SRs HR-E8, HR-F7 (the initial text and the last bullet), and HR-G1. Note that some of the SRs for Category I applications could lead to HEPs that are significantly non-conservative in comparison with the results of Category II/III analyses.

Table 4.4-5-1 The high level requirements are OK, but they are very high level. Perhaps modify HLR E as follows “A systematic process shall be used to identify **and define** the human failure events associated with post-initiator human actions”, Human Reliability Analysis.”

Table 4.4-5a-1 SR HR-A1 is the only supporting requirement needed for HLR A, which refers only to activities that need to be addressed.

SR HR-A2 can be deleted; it’s dealt with through HLRs B and C

SR HR-A3 belongs with HLR B.

Combine some of the elements of SRs HR-A3 and HR-B1 as the following. “ By review of procedures, operating experience and plant practices IDENTIFY those activities that lead to equipment realignment and can leave equipment outside its normal operational or standby status. (Delete the next sentence - it is obscure.) Identify a reasonably complete set of human failure events that can result from: (then add the three bullets from SR HR-A3).

Table 4.4-5b-1 Delete SR HR-B2.

Table 4.4-5b-2 Rev. 12 provides no requirement on screening for Category I applications (SR HR-B3). It doesn't even require that the screening be done systematically. At the minimum, the Category II SR needs to be used.

Table 4.4-5c-1 SR HR-C3 Under category I, delete the first paragraph.

SR HR-C5 This is not clear, and probably could be deleted. Methods such as THERP include recovery of the initial error as a result of administrative controls, such as independent checking, in the estimation of the HEPs for events such as failure to restore. The bullets following the reference to NUREG/CR-4772 are examples of administrative controls that are identified in SR HR-C3.

Delete SR HR-C8 as it is little more than a restatement of the HLR C.

Table 4.4-5c-2 SR HR-C3 allows the use of screening estimates, but does not provide any requirements concerning these estimates.

Table 4.4-5c-3 References need to be provided for SR HR-C1.

Table 4.4-5e-1 The standard for post-initiator human failure events is not explicit about requiring that the contributions from cognitive and execution failures are included.

SR HR-E2: Is this a requirement to address errors of commission?

SR HR-E3: The review system operation needs to be included for Category I also.

SR HR-E6: Why are the fourth and fifth bullets left out in Category I? The cues and other indications are essential since their absence can be conservatively treated as a failure criterion. The logic model for category I might be less detailed but it needs to still reflect the complexity.

Add a first bullet: "contributions from cognitive failures (i.e., failures to detect, diagnose, and formulate a response) and failures to execute the required actions". This is an important consideration when addressing dependencies.

Why is the thought contained in the last paragraph in Categories I and III not included for category II? Delete the last sentence under Category III; this is inappropriate in a discussion of a qualitative analysis.

SR HR-E8: The factors in the bullets are both <u>scenario</u> and plant-specific. The opening sentence for Categories II and III needs to make this clear. What is the message here? Are the bullets the PSFs that we expect to be addressed? What is the meaning of the last paragraph in Category III? Is it just to say that additional PSFs may (should or shall) be added as necessary?

Table 4.4-5f-1 SR HR-F1: Delete. It is a trivial point.

SR HR-F3: In the column for category II applications, which is the most useful column, bounding assessments are allowed. This is not good practice. It needs to read the

same as Category III. Replace “time dependent HEPs” by HEPs. The timing issue has already been addressed.

SR HR-F4: Delete. There are no generic data on human errors in post-initiator scenarios.

SR HR-F5: This requirement is addressing dependency, although the word does not appear. This requirement appears again in SR QU-B2, although it is worded differently.

SR HR-F6: Tests for consistency need to be performed whatever the category.

Table 4.5-5f-2 It isn’t clear what SR HR-F6 is requiring.

Section 4.4.6, Data

4.4.6-1 Numerous requirements in Revision 10 were not incorporated in Revision; this is particularly evident for the data requirements; see table at end of data comments for a comparison of Revision 10 and Revision 12 for just the data requirements.

4.4.6-2 General Comment: The word data is used indiscriminately to represent unreduced data (such as event reports), reduced data (such as numbers of failures and numbers of demands), or other estimates. An example is SR DA-A4. If the data needed is the unreduced data, it would be easier to get it from one's own plant rather than from others. The inference is that in this case, data refers to estimates, which might be easy to get. The language needs to be cleaned up to clarify what is intended.

4.4.6-3 Objectives listing -The second bullet needs to be the first since it describes the fundamental objective of this PRA task.

The third, fourth and sixth bullets are details not objectives, or in the case of the sixth, already covered.

4.4.6-4 The introductory paragraph indicates that Appendix A contains a description of the top down approach used in the standard to develop the requirements for Data Analysis contained in the subsequent table. Appendix A was not listed in the Table of Contents for Draft 12 nor was it available for review.

4.4.6-5 This section seems to use "evidence" interchangeably with "data." Neither is defined, so the user will not know if there is a distinction between the two. In some cases they appear to mean raw data and in others they mean parameter estimates.

Table 4.4-6-1 The words that follow the words "Scope, Realism and Parameter Estimation" do not relate well.

A Scope: This high level requirement does not address scope clearly. Suggest "Estimates shall be provided for parameters required to quantify the probabilities of the basic event in the PRA model". All the supporting requirements in HLR A relate to data collection. They do not define a systematic process and there are no process requirements as the current requirement statement would suggest, nor do they define scope.

B Realism: Realism is not mutually exclusive with HLRs A and C. There is no clear basis for organizing the supporting requirements. The current text of HLR B deals with parameter estimates, but they are the stuff of HLR C. Suggest instead "The parameters shall be estimated taking into account the definitions of SSC boundaries and the basic events." The first two sentences of HLR C need to be moved here. Move the current discussion under B into C.

C Parameter Estimation: Suggest rewriting as the two sentences from B and the last sentence of the current C.

Table 4.4-6-2 HLR D "Documentation: The supporting requirement defines what elements to document. There is not a correspondence, however, between the required elements and the components of the HLR. For instance, would a peer review be complete if these elements alone are documented or are other elements required?

Table 4.4-6-3 There seems to be no organizing principles to the HLRs. For example, the following supporting requirements categorized in HLR C could fit slightly better in HLR B, because they deal with the question, are the data real.

SR DA- C7: “BASE AC power non-recovery probabilities on available and applicable data that is traceable to its source. Lacking strong site-specific data, USE generic data for recovery of loss of offsite power.”

SR DA-C4: “When the Bayesian approach is used in developing the prior distribution, ACCOUNT for relevant generic data and plant-to-plant variability. INCLUDE in the plant-specific data all relevant and recent operating experience.”

The supporting requirements need to be reorganized to meet the HLRs.

Table 4.4-6a-1 SR DA-A1 is the only supporting requirement for HLR A.

SRs DA-A4 and DA-B6 are inconsistent.

Table 4.4-6a-2 SR DA-A2, first paragraph, Category I applications requirements for generic data appear to be more stringent than the corresponding Category II and Category III requirements for generic data and plant-specific data.

Table 4.4-6b-1 SRs DA-B9, DA-B10 and DA-B11 belong in the systems analysis part of the standard.

Table 4.4-6b-2 and table 4.4-6c allow the use of generic data, but do not have any requirement to check if plant-specific experience: a) is vastly worse than the generic data, and b) use of the plant-specific experience could significantly impact the PRA results (with respect to the application). Such a requirement is needed.

Table 4.4-6c-1 None of the cited references appear to be provided.

Table 4.4-6c-2 SR DA-C6 is stated as a requirement to the reviewer, rather than as a requirement for the PRA analyst.

Table 4.4.6c-3 SR DA-C1, Category II and Category III, “Reference 4.4.64" needs to be “Reference 4.4.6-4.”

Table 4.4-6c-4 SR DA-C6: How do you address uncertainties in assessing point values? Aren’t point estimates typically given when no effort is made to address uncertainty?

Table 4.4.6d-1 Documentation Requirements, do not address the documentation of uncertainties used in the parameter estimation as specified in Table 4.4.6c, SR DA-C6.

Comparison of Actual Text in Draft 10 to Draft 12

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
3.3.5 Data Analysis. The data analysis <u>**shall**</u> represent performance (plant-specific and across-the-industry) of equipment under conditions modeled in the PRA.		
3.3.5.1 Methods Selection. Data that is specific to the event, equipment, and the plant in question <u>**shall**</u> be used; if data at the specific level is not available, then data that corresponds to equivalent events, equipment, or the plant <u>**shall**</u> be used; if no data is available, estimates based on models of the events <u>**shall**</u> be used; if modeling the events is not feasible, then expert judgment <u>**shall**</u> be used.	DA-B4 except "appropriate" instead of "specific." DA-B4 except "appropriate" instead of "specific," "similar" instead of "corresponds to equivalent," and "plant type" instead of "plant." DA-B4	
Whatever method is adopted, any estimate <u>**shall**</u> be accompanied by a characterization of the uncertainty in that estimate. **Uncertainty <u>shall</u> be characterized by a probability distribution on the parameter value, using the subjectivist approach to probability (Reference [3.3.5-1]).** Bayesian updating <u>**shall**</u> be used to combine plant-specific data with generic prior estimates (References [3.3.5-2], [3.3.5-3], and [3.3.5-4]).	DA-C6 "VERIFY that uncertainties are addressed in estimating the mean values of the data parameters to allow the estimation of the mean values of CDF and LERF." NF	DA-C1 "ESTIMATE mean values of parameters used to determine the frequencies or probabilities of events modeled in the PRA. <u>Acceptable systematic methods include: Bayesian updating, [Reference 4.4.64], [Reference 4.4.6- 5], frequentist method, [Reference 4.4.6- 6] or expert judgment"</u>
***3.3.5.1.1 Generic Dat*a. PRAs <u>shall</u> use the generic data sources specified in Subparagraphs *3.3.5.2 - 3.3.5.6* for each type of data. The generic data identified in this Standard <u>shall</u> be used as the plant-specific prior distributions.**	NF	
*Exceptio*n. - The requirement to use the specified generic data <u>**may**</u> be waived if other generic data used in the PRA is consistent with the database provided here.	NF	
3.3.5.1.2 Plant Specific Data. Plant-specific data collected in accordance with the requirements of Subparagraphs *3.3.5.2 - 3.3.5.6* <u>**shall**</u> be used to update the generic priors, as applicable. **Because the collection and interpretation of plant-specific data requires judgments based on a mix of engineering, systems modeling, operations, and statistical knowledge (Reference [3.3.5-5]), the reasoning supporting each interpretation <u>shall</u> be documented. *Exceptio*n. - Traditional frequentist**	DA-B2 "UPDATE generic data with plant specific data <u>except for components whose importance can be shown to be sufficiently low so as to not impact applications."</u> NF	

