Attachment 4

NRC comments to ASME on Rev 10 in response to public review and comment

May 1999

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 3, 1999

Mr. Jess Moon
The American Society of Mechanical Engineers
3 Park Avenue
New York, NY 10016-5990

SUBJECT: STAFF COMMENTS ON ASME DRAFT "STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER PLANT APPLICATIONS"

Dear Mr. Moon:

I was pleased to see ASME's draft "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications" out for public review and comment. This letter includes the staff's comments on the subject standard. The staff's comments were provided by the Office of Nuclear Reactor Regulation, Office of Nuclear Regulatory Research, Office of Nuclear Materials Safety and Safeguards, and the Regional Offices. We offer several observations:

- The issue of PRA quality is application dependent. The standard needs to better reflect this concept.
- The standard has established the correct scope and level of detail in its requirements and has achieved an appropriate balance between specificity and flexibility.
- The staff will develop internal guidance in the use of a PRA standard.

I had indicated in my correspondence to Ms. Ling in February of 1998 that "development of a PRA standard can provide a level of confidence to the NRC staff regarding the technical quality of a PRA utilized by a licensee to support a risk informed initiative. Such a standard can, therefore, result in a more focused technical review of the PRA by the NRC staff and thereby make more efficient use of both NRC and industry resources, while still ensuring the safety of the decisions being supported by PRA insights."

We offer the following overall comments:

1. We agree in concept with the statement in the FOREWORD:
   "...to have a PRA Standard such that the level of confidence in the technical quality of the PRA would be sufficiently adequate to support the identified applications and such that only an audit or inspection of the PRA by the United States Nuclear Regulatory Commission (NRC) would be needed to ensure its quality to support those applications."

   NRC's endorsement of the standard (and therefore the above statement) will, however, depend on the final structure and content of the standard.

2. A major strength of the standard is its basic structure of recognizing that the needed scope and level of detail of a PRA is dependent on the application. Therefore, an effective and efficient structure is one that defines both the requirements for a reference PRA and the criteria for determining if the requirements are necessary and sufficient to assess the application. This structure, however, is not readily apparent in the current standard, as written. Consequently, readers can easily misinterpret the requirements (e.g., that every "shall" of the reference PRA is required for every application). The structure should be clearly discussed and explained at the beginning of the standard. Therefore, we recommend that Section 7 be moved to the front and precede the sections on the technical, documentation, configuration control and peer review requirements of the reference PRA.

3. Identifying the requirements for a "reference PRA" (Sections 3, 4 and 5) is an appropriate approach, particularly for users who, over time, will be updating and modifying their PRAs and for users who do not have a PRA. The objective of this reference PRA needs to be descriptive enough to support the defined requirements. The goal or objective of this reference PRA is stated (e.g., in Section 1.3) as *"The requirements ... shall be used to provide a realistic estimation of risk."* This description is insufficient to determine if the subsequent defined requirements of the reference PRA are necessary. We recommend that this description be rephrased and expanded; a possible recommended rewrite is as follows:

   "The requirements ... shall be used to provide a reasonable estimation and understanding of risk. The metrics used to characterize risk are core damage frequency (CDF) and large early release frequency (LERF). The estimation shall include an overall CDF, a CDF of the individual accident sequences, an overall LERF, and a LERF of the individual accident progressions. The understanding shall include identification of the accident sequences leading to core damage and the accident progressions leading to large early release, and the contributors to these accident sequences and progressions. The understanding shall also include a relative importance of the accident sequences and the accident progressions. The estimation and understanding shall be based on a PRA model that represents the current design, operation and maintenance practices of the plant."

4. As stated above, defining requirements for a reference PRA is an effective and efficient approach. Since the requirements are defined based on the objective of the reference PRA, the standard should specify which requirements are mandatory (i.e., "shalls"), which are recommended (i.e., "shoulds"), and which are optional (i.e, "may") to achieve the defined objective. It should be stated, however, that these requirements are only for meeting the objective of the reference PRA and can change depending on the specific application.

5. The definition (or objective) of the reference PRA in essence defines a single category for the standard. ASME may want to consider adding a set of categories for different applications considering the current and any anticipated applications. For example, this set of categories could be three categories, A, B and C with the current standard being Category B. Category A would then define a lesser set of requirements and Category C

would define a greater set of requirements, both as compared to Category B, the current standard. Including other categories would, however, require a definition of each category, examples of applications for each category, and the bases for why these applications fit into each category. These categories and requirements could be added as an appendix to Section 7. A possible approach is provided in Attachment 1. We recommend that if ASME decides to add such an option, it should not delay the current schedule in finalizing (i.e., publishing) the standard.

6. It is apparent that the standard has made use of previous work; the list of references is very long. We are aware that the BWR Owner's Group has instituted a peer review program and that the PWR Owner's Groups are instituting similar programs. It is not apparent if this standard and the peer review programs are compatible.

   RG 1.174 states two approaches for ensuring the quality of the PRA supporting the application:

   - a PRA standard
   - a peer review program .

   If a peer review program is used, RG 1.174 states that *"... a description of the .... standard or guidelines .... to which the PRA is compared .... should be provided for NRC review."* The objective of the ASME standard is *"...to have a PRA Standard such that the level of detail of confidence in the technical quality of the PRA would be sufficiently adequate to support the identified applications and such that only an audit or inspection of the PRA by the United States Nuclear Regulatory Commission (NRC) would be needed to ensure its quality to support those applications."* If the Owner's Groups peer review programs are to reference or use the standard for providing *"a description of the .... standard or guidelines .... to which the PRA is compared,"* and the standard is to reference the Owner's peer review programs, it needs to be shown how these two efforts are related. We recommend that a "mapping" of this relationship be performed and documented (either in the peer review program or as an appendix to the standard). This mapping also should not delay the current schedule of finalizing the standard.

7. The standard, as written, has achieved an appropriate balance between specificity and flexibility. It provides requirements for what is needed without prescribing how to perform those requirements. This approach should be consistent throughout the standard. Section 3.5 on the Use of Expert Judgment, however, is not consistent with this approach. It only supports a single approach for acceptability. We recommend that this section reference this approach as ***one*** acceptable approach and also reference NUREG-1563 (Branch Technical Position on the Use of Expert Elicitation in the High Level Radioactive Waste Program, November 1996) as another acceptable approach. (See detailed comments on Section 3.5 and Appendix A.3.5.)

8. A PRA by its very nature covers numerous disciplines, tasks, and activities. Separating the general requirements in Section 1 from the specific requirements of Sections 3, 4, 5 6 and 7 makes reading and understanding the requirements of the standard difficult. We recommend deleting Section 1 and moving the general requirements to the beginning of

each appropriate section (e.g., move requirements in Section 1.3 to the beginning of Section 3, Section 1.4 to the beginning of Section 4).

9. The definitions in Section 2 need to be reconciled with the standard. For example, in several cases the definition of a term is inconsistent with the use of that term in the standard. (See detailed comments on Section 2.)

10. The methods and assumptions used in an analysis can play a critical role in the outcome of the results. Therefore, to meet the objective in the FOREWORD, requirements regarding an assessment of the adequacy of the methods and key assumptions by the peer review team are essential (see detailed comments on Section 6).

11. There are "issues" that can greatly impact the results. One example is the use of generic data. The standard appropriately addresses this issue by providing a list of acceptable generic data. The standard should identify other key issues and provide at least one acceptable resolution. Attachment 2 provides an example list.

12. The structure of the technical requirements of the reference PRA (in Section 3) appears to be as follows:

    - identify the necessary elements of the PRA
    - define the specific objective of each identified element
    - define the supporting technical requirements to achieve element objective
    - define the detailed requirements to achieve each supporting requirement

    This structure is not "cleanly" or consistently adhered to in Section 3 for each element. Attachment 3 provides a direct matching of the objective to supporting requirements to detailed requirements using the Initiating Event Analysis as an example with recommended changes. Attachment 4 then provides a recommended example revision of the Initiating Event Analysis. (This revision includes the staff's detailed comments on Section 3.3.1.) We recommend that a similar exercise be performed on each of the elements.

13. The information provided in Appendix A (except Section A.3.5) is appropriate and will help in providing clarity, uniformity, and consistency. The appendix, however, is incomplete. There are several places in Sections 3, 4, 5, 6, and 7 that could benefit from including additional guidance and examples in Appendix A.

In addition to the above comments, detailed comments on the standard are provided in Attachment 5. Attachment 6 includes comments from the Advisory Committee on Reactor Safeguards.

I would also like to recognize and applaud ASME's effort in this endeavor. The publication of this draft standard in the given time-frame is a significant accomplishment. This standard should greatly enhance progress toward risk-informed nuclear operations and regulatory decisionmaking. Therefore, it is our intent to continue our support to ASME in the finalization of Phase 1 of this standard. If you have any questions, please contact Mary Drouin at (301) 415-6675. I look forward to the final publication of this standard.

Sincerely,

Ashok C. Thadani, Director
Office of Nuclear Regulatory Research

Enclosures:
As stated

cc: G. Eisenberg, ASME
R.Simard, NEI

Attachment 1
Example of Approach in Defining Alternate Categories

Definitions for each category would need to be provided along with associated applications and justification. For a set of three categories, example definitions are provided.

Category	Definitions	Example Applications
Reference PRA (Category B)	A PRA that provides a reasonable estimation and understanding of CDF and LERF. The estimation shall include an overall CDF, a CDF of the individual accident sequences, an overall LERF, and a LERF of the individual accident progressions. The understanding shall include identification of the accident sequences leading to core damage and the accident progressions leading to large early release, and the contributors to these accident sequences and progressions. The understanding shall also include a relative importance of the accident sequences and the accident progressions. The estimation and understanding shall be based on a PRA model that represents the current design, operation and maintenance practices of the plant.	Applications that involve fundamental changes to the basic design, operation or maintenance as the plant is licensed or operated (e.g., risk-ranking of SSCs).
'A'	standard needs to define	standard needs to define
'C'	standard needs to define	standard needs to define

Using the Initiating Event Analysis revision (see Attachment 4), for each technical requirement defined in the Standard for the Reference PRA, requirements would then be defined for the other categories .

Reference PRA Requirement Section Number	Category A Requirements	Category C Requirements
3.3.1 Initiating Event Analysis:		
3.3.1.1 (a)	standard needs to define	standard needs to define
3.3.1.1 (b)	standard needs to define	standard needs to define
3.3.1.2 (a)	standard needs to define	standard needs to define

Reference PRA Requirement Section Number	Category A Requirements	Category C Requirements
3.3.1.2 (b)	standard needs to define	standard needs to define
3.3.1.2 (c)	standard needs to define	standard needs to define
3.3.1.2 (d)	standard needs to define	standard needs to define
3.3.1.2 (e)	standard needs to define	standard needs to define
3.3.1.2 (f)	standard needs to define	standard needs to define
3.3.1.2 (g)	standard needs to define	standard needs to define
3.3.1.2 (h)	standard needs to define	standard needs to define
3.3.1.2 (i)	standard needs to define	standard needs to define
3.3.1.3 (a)	standard needs to define	standard needs to define
3.3.1.3 (b)	standard needs to define	standard needs to define
3.3.1.4 (a)	standard needs to define	standard needs to define
3.3.1.4 (b)	standard needs to define	standard needs to define
3.3.1.4 (c)	standard needs to define	standard needs to define
3.3.1.4 (d)	standard needs to define	standard needs to define
3.3.1.4 (e)	standard needs to define	standard needs to define
3.3.1.5 (a)	standard needs to define	standard needs to define
3.3.1.5 (b)	standard needs to define	standard needs to define
3.3.1.5 (c)	standard needs to define	standard needs to define
3.3.1.5 (d)	standard needs to define	standard needs to define
3.3.1.6	standard needs to define	standard needs to define

Attachment 2
Example Issues That Need to be Addressed in Standard

The following issues need to be added to the standard with the requirement that the PRA owner identify these issues and the bases (justification) for whatever model is chosen.

Issue	One Acceptable Resolution
Success criteria for BWR ATWS modeling	standard needs to identify
Percent that MTC is unfavorable for PWR ATWS sequences, and therefore, leads directly to core damage	standard needs to identify
RCP seal LOCA model with pump trip	standard needs to identify
RCP seal LOCA model without pump trip	standard needs to identify
Number and timing of relief valve demands during transients	standard needs to identify
Feed and bleed cooling calculations	standard needs to identify
Operability of steam generator relief valves after passing water	standard needs to identify
Probability of multiple steam generator tube rupture	standard needs to identify
Functionality of ECCS following containment failure	standard needs to identify
Generic data source	One acceptable source is Appendix 1 of the standard

Attachment 3
Physical Presentation of Technical Requirement Structure
Using Initiating Event Section 3.3.1 as Example

The text in Section 3.3.1, Initiating Event Analysis, from Revision 10 of the draft standard was formatted into the below table. The objective of the element is shown along with its supporting requirements in the left hand column and the detailed requirements for each supporting requirement in the right hand column. The location of the text in the draft standard is shown in parentheses. Given this formatting, modifications were made to the text to more appropriately support this structure. Additions to the text are highlighted, and deletions are "lined-out."