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
methods or Bayesian updating of non-informative prior distributions <u>may</u> be used (References [3.3.5-3], [3.3.5-6], [3.3.5-7], and [3.3.5-8]).		
*3.3.5.1.3 Verification Of Bayesian Data Analysis Result*s. When the Bayesian approach is selected, tests described in *(a)* and *(b)* below **<u>shall</u>** be performed to ensure that the updating is accomplished correctly and that the generic data is consistent with the plant-specific application: (a)any computer code used for Bayesian updating **<u>shall</u>** be verified on problems designed to test that binning routines do not lead to posteriors with single bin histograms and that plant-specific data with zero failures do not overly affect the posterior; and **(b) posterior distributions <u>shall</u> be examined to identify unusual results that can signify potential inconsistencies between the prior data and the actual equipment in the plant, incorrect plant-specific data (e.g., a data entry problem), or problems in the algorithm used for calculation.** Such unusual results **<u>shall</u>** be investigated to determine and explain the cause (equivalent to statistical testing among alternative hypotheses, Reference [3.3.5-9]);	DA-C5 When the Bayesian approach is used to derive a distribution and mean value of a parameter, PERFORM the following tests to ensure that the updating is accomplished correctly and that the generic data is consistent with the plant- specific application: •VERIFY that the Bayesian updating does not produce a posterior distribution with a single bin histogram; •IDENTIFY inconsistencies between the prior distribution and the plant- specific evidence; •VERIFY that the Bayesian updating algorithm provides valid results over the range of values being considered; **[What is valid?]** •VERIFY the reasonableness of the posterior distribution mean value. **[How; what is reasonable?]**	DA-C4 [3.3.5.1.3] When the Bayesian approach is used in developing the prior distribution, ACCOUNT for relevant generic data and plant-to-plant variability. INCLUDE in the plant-specific data all relevant and recent operating experience.
*3.3.5.1.4 Verification Of Frequentist Data Analysis Result*s. When traditional frequentist methods are used, results inconsistent with the generic data **<u>shall</u>** be investigated to ensure that the data generation and statistical calculations are correct and reasonable. Appropriate hypothesis tests **<u>shall</u>** be used to ensure that data from components grouped together for analysis is from compatible populations (Reference [3.3.5-10]). **Data from similar equipment (e.g., motor operated valves of different size) <u>may</u> be pooled when there are no engineering or operational reasons to expect significantly different performance (i.e., no design features or operational environments that would introduce or eliminate particular failure modes) and the grouped data pass an appropriate statistical test (References [3.3.5-3], [3.3.5-6], and [3.3.5-7]) to demonstrate that the pooled data does not contain information from significantly different populations from a statistical**	NF NF	DA-C3 When updating generic data using any method: •COMPARE the derived parameter value to that obtained from generic data. •USE appropriate hypothesis tests to ensure that data from grouped components are from compatible populations (Reference [4.4.6- 6], [4.4.6- 4], [4.4.6- 7], and [4.4.6- 8].

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
standpoint.		
*3.3.5.2 Initiating Event Data Attribute*s. The frequency of occurrence (per calendar year) for each transient, LOCA, and loss of support system event defined in the initiating events analysis Paragraph 3.3.1 **shall** be evaluated.	Table 4.4-1d IE-D13 "COLLECT and PRESENT initiating event frequencies on a calendar- year basis."	IE-D1 "USE as screening criteria the following characteristics (or more stringent characteristics as devised by the analyst) to eliminate initiating events from further evaluation: a) the frequency of the event is less than 1E- 7 per reactor- year (/ ry) and the event does not involve either an ISLOCA, containment bypass, or vessel rupture; b) the frequency of the event is less than 1E- 6/ ry and core damage could not occur unless at least two active trains of diverse mitigating systems are independently failed; c) the resulting reactor trip is not an immediate occurrence. That is, the event does not require the plant to go to shutdown conditions until sufficient time has expired during which the initiating event conditions, with a high degree of certainty (based on supporting calculations), are detected and corrected before normal plant operation is curtailed (either administratively or automatically). If either criterion (a) or (b) above is used, then CONFIRM that the value specified in the criterion meets the requirements in the Data- Analysis and Level- 1-Quantification sections."
3.3.5.2.1 Generic Initiating Event Data. The approach for analysis and, therefore, the generic data requirements depend on specific characteristics associated with the following three classes of initiating events:	NF	

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
(a) Observed Events - These events have been observed in the industry, have been adequately represented in the generic database, and are similar from one plant to another. The generic data for initiating event frequencies **shall** be taken from existing reports on initiating events (Reference [3.3.5- 11]) and loss of off-site electrical power (References [3.3.5-12], [3.3.5-13], and [3.3.5-14]). Re-grouping to accommodate plant-specific needs **may** be performed.	NF	
When the generic data report does not provide a distribution, a plant-to-plant variability prior **should** be generated using the first stage of the two stage Bayesian model with an uninformed prior, which accounts for the number of events that have occurred at each specific plant (Reference [3.3.5-15]), or using the empirical Bayes approach (Reference [3.3.5-10]).	NF	
***(b) Events Amenable to Fault Tree Modeling* –Initiating event level generic data shall not be used in the following cases.** • **for rare events that occur due to plant-design-specific combinations of lower level failures, whether the initiating events have been observed or not** • **for failure conditions that will evolve into initiating events if no operator recovery occurs**	NF	IE-D15 “For rare initiating events, USE industry generic data and AUGMENT with a plant specific fault tree evaluation that accounts for plant specific features, if applicable. For extremely rare initiating events, engineering judgment MAY be used; if used, AUGMENT with applicable generic data sources. INCLUDE in the quantification the plant specific features that could influence initiating events and recovery probabilities. Examples of plant specific features that merit inclusion are the following: · Plant geography, climate, and meteorology for LOOP and LOOP recovery · Service water intake characteristics and plant experience · LOCA frequency calculation
Generic data for the lower level failure events **shall** be used as described in Subparagraphs *3.3.5.3– 3.3.5.5* to support fault tree analysis described in *3.3.5.2.5(b)*.	NF	
(c) Unobserved Events, Not *Amenable to Fault Tree Modeling* - The probability of occurrence for major events that have not occurred in the industry **should** be	NF	

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addressed using selected techniques of expert elicitation in accordance with the criteria of Subsection 3.5 to assess an informed prior distribution based on the available engineering and operational knowledge. In each case, the identified information sources and the justification for their applicability to the plant **shall** be provided.		
***Exceptio*n. - For large and medium LOCAs that fit this category of initiators, the generic frequency of the events, based on the results of analysis and experiment, reported in (Reference [3.3.5-11]) should be used.**	NF	IE-D16 "In the interfacing system LOCA frequency analysis, ADDRESS those features of plant and procedures that could significantly influence the ISLOCA frequency.
***3.3.5.2.2 Initiating Event Data Definitions.* The procedure for selecting initiating event groups is defined in Paragraph 3.3.1. If new events, or events with differing immediate consequences (i.e., differing impacts on the systems required in the event sequence development of Paragraph 3.3.2) are found during the collection of data, the types of initiating events described in Paragraph 3.3.1 shall be revised. Initiating event frequencies should be collected and presented on a calendar year basis.**	NF	
***3.3.5.2.3 Plant-Specific Initiating Event Data Collectio*n. Events that lead to reactor trip shall be counted. Plant-specific data sources shall be reviewed and compared to ensure that all reactor trips are counted. A thorough search of plant-specific data sources shall be performed to identify all plant-specific initiating events.**	NF	
The events **shall** be grouped in accordance with the initiating event groups of Paragraph 3.3.1. The rationale **shall** be presented for those cases where the event data is complicated or unclear.	NF	
*3.3.5.2.4 Plant-Specific Initiating Event Data Applicabilit*y. Interpretations of plant records for collecting plant-specific initiating event data **shall** be based on the description of the initiating events provided in Paragraph 3.3.1 and **shall** be consistent with plant practices and record keeping (Reference [3.3.5-5]).	NF	IE-D2 "CALCULATE the initiating event frequency from plant specific data, if sufficient data are available. USE the most recent applicable data to quantitatively characterize the initiating event frequencies. CONSIDER CREDITING rectification actions as appropriate.
The time period for collecting data should be as broad as possible. Time periods shall not be manipulated to avoid specific events.	NF	IE-D4 "DO NOT USE data from the initial year of commercial operation in the quantification.
*3.3.5.2.5 Plant-Specific Initiating Event Data Analysi*s. The details of the analysis of initiating event data depends on specific characteristics associated with the three	NF	

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classes of initiating events introduced earlier.		
(a) Analysis of Observed Initiating Events - These events have been observed in the industry and might have occurred at the plant in question. These event frequencies **shall** be analyzed using Bayesian or frequentist methods as described in Subparagraph *3.3.5.*1. Time trend analysis **may** be used to account for decreasing reactor trip rates in recent years. Exclusion of earlier years that are not representative of current data **shall** be justified, (Reference [3.3.5- 10]).	NF IE-D3	IE-D8 “In the quantification of initiating event frequencies, USE a Bayesian update process of generic industry data if only limited plant-specific data are available. IE-D10 “USE plant- specific information in the assessment and quantification of recovery actions where available.
*Exceptio*n. - If desirous for other reasons (such as to establish a cause and effect relationship), a fault tree model as described in the following section **may** be used for initiating event quantification, provided that the results are consistent, with the higher level data analysis.	NF	IE-D11 “COMPARE the results of the initiating event analysis with generic data sources to provide a reasonableness check of the quantitative and qualitative results. IE-D12 “PERFORM a review/ comparison with industry generic data.
(b) Analysis of *Initiating Events, Amenable to Fault Tree Modeling* - These events, usually support system failure events, and are highly dependent upon plant-specific design features. They **shall** be analyzed using the systems analysis methods in described in Paragraph 3.3.4 as modified in the following paragraphs. The fault tree models for initiating events **shall** be used to quantify the initiating event frequency (as opposed to the probability of an initiating event over a specific time frame, which is the usual fault tree quantification model described in Paragraph 3.3.4. Thus, the fault tree computer codes that are designed to compute top event probabilities **shall** be modified as necessary to capture the top event failure frequency. The model **shall** capture all combinations of cutsets involving the frequency per calendar year of one component failure combined with the unavailability (or failure during the repair time of the first component) of other components. The PRA **shall** document how all applicable system failure modes are taken into account for each fault tree minimal cutset.	IE-D5 IE-D6 IE-D7 NF	
For sequences initiated at power, the initiating event **shall** account for the plant availability such that the frequencies are weighted by the fraction of time the plant is in operation which is a condition for the at-power PRA model. Assumptions about the plant availability factor that is used to make this calculation **should** be clearly documented. Differences between historical plant availability over the period of event occurrences in the plant data base and future plant availability	IE-D14 NF	

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which **may** be greater than historical values **should** be accounted for.	IE-D14	
(c) Analysis of Unobserved Initiating Events, Not *Amenable to Fault Tree Modeling* - Plant-specific Bayesian updating is not required and **should** have no impact on the generic prior distributions.	NF	
*3.3.5.3 Equipment Independent Failure Data Attribute*s. Appropriate plant-specific estimates of equipment unreliability (i.e., equipment fails to function or fails to continue to function throughout its required mission time) **shall** be developed.	NF	
*3.3.5.3.1 Generic Equipment Independent Failure Dat*a. The generic database presented in (Reference [3.3.5-16]) **shall** be used as the generic data for the applicable equipment independent failure parameters. *Exceptio*n. - The requirement to use the specified generic data **may** be waived if other generic data used in the PRA is consistent with the database provided here.	DA- B3 USE an accepted generic data source, such as NUREG/ CR- 4639 [Reference 4.4.6- 1], to estimate component failure probabilities. IDENTIFY the derivation process and/ or source of the generic data. [Accepted?]	
*3.3.5.3.2 Equipment Independent Failure And Success Definitio*n. The failure definitions, including mission time, **shall** be consistent with the success criteria of Paragraph 3.3.3. Thus, "failure" **shall** mean functional failure of the component to fulfill its mission, as defined in the PRA. Note that most in-plant sources of component failure information, such as maintenance records, include additional events that fail to meet this definition (e.g., packing leaks or out-of-specification valve stroke times). Therefore, the problem in collecting this information in some cases, **may** be associated with the component function. Where the component function **may** be degraded, rather than failed. If the component would have successfully completed its mission, as defined in the success criteria, it **should** not be counted as a failure. The rationale for distinguishing among functional failures, incipient failures, and degraded states **shall** be described. For those cases where no actual functional failures have occurred, analysis of degraded conditions **may** provide useful information for an expert judgment process as described in Subsection 3.5. **Degraded conditions, for which failure would have occurred if a demand, as modeled in the PRA, had occurred, shall be counted as failures (e.g., an operator discovers that a pump has no oil in its lubrication reservoir). The definition of "success" and the approach for collecting success data (i.e., number of successful demands, or total time without failure) shall account for subtleties in the interpretation of the raw data. Failures occur in either operating or standby equipment. For operating equipment, success shall be the total run time of the component. For standby equipment that operates on**	DA-B1 DEFINE SSC boundaries, failure modes, and success criteria consistent with corresponding definitions in Systems Analysis (SY- B5, SY- B11, SY-C1, SY- C2) for failure rates and common cause failure parameters. NF DA-B1 NF	

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demand, success data <u>shall</u> include the accumulated successful demands for the component to start or to operate. Demands <u>shall</u> be estimated by totaling real operational (unplanned) demands and the planned tests and operations that are representative of conditions during unplanned demands. Some PRAs track of the distinction between failures that occur due to time-related degradation and shock-related failures. Time-related failures during the standby time are either announced or unannounced. Announced failures (e.g., alarm lights associated with loss of continuity in a control circui*t)* are likely to be discovered soon after they occur and therefore, the time of occurrence is known. Unannounced failures will only be discovered when the component is called upon to operate. These failures are often difficult to distinguish from shock failures and engineering analysis <u>may</u> be required. Test, maintenance, and calibration errors resulting in a component or train being left in an unavailable state after the activity require careful coordination with the HRA of Paragraph 3.3.6. Those events that impact single channels or trains <u>shall</u> be properly accounted for as either unavailability or HEs. Events that impact multiple components, channels, or trains <u>shall</u> be addressed in the HRA.		
*3.3.5.3.3 Plant-Specific Equipment Independent Failure Data Collectio*n. To permit the PRA to calculate appropriate plant-specific estimates of equipment unreliability and unavailability, data <u>**shall**</u> be collected on failures and successes.	BA-A2 SSC failure rate data, equipment maintenance unavailabilities, common cause failure rates, and other PRA parameters. IDENTIFY plant specific demands, operating time periods, and the frequency of planned outage periods for testing and preventive maintenance. COLLECT generic data and plant specific event data to establish SSC failure rate data, common cause failure parameters, and other PRA parameters on basic events that impact the dominant risk sequences. IDENTIFY plant specific demands, operating time periods, and the frequency of planned outage periods for testing and preventive maintenance. IDENTIFY outage periods needed for corrective maintenance according to HR- D1. DO NOT mask temporal trends nor exclude specific events nor bias plant- specific or generic data to obtain lower failure rates.	

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(a) Source Requirements - A thorough search of plant-specific data sources **shall** be performed. However, some data sources (e.g., NPRDS and EPIX) include tests following preconditioning of the component and therefore do not represent complete test of the component under normal demand conditions. See the discussion on partial tests below for conditions under which such test information **may** be used.	NF	
***(b) Counting Successes* - In counting successes, the analysis <u>should</u> be based on a search of the surveillance tests to identify the number of times specific components are operated each surveillance period due to this cause. For time-based failure rates, runtime data <u>shall</u> be collected. For those cases where demands are not normally tracked (e.g., using a safety pump to regularly fill a tank), demands <u>may</u> be estimated based on plant operating practice and operating history.** Demands and their associated failures **shall** be collected and tabulated by the nature of the demand (i.e., actual, spurious, type of test, full/partial test, etc.).	NF DA-A3 For collection of failure data, GROUP SCCs according to the characteristics of their usage. For Example: • Size/ Type of component • Environmental conditions • Service condition • Maintenance practices •Frequency of demands • Any other appropriate characteristic	
(c) Counting Failures - Failure events **shall** be collected for those failures that meet the functional definition of the success criteria of Paragraph 3.3.3. However, because of ambiguities in the data sources, care is required to assess if an event **should** be counted as a failure in the failure rate calculation, as a maintenance event in the out of service unavailability calculation of Subparagraph *3.3.5.*5, or both (Reference [3.3.5-5]). The PRA **shall** report how such judgments were made.	DA-B5 When screening (censoring) data, DO NOT LOSE important information and thereby bias the estimated parameters. JUSTIFY the rationale for any screened data (e. g., plant design modifications, changes in operating practices).	
3.3.5.3.4 Plant-Specific Equipment Independent Failure Data Applicability. Requirements for pooling data, relevance of data, and problems associated with data from incomplete tests are considered separately below.		

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(a) Pooling Demand Data - Pooling demand data and associated failure data **<u>may</u>** be done when (1) the nature of the demands are similar, (2) the nature of the failures are similar, and (3) the failure probabilities from the pooled sources represent similar statistical populations as described in Subparagraph *3.3.5*.1.	DA-A3 For collection of failure data, GROUP SCCs according to the characteristics of their usage. For Example: •Size/ Type of component • Environmental conditions •Service condition • Maintenance practices •Frequency of demands • Any other appropriate characteristic	
***(b) Relevant Data* - Data used in the component failure probability estimations <u>shall</u> be relevant to the current component design and operation. The failure to run rate <u>shall</u> be used for operating equipment; (i.e., components that operate for an extended period following a demand). This period <u>should</u> be a time after the equipment reached rated speed or voltage and ran long enough to be judged a successful start. The failure to run data for equipment normally in standby <u>shall</u> be the cumulative hours of operation after a successful start and the number of failures observed during these hours of operation. For surveillance test or other demands for which the actual run times are distinctly less than the length of the mission time modeled in the PRA, it <u>shall</u> be determined whether the failure rate derived from truncated tests or demands is applicable over the full mission time. The failure on demand rate <u>shall</u> be used for standby equipment failure to operate or failure to start. The time period for collecting data <u>should</u> be as broad as possible and <u>shall</u> be treated consistently for each plant component. Time periods <u>shall</u> not be manipulated to avoid specific failure events. Repeated failures occurring within a small time interval <u>shall</u> be counted as a single demand and a single failure if there is a single, repetitive problem that causes the failures.**	NF	
The analysis <u>shall</u> not count additional damands from post-maintenance testing. That is part of the successful renewal. If modifications to plant design or operating practice lead to a condition where past data is no longer representative of a component's performance, two approaches <u>may</u> be used to limit the use of old data.	NF	
If modifications to plant design or operating practice lead to a condition where past data is no longer representative of a component’s performance, two approaches <u>may</u> be used to limit the use of old data.	NF	

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if the modification involves new equipment or a practice where significant generic data is available, the generic data <u>should</u> be used and updated with plant-specific data as it becomes available, or; **if the modification is unique to the extent that generic data is not available and only limited experience is available following the change, then the change <u>should</u> be reviewed to identify new failure mechanisms that <u>may</u> have been introduced. Because perfect fixes are never possible, some account <u>shall</u> be given to data collected before the fix and to the possibility that the fix has introduced new failure modes. To this end, the analysis <u>may</u> develop an engineering-adjusted prior (i.e., the plant-specific distribution for the old design is modified) to account for a best estimate that the "fixed" failure mechanism has been eliminated, while allowing a low probability chance that the new design might introduce an even more likely failure mode (Reference [3.3.5-17])**		
Either selected approach <u>shall</u> neither assume that the fix is 100% effective nor assume that no new failure modes have been introduced. Furthermore, the analysis <u>shall</u> recognize that additional failure mechanisms not yet represented by events in the database are possible. Although not required for the basic PRA, the component failure mode <u>may</u> be decomposed into specific causes, if desired to support special applications from systems analysis. When decomposed in this manner, demand failures represent purely shock failure. If the failures are not decomposed, failures on demand include a mix of shock and time-degradation failures. Therefore, the failure rate of subsequent demands would be less than the initial demand. This <u>may</u> be assessed in the data analysis.	NF	
*Exceptio*n. Failures recovered promptly from the control room such that the function of the component was not compromised **<u>may</u>** be excluded as failures from the data set, provided that the model does not credit such recovery elsewhere.		
***(c) Use of Data from Incomplete Tests* - Most of the tests performed on components do not simulate actual demand conditions, therefore the tests will not be able to detect each possible failure and failure mode. The PRA analysis <u>shall</u> review the test procedure and decide whether a test <u>should</u> be credited for each possible failure mode.**	NF	
Because incomplete tests do not test each failure mode, only complete tests or unplanned operational demands <u>should</u> be counted as success for component operation. If the component failure mode is decomposed into sub-elements (or causes) that are fully tested, then tests that test specific sub-elements <u>may</u> be used in their evaluation. Thus, one sub-element sometimes has many more successes than another.	NF	