Supporting Requirements	Detailed Requirements
HIGH LEVEL REQUIREMENT (OBJECTIVE): The initiating event analysis ***shall*** identify those events that challenge normal plant operation and that require successful mitigation to prevent core damage (3.3.1)	
Two ~~types~~ classes of initiating events ***shall*** be identified and analyzed: LOCAs and transients ~~and LOCAs~~ (3.3.1)	LOCAs ***shall*** include both equipment and human induced initiating events that disrupt the plant by causing a breach in the core coolant system with a resulting loss of core coolant inventory. (3.3.1, 2nd para)
	Transients ***shall*** include both equipment and human induced non-LOCA initiating events ~~that disrupt the plant and leave the core coolant inventory intact~~. (3.3.1, 2nd para)
~~The initial list of initiating events shall include the following~~ (3.3.1.1) A systematic search for transients and LOCAs ***shall*** be performed	The general categories of events analyzed in accident analyses chapter of the plant's Final or Updated SAR ***shall*** be included. (3.3.1.1(a))
	Postulated events resulting in a loss of core coolant, including leaks and ruptures of various sizes and at different locations in the core coolant system (e.g., primary system pipe breaks, penetration failures, SGTRs, and vessel rupture) ***shall*** be included. (3.3.1.1(b))
	Postulated events representing active components in systems interfacing with the reactor coolant system that could fail or be operated in such a manner as to result in an uncontrolled loss of core coolant [i.e., interfacing systems LOCA (ISLOCAs)] ***shall*** be included. (3.3.1.1(c))
	Events which have occurred at the plant or at other plants if they can occur at the plant being analyzed ***shall*** be included. (3.3.1.1(d))
	Events that have occurred at conditions other than full power operation (i.e, during low power or shutdown conditions) ***shall*** be included unless it is determined that they are not applicable to full power operation. (3.3.1.1(e))
	Events resulting in the loss of systems (e.g., AC power, DC power, cooling water, air) supporting the operation of other plant systems whose loss results in an automatic or manual scram ***shall*** be included. (3.3.1.1(f))
	Events consisting of multiple equipment failures, if the equipment failures result from a common cause ***shall*** be included. (3.3.1.1(g))

Supporting Requirements	Detailed Requirements
	Events that can impact both plants of a multiple plant facility where systems are shared or can be cross-tied ***shall*** be included. (3.3.1.1(h))
	Events resulting in a controlled shutdown that includes a scram prior to reaching low power conditions ***shall*** be included. (3.3.1.1(i))
~~After establishing a reasonably complete set of initiating events, appropriate methods and techniques **should** be used to effect a systematic search for additional initiating events.~~ (3.3.1.1, 2nd para) A systematic search for additional events ***shall*** be performed using appropriate methods and techniques.	The identification of the initiating events ***shall*** consider the plant-specific safety functions. (3.3.1.1, 2nd para)
	The search ***should*** consider initiating event precursors and ***should*** consider each system alignment and alignments of supporting system that could influence the likelihood that single failures cause an initiating event, or magnify the severity of the challenge to plant safety functions that would result from such an event. (3.3.1.1, 2nd para)
	~~Such a systematic search **may** employ.~~ *Examples of acceptable methods and techniques include:* • *master logic diagrams (Reference [3.3.1-1])* • *heat balance fault trees (Reference [3.3.1-2])* • *failure modes and effects analysis (FMEA) (Reference [3.3.1-3])* (3.3.1.1, 2nd para) • *comparison to lists of common initiating events such as the list in Reference 3.3.1-4*
Events that result in the same or nearly identical plant response ~~**may**~~ ***should*** be grouped. ~~to reduce the number of initiating events requiring further analysis. Events with the following characteristics **shall** be grouped~~ (3.3.1.2)	Those events resulting in the same accident progression (i.e., requiring the same systems and operator actions for mitigation) ***shall*** be grouped. (3.3.1.2(a))
	Those events having the same success criteria for each system required for mitigation (e.g., the required number of pump trains) ***shall*** be grouped. (3.3.1.2(b))
	Those events having the same effect on the operability and performance of each mitigating system and the operator ***shall*** be grouped. (3.3.1.2(c))
	LOCAs ***shall*** be grouped according to required system response and the location of the reactor coolant system breach. (3.3.1.2, 2nd para)
	Breaches that bypass the containment ***shall*** be treated separately. (3.3.1.2, 2nd para)

Supporting Requirements	Detailed Requirements
Events ~~may be eliminated from further evaluation if they~~ that do not contribute significantly to core damage or a large early release ***should*** be eliminated from further evaluation. ~~The fact that an event has never occurred, by itself, is not a sufficient basis for eliminating an initiating event from evaluation. The following characteristics shall be used to eliminate events from further evaluation.~~ ~~(3.3.1.3)~~	If an initiating event is screened based solely on its frequency, the frequency of the initiating event ***shall*** be ~~is~~ less than 1E-7 per reactor-year (/ry). This screening criteria shall not be applied to initiating events involving ~~and the event does not involve~~ either an ISLOCA, containment bypass, or vessel rupture. (3.3.1.3(a)) The determination of the initiating event frequency used in the screening ***shall*** meet the requirements of Section 3.3.5. (3.3.1.3, 2nd para)
	If an initiating event is screened based both on its frequency and the availability of mitigating systems, the initiating event frequency ***shall*** be ~~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 for each required mitigating function ***shall*** be available to prevent core damage. ~~are independently failed~~. (3.3.1.3(b)) The determination of the initiating event frequency used in the screening ***shall*** meet the requirements of Section 3.3.5. (3.3.1.3, 2nd para)
	An initiating event ***may*** be eliminated if the resulting reactor trip is not an immediate occurrence. Supporting calculations ***shall*** be performed to show, with a high degree of certainty, that ~~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). (3.3.1.3(c))
	An initiating event ***shall*** not be eliminated based solely on the fact that the event has never occurred. (3.3.1.3)
The Initiating Event Analysis ~~task~~ element ***shall*** interface ~~has interfaces~~ with other elements of the PRA ~~tasks that shall be traceable in the PRA documentation~~. (3.3.1.4)	~~*Examples of interfaces with other tasks include:*~~ ~~• *systems analysis*~~ ~~• *sequence development*~~ ~~• *Level 1 quantification and review of results*~~ ~~• *data analysis*~~ ~~• *Level 2 analysis*~~ The initiating event frequencies calculated in the Data Analysis task ***shall*** be evaluated using events and data that match the initiating event descriptions. (3.3.1.4)
	The success criteria for each initiating event ***shall*** be reflected in the Level 1accident sequence models. (3.3.1.4)
	The success criteria for each initiating event ***shall*** be reflected in the Level 2 analysis. (3.3.1.4)

References

[3.3.1-1] NUREG-2300, PRA Procedures Guide

[3.3.1-2] Houston Lighting and Power Co., South Texas Project Electric Generating Station Level 2 PSA and IPE, August 1992

[3.3.1-3] FMEA reference *(In the course of preparation).*

[3.3.1-4] NUREG/CR-5750, Rates of Initiating Events at U.S. Nuclear Power Plants: 1987-1995, INEEL, February 1998.

Attachment 4
Example of Revision -- Initiating Event Analysis

Using Attachment 3, Section 3.3.1 of the draft standard was revised. In this example, as seen, the structure is clean: the objective of the element appears as the overall sub-section number, each supporting-requirement is a sub-subsection number, and each detailed requirement is lettered; therefore, every requirement can be "numerically" traced.

3.3.1 Initiating Event Analysis. The initiating event analysis ***shall*** identify those events that challenge normal plant operation and that require successful mitigation to prevent core damage

3.3.1.1 Identification of Initiating Events. Two classes of initiating events ***shall*** be identified and analyzed: LOCAs and transients.

(a) LOCAs ***shall*** include both equipment and human induced initiating events that disrupt the plant by causing a breach in the core coolant system with a resulting loss of core coolant inventory.

(b) Transients **shall** include both equipment and human induced non-LOCA initiating events.

3.3.1.2 Selection of Initiating Events. A systematic search for LOCAs and transients ***shall*** be performed.

(a) The general categories of initiating events analyzed in accident analyses chapter of the plant's Final or Updated SAR **shall** be included.

(b) Postulated initiating events resulting in a loss of core coolant, including leaks and ruptures of various sizes and at different locations in the core coolant system (e.g., primary system pipe breaks, penetration failures, SGTRs, and vessel rupture) ***shall*** be included.

(c) Postulated initiating events representing active components in systems interfacing with the reactor coolant system that could fail or be operated in such a manner as to result in an uncontrolled loss of core coolant [i.e., interfacing systems LOCA (ISLOCAs)] ***shall*** be included.

(d) Initiating events which have occurred at the plant or at other plants if they can occur at the plant being analyzed ***shall*** be included.

(e) Initiating events that have occurred at conditions other than full power operation (i.e, during low power or shutdown conditions) ***shall*** be included unless it is determined that they are not applicable to full power operation.

(f) Initiating events resulting in the loss of systems (e.g., AC power, DC power, cooling water, air) supporting the operation of other plant systems whose loss results in an automatic or manual scram ***shall*** be included.

(g) Initiating events consisting of multiple equipment failures, if the equipment failures result from a common cause ***shall*** be included.

(h) Initiating events that can impact both plants of a multiple plant facility where systems are shared or can be cross-tied ***shall*** be included.

(i) Initiating events resulting in a controlled shutdown that includes a scram prior to reaching low power conditions ***shall*** be included.

3.3.1.3 Completion of Initiating Event Identification. A systematic search for additional initiating events ***shall*** be performed using appropriate methods and techniques.

(a) The identification of the initiating events ***shall*** consider the plant-specific safety functions.

(b) The search ***should*** consider initiating event precursors and ***should*** consider each system alignment and alignments of supporting system that could influence the likelihood that single failures cause an initiating event, or magnify the severity of the challenge to plant safety functions that would result from such an event.

Examples of acceptable methods and techniques include:

- *master logic diagrams (Reference [3.3.1-1])*
- *heat balance fault trees (Reference [3.3.1-2])*
- *failure modes and effects analysis (FMEA) (Reference [3.3.1-3])*
- *comparison to lists of common initiating events such as the list in Reference 3.3.1-4*

3.3.1.4 Grouping of Initiating Events. Initiating events that result in the same or nearly identical plant response ***should*** be grouped. If grouping is performed:

(a) Those initiating events resulting in the same accident progression (i.e., requiring the same systems and operator actions for mitigation) ***shall*** be grouped.

(b) Those initiating events having the same success criteria for each system required for mitigation (e.g., the required number of pump trains) ***shall*** be grouped.

(c) Those initiating events having the same effect on the operability and performance of each mitigating system and the operator ***shall*** be grouped.

(d) LOCAs ***shall*** be grouped according to required system response and the location of the reactor coolant system breach.

(e) Breaches that bypass the containment ***shall*** be treated separately.

3.3.1.5 Screening of Initiating Events. Initiating events that do not contribute significantly to core damage or a large early release ***should*** be eliminated from further evaluation.

(a) If an initiating event is screened based solely on its frequency, the initiating event frequency ***shall*** be less than 1E-7 per reactor-year (/ry). This screening criteria ***shall*** not be applied to initiating events involving either an ISLOCA, containment bypass, or vessel rupture. The determination of the initiating event frequency used in the screening ***shall*** meet the requirements of Section 3.3.5.

(b) If an initiating event is screened based on both its frequency and the availability of mitigating systems, the initiating event frequency ***shall*** be less than 1E-6/ry and at least two active trains of diverse systems for each required mitigating function ***shall*** be available to prevent core damage. The determination of the initiating event frequency used in the screening ***shall*** meet the requirements of Section 3.3.5.

(c) An initiating event ***may*** be eliminated if the resulting reactor trip is not an immediate occurrence. Supporting calculations ***shall*** be performed to show, with a high degree of certainty, that the event does not require the plant to go to shutdown conditions until sufficient time has expired during which the initiating event conditions are detected and corrected before normal plant operation is curtailed (either administratively or automatically).

(d) An initiating event ***shall*** not be eliminated based solely on the fact that the event has never occurred.

3.3.1.6 Initiating Event Analysis Interfaces. The Initiating Event Analysis element ***shall*** interface with other elements of the PRA.

(a) The initiating event frequencies calculated in the Data Analysis task ***shall*** be evaluated using events and data that match the initiating event descriptions.

(b) The success criteria for each initiating event ***shall*** be reflected in the Level 1 accident sequence models.

(c) The success criteria for each initiating event ***shall*** be reflected in the Level 2 analysis.

References

[3.3.1-1] NUREG-2300, PRA Procedures Guide

[3.3.1-2] Houston Lighting and Power Co., South Texas Project Electric Generating Station Level 2 PSA and IPE, August 1992

[3.3.1-3] FMEA reference *(In the course of preparation).*

[3.3.1-4] NUREG/CR-5750, Rates of Initiating Events at U.S. Nuclear Power Plants: 1987-1995, INEEL, February 1998.

Attachment 5

Detailed NRC Staff Comments on Draft ASME Standard

Section 1, General Requirements

1-1. The Section 1 writeup refers several times to the "Owner." The underlying model for the Standard appears to be aimed at licensees. While the language in Section 1 doesn't seem to specifically exclude other Standard users, this should be checked. In a number of cases, the qualifier "Owner" can probably be dropped without affecting the intent of the Standard.

1-2. The portion of Appendix A associated with Section 1 should contain some background material on the Standard's view of NPP PRA. Two important points concern: a) what definition/interpretation of "probability" is used by the Standard, and b) what does the Standard mean by "frequency." (Regarding the latter, presumably the Standard is referring to an implicit Poisson model for events; this should be explicit.) I recommend Appendix material because few-line definitions (which should also be provided) probably won't be sufficient by themselves.

1-3. Section 1.3: It is not clear that the word "realistic" is appropriate as a characterization of the risk estimate. Presumable, what is intended is that the estimate be as good as can be obtained consistent with the collective understanding of relevant issues. Recommend rewrite as follows:

"The requirements ... shall be used to provide a reasonable estimation and understanding of risk. The metrics used to characterize risk are core damage frequency (CDF) and large early release frequency (LERF). The estimation shall include an overall CDF, a CDF of the individual accident sequences, an overall LERF, and a LERF of the individual accident progressions. The understanding shall include identification of the accident sequences leading to core damage and the accident progressions leading to large early release, and the contributors to these accident sequences and progressions. The understanding shall also include a relative importance of the accident sequences and the accident progressions. The estimation and understanding shall be based on a PRA model that represents the current design, operation and maintenance practices of the plant."

1-4. The term (e), "data analysis" is inaccurate; what is really meant is parameter estimation.

1-5. 3rd paragraph, 2nd sentence: Replace by "If a formal expert judgement elicitation, rather than the judgement of a knowledgeable analyst is required, the requirements of Section 3.5 shall be followed."

1-6. Section 1.6.1: Add a phrase to the first sentence of sentence to Section 1.6.1, so that it reads: "The peer review team shall .... properly implemented, and to identify and assess the impact of specific assumptions or modeling approaches used."

1-7. Section 1.6, 1st paragraph: Suggest the following change (see redline/strike-out):

..... PRAs that are used in the regulatory decision-making at a nuclear power plant shall receive a peer review. ~~Only a single peer review is necessary ....considered the review of record.~~ The objective of the peer review shall ...

The above change is suggested because we really do not care if the plant does one or many peer reviews, just so that the version of the PRA used is reviewed. Concerning the latest version of the review being the review of record, this may not be practical since the latest review may only center on a small portion of the PRA being updated, and so the latest review is not all encompassing.

1-8. Since the standard is not prescriptive, perhaps the purpose of the review should be to "provide reasonable assurance that the technical requirements of this standard have been met, and that the (non-prescribed) assumptions made and models adopted are reasonable, consistent with the state-of-the-art, and do not significantly bias the results either conservatively or non-conservatively."

1-9. Section 1.6.2: The term "written methodology" is used in this section twice. It is not clear what this includes. Suggest use of "documented methodology" instead. Also, item (b), differing opinions need not be resolved; they may be recognized and accommodated.

1-10. Section 1.6.2: Add to item (d) of Section 1.6.2, "including the assessment of assumptions and modeling approaches."

1-11. Sections 1.3 through 1.6 provide multiple requirements. Separating these requirements (using paragraphs, subparagraphs, etc.) would add clarity.

1-12. p. 2, 2nd column. Are turbine missiles included in the current version of the Standard? Spent fuel pool accidents apparently are not (although this may not be apparent until the reader looks up the definition of Level 1 analysis). Perhaps there should be a table listing what is and what isn't included.

1-13. p. 2, 2nd column, last line. Should reference Figure 1.2-1.

1-14. p. 2, figure. Change number to 1.2-1. Also insert "are" after "requirements" in peer review box.

1-15. p. 3, 1st column, 3rd para, 2nd sentence. Phrase "Expert Judgement is performed" is awkward. Suggest using "If expert elicitation is used." More broadly, should the plant familiarization and the expert elicitation requirements be singled out here? Suggest deleting paragraph.

1-16. p. 3, 1st column, 4th para. Delete 1st sentence; adds nothing to requirement for computing CDF and LERF specified in next sentence.

1-17. p. 3, 1st column, last para. Should point out that specific requirements for documentation appear in Section 4.

1-18. p. 3, 1st column, last line. Lots of information might be retrievable/traceable in principle. Suggest using a qualifier (e.g., "easily," "readily," "practically").

1-19. p. 3, 2nd column, 2nd para, 1st sentence. Suggest replacing "methodology" with "methodology and tools (e.g., software codes and models)."

1-20. p. 3, 2nd column, 2nd para, 2nd sentence, reference to "general assumptions." How does this relate to the later discussion on assumptions (4th para)? Suggest deleting "general."

1-21. p. 3, 2nd column, 3rd para, 2nd sentence. Suggest deleting this sentence; the requirement is already included in the 1st sentence.

1-22. p. 3, 2nd column, 4th para, 1st sentence. Is the Standard is calling for the documentation of all assumptions? (Some, e.g., the lack of aging, are embedded in usual PRA methodologies.) Suggest adding a qualifier (e.g., "key").

1-23. p. 3, 2nd column, 4th para, 2nd sentence. Suggest deleting this sentence; the requirement is already included in the 1st sentence.

1-24. p. 3, 2nd column, 4th para, 3rd sentence. Appears to refer to the "appropriateness of ... the limitation." The meaning is clear (the reviewer has to be able to determine if the limitation is a problem), but the phrasing is awkward.

1-25. p. 3, 2nd column, 5th para, 2nd sentence. Suggest deleting "or deliverables;" it doesn't add to the sentence. Also suggest deleting "and outcomes" from the paragraph; in this general discussion, the distinction (which is not clarified in the Standard - note that Section 3 does not seem to specifically identify by name the "products" or "outcomes" of each technical element) doesn't add to the discussion.

1-26. p. 3, 2nd column, 6th para. Suggest deleting references to "outcomes;" in this general discussion, the distinction from "products" doesn't add to the discussion.

1-27. p. 4, 1st column, 1st para, 2nd sentence. Replace "this Section" with "this Subsection." Also change reference to "Section 5."

1-28. p. 4, 1st column, 2nd para, 1st sentence. Replace "shall be applicable ... amend the basis" with "shall be applicable to those PRAs which are used to support amendments to the basis." The configuration control requirements are literally applicable to the PRAs and not the NPPs.

1-29. p. 4, 1st column, 2nd para, 2nd sentence. Delete "to establish the capability."

1-30. p. 4, 1st column, 2nd para, 3rd sentence. Suggest deleting this sentence; the requirement is already included in the 2nd sentence.

1-31. p. 4, 1st column, 3rd para, 1st sentence. Delete "Owner's." Qualifier not needed.

1-32. p. 4, 1st column, 3rd para, 2nd sentence. Replace "that are used... power plant" with "that meet the requirements of this Standard."

1-33. p. 4, 1st column, 3rd para, 3rd sentence. "base PRA" needs to be defined. (There is an implicit assumption of process here; the process should be described in Appendix A.)

1-34. p. 4, 2nd column, Section 1.6.1, 1st sentence. Deletesentence. The peer review objective was stated in the previous paragraph.

1-35. p. 4, 2nd column, Section 1.6.1, 2nd sentence. Replace "shall conduct the review of the PRA with" with "shall have." Clarifies requirement, eliminates excess words.

1-36. p. 4, 2nd column, Section 1.6.1, 3rd sentence. Replace "The PRA peer ... use a team of" with "The team shall consist of."

1-37. p. 4, 2nd column, -Section 1.6.1, 4th sentence. Delete sentence. Section 6 covers the personnel qualifications, and distinguishing between an "objective review" and a "subjective assessment" is not fruitful.

1-38. p. 4, 2nd column, Section 1.6.1, 5th sentence. Delete "and facilitated."

1-39. p. 4, 2nd column, Section 1.6.1, last line. Could this requirement be taken to mean that somebody other than the Owner would have to pay for the peer review (which would be unrealistic)?

1-40. p. 4, 2nd column, Section 1.6.2, bullet (c). Replace "an approach" with "the approach."

1-41. p. 4, 2nd column, last para. Replace first part with "The requirements in Section 7 shall be used to define the process for evaluating the applicability of the Section 3 technical requirements to..." and delete last sentence. Check to see that the scope and intent match that provided in the Preface's description of Section 7.

Section 2, Definitions

General Comments:

2-1. The definitions are very much in need of revision. Many are incorrect, and others provide no meaningful information. They are also inconsistent in terms of defining systems, e.g., CCW, SW, RCP, RCIC, RCS, and HPCI are included, but others such as LPCI, LPCS, AFW, MFW, etc. are not. Some suggestions and comments are provided below. When writing definitions, care should be taken to distinguish between events (i.e., basic events) in a model and events (observations) in the real world.

2-2. Distinction should be made between definitions and acronyms.

Specific Comments:

2-3. **Accident class**: Replace "such as, transients" by "e.g., accidents initiated by transients." Add "accidents" after "bypass." Suggest deleting this definition.

2-4. **Accident conditions**: The last part of the definition does not make sense. Provide examples of the operational conditions being referred to.

2-5. **Accident consequences**: The definition should include interdicted land, water contamination, etc. In some cases, these are more important than the economic cost. Delete "radiological." (It doesn't matter anyway for the current standard, but I assume we care about toxic effects as well.) Should the modifier "public" be used? Suggest deleting this definition.

2-6. **Accident initiators**: The definition should include "and causes a plant trip if the plant is at power." If this definition is to be more general than for the use of this standard alone, it should also refer to non-power plant states. The definition should cross-reference, and be the same as "initiating events." Suggest deleting. Definition appears to be covered by parenthetical statement in initiating event definition.

2-7. **Accident sequence**: A combination of system, function and operator failure or success events that follow an initiating event and can potentially lead to an undesired consequence such as core damage, or radioactive release. Is the term "accident consequence" being replaced by "undesired consequence" to stop the sequence at Level 2?

2-8. **Accident sequence analysis**: Should the word "contributions" be replaced by "combinations?" Definition only includes core damage, but preceding definition of "accident sequence" is not limited to CD. Clarification is needed. Do we need to add "or LERF" to this definition?

2-9. **Actual time**: Delete definition; it takes a common English term and restricts it to a particular HRA-related usage. Spell out the usage in the appropriate part of the Standard.

2-10. **Availability**: This current definition has elements of "reliability" in it. This should be broken out, and a separate definition of "reliability" provided.

2-11. **Best estimate**: Remove the last sentence. Which estimate is best will depend on what the value is being used for. Either insert "or output from" after "utilized in" or delete "utilized in a computation." *Suggest deleting this definition and deleting term from text.*

2-12. **Birnbaum importance measure**: Is it necessary to define these importance measures? They are technical definitions that could be handled by reference at the appropriate place in the standard. If they are retained then remove the last sentence. Why not include the mathematical formula for determining each importance measure? Suggest deleting this definition and deleting term from text.

2-13. **Common cause failure**: A failure of two or more components as a result of a shared cause. Delete the also referred to as common mode failure. Common cause failure: What is meant by adversely affect. CCF is a single event that fails two or more components at the same time. Note: It is improperly referred to as common mode failure. *Suggest deleting term "common mode" everywhere it is used and using "common cause"instead.*

2-14. **Component fragility**: Delete definition unless it is actually used in the Standard.

2-15. **Containment bypass**: This is a description of a condition, and not necessarily an event. Remove the "an event which opens." Also, in the definition of "containment bypass," examples are provided. This should be deleted since examples are not provided in the majority of the other definitions.

2-16. **Containment failure**: Does the parenthetical mean that failures to isolate containment are not "containment failure?" Is the parenthetical needed?

2-17. **Core Damage**: First sentence is a run-on. Use ".".. is anticipated. This represents the onset of gap release of radionuclides and is characterized by:" This definition needs work. The proposed BWR definition will "certainly" produce core damage! What is the basis for having more than one temperature for BWRs vs PWRs? Don't provide multiple temperatures (or other parameter values) unless they are internally consistent. What are the requirements of the codes that produce the temperature estimates?

2-18. **Core damage frequency**: Remove the word "average." Replace with "expected number of core damage events per unit time." This is consistent with the definition of "failure frequency."

2-19. **Cut set**: The definition provided is for minimal cut set, not cut set. Suggest using the terminology minimal cut set as much as possible, and pointing out that "cut set," when used, is shorthand jargon. Replace *"cut set"* with *"minimal cut set (MCS)* - minimum combination of a set of events that, if they occur, will result in an undesired event such as the failure of a system or the failure of a safety function." Also, this Standard sometimes writes cutset instead of cut set; this should be corrected to use cut set. *Suggest dropping "cut set" from definitions and text, and use "minimal cut set" instead in definition and text.*

2-20. **Dominant contributor**: Why does it have to be an accident class? It could also be a cutset. The term "major impact" should be defined, e.g., >= 10%.

2-21. **End state**: After "success states", insert "(i.e., negligible impact)." The term "release categories" needs to be defined.

2-22. **EOPs/AOPs**: Technically it should read emergency operating procedures/abnormal operating procedures.

2-23. **EPIX**: Capitalize the system name.

2-24. **Equipment qualification**: It's not clear that qualification "ensures" that equipment is operable, it merely demonstrates that it is capable of operating under the conditions of the qualification test. Delete also "operate on demand to."

2-25. **Event tree**: Existing definition is somewhat clumsy. Replace text with "an inductive logic diagram that depicts possible accident sequences (starting from an initiating event and ending in an end state) and provides a framework for determining the frequency of these sequences."

2-26. **Expert judgement**: This is not a definition as written, rather it is a brief description of a method. Definition is circular. Really seems to be focused on elicitation. Note that the Standard uses both "judgement" and "judgment." Suggest the following replacement: "formal methods for the elicitation and collection of judgments from experts in a specific area that can be used to produce probability estimates" *Suggest changing definition as applying to "expert elicitation" for Section 3.5, and using "engineering judgement" instead of "expert judgement" elsewhere.*

2-27. **External event**: This usually includes fires within the plant. May need to clarify what "outside plant systems" means. Are onsite toxic gas releases included?

2-28. **Failure mechanism**: The failure mechanism is the human, not human factors. Human factors can affect the likelihood of failure.

2-29. **Failure mode**: Current definition is incorrect. Existing definition uses "mode" in a manner different from common usage. A mode is a manifestation of how you know there's a failure, i.e., failure to start, failure to run. This reads more like a definition for a failure mechanism. Replace text with "the manner in which an SSC failure occurs (e.g., fails to open, fails to remain open)."

2-30. **Failure rate**: Delete "in a given time interval;" qualifier is not needed for the definition. The last sentence is unnecessary.

2-31. **Fault tree**: Provide the following definition: "a deductive logic diagram that, starting from an undesired event (the fault tree top event), depicts how a particular undesired event can occur and provides a framework for determining the probability of the top event occurrence.

2-32. **Fault tree analysis**: Given the preceding definition of "fault tree," suggest deleting this definition.

2-33. **Front-line system**: According to this definition, it looks like reactivity control systems (e.g., RPS, SLCS) are not included. What about pressure control?

2-34. **Fussell-Vesely measure**. Delete the last sentence. Also, the focus on CDF and LERF is understandable but not fundamental. (Same issue arises with the other importance definitions.) In principle, it is reasonable to talk about the importance of SSCs to system performance as well as plant performance. Suggest removing the phrase "Fussell-Vesely importance is" from the definition, it is not needed.

2-35. **Human error**: This definition includes action, but would not normally be read to include inaction. It needs to be better integrated with the following HEP and HRA definitions.

2-36. **Human error probability**: Replace with "the probability that plant personnel will fail to correctly perform a required action (or set of actions)." (See earlier Section 1 comment on the need to define probability.)

2-37. **Importance measure**: This is a meaningless definition. Replace with "a quantitative measure of the significance of an event (typically an SSC failure or HE) to the likelihood of an undesired event (typically core damage or large early release)."

2-38. **Initiating Event**: This definition is incomplete, particularly with respect to shutdown events (why are inventory loss or failure to control reactivity not included for example). See comment on Accident initiator also. The definition sounds like minor perturbations could be included (there is no definition of "transient"), especially since a definition has been provided for "accident initiator." Point out that, for steady state operation, IEs are generally events that lead to a demand for reactor scram? The use of the phrase "thereby initiating a transient within the plant" may not make it clear that initiating events also include LOCAs. Replace with *initiating event* - "any event that perturbs the steady state operation of the plant, if operating, or the steady state operation of the decay heat removal system during shutdown operations, thereby initiating an abnormal event (such as a transient or LOCA) within the plant. (Initiating events trigger sequences of events that challenge plant control and safety systems).

2-39. **Internal events**. Delete remainder of definition starting with "and, in combination..."

2-40. **Internal flooding event**: *Suggest deleting definition.* If it remains, delete the "(e.g., SW pipe break in a reactor building)" since this example does not help. Suggest removing the phrase "large volume of" from the definition. Submergence by water is the important characteristic, not the volume of water causing the submergence. Replace with something like "initiating event leading to the exposure of SSCs to water and their subsequent failure. Potential exposure mechanisms include submergence, spray, dripping, and splashing."