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(d) Establishing Component Boundaries -Component boundaries for systems analysis and data analysis **shall** be consistent. To a PRA, a component can be a piece of a larger component *(e.g., a contact pair within a relay)* or it can be an agglomeration of many parts, and can indeed be a complete system *(e.g., an emergency power supply consisting of a diesel generator together with its air start and cooling systems).* The data analysis **shall** demonstrate a clear understanding of what the systems analysis includes in each component boundary.	DA-B1 DEFINE SSC boundaries, failure modes, and success criteria consistent with corresponding definitions in Systems Analysis (SY- B5, SY- B11, SY-C1, SY- C2) for failure rates and common cause failure parameters. DEVELOP a rationale for distinguishing between functional failures, incipient failures, and degraded states.	
3.3.5.3.5 Plant-Specific Equipment Independent Failure Data Analysis. Estimates of equipment reliability parameters **shall** be based on Bayesian updating in which the generic data distribution is used as a prior distribution that is subsequently updated with plant-specific data. Generic data sources **shall** be representative of the plant components and the nature of the failures and demands in the pooled data set **shall** be consistent with the plant-specific applications modeled in the PRA. Plant-specific data **shall** be used to update the generic plant-to-plant variability curves using an appropriate Bayesian update procedure. Pooling assumptions in the generic data should be tested for plant-specific data. The requirement on review of posteriors in Subparagraph 3.3.5.1.2 **shall** be met. Data censoring (screening) **shall** always be approached carefully to avoid losing important information and biasing results. A sound technical justification **shall** be provided. Plant-specific data **shall** not be selectively used to obtain lower failure rates for components that perform better than the generic mean, while ignoring the data for poor performers. The uncertainties associated with the component reliability **should** reflect the current level of knowledge for the failure mode of concern. The analysis **may** begin the PRA calculations using crude conservative estimates, followed by more rigorous analyses commensurate with the risk importance of the components. The estimate of the failure rate of a component in a harsh environment of an accident **shall** account for that environment. It **may** be based on the deterministic criteria derived from test results, engineering evaluation, and subjective judgments.	DA-B2 UPDATE generic data with plant specific data except for components whose importance can be shown to be sufficiently low so as to not impact applications. DA-C1 ESTIMATE mean values of parameters used to determine the frequencies or probabilities of events modeled in the PRA. Acceptable systematic methods include: Bayesian updating, [Reference 4.4.64], [Reference 4.4.6- 5], frequentist method, [Reference 4.4.6- 6] or expert judgment	
Exception. Plant-specific data alone with traditional frequentist methods or Bayesian update of non-informative priors **may** be used. *Exception* - Generic data, rather than plant-specific data **may** be used for a particular component, if the importance of that component, following quantification, meets the following criteria: *(a)* Fussell-Vesely Importance < **[value**]; and *(b)* Risk Achievement Worth (RAW) < **[valu**e, suggested 2.**0]**	NF	
*3.3.5.4 Equipment Common Cause Failure Data Attribute*s. One of the following methods **should** be used for estimating CCF parameters. · alpha factor models	DA-B9 plus " JUSTIFY the use of alternative methods."	DA-B10 "ESTABLISH common cause groups by using a logical, systematic process that considers similarity in:

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· the multiple Greek letter model · the basic parameter model · the binomial failure rate model (Reference [3.3.5- 18])		· service conditions • design · environment • maintenance JUSTIFY the basis for the common cause component groups. (See SY-C4) DA-B11[new] IDENTIFY and JUSTIFY assumptions made in modifying or applying common cause models that assume symmetry among the components in the common cause group to groups of asymmetrical components.
3.3.5.4.1 Generic Equipment Common Cause Failure Data. The generic data for common-cause failure **shall** be taken from the reports on common-cause failure data (References [3.3.5-19] and [3.3.5-20]).	DA-B7 USE accepted generic sources for common cause data, such as, NUREG/ CR- 5497 [Reference 4.4.6- 2].	
Exception. The requirement to use the specified generic data **may** be waived if other generic data used in the PRA is consistent with the database provided here.	NF	
3.3.5.4.2 Equipment Common Cause Failure Data Definitions. Common-cause data definitions **shall** be consistent with the common cause data report (Reference [3.3.5-19]).	DA-B1 DEFINE SSC boundaries, failure modes, and success criteria consistent with corresponding definitions in Systems Analysis (SY- B5, SY- B11, SY-C1, SY- C2) for failure rates and common cause failure parameters. DEVELOP a rationale for distinguishing between functional failures, incipient failures, and degraded states.	
3.3.5.4.3 Plant-Specific Equipment Common Cause Failure Data Collection. The data needed for estimating CCF probabilities are the number of independent failures and the number of multiple failures due to a common cause. Since there is usually insufficient data to derive plant-specific estimates of the CCF parameters, or even make significant changes to the generic prior distributions, generic data **should** be used.	DA-B7 USE accepted generic sources for common cause data, such as, NUREG/ CR- 5497 [Reference 4.4.6- 2].	
3.3.5.4.4 Plant-Specific Equipment Common Cause Failure Data Applicability. Limited plant-specific common cause data **shall** not be used to claim that rare failure modes are impossible.	DA-B12 DO NOT USE limited plant- specific common cause data to claim that rare failure modes are impossible.	
***3.3.5.4.5 Plant-Specific Equipment Common Cause Failure Data Analysi*s. The generic data shall be evaluated to determine their applicability to the specific plant. In those cases where some plant-specific data are available, they may**	NF	

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be used to update the generic data with Bayesian methods. Common cause modeling is highly interactive between parameter estimation and system modeling in Paragraph 3.3.4. The systems and data models <u>shall</u> be consistent.		
3.3.5.5 Out Of Service Data Attributes. Out of service unavailability data **<u>shall</u>** be developed for equipment removed from service for planned or unplanned repair or testing, such that the component cannot provide its PRA required function. Uncertainty associated with the data **<u>shall</u>** be addressed.	DA-A4 COLLECT plant-specific data on maintenance and testing outage times at the component, train, or system level. DA-C6 VERIFY that uncertainties are addressed in estimating the mean values of the data parameters to allow the estimation of the mean values of CDF and LERF.	
*3.3.5.5.1 Generic Out Of Service Dat*a. No generally applicable generic out of service data is available. Furthermore, plant maintenance practice has important impact on both the likelihood that a particular component is taken out of service for maintenance and the speed with which it is returned to service. Therefore, plant-specific out of service rate and maintenance/test duration data **<u>should</u>** be used. If generic data is developed, it **<u>shall</u>** be compatible with plant maintenance practices.	DA-B6 USE maintenance and testing data that are consistent with plant- specific practices and Maintenance Rule goals. USE the actual time period that the equipment was unavailable for the maintenance duration.	
3.3.5.5.2 Out Of Service Data Test And Maintenance Criteria. Test rates **(tests/yr) <u>shall</u> be based on plant surveillance requirements and actual practice. Planned maintenance rates (maintenance actions/yr) <u>shall</u> be based on plant maintenance plans and actual practice. Unplanned maintenance rates (maintenance actions/yr) <u>shall</u> be based on actual plant experience. Each of these test or maintenance rates only apply to actions that take a component out of service such that it cannot fulfill its mission as defined in the success criteria of Paragraph 3.3.3. The test duration, maintenance duration, or both that applies to these rates is the length of time that the component is unavailable to perform its required mission and is based on actual experience.**	NF	
*3.3.5.5.3 Plant-Specific Out Of Service Data Collectio*n. The out of service time for each component and the total time the component is required to be operable **<u>shall</u>** be developed. **Coincident outage times for redundant equipment (both intra- and inter-system) <u>shall</u> be examined and accounted for based on actual plant**	DA-B6 USE maintenance and testing data that are consistent with plant- specific practices and Maintenance Rule goals. USE the actual time period that the equipment was unavailable for the maintenance duration. NF	

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experience. Calculations of outage unavailabilities <u>shall</u> reflect actual plant experience.		
***3.3.5.5.4 Plant-Specific Out Of Service Data Applicability.* Two classes of subtleties associated with out of service data collection and interpretation that <u>shall</u> be taken into account are: *(a)* Issues associated with the assignment of specific events with failure, initiating event, or out of service data described earlier in Subparagraph *3.3.5.3.*3; and *(b)* Issues that apply only to maintenance events (Reference [3.3.5-5]) as detailed below;** **· *Maintenance Rate* - Unavailability <u>may</u> be included at a component, segment, or train level. The basis for these judgments <u>shall</u> be documented.** **· *Maintenance Duration* - It <u>should</u> not be taken for granted that a maintenance act leads to unavailability; but it <u>should</u> be determined on a case by case basis. If the maintenance does lead to unavailability, the maintenance duration <u>should</u> be the actual time that the equipment was unavailable. The time of ragout or the time of entering a TS limiting condition for operation (LAO) <u>may</u> be used as the start time. The time when the component is restored to service <u>may</u> be used as the end time of maintenance. Maintenance outages are a function of the plant status. Therefore, only outages occurring during plant at power <u>should</u> be included when modeling power operation. Special attention <u>should</u> be paid to the case of a multi-plant site with shared systems, when the TS can be different depending on the status of both plants. Accurate modeling generally leads to the creation of special basic events in the model, whose definition implies a particular allocation of event data to take this mode dependence into account. In the case that reliable estimates or the start and finish times are not available, interviews with the plant maintenance and operations staff <u>may</u> be used to provide estimates of ranges in the unavailable time per maintenance act for certain key components. The time period for collecting data <u>should</u> be as broad as possible and <u>shall</u> be treated consistently for each plant component. Time periods <u>shall</u> not be manipulated to avoid specific maintenance events.**	NF	
*3.3.5.5.5 Out Of Service Data Analysi*s. Calculation of maintenance unavailability **<u>may</u>** be either the product of the maintenance rate times the maintenance duration, or the sum of the out of service durations, divided by the time the plant spends at power.	NF	
3.3.5.6 Equipment Repair And Recovery Of Off-Site Power Data Attributes. The PRA models **<u>may</u>** include repair and **<u>shall</u>** include recovery actions. Generally component repair is not modeled in PRAs because the time is often too limited and	DA-C7 BASE AC power non-recovery probabilities on available and applicable data that is traceable to its source. Lacking strong site-specific data, USE	

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because alternatives exist (and are often required by procedure) to recover necessary plant functions using alternative equipment. Recovery is, in general, an HRA problem that is addressed in Paragraph 3.3.6. Paragraph 3.3.6 considers only recovery of power from off-site sources to the plant switchyard.	generic data for recovery of loss of off-site power.	
*3.3.5.6.1 Generic Equipment Repair And Recovery Of Off-Site Power Dat*a. No generic repair data is specifically recommended. Loss of off-site power **shall** be addressed using the data provided in (References [3.3.5-12], [3.3.5-13], and [3.3.5-14]).	NF	
***3.3.5.6.2 Equipment Repair And Recovery Of Off-Site Powe*r. Repair time shall be calculated as the time period required for repair, from identification of the component failure, until the component is returned to service. Recovery from loss of off-site power is a complicated modeling process that includes systems analysis modeling in Paragraph 3.3.4 of alternative power sources and human reliability modeling in Paragraph 3.3.6. However, the part of recovery from loss of off-site power associated with recovery of power from off-site sources into the plant switchyard is a data problem and that is the only recovery problem addressed here. The result shall be the time from initial loss of off-site power until the normal source of off-site power is restored or an alternate off-site power source is restored.**	NF	
***3.3.5.6.3 Plant-Specific Equipment Repair And Recovery Of Off-Site Power Data Collectio*n. Plant-specific data may be collected on repair times. However, data in maintenance records for repair times are for component outages with no real pressure for speedy repair, beyond the TS LCOs. Interviews with plant maintenance personnel, tempered by the longer repair times for recorded failures, may be used in an abbreviated expert elicitation process described in Subsection 3.5.** Loss of off-site power data is very sparse for most plants. Plant system outage data is useful in assessing the applicability of the generic data. Lacking strong evidence to the contrary, the generic data **should** be used for recovery of loss of off-site power.	NF NF DA-C7 BASE AC power non-recovery probabilities on available and applicable data that is traceable to its source. Lacking strong site-specific data, USE generic data for recovery of loss of off-site power.	
*3.3.5.6.4 Plant-Specific Equipment Repair And Recovery Of Off-Site Power Data Applicabilit*y. The generic data studies have examined regional differences in loss of off-site power and its recovery. Extensions to plant-specific data and models **shall** be thoroughly justified and documented.	NF	
3.3.5.6.5 Plant-Specific Equipment Repair And Recovery Of Off-Site Power Data	NF	

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
*Analysi*s. Analysis of component repair data, if performed, **shall** comply with the requirements of Subparagraph *3.3.5.*1. Analysis of recovery of loss of off-site power **shall** use generic data unless use of additional data is well justified.	DA-C7 BASE AC power non-recovery probabilities on available and applicable data that is traceable to its source. Lacking strong site-specific data, USE generic data for recovery of loss of off-site power.	
3.3.5.7 Data Analysis Integration. The data analysis **shall** be closely coordinated with systems modeling in Paragraph 3.3.4 and success criteria in Paragraph 3.3.3. Definitions, component boundaries, and failure interpretations **shall** be consistent. Because the data and associated parameter estimates are imbedded in the PRA computer codes, system analysis and data analysis naming conventions **shall** be verified to be consistent.	DA-B1 DEFINE SSC boundaries, failure modes, and success criteria consistent with corresponding definitions in Systems Analysis (SY- B5, SY- B11, SY-C1, SY- C2) for failure rates and common cause failure parameters. DEVELOP a rationale for distinguishing between functional failures, incipient failures, and degraded states.	
3.3.5.8 Interfaces With Other Sections Of This Standard. The Data Analysis task has important interfaces with other PRA tasks that **shall** be traceable in the PRA documentation. First, the data that is gathered and analyzed in this PRA element **shall** be specified in the Initiating Events Analysis task Paragraph 3.3.1 and the Systems Analysis task Paragraph 3.3.4. An important aspect of these interfaces is that the initiating events and component boundaries defined in these tasks **shall** be the same, as those in the data analysis task. The data analysis **shall** provide information to the Initiating Events Analysis task Paragraph 3.3.1, the Systems Analysis task Paragraph 3.3.4, and the Level 1 Quantification and Review of Results task Paragraph 3.3.8.	DA-B1 [DEFINE SSC boundaries, failure modes, and success criteria consistent with corresponding definitions in Systems Analysis (SY- B5, SY- B11, SY-C1, SY- C2) for failure rates and common cause failure parameters. DEVELOP a rationale for distinguishing between functional failures, incipient failures, and degraded states.	
References [3.3.5-1] Apostolakis, G. E., Probability and Risk Assessment: The Subjectivist Viewpoint and Some Suggestions, Nuclear Safety, 19(3), 305-315, (May - June 1979). [3.3.5-2] Garrick, B.J., S. Kaplan, D.C. Iden, E.B. Cleveland, H.F. Perla, D.C. Bley, D.W. Stillwell, H.V. Schneider, and G. Apostolakis, Power Plant Availability Engineering: Methods of Analysis, Program Planning, and Applications, NP-2168, Research Project 1446-1, Electric Power Research Institute, Palo Alto, CA, May 1982. [3.3.5-3] Martz H.F., and R.A. Waller, Bayesian Reliability Analysis, John Wiley & Sons, New York, 1982. [3.3.5-4] Barlow, R.E., Engineering Reliability, ASA-siam, 1998. [3.3.5-5] Parry, G.W., Data Requirements and Analysis for IPEs, Appendix I in T.	[4.4.6-1] NUREG/ CR- 4639 Nuclear Computerized Library for Assessing Reactor Reliability, January 31, 1989 [4.4.6-2] NUREG/ CR- 5497 Common Cause Failure Parameter Estimations, October 31, 1998 [4.4.6-3] NUREG/ CR- 5485 Guidelines on Modeling Common- Cause Failures In Probabilistic Risk Assessment, November 30, 1998	

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
Morgan, G.W. Parry, and C. Schwan, "Nuclear Plant Reliability: Data Collection and Usage Guide," TR-100381, EPRI, April 1992. [3.3.5-6] Mann, N.R., R.E. Schafer, and N.D. Singpurwalla, Methods for Statistical Analysis and Life Data, John Wiley & Sons, New York, 1974. [3.3.5-7] Green, A.E., and A.J. Bourne, Reliability Technology, Wiley-Interscience, London, 1972. [3.3.5-8] Barlow, R.E., and F. Proschan, Mathematical Theory of Reliability, Society for Industrial and Applied Mathematics (siam), Philadelphia 1996. [3.3.5-9] Jaynes, E.T., Probability Theory: The Logic of Science, Unpublished manuscript, St. Louis, MO, Washington University, ftp://bayes.wustl.edu/pub/Jaynes/book.probability.theory/pdf [3.3.5-10] Atwood, C.L., Hits per Trial: Basic Analysis of Binomial Data, EGG-RAAM-11041, September, 1994. [3.3.5-11] Poloski, J.P., D.G. Marksberry, C.L. Atwood, and W.J. Galyean, Rates of Initiating Events at U.S. Commercial Nuclear Power Plants 1987 through 1995 (DRAFT), INEEL/EXT-98-00401, April 1998. (Final to be published as NUREG/CR in August 1998). [3.3.5-12] Atwood, C.L., D.L. Kelly, F.M., Marshall, D.A. Prawdzik, and J.W. Stetkar, Evaluation of Loss of Off-Site Power Events at Nuclear Power Plants: 1980-1996, NUREG/CR-5496 (INEEL/EXT-97-00887, November 1998. [3.3.5-13] Wyckoff, H., Losses of Off-Site Power at U.S. Nuclear Power Plants, NSAC 182/203, March 1992. [3.3.5-14] Iman, R.L., S.C. Hora, Modeling Time to Recovery and Initiating Event Frequency for Loss of Off-Site Power Incidents at Nuclear Power Plants, NUREG/CR-5032, SAND87-2428, Sandia National Laboratories, Albuquerque, NM, January 1988. [3.3.5-15] Kaplan, S., On a "Two-Stage" Bayesian Procedure for Determining Failure Rates from Experiential Data, IEEE Transactions on Power Apparatus and Systems, 1981. [3.3.5-16] A preliminary generic database is being prepared for an Appendix to this standard, based on the database of NUREG-4550, with correction of known problem areas. [3.3.5-17] Kaplan, S., B.J. Garrick, "On the Use of a Bayesian Reasoning in Safety		

Draft 10 Text for Section 3.3.5	**Draft 12 section 4.4.6 corresponding supporting requirements with notes** NF = Not Found in Draft 12	**Draft 12 new requirements not found in Draft 10 section 3.3.5.**
and Reliability Decisions–Three Examples," Nuclear Technology, Vol. 44, pp. 231- [3.3.5-18] Common-Cause Failure Parameter Estimations, NUREG/CR-5497, INEEL/EXT-97-01328, to be published in August 1998. [3.3.5-19] Common-Cause Failure Database and Analysis System, NUREG/CR-6268, Volumes 1-4, INEEL/EXT-97-00696, to be published in August 1998.		

Section 4.4.7, Internal Flood

4.4.7-1 To be consistent with the objective of the other PRA elements, the following objective needs to be added: "The documentation clearly describes the methodology .... "

4.4.7-2 This is the best documented PRA element in Section 4.4. The HLRs for the internal flooding analysis are defined such that the supporting requirements are presented in a logical fashion. The HLRs for other elements need to be defined to provide a similar logical presentation of the supporting requirements.

Table 4.4-7-1 The definition of HLR-IF-B needs to be expanded to include identifying flooding mechanisms <u>and capacities</u>.

Table 4.4-7a-1 The definition of each of the application categories at the top of Tables 4.4-7a through 4.4-7f may be the only example of where differentiation based on dominant and risk-significant scenarios may be appropriate. This is because the difference in the categories occurs primarily for requirements dealing with screening and grouping of events. The rest of the analysis requirements are virtually the same.

Table 4.4.7a-2 SR IF-A2: "SSCs modeled in the PRA" need to include those not directly modeled, e.g., electrical components like junction boxes, etc., connected to the SSCs.

Table 4.4.7c-1 SR IF-C2: include isolation valves in the list of examples

SR IF-C4: flood scenarios are also dependent on the flood growth rate within the area, and the critical flood heights of the affected SSCs. (A crucial flood height is the height above floor level at which an SSC is disabled by water submergence.