2-41. **Large early release**: Use "Consequence of an accident leading to ...." Is the last sentence complete? (isolation "failure")

2-42. **Large early release frequency (LERF)**: Delete "average." Replace with "expected number of large early release events per unit time." This would be consistent with the definition of "failure frequency."

2-43. **Level 2 analysis**: Definition appears to exclude bypass scenarios. Is this intentional? Recommend that the definition discuss releases from core damage accidents.

2-44. **Level 3 analysis**. *Suggest deleting definition and usage in text.* If not, replace "resulting consequences" with "consequences resulting from radioactive material releases."

2-45. **Level of detail**: *Suggest deleting definition.*

2-46. **Mission time**: Delete the example since it does not help. Replace "for example" with "For example." Replace the comma after HFs with a period. Insert "containment spray" before "mission time" in parenthetical. Add after ...function "assumed in PRA."

2-47. **Model**: *Suggest deleting definition.*

2-48. **Modeling assumption**: *Suggest deleting definition.* If not, delete the phrase within the parentheses.

2-49. **Monte Carlo uncertainty propagation**: *Suggest deleting definition* If not, the sentences beginning with "in general a Monte Carlo simulation with SRS involves four steps...." should be deleted. This is a description of the methodology to perform the propagation, and shouldn't be in the definition. Replace with "a sampling-based technique for determining the probability distribution of a model output variable (or set of variables), given the probability distributions of the input variable(s)." Existing definition is not very helpful to somebody who doesn't already know.

2-50. **Monte Carlo uncertainty propagation**: This definition should be broken into a definition for Monte Carlo simulation and then a definition on Monte Carlo uncertainty propagation (or analysis).

2-51. **Mutually exclusive events**: Replace with "a set of events which cannot occur at the same time."

2-52. **NPRDS**: Capitalize system name.

2-53. **Plant damage state**. Don't like calling "sequences" a "state" (the sequences end with the plant being in the given state), but the meaning is clear. Replace "HE rates" with "HEPs." Provide closing parenthesis.

2-54. **Performance shaping factor**: Delete the parenthetic remark up to the colon. Replace "HE rates" with "HEPs." Provide closing parenthesis.

2-55. **Plant-specific data**: Replace "consisting of observed sample data" with "derived from observations from the specific plant of interest." The definition does not define plant-specific--observed sample data can come from any source. The last clause identifies the necessity that the data come from "the plant." Definition should be reworded as follows: "consists of observed sample data from the plant being analyzed."

2-56. **Post- and pre-initiator human failure events**: "Basic events that represent human errors committed ..... ." These definitions introduce the ATHEANA terminology (HFE) but don't use the ATHEANA lexicon.

2-57. **Probabilistic risk assessment**: *Suggest deleting definition.* The definition is non-classical: it talks about the frequency of "events" rather than frequencies and consequences. It's OK when talking about Level 1 and limited scope Level 2, but gets murkier past this point. The explanatory material starting with "A Level 1 maps..." should be deleted; definitions are provided elsewhere. Might also consider deleting the previous sentence starting with "In general..." Also, change "associated with plant operation...." to "associated with design, operation...." Everything after "Risk is...." should be deleted as it really adds nothing to the definition of PRA.

2-58. **PRA configuration control plan, PRA program plan, PRA QA plan**: *Suggest deleting definitions.* If the first and third plans are subsets of the 2nd, this should be stated explicitly. See the last para of Subsection 1.5, last sentence. Says "This program plan" in apparent reference to the PRA Configuration Control Plan.

2-59. **Recovery factor**: The definition suffers from a common PRA jargon problem; the mixing of events (cut sets) and their likelihood. Use "a factor that is used to modify the likelihood of an accident sequence in order to account for potential recovery actions." Delete parenthetical; this should be addressed in the HRA section." Also, delete the sentences within the parenthesis. Suggest adding "(nor-recovery)" between the words recovery factor.

2-60. **Risk**: This definition doesn't completely match the one provided in PRA. There are a number of definitions of risk floating around; the NRC probably has one in its white paper on risk-informed, performance-based regulation. Suggest removing the word "risk" from the definition.

2-61. **Risk Achievement Worth**: Replace "out-of-service due to testing, maintenance, or failure" with "unavailable." Replace the second sentence by "It is the ratio of the CDF or LERF evaluated with the SSC's basic event probability set to one, to the base case CDF or LERF." Delete last sentence. Suggest removing the words "Risk Achievement Worth" from the definition. Also suggest noting that RAW can be determined on both an interval and ratio basis. As is the definitions limits RAW to a ratio.

2-62. **Risk Reduction Worth**: *Suggest deleting definition, not used in text.* If not, delete the last sentence. See comments on Birnbaum and FV. See note on RAW.

2-63. **Screening analysis**: Use "An analysis that eliminates those items (components, systems, human actions, accident sequences,etc) from further consideration based on their negligible contribution to the probability of a significant accident or consequence."

2-64. **Screening criteria**: *Suggest deleting definition.* Screening criteria need not be values, they can be conditions. If not deleted, this needs to be rewritten. The definition assumes that screening is only used for applications. If kept, the definition should be expanded to include the screening of initiating events, failure modes, accident sequences, human actions, etc. Suggest also deleting "best estimate." This qualification seems unnecessary and possibly

contrary to standard practice. (It would seem that, by definition, one would want to make screening criteria conservative from the point of view of avoiding mistakes in screening.)

2-65. **Split fraction**: Replace with "Conditional probability of branch given previous events in sequence." Remember that not every unitless parameter is a probability, so remove the "i.e."

2-66. **Standby system**: The definition is only partially correct. The current definition introduces the concept of "primary system." This should be defined or the definition reworked to remove a reference to an "unknown" concept. For example, AFW is a standby system, yet it does not fit into this definition, in that a "primary" system does not have to fail before the standby system is required. Replace definition with "a system which is not normally operating, but is intended to be ready to operate upon demand."

2-67. **Station blackout**: The definition should only include loss of onsite and offsite power. Recovery of power should not be part of this definition. For a BWR with HPCS, does this definition imply that SBO occurs only when all three onsite emergency AC sources (DGs) fail?

2-68. **Success criteria**: Replace with "criteria for determining whether a SSC has successfully performed its mission. System success criteria are typically stated in terms of the minimum number of trains or components that are required to operate over a specified period of time to ensure that safety functions are adequately performed."

2-69. **Support system**: Should the "for" in "for example" be capitalized?

2-70. **System failure**: Delete the "Note."

2-71. **THERP**. Capitalize name. Should a reference (NUREG/CR-1278) be provided?

2-72. **Top event**: The definition provided here is specific to a fault tree. The term "top event" can be, and is, used to describe events in an event tree. An appropriate event tree definition should be added. The Standard uses "top event" as synonymous with a "heading" of an event tree. While, in many cases, they are synonymous, sometimes a heading will not be related to a top event of a system; a good example is human actions included as headings in event trees, which obviously are not top events of systems. For clarity, it would be better to use the term "heading" when it refers to an event tree, and "top event" when it refers to a fault tree (that may be a heading of an event tree).

2-73. **Truncation limit**: Truncation limit also refers to initiating events and component failure mechanisms. The current definition should be expanded to cover these cases.

2-74. **Unavailability**: Take definition for availability and add the word "not."

2-75. **Uncertainty analysis**: *Suggest deleting definition.* If not, replace with "process used to quantify the uncertainties in the results of an analysis, due to uncertainties in the analysis models and data." Existing definition raises questions (e.g., concerning "random variability in parameters"). If questions are raised as to what is meant by "quantify the uncertainties," could be more formal and use: "process used to quantify the probability distribution(s) for

the model output variable(s) of interest. This includes methods for assessing probability distributions for model parameters and for propagating these distributions through the model structure."

2-76. **Verify**: *Suggest deleting definition.*

2-77. **Walkdown**: Should this include a walkdown of procedures?

Section 3, Technical Requirements

General comments:

3-1. Discussion of dependencies is scattered over several subparagraphs. Since analysis of dependencies is a very important element of a PRA, I suggest consolidating all this discussion, including CCFs, into one paragraph or subparagraph.

3-2. It is recommended that important points, such as success criteria in 3.2.1.4 (c), are cross-referenced (a reference to the section in the Standard where more detail is provided).

SECTION 3.1, SCOPE
General Comments

3.1-1. The standard can greatly help by ensuring that the PRA is assembled in an appropriate manner, so that, for example, it can be assumed that the component boundaries have been used correctly in the data and the systems analysis tasks. In this way, the NRC review could be focused on those assumptions and specific models that are relevant to the decision being made, and not be concerned about the mechanics of the PRA process.

3.1-2. If it is intended that a peer review is a requirement, then it can be taken as assurance that the technical requirements of Section 3 have been met. However, it could be strengthened by requiring that the reviewers identify key assumptions and methods (for HRA, for example), and assess and document whether these assumptions and methods are generally accepted, and attempt to characterize their impact on the results (does the method lead to a conservative estimate of HEPs for example). If the assumptions or methods are not commonly accepted ones, this should be identified by the reviewers and, if possible, an assessment made of the impact on the PRA results. Such a review report would further strengthen the role of the Standard.

3.1-3. The entire document needs to be searched for the following words and consider deleting them: "all", "every", "always", and "each." In most cases they are not needed and the sentences will be sufficiently robust without them. Including these words will make many of the requirements much more difficult to meet than needed.

3.1-4. Section 3.1 - In Figure 3.1-1, the role of internal flooding analysis is mischaracterized.

3.1-5. The bottom half of Figure 3.1-1 apparently summarizes the top half, but doesn't really add anything. Suggest deleting. There are two flows; top to bottom and left to right. Suggest orienting in one direction (so plant familiarization feeds in from the left). Not clear why expert judgement is separated out; expert judgement (in the general sense) is always used in modeling and analysis; expert elicitation is used in specific parts of the process.

SECTION 3.2, PLANT FAMILIARIZATION
General Comments

3.1-6. First 4 bulletized lists. Delete bullets on "other information." Not necessary or useful.

Specific Comments

3.1-7. p. 18, 1st column, 1st para. Suggest keeping the first sentence and deleting the rest. The 2nd sentence is a little confusing (it says that "plant familiarization involves ... using plant information") and the requirement in the 3rd sentence is essentially repeated in 3.2.1.

Section 3.2.1
Specific Comments

3.1-8. Last sentence. Replace "be as current ... PRA reflects" with "be sufficiently current that the PRA adequately reflects." Issues of practicality shouldn't be ignored, but seem to better fit in Section 7.

3.1-9. 1st sentence. Replace with "Plant design information reflecting the normal and emergency configurations of the plant and relevant to the SSCs addressed in the PRA shall be collected."

3.1-10. 3.2.1.1 (a) through (h). Provide references to appropriate sections of the Standard where these activities are performed.

3.1-11. 3.2.1.1(c). Need to define the terms "functional dependency" and "hardware dependency" or at least point out their difference.

3.1-12. 3.2.1.1(e). Replace "auto" with "automatic."

3.1-13. 3.2.1.1(h). Delete. Not very helpful, and requirement is included in 3.2.1.1 first paragraph ("The information shall include:").

3.1-14. Need a requirement to collect design information needed to perform an internal flooding analysis. This goes beyond the requirements of 3.2.1.1(g).

3.1-15. 1st sentence. Replace with "Information on plant procedures and practices relevant to the SSCs and human actions addressed in the PRA shall be collected."

3.1-16. 1st sentence. Provide references to appropriate sections of the Standard where these SSCs and human actions are identified.

3.1-17. 2nd sentence. Delete "to be identified."

3.1-18. 1st sentence. Replace with "Information on test and maintenance procedures and practices relevant to the SSCs and human actions addressed in the PRA shall be collected."

3.1-19. 2nd sentence. Delete "to be identified."

3.1-20. 1st sentence. Replace with "Information on the engineering aspects of the plant design relevant to the SSCs addressed in the PRA shall be collected."

3.1-21. 2nd sentence. Delete "to be identified."

3.1-22. 3.2.1.4(d). Delete. Not very helpful, and requirement is included in 3.2.1.4 first paragraph ("The information shall include:").

Section 3.2.2
General Comments

3.1-23. It might be better to say what the walkdowns are intended to achieve. The discussion in the non-standard appendix makes this clearer and should be included in the main body of the text. It is difficult to see how a walkdown would support the sequence development that did not do so via the system analysis or the HRA.

Specific Comments

3.1-24. Replace with "Plant walkdowns shall be conducted to corroborate information obtained from the documented information sources addressed in Paragraph 3.2.1, and to obtain information that can be gained only by direct observation."

3.1-25. Use of the simulator and observation of operating crews to establish actual plant response and human performance should also be included.

Section 3.2.3
Specific Comments

3.1-26. Delete requirement or provide more detail as to what it means.

Section 3.3.1
General Comments

3.3.1-1. Much of the discussion uses "events" as shorthand for "initiating events." Recommend against this practice; formal terminology should be used throughout the Standard to avoid confusion.

Specific Comments

3.3.1-2. 1st para, last sentence. Replace "types" with "classes."

3.3.1-3. 2nd para, 1st sentence. Replace with "Transients shall include both equipment and human induced non-LOCA initiating events" and move to after the sentence on LOCAs. Insert "initiating" before "events" in the sentence on LOCAs. New wording ensures that transient that turn into LOCAs are addressed.

Section 3.3.1.1
General Comments

3.3.1-4. reference for initiating event types is the newly published NUREG/CR-5750, which would provide the "reasonably" complete list.

Sections 3.3.1.1-3.3.1.3
Specific Comments

3.3.1-5. 3.3.1.1(f). This presumably is a reference to the so-called common-cause, or support system initiating events. Some examples would be helpful here.

3.3.1-6. 3.3.1.1(h). This is an important issue, because it has the potential for limiting the systems available for response. However, nowhere else in the standard is there a discussion of this. Perhaps in the success criteria, sequence development, and systems analysis sections, a place can be found that says something like: "where equipment available is limited by an initiating event that impacts multiple units, this shall be reflected in the [event sequence development, success criteria, fault tree - pick one]. When there are shared systems (as at Peach Bottom where ESW and the EDGs are shared between two units) the models can become complicated. As another example, when there is a swing diesel, what should the assumption be concerning which plant gets the diesel.

3.3.1-7. 2nd para, 1st sentence. The term "reasonable" is used but not defines. Also, this sentence can be interpreted to mean that you can use inappropriate methods.

3.3.1-8. 2nd para, 1st sentence. Change "should" to "shall." Important for completeness.

3.3.1-9. 1st para. The first two sentences are inconsistent. The first says that events may be grouped. The second says that grouping shall be done.

3.3.1-10. 1st para, 2nd sentence. Replace with "If grouping is performed, only events with the following characteristics may be grouped." A similar change is needed for the LOCA sentence following the requirements.

3.3.1-11. Title. Replace with "Screening of Initiating Event Groups."

3.3.1-12. 1st para, 1st sentence. Replace "contribute to .. release" with "contribute significantly to CDF or LERF."

3.3.1-13. 1st para, 3rd sentence. Note, as written, this sentence allows the use of other screening criteria. Suggest replacing sentence with "If initiating event screening is performed, the following criteria shall be used in the screening process." Do we really want to say "only the following criteria may be used"?

3.3.1-14. 1st para, 3rd sentence. If use of the Standard does not require that **all** of the following criteria be met, then replace with "Any one of the following characteristics shall be used to eliminate events from further evaluation:."

3.3.1-15. 3.3.1.3(a). Does the Standard require the treatment of vessel rupture? This seems to be implied by the text.

3.3.1-16. 3.3.1.3 (b). In principle, two active trains can fail due to a common cause failure; hence this criterion is questionable.

3.3.1-17. 1st para, last sentence. Is the following what is meant? "If either criterion (a) or (b) above is used, then the estimate used for comparison with the criterion shall meet the requirements in Section 3.3.5 and 3.3.8." What requirements in Sections 3.3.5 and 3.3.8 shall the criterion meet.

Section 3.3.1.4
General Comments

3.3.1-18. Delete unless there are technical requirements. The current requirement should be part of the documentation requirements. Note that an example is needed to illustrate what needs to be traced across the interface.

3.3.1-19. If the section is maintained, additional information should be provided.

Section 3.3.2
General Comments

3.3.2-1. This section is not written clearly, and, since it is probably one of the more important part of the risk model, in that if the event tree structure is not correct, it's not worth doing the analysis, it is perhaps unnecessarily brief when compared with some of the other sections. Would it be possible to convert the comparison table A-3.3.2-1 into a set of requirements for the two basic methods?

3.3.2-2. The Standard appears to use "top event" as synonymous with a heading of an event tree. While, in many cases, they are synonymous, sometimes a heading will not be related to a top event of a system; a good example is human actions included as headings in event trees, which obviously are not top events of systems. For clarity, it would be better to use the term"heading" when it refers to an event tree, and "top event" when it refers to a fault tree (that may be a heading of an event tree).

Section 3.3.2.1
General Comments

3.3.2-3. The term "questions" is used three times. Suggest replace with "parameters."

Specific Comments

3.3.2-4. 1st para, 2nd sentence. Depending on role of 3.3.9, either delete sentence or replace "Core damage sequences may be" with "To support LERF calculations, core damage sequences shall be." Provide reference to Paragraph 3.3.9 for interface requirements.

3.3.2-5. 2nd para. Delete. Second paragraph seems to be referring to different ways of interfacing Level 1 and Level 2 (e.g., a "bridge tree" type of analysis). This says "what"

and not "how." Also avoids question of what exactly is meant by "included in the interface." Content of second paragraph can be addressed in 3.3.9 or Appendix A if desired.

Section 3.3.2.2
General Comments

3.3.2-6. The differences between models and methods should be clearly distinguished in the Standard. One can have exactly the same model (the same assumed set of cause-effect relationships, as shown by the same event tree and supporting fault trees) but quantify it using different methods (fault tree linking vs. split fractions). Of course, one can have two different models (e.g., due to different assumed success criteria) which are solved by the same method. Finally, there's a third dimension. One can have the same cause-effect model (e.g., loss of service water fails EDGs) but different representations (e.g., keeping support systems in the fault trees or breaking them out as separate top events). Subparagraph 3.3.2.2 really says that event trees (as opposed to something else, e.g., a discrete event simulation model or a Markov chain) are the required representational scheme for defining the sequences following from the initiating event, and that the trees should have sufficient breadth and depth to address a number of issues. The subparagraph doesn't say much about modeling (other than the model must address a number of issues; note that the requirement for the treatment of dependencies in the current 3.3.2.3 is a modeling requirement). The subparagraph also doesn't place many requirements on the methods; these are presumably addressed in Paragraph 3.3.8.

Sections 3.3.2.2-3.3.2.5

3.3.2-7. Title. Delete "Techniques and."

3.3.2-8. 3.3.2.2(b). Replace "model the differences in plant response" with "model the different plant responses." Does the requirement to model containment challenges conflict with the "may" clause in the current version of 3.3.2.1?

3.3.2-9. 3.3.2.2(d). Replace with "support the development of an interface between Level 1 and Level 2; and."

3.3.2-10. Change title to "Sequence Development Input." Replace text with "Sequence development shall be based on information provided by the success criteria (Paragraph 3.3.3), systems analysis (Paragraph 3.3.4), and human reliability analysis (Paragraph 3.3.6) technical elements." Create a new subparagraph for the dependencies analysis, and define what is required of the evaluation (other than it be systematic).

3.3.2-11. Last sentence. If the last sentence is used (see comment 3.3.2-10), please note that the evaluation of dependencies is documented in dependency matrices not provided by them.

3.3.2-12. 1st sentence. End first sentence after "process." Add "The methods shall support the identification of possible event sequences and the identification of dependencies between events." Move the discussion on acceptable methods to Appendix A. Per

comment 3.3.2-10, the notion of dependencies (including deterministic dependencies, e.g., forced failures, guaranteed successes, and N/As, as well as probabilistic dependencies) should be discussed in a separate subparagraph.

3.3.2-13. Last sentence. This sentence seems to suggest that one of the three methods will be chosen. As discussed in section A-3.3.2.2, it is likely that all three may be used to develop the final event trees. Sentence should be rewritten to clarify whether one or more methods can be used.

Section 3.3.2.4.1
Specific Comments

3.3.2-14. 1st para, 1st sentence. Replace "dynamic operator actions" with "post-initiator human failure events" or by whatever is chosen as the final terminology.

3.3.2-15. 3rd para, 1st sentence. Insert "with conditional split fraction" after "event tree."

3.3.2-16. 4th para, 2nd sentence. Delete "reflected as event tree top events ... effects are" and move requirement; it should be more general than just for the event tree with conditional split fraction approach.

3.3.2-17. 4th para, last sentence. Move to the beginning of 3.3.2.4 or even 3.3.2.

3.3.2-18. 5th para. Move to somewhere in Paragraph 3.3.3 (if not already addressed). These are requirements for the success criteria, not for the ordering and definition of top events.

3.3.2-19. 6th para. Delete 1st and 3rd sentences. (Similar requirements have already been provided.) Also delete 2nd sentence. Add notion of training and simulator exercises to 1st paragraph of 3.3.2.

3.3.2-20. 7th para, 2nd sentence. While functional dependencies are mentioned, no example is given, yet these may be arguably the most important in the development of the trees. Provide examples. The classic example is in the development of the transient tree for BWRs, where failure of depressurization leads to inability to use the low pressure injection systems.

3.3.2-21. 8th para, 3rd sentence. The sentence should be replaced by: "Dependencies among mitigating systems and operator actions shall be modeled in the accident sequence model if it is not already included in the system logic models."

3.3.2-22. 7th para. through the end of 3.3.2.4.1. Move material to a separate subparagraph on treating dependencies. (See comment 3.3.2-10). Provide definitions of functional, phenomenological, and operational dependencies in Section 2.

3.3.2-23. 1st Example, 2nd sentence. Add ", when such effects adversely impact the environmental conditions of the plant" to the end of the sentence.

Section 3.3.2.4.2

3.3.2-24. 3.3.2.4.2(b). Check to ensure that "sequence cut sets" is defined in Section 2.

Section 3.3.2.5

3.3.2-25. moving to Section 4; the requirement is for traceability of documentation.

3.3.2-26. 2nd bullet. Change "must" to "shall."

3.3.2-27. 3rd bullet. Change "must" to "shall."

References
Specific Comments

3.3.2-28. Provide complete references for 3.3.2-1, 3.3.2-2, and 3.3.2-4.

3.3.2-29. Replace "NUREG/CR-4550, Vol. 1 Rev. 1, A Analysis of Core Damage Frequency:..." with "NUREG/CR-4550, Vol. 1 Rev. 1, Analysis of Core Damage Frequency:...."

Section 3.3.3
General Comments

3.3.3-1. The definition of success criteria is one place where significant modeling takes place. Thus, it can be a source of considerable variability. If the Standard is to reduce variability, it needs to focus in on a limited set of modeling practices. It isn't clear that the current version of the Standard provides enough control here. For example, the Standard states that generic calculations, codes, and models shall be applicable to the plant, but it doesn't define "applicable" operationally. The Standard also allows the use of expert judgment. While it points out that this use should be limited, it doesn't seem to say under what specific conditions EJ may be used.

3.3.3-2. There is a lot of useful information in the draft standard. However, it puts an excessive burden on the review process. This can be lessened by more prescriptive direction on exactly what method is acceptable. Therefore, the "approved" thermal-hydraulic computer codes should be stated and only those codes can be used for establishing success criteria. For Westinghouse reactor coolant pumps, the seal LOCA model MUST be prescribed with the uncertainty provided. This one aspect of the modeling can skew the total CDF results.

Specific Comments:

3.3.3-3. 1st para. Need to provide examples of "success criteria for high level functions" in Appendix A.

3.3.3-4. p. 23, 2nd column, 1st para, 2nd sentence. Should point out that Subparagraph 3.3.3.3 discusses under what conditions expert judgment may be used. Note that it doesn't specify who is an expert.

3.3.3-5. First italicized paragraph: Why would success criteria change unless the plant design changed or our understanding of the plant changed? Suggest deleting.

3.3.3-6. Sec 3.3.3.1.1: The term "safe, stable state" is used here. This term should be defined either in this section or in Section 2. Related to this comment is the fact that "mission time" is not well defined in the success criteria section.

3.3.3-7. 3.3.3 and 3.3.3.1.2. Subsection 3.3 deals with Level 1 technical elements. Level 2 success criteria should be dealt with under Level 2 technical elements.

3.3.3-8. 3.3.3.2. The several different requirements should be separated using 3.3.3.2(a), 3.3.3.2(b), etc.

3.3.3-9. 3.3.3.2, 3rd para, last sentence. Also 4th para, last sentence. Replace "following should be considered" with "following options shall be used." Current version is too vague, allows distorted risk profiles. Relaxations should be addressed in Section 7.

3.3.3-10. Section 3.3.3.2: Most accident sequences in fault tree linking models represent multiple scenarios, particularly with respect to timing. The first of the two ways of dealing with cases where assuming the most limiting conditions is too conservative, seems to be a redefinition of the event tree to a higher level of detail. This would be a better way of saying this.

3.3.3-11. 3.3.3.2, 4th para. Also title of following example. Delete "and time dependencies;" this term is apparently being treated as being synonymous with "accident progression dependencies."

3.3.3-12. 3.3.3.2, 5th para. Replace "identify" with "reflect."

3.3.3-13. 3.3.3.2, Example of accident progression dependencies. Move material following ".. allow low pressure injection" to somewhere outside of the example. Guidance material such as general "should" statements should not be part of an example.

3.3.3-14. First paragraph after Example of Mission Time Measurement: Is the "should credit both safety and non-safety" ... consistent with "justification shall be provided if non-safety systems are not?"

3.3.3-15. 3.3.3.3. The several different requirements should be separated using 3.3.3.3(a), 3.3.3.3(b), etc.

3.3.3-16. 3.3.3.3, 2nd para, last sentence. Is it acceptable to use analyses that are known to be optimistic? If so, the conditions under which this is acceptable, should be clearly spelled out. Appendix A should provide examples of acceptable justifications.

Section 3.3.3.3

3.3.3-17. Third paragraph. It is also a concern if potentially non-conservative analyses are used.

3.3.3-18. The last paragraph states that "success criteria for selected situations may involve significant controversy or uncertainty" and that these situations shall be addressed. The standard has to specify what these "selected" situations are, and what needs to be done to address these situations.

3.3.3-19. 3.3.3.3, 5th para., last sentence. Delete "or another process..." The use of "may" allows other processes, in principle.

3.3.3-20. 3.3.3.3, 6th para. Need to be more specific under which conditions is expert judgment acceptable. Should generally not be allowed for situations for which analysis results and/or analysis tools exist.

3.3.3-21. 3.3.3.3, 7th para. Delete "following" and replace "identifies" with "identify."

3.3.3-22. 3.3.3.4, 1st para. Delete 1st sentence and "As a result."

3.3.3-23. 3.3.3.4. The list of interfaces with other PRA tasks should be as complete and informative as possible. It shouldn't be limited to a small number of examples.

3.3.3-24. 3.3.3.4, 1st para after example. End first sentence after "updates." Replace remainder with "This identification ensures that the effects on interfacing tasks due to success criteria changes are consistently addressed."

3.3.3-25. 3.3.3.4, last para. Change all "shoulds" to "shalls." This only calls for review.

Section 3.3.4

3.3.4-1. 3.3.4, General Question/Comment. Given fixed success criteria and fixed basic event probabilities, what are the major sources of variability in system analysis results that have been observed? If one source is the treatment of dependent failures, both modeling (e.g., the Surry 1150 assumption that the intake canal can fail and kill everything) and method (e.g., beta factor vs. MGL vs. alpha factor), it isn't clear that this section provides sufficient requirements to control this variability. Is variability control a concern? If it is, the lists of examples (e.g., of "plant interactions") provided in this section should be made as complete as possible (at least complete enough to reflect what we've seen) at some level of abstraction.

3.3.4-2. 3.3.4, 1st para, last sentence. Replace last word ("systems") with "SSCs."

3.3.4-3. 3.3.4.1, 1st sentence. Should requirements that are difficult to determine if they have been met be included in the Standard? Suggest deleting sentence. Could put the statement of intention in Appendix A.

3.3.4-4. 3.3.4.1, 3.3.4.3, 3.3.4.4, etc. Should use Standard's standard lettering scheme for sub-subparagraphs.

3.3.4-5. 3.3.4.1.1, 1st para after example, 1st sentence and 3rd sentence. Delete "identification of."