Table 4.4.7d-1 SR IF-D5: To address human induced flood mechanisms (e.g., maintenance actions or overfilling tanks), a review of plant procedures may also be needed.

Table 4.4.7f-1 SR IF-F2: The last bullet calls for documentation of sensitivity and uncertainty analysis. These analyses are not described as required by any of the previous high level requirements for internal flooding.

Section 4.4.8, Quantification

4.4.8-1 This section needs to be called quantification and analysis of results, because the interpretation of the results to gain a qualitative and quantitative understanding of the contributors and an identification of the sources of uncertainty and their potential impact are equally important for a decision-maker.

4.4.8-2 Objectives - Instead of the current fourth bullet, which focuses on quantitative uncertainty analysis, suggest:

"an identification of the principal sources of uncertainty in the model and the key assumptions made, and an assessment of the impact of the uncertainties on the results using methods that include, uncertainty propagation and sensitivity analyses."

The thought is that it is more useful to know which assumptions have a potentially big effect on the results than to have an integrated probability distribution that only addresses parameter uncertainty.

4.4.8-3 This whole section needs to be reorganized. It is not structured logically. For example, SR QU-D3 needs to come before SR QU-D2. Other examples follow.

4.4.8-4 The high level requirements for quantification (HLRs-QU) do not all provide a logical organizational structure, they do not represent a process and are not mutually exclusive. If one picked up the standard looking for a particular supporting requirement, it would be very difficult to find.

It was impossible to completely evaluate the internal consistency of this section because two of the HLRs, B and C, are identical. This evaluation assumes that it is the supporting requirements for HLR B that refer to the statement :

"The Level 1 Quantification Methodology shall be traceable and shall describe the relationship of the PRA technical elements to the quantification process (including the model assumptions). [HLR-QU-C]". HLR C appears to have something to do with reasonableness.

4.4.8-5 The supporting requirements under HLR-D appear to focus on quantification and have very little to do with "Realism and Treatment of Dependencies."

Table 4.4-8-1 The HLRs need renaming. The words that go with A SCOPE, read more like E MODEL PLANT FIDELITY. B is identical to C. E needs to be called something like LEVEL 2 INTERFACE.

Interpreting high level requirement A from the perspective of the supporting requirements implies that it needs to be reworded something like "quantification methodology shall quantify accident sequence frequencies with sufficient accuracy that the results capture the significant dependencies." This sounds like it could be called COMPLETENESS IN DETAIL. The "plant specific and unique factors" need to be captured in the logic model structure and parameter values; there is no need to restate that particular requirement here.

Table 4.4-8-2 and Tables 4.4-8a through f. There appears to be no V&V requirements concerning the PRA software used. (Rev. 12 does require in 5.7 that the codes be “controlled,” but no details are provided.) Although this has not been an issue in the past, isn’t it something that the Standard needs to address?

Table 4.4-8a-1 SR QU-A4 is lost in the truncation requirements!

The thought contained in SR QU-A10, that sequences and cutsets MAY be truncated needs to come before SRs QU-A3, and QU-A5 through QU-A16. Are all these necessary, or could they be rationalized? This seems to be a very prescriptive set of requirements that could be rationalized by focusing on what the goal is.

Table 4.4-8a-2 Add supporting requirement, “INCLUDE recovery and an evaluation of parameter uncertainty in the quantification process.”

Table 4.4-8b-1 SR QU-B1 is superfluous.

SRs QU-B2 and QU-B6 are essentially the same, and SR QU-B11 addresses the same issue. The first two need to already be addressed in the accident sequence and HRA sections.

What does the last line in SR QU-B4 mean?

Table 4.4-8b-2 SR QU-B3: Revise as “Realistically COMBINE models and sensitivity studies of integrated performance of equipment and personnel under conditions modeled in the PRA.”

Table 4.4-8b-3 SR QU-B7: Revise to add, “CONSIDER the recover of component or system failures (e.g., recovering off-site power or the power conversion system, remotely opening a valve, aligning alternate room cooling or cross-tying electrical buses) in the final quantification process if covered by procedures.” However, it is already addressed in the human reliability section and could be deleted.

Table 4.4-8b-4 SR QU-B11. Revise the third sentence as “PERFORM the final quantification of these post-initiator HEs at the cutset or saved sequence level.”

Table 4.4-8b-5 Add supporting requirement, “Besides the incorporation of HE events directly into the system and accident sequence models, ADD events depicting the non-recovery probability of human actions directed by procedures to mitigate an accident sequence during the quantification phase of the analysis after an initial generation of sequence cutsets or frequency. ENSURE that the total operator failure probability of post initiator human actions for a given sequence or cutset is not less than 1E-6.”

Table 4.4-8b-6 Add supporting requirement, “If the accident sequences are developed such that the recovery action is applicable for all cutsets for that sequence and has the same timing requirements for performing the recovery, then the nonrecovery probability may be added to the sequence frequency.”

Table 4.4-8b-7	Add supporting requirement, “ADD the nonrecovery events to the individual cutsets to account for the variation in times to perform the recovery action if cutsets for an accident sequence result in different times to core damage.”
Table 4.4-8c-1	SR QU-C2 is already addressed in the systems analysis and data sections. SR QU-C4 requires reviewing non-dominant sequences even for category I, for which according to the accident analysis, they are not required. SR QU-C6 repeats SRs QU-B2, QU-B6, and QU-B11. Delete SR QU-C7 it has no place here. In SR QU-C9, the admonition to review the importance values to ensure they make sense is a good idea even for Category I. You still want the results to be correct. SR QU-C10 needs to read the same for all three categories, at least as far as questioning modeling assumptions and human actions’ consistency with plant procedures and conditions go.
Table 4.4-8c-2	SR QU-C3. Revise to add, “INVESTIGATE the reasons for significant deviation.”
Table 4.4-8c-3	Add supporting requirement, “SEARCH for sequences or cutsets that would be expected to make significant contribution, but are not found among the listed contributors. This search needs to begin by extrapolating from the review of significant contributors by asking probing questions.”
Table 4.4-8c-4	Add supporting requirement, “APPLY a questioning process similar to that for review of sequences at the individual fault tree level, focusing on the reasonableness of cutsets, the consistency of the dominant cutset results, and possible missing contributions. EXAMINE results on an absolute basis and for relative consistency among cutsets and sequences.”
Table 4.4-8d-1	SR QU-D2. The parameter uncertainty we deal with in PRA is epistemic, not aleatory. The parameter itself may be used in a model of an aleatory process (component failures), but what the uncertainty represents is our lack of knowledge about the value. Delete the parenthetic aleatory and epistemic. SR QU-D3. Category I is begging for the same words as the other two categories if the objective above is to be achieved. SR QU-D9 seems to be mixing model uncertainty with completeness uncertainty.
Table 4.4-8d-2	SR QU-D6. Add to Category II, “DO NOT give more weight to deterministic calculations based on narrowly defined plant conditions than less rigorous information that applies to a more realistic range of conditions,” and, “EXPLAIN the effects of these key uncertainties on potential decisions based on the PRA results.”
Table 4.4-8f-1	Missing from SR QU-F4 is an item requiring the documentation of the principal sources of uncertainty and the assumptions made to deal with these uncertainties. This is a

necessary precursor to the sensitivity studies, and is required even for category I applications, according to the description in the heading. In addition, for item (h), it might be worth adding “the results of all sensitivity analyses and an interpretation of their results”.

Section 4.4.9, Level 2

4.4.9-1 There are a number of problems with the arrangement of the High Level Requirements (HLR) and their Supporting Requirements (SR).

- The order of the HLRs presented in Table 4.4-9 could be improved: For example: Interfaces would seem to belong before Accident Sequence Development. Also, based on the definition of the HLRs, both HLR-L2-B and HLR-L2-C, to some extent, deal with the interface (as used in HLR-L2-B) or the dependence (as used in HLR-L2-C) with Level 1 accident sequences. However, other issues (e.g., success criteria, LERF definition, etc), which, strictly speaking, do not involve Level 1 results, are also discussed in these two HLRs. These issues could be regrouped in a more logical manner.
- The order of the SR below an HLR is not always logical. For example: It would be more logical to put L2-E4 ("..data for determination of CET branch points") before L2-E3 ("SOLVE LERF tree"). Another example: According to the SRs presented in 4.4-9a, the containment event tree (CET) is developed in HLR-L2-A, before the initiating states (i.e., PDSs, defined in L2-B2) and end states (i.e., LERFs, defined in L2-B1) are defined. Although the definition of these states and the development of the CET are highly interactive and they needed to be worked together, it does not seem logical to develop a CET before the initiating and end states are defined. A logical order would be defining the PDSs before the development of the CET.
- Some SR do not seem to belong under the HLR under which they are listed. See comment 3 for an example.

4.4.9-2 The technical quality requirements are often not sufficient described in the tables. The requirements for systems and HEPs are only provided in very general terms. For example: L2-A3 (decision points for CET) states that for a Category III Application "INCLUDE (1) the systems and HEPs necessary for the determination of LERFs, (2) reasonable operator recovery actions ...". The requirements for systems are mentioned in L2-B4 and the requirements for operator actions are mentioned in L2-C1. They are described in very general terms. The technical quality requirements for these issues could be addressed by referring to an expanded Table 4.4-4 (for system analysis) and Table 4.4-5 (for human reliability analysis). Similarly, technical quality requirements for the data used in CET quantification are not described sufficiently in Table 4.4-9e for LERF quantification (HLR-L2-E). Reference could be made to Table 4.4-6 (for data analysis) for technical quality requirements.

4.4.9-3 The definition of HLR-L2-B (Interfaces) and the Supporting Requirements (SRs) included in this HLR are confusing.

- According to Table 4.4-9, HLR-L2-B states "The interface with definition and quantification of Level 1 accident sequences, HRA, and LERF, as well as other relevant success criteria shall be defined". What does this mean?
- Except for Supporting Requirement L2-B2, which deals with "GROUP/BIN challenges based on Level 1 condition", the other SRs included in this HLR, which deal with LERF definition (L2-B1), containment integrity success criteria (L2-B3), and system success criteria (L2-B4), are not really issues related to the Level 1 interface. Also, HRA, which is mentioned in the definition of the HLR, is not discussed in the SR.
- L2-B1 states that LERF needs to be defined consistent with the definition in Section 2 of the Standard. However, the definition of LERF in Section 2 is basically just

defining the acronym, while the definition of "large early release" in Section 2 is missing any reference to large, i.e. the health effects.

- The use of the term "challenges" in L2-B2 for "GROUP/BIN challenges based on Level 1 definition" is also confusing. First, it is not clear what "challenges" mean here, and second, to assure consistency and avoid ambiguity, the term "challenges" needs to be used only for "containment challenges" as in L2-A1. (Terms are not used consistently in the tables of this document. For example, in L2-A1, both "dominant contributors" and "containment challenges" are used to refer to severe accident phenomena. As noted above, the term "challenges" is also used in L2-B2. Terms need to be used consistently in the document to avoid ambiguity.)
- L2-B2 seems to deal with the grouping of Level 1 results for the level 2 analysis. Results of this grouping are commonly referred to in PRAs as Plant Damage States (PDSs). This term, although not used here, is used in L2-E1 for LERF quantification. If L2-B2 indeed deals with the definitions of PDSs, then the term "PDSs" needs to be defined here, instead of in L2-E1. Also, one important task in defining the PDS is to identify Level 1 attributes important to Level 2 accident progression. This needs to be discussed in L2-B2 to assure adequate handling of the Level1/Level 2 interface.

4.4.9-4 The definition of HLR-L2-C (Dependencies) and the Supporting Requirements (SRS) included in this HLR are confusing and do not seem to be consistent. According to the definition of HLR-L2-C in Table 4.4-9, "Dependencies due to Level 1 Accident Sequences, human interface, functional, spatial, environmental dependencies, and common cause failure shall be addressed in the definition of LERF sequences". However, only L2-C1, dealing with human actions appears as a Supporting Requirement. SRS on the other issues are needed to understand the requirements for the HLRs.

4.4.9-5 The definition of HLR-L2-D in Table 4.4-9 is "CONTAINMENT PERFORMANCE/STRUCTURAL ANALYSIS: The containment structural analysis and bypass assessment shall represent failure conditions of systems, structures and components operating during severe accidents, as needed to support realistic LERF." The SRS of this HLR provide further discussion on containment capacity, isolation failure, ISLOCA, and containment analysis. L2-D7, in Table 4.4-9d, states that, for a Category I Application, "For BWR containment design, USE available containment analyses from generic or plant specific sources", and that for Categories II and III Applications, "For BWR containment design, Use plant specific containment thermal hydraulic analyses to model containment or RPV response under severe accident progression." (for Categories II and III applications, the same sentence is repeated twice.) Only BWR containment is mentioned but no PWR containment.

Also, from the description in L2-D7 the use of the containment thermal hydraulic analysis results for containment performance/structural analysis, the objective of HLR-L2-D, needs to be explained.

4.4.9-6 The documentation requirement as described in Table 4.4-9f is very limited. It only covers "success criteria for Level 2/LERF" and "defining those parameters to be used as the basis for assigning containment bypass or failure" (L2-F1), "Containment Capacity Assessment" (L2-F2), and "geometric details impacting hydrogen related phenomena" for ice condenser and BWR Mark III containment (L2-F3). It needs to be

expanded to cover other issues addressed in the HLRs. A requirement on results interpretation also needs to be described.

Section 4.5, Process Check

4.5-1 This section appears to be requiring an independent review of some of the PRA analyses. It is assumed that this is independent of the peer review discussed in Section 6. An independent review is a good idea and standard engineering practice. Thus, inclusion of this requirement is a plus. However, the scope of the current requirements need to be expanded to indicate that all PRA elements need to be subjected to an independent review. In addition, requirements on the reviewers need to be established. The independent review needs to be made by personnel who did not generate the changes. These personnel can work for the same utility but need to have PRA experience and/or training (e.g., a review by another PRA analyst). The reviewers need to also be familiar with this Standard.

Section 4.6, Use of Expert Judgment

4.6-1 In Section 6.4, isn't the selection of the expert judgement process determined by the factors listed in 4.6.3? If so, this needs to be clearly indicated.

4.6-2 Section 4.6 places no technical requirements on the analyst/team responsible for integrating the expert inputs. At the minimum, some requirements are needed to document the basis for discounting the input from a given expert, should such a situation arise. (Note also that Section 4.6 has no documentation requirements for the expert elicitation process. SR SC-D2 requires the documentation of expert judgment in the context of success criteria, but expert judgment has broader uses.)

4.6-3 Section 4.6 places no technical requirements on the process used to elicit the expert judgments. Some requirements are needed to reduce the impact of personalities and group dynamics on the results.

Section 5, PRA CONFIGURATION CONTROL

Overall Observations and Conclusions

- A strength of the standard is the recognition of the need to maintain and update the PRA. However, a clear differentiation between "maintain" and "update" needs to be included.

- Changes in PRA technology may require a change to the standard which may or may not result in a change to the PRA required for a specific application. This should be reflected in revisions to the Standard itself. Requirements in the standard to change the PRA need to be related specifically to plant changes, or updated data which would impact the PRA results.

Specific Comments

5.2-1 The need for a PRA Configuration Control Program is not explicitly identified in this section. This is the procedure that controls the update process. Recommend changing the first sentence in this section to read: "A Configuration Control Program shall be in place for PRAs used in risk-informed applications. The Configuration Control Program shall contain the following elements:"

5.2-2 The Configuration Control Program needs to also contain requirements on when a PRA Maintenance needs to be performed. Without such a requirement, the Standard would allow a licensee to use the same PRA for risk-informed applications throughout the remaining operating life of the plant as long as the "changes are addressed in a fashion similar to the approach used in Section 3" as indicated in Section 5.5. Some pending changes may be difficult to address by the methods referred to in Section 3 and thus will affect the ability to use the out-of-date PRA. The first paragraph of Section 5.4 appears to be the logical place for addressing such a requirement since it specifies that the PRA be maintained such that it reflects the as-built and as-operated plant. Revision 10 of the Standard suggested PRA maintenance be performed every 2 years. An alternative interval for PRA Maintenance could be tied to the refueling schedule (since many plant hardware modifications occur during refueling) with an extension allowed if plant modifications between refueling outages are minor or do not impact equipment modeled (implicitly or explicitly) in the PRA. Plant-specific data updates need to always be performed at a specified interval.

5.2-3 The Configuration Control Program also includes an element for documenting the configuration control process (this is discussed in Section 5.8). This needs to be listed as the last bullet in this section.

5.2-4 Perhaps it's a matter of emphasis, but the key element "a process for monitoring PRA inputs and collecting new information" as expressed in the first bullet sounds as if it could be extensive. Perhaps what is needed, as a practical measure, is a process to collect information on plant changes and screen them to identify those that could impact the PRA inputs and assumptions.

5.3-1 The first and last sentences are redundant in that both specify that changes in industry-wide operational history be reviewed. Suggest deleting the reference in the last sentence. The subject matter of the first sentence is covered in PRA Maintenance while the subject matter of the last sentence is covered under PRA Updates. It would be beneficial to define these terms in this section in addition to or in lieu of providing the definitions of these terms in Section 2.

5.3-2 Rev. 12 requires a process to evaluate industrywide operational history.

5.3-3 Changes in technology, if significant, should lead to changes in the Standard. However, if the PRA has previously been judged to meet the standard, why would it be necessary to upgrade at all, unless the Standard had been upgraded?

5.4-1 The last sentence of the second paragraph in Section 5.4 identifies which SRs need to be used when updating a PRA. It states that “Changes that are relevant to a specific application shall meet the Supporting Requirements provided in Section 4” when it really needs to state “Changes that are relevant to a specific application shall meet the Supporting Requirements pertinent to that application as determined through the process discussed in Section 3.4” (not all of the required SRs may be identified in Section 4 of the Standard).

5.4-2 The third paragraph of Section 5.4 differentiates between “PRA Maintenance” and “PRA Upgrades” primarily for the purpose of establishing different review requirements. Currently, the Standard states that PRA Upgrades (i.e., changes in PRA methodology) shall satisfy the peer review requirements specified in Section 6 but is limited to those aspects of the PRA that have been upgraded. The impression obtained from reading this is that all of the peer review requirements in Section 6 (including an audit of the methodology implementation) apply to PRA Updates. However, Section 6.1.1 states that only a single peer review is required and does not require a peer review of a PRA Update. Thus the requirement provided in Section 5.4 is currently meaningless and not performing any review of a PRA Update will satisfy the Standard. Section 6.1.1 needs be changed to indicate that a peer review of the PRA change is required.

For PRA Maintenance, the Standard states that a peer review is not required. Since the purpose of the peer review is to provide an independent audit of the PRA, changes to the PRA also need to be audited. It is recommended that PRA Maintenance changes be peer reviewed on a periodic basis (e.g., after 2 or 3 PRA update cycles or as determined by the extent of the PRA changes generated in scheduled maintenance updates). In between peer reviews, an independent review of the changes needs to be made by personnel who did not generate the changes. These personnel can work for the same utility but need to have PRA experience and/or training(e.g., a review by another PRA analyst). The reviewers need to also be familiar with this Standard and the results of the peer review in order to improve the PRA models (i.e., eliminate weaknesses identified in the original peer review and improve the models to meet Category III requirements).

5.5-1 Initiation of a new PRA application needs to be a trigger for updating the PRA models required for the application unless, of course, the plant models are not significantly affected by the plant modifications that have taken place since the last update. Relying on expert panels to qualitatively assess the impact of plant modifications on an application weakens the quality of the application. Plant-specific data updates can still be performed at a specified interval.

5.6-1 If the PRA model has been maintained, it will have addressed the impact of prior changes. Why is it then necessary to revisit old decisions to see if they are impacted by the new change. This will come out in an integrated manner during the assessment of the latest change. However, as expressed in Reg Guide 1.174, what is of interest is maintaining a record of the cumulative effect of past changes.

5.8-1 The second bullet is worded so poorly that the intent of the bullet is not clear. In fact, the wording of most of these bullets could be improved to more clearly indicate the documentation requirements. For example, the sixth bullet needs to provide more than evidence of the performance of the appropriate review, it needs to provide the results of the review. The seventh and eighth bullets state that descriptions of the process used to address the aggregate impact of pending changes and the process used to evaluate changes on previous applications needs to be documented. However, the section must also state that the results of these processes need to be documented. Is this the intent of the fourth bullet? If so, then the bullet needs to be clarified. If not, the bullet still needs to be rewritten to clearly identify it's intent.

5.8-2 It is not clear if Section 5.8 requires that the actual changes to the PRA models due to plant changes or methodology updates be documented. The current wording appears limited to requiring that only a description of the potential changes be provided. Section 5.8 needs to clearly state that documentation of the actual PRA changes needs to be provided. This needs to include changes to the documentation required in Section 4.