3.3.4-6. 3.3.4.2, 2nd para. (page 28, left column): There is a sentence "Screening may be performed to simplify a system model." Define screening, and the way it works.

3.3.4-7. 3.3.4.2, 3rd para, 1st sentence. Replace "for systems with ... action dependencies" with "for systems with no significant hardware dependencies with other systems and with no significant dependencies with post-initiator human actions."

3.3.4-8. 3.3.4.2, 3rd para. (page 28, left column): Add the following sentence: "When a system has more than one success criteria, the system unavailability shall be evaluated as a function of such criteria." after the sentence "For such systems, data shall be collected for the failure of the overall system to perform its function rather than the failure of the individual components."

3.3.4-9. Section 3.3.4.3. The standard is repetitive. For example, Section 3.3.3.3 discusses success criteria calculations (realistic, engineering analysis, plant specific, etc). Section 3.3.4.3 directs the reader to use realistic success criteria and Section 3.3.4.3.1 discusses engineering, plant specific calculations. Section 3.3.4.3 states the realistic (as opposed to conservative) success criteria shall be determined. 3.3.4.3.1 adds that plant specific engineering analysis should be used. If this paragraph is retained, replace "The criteria defining realistic (as opposed to conservative) requirements..." with "The criteria defining realistic (as opposed to conservative or optimistic) requirements..."

3.3.4-10. 3.3.4.3.1, last sentence. Circular reference. Refers back to 3.3.3 for "a more detailed discussion," but 3.3.3.2 (2nd para) refers to 3.3.4.3 for "more specific requirements." Subparagraph 3.3.4.3 is also largely a repetition of 3.3.4.2; it provides little/no additional detail (other than the examples, which are good). Recommend deleting 3.3.4.3 and keeping success criteria discussion (with all necessary details) in 3.3.3.2.

3.3.4-11. Section 3.3.4.3.2: Strict adherence to using Time dependent success criteria (which Section 3.3.4.3.2 states shall be incorporated into the system model) might be too strong a requirement. Not adhering to this is likely to be conservative.

3.3.4-12. 3.3.4.4, 1st sentence. Delete "boundary." The model includes the following; the boundary does not. More importantly, this seems to imply that support systems shall be incorporated in the system models. This doesn't match the allowance of event trees w/CSFs. Requirements need to be revised.

Section 3.3.4.4.1

3.3.4-13. The first paragraph specifies that both active and passive components shall be included in the models. Examples provided for passive components included piping. Suggest that, for passive components (especially piping), this requirement be softened, perhaps by requiring only those that could result in common cause failures of systems.

3.3.4-14. Last sentence states that, "Thus, (shared) component that are typically screened from a system model, have to be included when their failure affects more than one system (e.g. a common suction pipe feeding two separate systems." This is confusing so we suggest, " Since the failure of a shared component results in two system (or system train) failures, its failure probability has to be compared to other components' failure

probabilities whose failure also results in both system (train) failure. Thus, even though the component might be screened out with respect to its contribution to any one system, at least one shared components has to be included in the model."

3.3.4-15. 3.3.4.4.1, 3rd para. (page 28, right column): When the exception "A component may be excluded from the system model if the total failure probability of the component failure modes..." is applied, it should be documented in the PRA. This exception shall be applied only after the final total failure probabilities of the other components in the same system train and of the train itself were determined.

3.3.4-16. Exception to 3.3.4.4.1: Some component failures (e.g., piping segment failures) not only result in direct" failure of the specific train/system being modeled but also result in the "indirect" failure of other components/trains/systems owing to spatial interactions (e.g., spray, flooding, pipe whip). If the intent of this exception is to allow these types of component failures to be excluded, then maybe the exception should clearly state that these types of component failures can be excluded.

3.3.4-17. 3.3.4.4.1, 4th para. (page 29, left column): There is a sentence "In essence, the criteria for screening a component given above shall be applied to the probability that the systems sharing the component fail simultaneously." If the criteria for screening is the exception mentioned in the comment just above, then this should be mentioned.

3.3.4-18. In the sentence just above 3.3.4.4.2, the words "have to" should be changed to "shall."

3.3.4-19. 3.3.4.4.2. Delete "also" in 1st sentence. Replace "included" with "explicitly modeled" in 3rd sentence. Delete "boundary" in last sentence.

Section 3.3.4.4.3

3.3.4-20. 2n'd sentence, "The presence of the conditions need .. shall be included in the model quantification." doesn't make sense. If you are using "flags" to turn on and off different signals it makes sense. The "flags" concept is explicit two sentences down. But you don't need flags, one often models the functions given the sequence it is used in, if the conditions are supposed to exist, the failure of the signal is modeled, otherwise not. Suggest, "The presence of the conditions needed ... shall be reflected in the model quantification. That is, when the conditions exist, the actuation signal shall be modeled and when they don't exist, the actuation signal shall not be credited."

3.3.4-21. Last paragraph states, "Human response actions that are required for component and system actuation shall be directly included directly in the system model or accounted for in the final quantification of accident sequences. The requirements for incorporating human actions into the PRA are discussed further in paragraph 3.3.7. (NOTE: 3.3.7 should be 3.3.6). But 3.3.6 only talks about identifying, estimating, and making sure that the total estimates are not unreasonable low given that these response actions are modeled in the fault tree. So, if response humans actions are "accounted for" in some other way, is the practitioner bound by the requirements of Section 3.3.6? It could be argued that he is not. It would be an improvement if "system models" were changed to "logic models" and the phrase "or accounted for..." removed.

3.3.4-22. 3.3.4.4.3, 1st para, last sentence. Replace "set to TRUE (i.e., failed)" with "assumed to be failed." Need to avoid jargon. Also put "refer to Subsection 3.4" in parentheses.

3.3.4-23. 3.3.4.4.3, 2nd para. Use whatever standard term is decided upon (e.g., "post-initiator HFE"). See earlier comments on HRA terminology. Replace "shall" with "may." Final sentence should refer to Paragraph 3.3.6.

3.3.4-24. 3.3.4.4.4, 1st sentence. Replace "The support systems required for operation of the system for..." with "The connections to the support systems required for operation of the system for..." Also replace "model" with "PRA." Also in the 1st para after the example, replace "be included in the system model" with "be modeled." Note that there already is a requirement to properly address dependencies. If this discussion doesn't explicitly address support system dependencies (it may not), then it should. Much of the material in 3.3.4.4.4 can be moved there.

3.3.4-25. 3.3.4.4.4: Since there is no qualifier (e.g, as required) in the last sentence just above the "Examples of support systems," the implication is that any other identified support function ... and ... systems "shall be modeled." Is this really what we want, or do we want to allow for some type of screening based on calculations, etc?

3.3.4-26. 3.3.4.4.4, 3rd para. (page 29, right column): Replace "Support systems required to supply motive power for continuous operation of components..." with "The connections to support systems required to supply motive power for continuous operation of components..."

3.3.4-27. 3.3.4.4.4. The 90% criterion looks like it will be controversial. The intent is good, but the criterion seems too arbitrary. For example, in the analysis, should the temperature be Centigrade? Kelvin? Farenheit? Rankine? Have the criterion been tried to see what its implications for analysis are? Doesn't the requirement to do uncertainty analysis get at this issue?

3.3.4-28. 3.3.4.4.4, last para. Replace "eliminating" with "not modeling." Final sentence should refer to Paragraph 3.3.6.

3.3.4-29. 3.3.4.4.4, last para. In the second sentence above 3.3.4.4.5, the words "should be" are used in reference to procedularized recovery actions. Unless these types of actions are included in a model, the model does not necessarily reflect the "as operated" system. Suggest changing the"should be" to "shall be."

3.3.4-30. 3.3.4.4.5, 1rst para. (page 30, left column): Replace "Conditions that isolate, trip, or fail a system or component include." with "Conditions that isolate, trip, or fail a system or component include, but are not limited to:"

3.3.4-31. 3.3.4.4.5, example. With a little more work, could this provide a reasonably complete set of important conditions to consider, rather than just a set of examples?

3.3.4-32. 3.3.4.4.6, 2nd para, 1st sentence. Replace "other" with "similar."

3.3.4-33. 3.3.4.4.7, 1st sentence. Replace "system function" with "performance level."

3.3.4-34. 3.3.4.4.7, title of example. Replace "a loss of desired system function ... functioning" with "inadequate system performance."

3.3.4-35. 3.3.4.5, 2nd sentence. Replace "operator failures" with appropriate terminology.

3.3.4-36. 3.3.4.5, Exception. Insert "one of" prior to "the following." Delete "and" between criteria. The "Exception" appears to be the screening criteria mentioned previously in the Standard. Appropriate cross-references should be given.

3.3.4-37. 3.3.4.5.1: The second sentence of the first para. references screening criteria. How does this screening criteria deal with component failures that result in "indirect" failures of one or more components? Should it?

3.3.4-38. 3.3.4.5.1, 3rd para. (page 31, right column): Replace "Hardware failures that shall be reviewed in a system model unless screened by the criteria provided in Subparagraph 3.3.4.5 or grouped together with other failure modes in the data analysis include:" with "Hardware failures that shall be reviewed in a system model unless screened by the criteria provided in Subparagraph 3.3.4.5 or grouped together with other failure modes in the data analysis include, but are not limited to:"

3.3.4-39. 3.3.4.5.1 list of bullets. In (a), replace "active" with "standby." Items (g) and (r) are redundant, and can be consolidated.

3.3.4-40. 3.3.4.5.2. Final sentence should refer to Paragraph 3.3.6.

3.3.4-41. 3.3.4.5.3, last para, 1st sentence. Replace "results" with "model can result in minimal."

3.3.4-42. 3.3.4.5.3: The last sentence just before 3.3.4.5.4 should probably refer to the Data Analysis Section (3.3.5) and not Level 2 Technical Elements (3.4).

3.3.4-43. 3.3.4.5.4, 1st sentence. Use "The system analysis shall address both explicit dependencies with other systems and common cause failures (CCFs)."

3.3.4-44. 3.3.4.5.4, 2nd para. (page 32, left column): Replace "How common-cause events are included in the model may vary (e.g., included in the system fault trees or added after initial cut set review of independent failure combinations)." with "The way common-cause events are included in the model may vary (e.g., included in the system fault trees, or in the event trees to model inter-system common-cause failures). Common-cause failures can be added to the model after initial cut set review of independent failure combinations."

3.3.4-45. 3.3.4.5.4: If the list of components represented in the NRC report on common-cause failures grow and the Standard has not been updated (or not scheduled for update for some time period), how is it ensured that all of the appropriate components are included in an analysis?

3.3.4-46. The candidates listed for common cause failure in 3.3.4.5.4 p32 2nd column should include instruments, transformers, relays.

3.3.4-47. 3.3.4.5.4, last para. Replace "Elimination" with "Screening" in 2nd sentence. Delete last sentence. (It requires that analysts to show that a CCF should be modeled; this could easily bias the analysts to not address CCF unless they're forced to.)

3.3.4-48. 3.3.4.5.4: Next to the last sentence in the section refers to Section 3.4, with the implication that the section deals with accident sequence quantification. Should this be Section 3.3.8, Level 1 Quantification And Review of Results?

3.3.4-49. 3.3.4.5.5, 1st para. Insert "Pre-initiator" before "human error" in 1st sentence. Delete parenthetical in 2nd sentence.

3.3.4-50. 3.3.4.5.5: 2nd sentence, 1st para. This sentence references para. 3.3.7 as the HRA section. It should be 3.3.6

3.3.4-51. 3.3.4.5.5, 2nd para. Insert "Post-initiator" before "HE" in 1st sentence. Delete explanatory clause (between commas) in 2nd sentence. More importantly, the requirement in the 1st sentence seems to contradict the material in 3.3.2.4.1 (where dynamic actions can be put in the event tree).

3.3.4-52. 3.3.4.5.6. If the air binding is treated as a plant interaction, then care must be taken that it isn't double counted as a CCF (which is how it normally would be treated). This section needs to be expanded and clarified (at least to indicate what interactions must be addressed). It would seem more logical for the standard to explicitly identify the specific list of interactions that must be considered when performing a PRA rather that refering to an ill-defined set of open literature. Better yet, the standard should provide specific criteria on how to deal with each interaction identified. At the very least, Table 3.3.4-1 p33 should include an example of an inadvertent Halon actuation securing the affected room's ventilation.

3.3.4-53. 3.3.4.6.1. Should reword requirement so that event naming scheme ensures an accurate representation of dependencies is obtained. (Consistent application of the scheme is not the bottom line objective.) Traceability/reviewability is another desireable attribute which should be mentioned.

3.3.4-54. 3.3.4.6.2, 1st para. (page 33, right column): There is a sentence "Furthermore, different linked models shall be generated for each required system configuration." It is not clear if this guideline applies in all cases. This approach is usually only used by the LET/SFT method, and if so, this should be mentioned to avoid confusion.

3.3.4-55. 3.3.4.6.2, 2nd para. (page 33, right column): There is a sentence "The correct use of the support state approach shall require that assignment of support states properly account for support system dependencies on other support systems." The term "support state approach" has not been defined in Chapter 3, and it should be defined before its use is required. Again, this approach is used by the LET/SFT method, and this should be mentioned to avoid confusion.

Section 3.3.4.6.3

3.3.4-56. The first bullet is badly written. The intention is to avoid having both recoverable and non-recoverable faults in a module. It would be OK if the recovery probability were the same for all the scenarios in which the module is used. However, a suggestion is to write it as - "hardware failures for which recovery probabilities are expected to be used and which vary with the scenario."

3.3.4-57. In the last bullet, add "components or" at the beginning of the sentence.

3.3.4-58. 3.3.4.6.3. Need to eliminate jargon, e.g., "events that are required by other systems." Also, requirements seem too restrictive. It should be possible to modularize events that meet the listed criteria if the error introduced is small. The last bullet doesn't seem to relate to events.

3.3.4-59. 3.3.4.6.4. The first sentence provides insufficient guidance. Either provide the equations (there aren't that many) or an appropriate reference. Note that "quantification of events" is jargon; we're determining the probabilities of the events. The last sentence is inconsistent with the definition of mission time (example: phased missions). Suggest deleting; mission times are covered under success criteria.