Section 6, PEER REVIEW

Overall Observations and Conclusions

- This chapter reads more as a quality assurance review rather than a peer review.
- There is an inadequate specificity of what to review and the level of review.
- There is an insufficient focus on the need for the reviewers to make value judgements on the appropriateness of the assumptions and approximations made in the PRA, and an assessment of their impact on the results.

General Comments

Gen. 6-1 One of the most important roles a peer review can fulfil is an identification of those assumptions and models that have a significant impact on the results of the PRA. The current Chapter 6 reads more like a QA type review process than a peer review; the focus is on whether the right subelements have been addressed but not on how they have been addressed. The conclusion of the peer review ought to be that the PRA produces, or does not produce, a robust set of results to support the type of application that fits into the Category, and an identification of what drives the lack of robustness. This is particularly important given that the standard is not prescriptive in describing how the subelements are to be modeled. An important element of the peer review report, and perhaps the most important element, needs to be a discussion of which results are affected by what assumptions and what is the potential impact of alternate plausible assumptions.

Gen. 6-2 Section 6, Peer Review, does not clearly indicate how the findings of the review team are to be stated with respect to the three Applications Categories I, II, and III.

Gen. 6-3 There are no acceptability criteria specified in Section 6. It only directs the review team to identify areas where the PRA differs from the requirements specified in Sections 4 and 5. It does not indicate what is considered the minimum acceptable number of differences.

Specific Comments

6.1-1 The current wording of the third sentence in Section 6.1 implies that the peer review is assessing the standard. The results of the peer review help establish the minimum application category for the PRA element by identifying which requirements the PRA meets. It is suggested that the sentence be changed to “The peer review shall assess the PRA Elements to determine which requirements of this Standard that it meets.”

6.1-2 Section 6.1 states that the peer review does not have to assess all aspects of the PRA against all the requirements in Section 4. The scope of the peer review identified in Section 6.3 is consistent with the fact that the purpose of the peer review is to audit the PRA models and not to perform an independent verification of every model. However, for the limited scope of the review identified in Section 6.3 for each element, all SRs for that element need to be checked. For example, for each event tree selected for review, it needs to be determined which requirements in Section 4 have been met. This fact needs to be explicitly stated in Section 6.1.

6.1.1-1 Section 6.1.1 is inconsistent with Section 5.4 and must be rewritten. Section 6.1.1 must state that subsequent peer reviews are required when PRA upgrades are performed. The section

needs to state that the initial peer review shall cover the entire PRA. PRA updates only have to be performed for the actual changes to the PRA.

6.1.1-2 Section 6.1.1 needs to specify a minimum frequency for performing a peer review of PRA upgrades. An interval tied to the refueling schedule (since many plant hardware modifications occur during refueling) was previously recommended for updates (with an extension allowed if plant modifications between refueling outages are minor or do not impact equipment modeled either implicitly or explicitly in the PRA). It is recommended that PRA Maintenance changes be peer reviewed every 2 or 3 refueling cycles (i.e., after 2 or 3 PRA update cycles) or as determined by the extent of the PRA changes generated in scheduled maintenance updates.

6.1.1-3 As a related point, there appears to be no formal review requirement for the selection of an Application Category for a particular application. It is not clear that the Application Category will always be obvious.

6.1.2-1 The first sentence of Section 6.1.2 needs to be changed to indicate that the written peer review methodology must also assess the requirements of Section 5.

6.1.2-2 Section 6.1.2 of the Standard states that the industry peer review process (i.e., NEI 00-02) provides an acceptable review methodology. Until the requirements in Sections 4 and 6 are finalized and compared to the industry peer review guidelines and their implementation, it is unclear whether the industry peer review process will meet the peer review requirements. Although the guidelines in the industry peer review process have been considered in the development of the Standard, there are requirements in the Standard that were not addressed in that process. Thus the industry peer review process can not by itself meet the requirement in paragraph 6.1.2 which states "The review shall be performed using a written methodology that assesses the requirements of Sections 4 and Section 6." Any endorsement by the ASME as implied in Section 6.1.2 is thus premature. Prior to incorporation of Reference 1 into this Standard, it needs to be reviewed, commented on, and formally endorsed by the ASME standards committee.

6.1.2-3 An additional element of the peer review methodology is establishing a scope of the review to ensure that the peer review provides a sufficient audit of all elements of the PRA. This needs to be added to the list provided in Section 6.1.2.

6.2-1 In light of general comment 6-1 above, one of the key attributes of the reviewers is that they have an appreciation of the general industry perspective, and not be narrowly focused on a particular approach to modeling, particularly if it is the approach used in the PRA being reviewed.

6.2-2 The word "performing" is used in this section as a requirement for a peer review team qualification. A peer reviewer, to have the necessary expertise, needs to have as a major part of his/her experience "performing" activities in the assigned area of review. However, a definition of what is meant by "performing" needs to be included so that the intent of this qualification is appropriately met. For example, experience gained by actually developing a fault tree from "scratch," having to go through the deductive process of identifying the failure paths, etc. is "performing;" however, utilizing an existing fault tree and revising is not "performing." It is through the former process that a peer reviewer will acquire the necessary

expertise and therefore have the knowledge needed to judge the technical quality without having a detailed, prescriptive technical standard.

6.2.1-1 In Section 6.2.1, requirement (a) for peer review team members needs to be changed to read “not have worked on the PRA.” The use of PRA results in risk-informed regulations requires that the public have confidence in the peer review process. Thus, all potential conflicts of interest must be eliminated. Allowing a Level 1 person who worked on the PRA to perform the peer review on the Level 2 portion of the PRA could impact the career path of the reviewer and thus violates the conflict of interest requirements delineated in requirement (b).

6.2.1-2 Team member requirement (b) in Section 6.2.1 needs to specifically preclude employment by the PRA owner (utility) or by a company seeking contract work with the owner (except for performing the peer review).

6.2.2-1 The wording in the second paragraph of 6.2.2 needs to be changed to indicate that the technical integrator must have actually done technical management of at least one PRA. This is consistent with the requirement that all reviewers have actual experience in performing the PRA element they are reviewing (i.e., technical integration needs to be considered a PRA element in this respect).

6.2.2-2 The peer reviewer qualifications for HRA and Level 2 Analysis are highlighted in Section 6.2.2. Currently, there is no substantial differentiation on the qualifications for reviewers of these PRA elements versus the other elements. It is felt that the HRA and Level 2 elements represent areas of specialized knowledge that maybe only one team member would possess versus the broad experience base that multiple peer review team members would have for the other elements. Thus, interaction between team members on a fault tree issue, for example, may not occur on an HRA issue. The lack of broad experience base among the reviewers needs to be compensated for by having a broader experience base for reviewers of these specialized PRA elements. The broader experience needs to be established by specifying that the reviewers have performed these elements in several PRAs, be familiar with the different methods available to perform the element, and specifically have used the method used in the PRA being reviewed.

6.2.2-3 There are other PRA elements where the experience in the review team may be limited to one member. This probably would include plant-specific data analysis and the review of thermal-hydraulic calculations used in success criteria evaluations. These need to require the same level of requirements as the HRA and Level 2 Analysis elements.

6.2.2-4 The text says “The peer reviewer shall also be knowledgeable (by direct experience) of the specific methodology, code, tool etc., that was used.” This implies, for example, that only someone who has used the HCR model can review it. While it is important for a reviewer to have experience in the methods used, for the purposes of providing judgements to decision-makers it is also important to have someone who has used a different methodology, so that he can provide a different perspective. In the same section it is stated there should be a minimum of five members of the peer review team. The restriction needs to be on the degree of coverage of the elements rather than on the number of people. However, it is essential to have more than one person to provide some diversity to the review.

6.3-1 The end of the1st paragraph in Section 6.3 states that there will be judgment involved in determining the specific depth of the review. However, it needs to be stated that the remainder of Section 6.3 identifies a minimum level of review.

6.3-2 The third paragraph of Section 6.3 states that "The High Level Requirements of Section 4 shall be used by the peer review team in assessing the completeness of a PRA Element." It is believed this statement is referring to the completeness of the models generated for each PRA element. If this is the case, the HLRs are not sufficient to assess the adequacy or completeness of the PRA models. The SRs are what the peer review must use to assess the adequacy and completeness of the models. The existing statement needs to be changed as it is incorrect.

6.3-3 The review requirements under each technical element in Section 6.3 have been changed. Specifically, "should" has replaced "shall" in the introductory statement specifying the scope of the review for each technical element. The use of "shall" is required to specify the minimum level of review needed to provide an adequate audit of the PRA elements. With the use of "should", a review of a single event tree would meet the requirements for peer reviewing the accident sequence analysis element. Clearly, this would be an inadequate peer review since a review of a single event tree would not provide an indication of the adequacy of event trees for totally different types of events.

6.3-4 The last sentence in Section 6.3.2 needs editing. In addition, this type of statement applies to all PRA elements. Section 6.3 needs to be changed to reflect this. The statement also needs to be expanded to indicate what needs to trigger the review of additional models. Generally, such triggers are major modeling inconsistencies within an element, errors in the models, failure to meet a requirement for any of the Application Categories, the lack of methodology documentation or procedures, and the lack of adequate model documentation.

6.3-5 The sixth bullet in Section 6.3.6 needs to be clarified to indicate that multiple HEPs in a sequence needs to be reviewed for dependencies, particularly if there is concern that multiple HEPs in cutsets would cause the cutsets to be truncated.

6.3-6 The fifth bullet in Section 6.3.5 states "HEPs for the same human action but with different times required for success." Is this meant to imply that available time is the only critical PSF? It would be better to say something like "HEPs for the same function but under the influence of different PSFs."

6.3-7 Suggest changing criteria in next to last bullet in Section 6.3.6 to any HEPs less than 1E-4.

6.3-8 Suggest changing the fifth bullet in Section 6.3.9 to read: "Demonstrate that phenomena that could impact the LERF characterization have been included." Examples include steam spike, steam explosion, direct containment heating, hydrogen combustion, containment shell meltthrough, and downcomer failure (Mark II BWR).

6.6-1 Section 6.6 needs to include the need for the peer review team to clearly indicate which of the three PRA categories, if any, are achieved for each of the technical elements. This is implied in some of the bullets, but not explicitly stated. Also, if the PRA is being reviewed for a specific application, there needs to be a finding from the peer review team relative to that application.