3.3.4-60. Section 3.3.4.6.4: This section is poorly written. The second sentence is unnecessary, and the final sentence is wrong. The following is a suggested replacement:

"The quantification of the component failure events in the system model shall use the unavailability or unreliability model that is consistent with the failure parameter estimated in the data analysis task. For example, if the parameter is a probability of failure on demand, the unavailability is given directly by the parameter. If the parameter is a standby failure rate λ, the appropriate equation to use is $\lambda T/2$, where T is the interval between tests, etc. Further details of the models can be found in (Fault tree handbook, EPRI TR100381)." Original third sentence is OK, then add "The mission time used to quantify component unreliability shall be that assumed for the mission of the component, which may be different from the overall mission time assumed in the PRA. Some systems are only required during a phase of the response for example (e.g., HPCI has only a limited mission time for a medium LOCA because of the depressurization)."

3.3.4-61. 3.3.4.7. Most of this discussion appears to be explanatory. Should it be moved to the Appendix? Note that the sentence on system dependencies refers to a "dependencies element;" this is not listed as one of the technical elements (at least at the 3.3.X paragraph level). Perhaps it should be.

3.3.4-62. 3.3.4.7, 1rst para. (page 34, right column): Replace "System dependencies such as shared components, support systems, and common-cause failures are included in the system models and are defined according to the requirements in the dependencies element of a PRA." with "System dependencies such as shared components, support systems, and common-cause failures are included in the system models and are defined according to the requirements in the dependencies element of a PRA. Common-cause failures can also be included in the accident sequence model." Also,

what is the definition of an element of a PRA? What is the difference between an element of a PRA and a task of a PRA?

3.3.4-63. A-3.3.4.2, 2nd para. Since this is a standard on what a PRA (any PRA) should do, the examples should be carefully constructed. The examples should clearly indicate that they are based on past experience (which this one does); past or current system designs (this one does by implication); and that any conclusions drawn are therefore subject to change given a different design, operational characteristics, etc. (not done in this example).

Section 3.3.5
General Comments:

3.3.5-1. The title of this section should be parameter estimation and not data analysis.

3.3.5-2. A comment on the note in this section. If you have bad data, how would you know what is risk significant, and what is not? This note really discusses an "applications" issue. This chapter of the Standards document should specify what is correct, not how you can get around what is incorrect. How can risk-significant components and systems be determined without plant-specific data?

3.3.5-3. Like most PRA documents, this Paragraph doesn't distinguish between raw data (e.g., counts of observed failures) and the "PRA data," e.g., probability distributions for failure rates; it calls both "data." It would be helpful to make this distinction.

3.3.5-4. Global comment: data is the plural of datum. Use "data are" vice "data is."

Section 3.3.5.1

3.3.5-5. 1st para. This implies that if plant-specific data are available, you don't use generic data. This is not the Bayesian approach; the Bayesian approach is to use all available evidence (weighted appropriately). In fact, this paragraph appears to contradict the updating requirement in the second paragraph. Need to revise.

3.3.5-6. 2nd para, 2nd sentence. Add the following reference to the general references on Bayesian methods. It was written to be a tutorial and, unlike one of the references provided, it's aimed directly at PRA.

N. Siu and D.L. Kelly, "Bayesian Probability and Statistics in PRA," *Reliability Engineering and System Safety*, *62*, 89-116, 1998.

Section 3.3.5.1.1:

3.3.5-7. 2nd sentence. Replace "shall be used as" with "shall be used to construct."

3.3.5-8. There should be an exception for situations where the prior distribution constructed from generic data actually is wrong. The discussion can reference 3.3.5.1.3.

3.3.5-9. In the "Exception" paragraph, the term "consistent" should be defined. In SRP Chapter 19, this is defined as "within a factor of 3." This comment is also applicable for 3.3.5.3.1

Section 3.3.5.1.2

3.3.5-10. Exception. The exception should be separated into two parts. The first part should read "Traditional frequentist methods (References 6-8) may be used when significant amounts of plant-specific data are available." This modification follows from the requirement for a subjectivist approach provided in the 2nd para of 3.3.5.1. By the way, does this exception imply that frequentist confidence intervals can be used as Bayesian confidence intervals for the purposes of characterizing uncertainty? They are not the same thing. The second part should be moved to 3.3.5.1.1; it shcuild read "Non-informative prior distributions may be used when generic data are unavailable or are not appropriate for the plant."

Section 3.3.5.1.3

3.3.5-11. The two bullets for examples of inconsistencies are actually better examples of the inappropriateness of using data from one environment in another; a more fundamental issue than Bayesian updating.

3.3.5-12. This section refers to items (a) and (b). Item (b) is missing.

3.3.5-13. (a). Replace "any computer code ... to test" with "any computer code or algorithm used for Bayesian updating shall be verified. When the code or algorithm employs discrete probability distribution arithmetic, the verification problems shall be designed."

3.3.5-14. (a), Comment. Why is this the only place where we require that the computer code be verified? We don't require verification for T/H codes, or PRA codes. Verification is a good thing; some degree of verification should be done for all tools used in the PRA.

3.3.5-15. (b). Insert "(b)" before "posterior." Is parenthetical needed for the standard?

3.3.5-16. The discussion needs to provide a requirement or guidance if inconsistencies are found, especially in the case of (b). How should the post-posterior prior be constructed?

Section 3.3.5.2.1

3.3.5-17. Item (a), 2nd para. Replace "uninformed" with "non-informative."

3.3.5-18. Item (b) and 3.3.5.2.5(b). Why should it be a fault tree analysis? Why not a Markov model or a simulation model? These may actually be more appropriate. At the least, the requirement for fault tree analysis should be changed to a requirement for system analysis.

3.3.5-19. Item (c) talks about "unobserved events, not amenable to fault tree modeling." The list of such events are reasonable standard in all PRAs and as such, this list should be provided together with potential acceptable sources of data that are acceptable.

3.3.5-20. The "example of a slowly evolving condition" is presumably related to the bullet directly above it. This should be made clearer, particularly as the slowly is only inferred in that bullet.

3.3.5-21. Item (c). Replace "assess an informed prior distribution" with "develop a prior distribution."

3.3.5-22. Under the "Exception", generic LOCA frequencies could also be calculated from generic pipe break frequencies documented in EPRI documents.

Section 3.3.5.2.2

3.3.5-23. last sentence. Replace "collected and presented" with "documented."

Section 3.3.5.2.5

3.3.5-24. This talks about data analysis, and doesn't seem to belong under 3.3.5.2 (initiating event data attributes).

3.3.5-25. (a) Replace "Bayesian or frequentist methods as described" with "the methods described." Note that 3.3.5.1 mandates a Bayesian approach. Standard shouldn't keep mentioning frequentist methods as an alternative.

3.3.5-26. (a) Example following exception. Replace "system" with "fault tree."

3.3.5-27. Reference 3.3.5-10 used in Item (a) is the incorrect reference.

3.3.5-28. (b), 1st para, 1st sentence. Delete "and."

3.3.5-29. (b), last para, last sentence. Replace "should" with "may." Don't think the Standard should strongly recommend a prediction of future plant availability. This covers a lot of issues outside the scope of PRA.

3.3.5-30. Second paragraph under (b), last sentence: The computer code does not need to be changed to capture the frequency. The fault tree model has to be structured correctly to make sure the answer comes out as a frequency.

3.3.5-31. In the second paragraph of Item (b), it is stated that "the PRA shall document how all applicable system failure modes are taken into account for each fault tree minimal cutset." Since there are thousands of cut sets, this requirement is unrealistic, and the requirement should be "for the important cut sets."

3.3.5-32. (b) (page 37, left column): There is a sentence "Differences between historical plant availability over the period of event occurrences in the plant data base and future plant availability which may be greater than historical values should be accounted for." What is meant by future plant availability, and how is it evaluated?

Section 3.3.5.3

3.3.5-33. 1st sentence. Delete parenthetical; definition is provided in Section 2.

3.3.5-34. Exception. Replace "other" with "the."

Section 3.3.5.3.2

3.3.5-35. Needs editing. Example: see sentence fragment "Where the .."

3.3.5-36. 2nd para. Modeling decisions as to what constitutes a representative demand may be an important source of variability. Should point out that guidance is provided in 3.3.5.3.4.

3.3.5-37. 3rd paragraph: Change "Some PRAs track..." to "PRAs may track..."

Section 3.3.5.3.3

3.3.5-38. 1st sentence. Delete "and unavailability" to be consistent with 3.3.5.3 introduction.

3.3.5-39. (b). Clarify what "due to this cause" means in the 1st sentence. Move last sentence before preceding sentence.

Section 3.3.5.3.4

3.3.5-40. (b), 2nd para. This provides a requirement on how the failure rate (for normally operating equipment) is used, not how to determine the relevance of data. Need to revise to provide requirements similar to those provided for standby equipment failure and success data in the next para. A similar comment holds for the 5th para.

3.3.5-41. (b), 2nd bullet (top of p. 39). Replace "Because perfect fixes ... (Reference [3.3.5-17])" with "An expert judgment process as described in Subsection 3.5 should be used to develop a prior distribution that reflects current knowledge about the effect of the modification."

3.3.5-42. (b), last para before exception. This appears to be Appendix A material.

3.3.5-43. (b), exception. This doesn't seem to be an exception to any specific requirement presented earlier in 3.3.5.3.4(b); it just provides another aspect of data relevance. Should probably remove "Exception" heading

3.3.5-44. (c), 1st para, last sentence. Replace with "Test procedures shall be reviewed to determine whether a test ."

3.3.5-45. (d), 1st para. As written, it will be very difficult to objectively show that the requirement in the last sentence has been met. The requirement in the 1st sentence is really all that is necessary. The second sentence is explanatory and can be moved to Appendix A.

3.3.5-46. (d), examples. Can this list of examples be made reasonably complete for components that are typically modeled in PRAs?

3.3.5-47. (page 39, right column): Replace "Because incomplete tests do not test each failure mode, only complete tests or unplanned operational demands should be counted as success for component operation." with "Because incomplete tests do not test each failure mode, only complete tests or unplanned operational demands should be counted as demands for component operation."

Section 3.3.5.3.5

3.3.5-48. 1st para. 1st sentence restates a requirement already presented in 3.3.5.1. 2nd sentence states requirements on generic data that are either already covered or should be covered in earlier Subparagraphs. 3rd sentence restates 1st sentence requirement. Last sentence refers to data testing requirements previously stated. Recommend stating requirements only once (to avoid potential problems arising from different wordings), as much as possible.

3.3.5-49. 2nd, 3rd, and 4th paras. Requirements here are either restatements of material presented earlier or should be presented earlier.

3.3.5-50. 5th para. The issue of harsh environment failure rates is probably large enough to warrant separate treatment. 3.3.5.3.5 should be re-oriented to address just this issue.

3.3.5-51. Exceptions. The first exception has already been addressed in 3.3.5.1.2. The second exception is the subject of the introductory note to 3.3.5. See earlier comment.

3.3.5-52. (page 40, left column): What is the meaning of the sentence "Pooling assumptions in the generic data should be tested for plant-specific data?"

3.3.5-53. How "zero failures" are considered needs to be added to the standard. Suggest adding the following wording:

"In cases where no failures have been observed in industry, it is necessary to generate estimates based on expert judgement. This sometimes involves the identification and modification of parameters estimated for comparable, surrogate components. Simple application of methods such as assuming 1/3, ½ or 1 failure shall be avoided. Arguments based on engineering analyses of the failure modes of the components shall be used. In some cases, where the parameter is especially important, the technique of expert elicitation in accordance with the criteria of Section 3.5 may be used to assess an informed prior based on the available engineering and operational knowledge. The identified information sources and the justification for their applicability to the plant should be provided. Alternatively, in some cases, where no failures have been observed in the industry, a point estimate may be selected as the upper 50 percent classical confidence bound. Then a non-informative prior should be obtained whose upper limit is equal to the upper 95 percent classical confidence bound for the parameter being estimated."

Section 3.3.5.4

3.3.5-54. The discussion on CCF methods should not be buried in the data analysis Paragraph, let alone a Subparagraph. The use of data by these methods is appropriate for 3.3.5.4.

3.3.5-55. Ref 3.3.5-19 and 20 should be 3.3.5-18 and 19.

Section 3.3.5.4.3

3.3.5-56. 1st sentence. Insert "for a given common cause failure group" (definition to be provided in Section 2) after "are."

3.3.5-57. Despite the rarity of data, shouldn't there be a requirement to collect plant-specific CCF data, if CCF events have occurred at a plant? Shouldn't there also be a requirement to study that data for engineering insights which can affect how the data are to be used?

Section 3.3.5.4.4

3.3.5-58. Replace "claim" with "assume."

Section 3.3.5.4.5

3.3.5-59. (page 41, left column): Replace "Common cause modeling is highly interactive between parameter estimation and system modeling in Paragraph 3.3.4. The systems and data models shall be consistent." with "Common-cause modeling is highly interactive between parameter estimation, system modeling, and sequence development in Paragraphs 3.3.2 and 3.3.4. The systems, sequence, and data models shall be consistent."

3.3.5-60. 3.3.5.5 (page 41, left column): Replace "Uncertainty associated with the data shall be addressed." with "Uncertainty associated with the data shall be assessed."

3.3.5-61. 3.3.5.5.2. Title is awkward. Last sentence: replace "is" with either "shall be" or "should be." This sentence seems to belong to 3.3.5.5.3.

Section 3.3.5.5.4

3.3.5-62. 1st sentence. Replace "subtleties" with "issues."

3.3.5-63. (b), 1st bullet. This bullet is cryptic and needs to be expanded (to provide a discussion in the context of data applicability).

3.3.5-64. (b): Add the following sentence at the end of the paragraph Maintenance Duration: When a component is taken out-of-service, but a spare component is put into service as a replacement, then the total maintenance duration is the time taken to replace the component. Appropriate justification shall be provided in this case.

3.3.5-65. (b): The text with the bullet Maintenance Rate appears to have little to do with rate; it is more a statement of how the maintenance outage may be incorporated in the model.

3.3.5-66. 3.3.5.6. Last sentence: replace "Paragraph 3.3.6" with "this Subparagraph." Note: need to add definition of "repair" (to distinguish it from recovery) in Section 2.

3.3.5-67. 3.3.5.6.3, 1st para. What specifically is meant by "abbreviated expert elicitation process?" How should the interviews be "tempered" by the data? It seems this section is ignoring the Bayesian formalisms (which are designed to deal with sparse data) required in earlier parts of 3.3.5. Same comment applies to 3.3.5.6.5. By the way, the full Bayesian updating of recovery time distributions is pretty straightforward if plant-to-plant variability is not treated, but very difficult if this variability is treated. My comment concerns the philosophical framework.

3.3.5-68. 3.3.5.6.4, last sentence. Delete "thoroughly."

3.3.5-69. 3.3.5.7 (page 42, right column): Replace "Definitions, component boundaries, and failure interpretations shall be consistent." with "Definitions, component boundaries, and failure interpretations shall be consistent across all the PRA tasks."

3.3.5-70. The Standard will include a database of failure data (reference [3.3.5-16]), and it also refers to other sources of failure data. Two concerns:

1.) The database of the Standard will be based on that of NUREG-4550. Since this publication is now more than 10 years old, it may not be representative of the current failure statistics of operating plants. However, identification of an acceptable generic data base needs to be in the standard.

2) The Standard states at several points that other databases may be used as long as they are "consistent" with the recommended ones. How does a reader (or a reviewer) check that a database is "consistent" with the recommended ones? What are the fundamental attributes that make it "consistent" or acceptable?

3.3.5-71. Appendix 1 Data Table. For this to be useful, and satisfy the requirements of the standard, there are some things that need to be added. First, and foremost, the component or event boundaries associated with the parameters need to be clearly defined. If this generic data base becomes mandatory, this then implies that the component boundaries themselves become predefined, which in turn has implications system modeling, etc. As a suggestion, given the nature of this compilation, is it necessary to have numbers to two significant places? Why not round up?

Section 3.3.6
General Comments

3.3.6-1 The version of this section that appeared in draft #6 was more logical, and more complete and strongly suggest going back to that version, particularly as it's not much longer. One thing that's missing from the current version is the requirement to perform some sort of task analysis. Without doing this, the plant specific contributors to human

failure events cannot be identified. In shortening this section, the placing of some of the requirements has made them illogical.

3.3.6-2 The HRA portion of the Standard does not explicitly require a task analysis. (It does require the collection of information needed to support such an analysis.) From the standpoint of a quality PRA, this is a mistake. The task analysis documents the analyst's basic understanding of what the operators are supposed to do, when they are supposed to do it, what job aids they have, what are the stressors, etc. In other words, it's really the model for the human action (from which things like the HRA event trees) are derived.

3.3.6-3 There should be references to widely used methods, even if the standard doesn't endorse any particular one. It looks like this was intentionally avoided in the Standard; this is somewhat like trying to avoid explicit references to alpha factor vs. MGL vs. beta factor in CCF, or event tree with conditional split fractions vs. fault tree linking in accident sequence analysis.

3.3.6-4 The HRA section needs to be significantly expanded to include these issues (comments 3.3.6-2 and 3.3.6-3). Given both the importance of human error and the potential for different treatments to lead to very different risk results and insights, this revision should have a high priority.

3.3.6-5 Equipment repair:

- Should be addressed as part of the HRA in all three areas: scope, identification, and quantification.
- Should be distinguished from equipment recovery and explained why typically a PRA does not credit repair.

3.3.6-6 The HRA section should emphasize that repair requires modeling of human performance during severe accident situations, and point out some assumptions that may be erroneous (e.g., take credit for equipment repair because are part of Emergency drills).

3.3.6-7 The HRA section should provide more concrete guidelines on the kinds of data needed and assumptions made (e.g. crew availability) for the quantification of equipment repairs.

3.3.6-8 The HRA section does not discuss commission errors (errors of commission).

Specific Comment

3.3.6-9 2nd sentence. Replace with "In particular, the HRA shall support the identification of human-related basic and top events (i.e., human failure events or HFEs); characterize the actions associated with these HFEs; and quantify the probability of the HFEs."

Section 3.3.6.1
Specific Comments

3.3.6-10 Replace entire section with "The HRA scope shall include human actions before the initiating event (pre-initiator actions) and actions following the initiating event (post-initiator actions). The pre-initiator actions shall include maintenance, test, and calibration activities for SSCs modeled in the PRA. The post-initiator actions shall include those human actions performed to prevent or mitigate core damage given the occurrence of the initiator."

3.3.6-11 If section not replaced as recommended in comment 3.3.6-10, then for 2nd and 3rd paragraphs it would be better to say "The human actions associated with ..." rather than "modeled as."

Section 3.3.6.2
Specific Comments

3.3.6-12 3.3.6.2(a). Replace "as a result of carrying out tests" with "following tests."

3.3.6-13 3.3.6.2(b). Replace with: "failure to restore equipment to correct standby status following maintenance acts that require the equipment to be aligned away from their normal positions; and." The criteria regarding realignment (the equipment is manually operated, the equipment is power operated but the power is removed, the automatic realignment function is disabled) should be addressed in the qualitative screening criteria of 3.3.6.2.2.

3.3.6-14 Last sentence. As a blanket requirement, this seems too strong. From the standpoint of accurate CDF and LERF estimates, explicit modeling seems to be important only when a single action can affect multiple SSCs. Requirement could be phrased to ensure that potential pre-initiator action related CCFs are explicitly addressed.

Section 3.3.6.2.1
General Comment

3.3.6-15 Section 3.3.6.2.1(c) and (d) are more useful in the screening and quantification stage than in the identification (this is an example of where moving the text around has lessened the clarity of the message). Identification of potential events is done by understanding the processes to find out which components are misaligned and how that is achieved in terms of system reconfiguration. For identification leave only items (a) and (e). Move the others to section 3.3.6.2.3.

Specific Comments

3.3.6-16 3.3.6.2.1(a). Replace "such that" with "to develop;" delete "is obtained."

3.3.6-17 3.3.6.2.1(b). Replace "such that" with "to develop;" insert "personnel" after "plant."

3.3.6-18 3.3.6.2.1(c). Replace "such that" with "to develop;" delete "is obtained."

3.3.6-19 3.3.6.2.1(d). Replace "have" with "gain."

Section 3.3.6.2.2
General Comments

3.3.6-20 In performing the quantitative screening analysis, the purpose is presumably to see if human failure events survive the truncation process. This should be stated in the text.

Specific Comments

3.3.6-21 1st para, 2nd bullet. Replace with "if the activity is a maintenance activity and a post-maintenance functional test is performed on the components involved in the maintenance activity, then misalignment of components that are verified with such functional test may be screened out."

3.3.6-22 Last para. Replace with "If a quantitative screening analysis is performed, the screening HEPs assigned shall be high enough that the effects of dependencies between HFEs are not overlooked. Screening HEPs less than 0.01 should not be used for pre-initiator HFEs."

Section 3.3.6.2.3
General Comment

3.3.6-23 In the past, there has been general agreement that THERP is perfectly adequate for dealing with pre-initiator HFEs. See for example, H. Blackman, N. Siu, and A. Mosleh, *Human Reliability Models: Theoretical and Practical Challenges*, Center for Reliability Engineering, University of Maryland, College Park, MD, 1998, p. 235. Why not specify THERP here as an acceptable method? (There would also have to be some discussion concerning particular THERP activities, e.g., the definition of tasks and the treatment of dependencies.) If a PRA uses a more simplified approach, this could be rationalized in Section 7 as appropriate.

3.3.6-24 The discussion of recovery of pre-initiator human failure events (in the 3rd paragraph) could be confusing. This recovery can be an integral part of the human failure event tree if THERP or an equivalent method is used. Perhaps it would be better to list all the things that could be taken into account in the evaluation of the HEP, such as: factors that lead to an initial error, including such things as layout, accessibility etc., and the factors that are inbuilt protection against the failure, such as these recovery issues.

Specific Comments

3.3.6-25 1st para, 2nd sentence. This requirement is too vague to be very useful. Much more specific guidance is needed regarding the factoring of information and PSFs. (See General Comments 2, 3, and 4 on Section 3.3.6.)

3.3.6-26 2nd para, (b). Replace with "no common human-, spatial-, or temporal-related factors exist."

3.3.6-27 2nd para, (b). The Standard should provide a list of the "human-related factors" to be considered.

3.3.6-28 3rd para, 1st sentence. Some guidance is needed on how to take credit for recovery.

3.3.6-29 3rd para, last sentence. Insert "One or more of" at the beginning of the sentence.

Section 3.3.6.3.1
General Comments

3.3.6-30 This is not as explicit as the #6 version in requiring a task analysis. The (a) through (e) list does not give any guidance on what it is that shall be looked at.

3.3.6-31 The HRA is a crucial part of the analysis and one that in the past has been performed with the greatest degree of variability. The standard should put forth a minimal set of requirements that includes a task analysis and the considerations of PSFs that are specified.

3.3.6-32 This Subsection should note that one of the most relevant identification processes takes place during the sequence development, when human response- and recovery-related actions are identified.

Specific Comments

3.3.6-33 1st para. Change (a) through (d) to active voice. (See comments on Section 3.3.6.2.1 (a) through (d).)

3.3.6-34 2nd para. Replace with "Observation of simulator exercises relevant to the modeled accident sequences should be documented and used to provide additional information regarding control room operational practices and crew performance. The exercise documentation should include the frequency and scope (e.g., number of crews, scenario boundary conditions, how ex-control room actions are treated) of the exercises."

3.3.6-35 3rd para. Replace "frequent" with "sufficient."

3.3.6-36 4th para. Replace with "Recovery actions may include actions involving the restoration and repair of failed equipment. Such actions are not normally modeled in PRAs (see Subparagraph 3.3.5.6); if they are modeled, a strong technical basis covering the availability of time and resources (personnel and materials), as well as relevant PSFs (e.g., workload, accessibility) must be provided to justify their credit in the analysis."

Section 3.3.6.3.2
Specific Comments

3.3.6-37 2nd para, 1st sentence. Replace "values" with "HEPs."

3.3.6-38 2nd para, 3rd sentence. Need to specify what is an appropriate lower bound for the HEP if the cutset truncation value is not equal to 10^{-9}/yr. Is there a published basis for the selection of the 0.5 value? It seems high for a minimum.

Section 3.3.6.3.3
Specific Comments

3.3.6-39 1st para, 2nd sentence. This requirement is too vague to be very useful. Much more specific guidance is needed regarding the factoring of information and PSFs. (See comments 3.3.6-2, 3.3.6-3, and 3.3.6-4).

3.3.6-40 2nd para, last sentence. Replace "plant-specific factors and practices" with "the following plant- and scenario-specific PSFs:"

3.3.6-41 3rd para, 1st and 2nd sentences. Delete 1st sentence. Delete 2nd sentence up to the colon.

3.3.6-42 3rd para, list. Add the following to the list: "(h) the quality of the control room design and additional operator supporting systems for the human- machine interface; (i) the quality of the individual operators' and the organizational safety culture at the plant."

3.3.6-43 4th para. Replace the paragraph with "The time available to the operator to diagnose the condition of the plant and execute the desired action, and the time that is actually needed to execute the action shall be addressed by the HRA model; subtracting the second from the first yields the time available to the operator to diagnose. The available time is accident sequence-specific and shall be determined from engineering analyses which are intimately related to the Sequence Development task (3.3.2), and the Success Criteria task (3.3.3). The actual time required to perform the action should be derived from walk-throughs and simulator observation. The point at which the operators receive relevant indications shall also be included in determining available time."

3.3.6-44 5th para. According to some terminologies, these are also PSFs. Replace "evaluation" with "assessment."

3.3.6-45 1st para after 1st example. In the terminology of the example, it would appear that "diagnosis" and "execution" are subtasks (or groups of subtasks). Discussion should be better integrated.

3.3.6-46 2nd para after 1st example. Add a period at the end of the text and then insert the following sentence "This consideration only applies to human actions in the same sequence."

3.3.6-47 3rd para after 2nd example. The terminology "human event" is now being used rather than "human failure event;" the latter terminology should be used for consistency and clarity. Change "effected" to "affected."

3.3.6-48 5th para after 2nd example. Replace paragraph with "Diagnosis or execution errors made by the original operator are sometimes recovered by the same operator (e.g., updated plant status information), or by other plant personnel (e.g., shift technical advisor, the response team formed to deal with emergency situations). Total credit for such recovery factors should not exceed a factor of 10 reduction in the HEP due to the uncertainty associated with determining the actual independence of the plant personnel

and the ability to precisely quantify human performance. Larger reductions shall be identified and justified."

3.3.6-49 6th para after 2nd example. Delete paragraph; the requirements apply regardless of method.

3.3.6-50 7th para after 2nd example, 2nd sentence. Replace "of the crew sometimes result in a low value" with "for the crew sometimes is low."

3.3.6-51 7th para after 2nd example, 3rd sentence. Insert "of a single human event" after the word "probability" and before the word "shall."

3.3.6-52 8th para after 2nd example, 2nd sentence. Replace "The values input into the ... mean values" with "When point estimate calculations for the sequence frequencies are being performed, the HRA inputs into the calculations shall be mean values."

3.3.6-53 8th para after 2nd example, 3rd sentence. Replace "(e.g., HEP mean value ...) with "(e.g., a lognormal distribution with a mean value of 0.8 and an error factor of 15 has a 95th percentile greater than 1.0)."

3.3.6-54 3rd example. Comment. It's a much better practice to re-examine the distribution to see if it reflects the analyst's understanding, rather than to force fit some arbitrary mathematical form.

Section 3.3.6.4
General Comments

3.3.6-55 Like most of the interface discussions, this section needs to provide more information. It should specify what information is being passed across the interface, and therefore, what should be checked for consistency.

Section 3.3.7
Specific Comments

3.3.7-1. 3.3.7, 1st para. Insert "Each flooding scenario shall be defined in terms of the flooding source (including the mechanism for water release), the propagation pathway, the equipment damaged (including the mechanism for damage), and the resulting accident sequence(s)." after the 2nd sentence.

3.3.7-2. 3.3.7.1, para after example. Replace with "Verification of drawings and other plant information sources shall be performed by plant walkdown. Walkdowns shall also be used to support the identification and characterization of potential internal flooding scenarios." Current version is too restrictive in parts, too loose in others.

3.3.7-3. 3.3.7.2. Need to define "flood area" in Section 2. Have to be a little careful; different propagation mechanisms can have different areas of influence. (Example: dripping water running along a conduit that penetrates crosses over a dike.) May wish to define flood areas only with respect to rising water level scenarios.

3.3.7-4. 3.3.7.3, Title. Replace with "Identification of Flood Sources and Initiating Mechanisms."

3.3.7-5. 3.3.7.3, p..48, 1st column, 1st para after 1st example. Replace with "All mechanisms that can cause a potentially risk significant flooding event shall be identified."

3.3.7-6. 3.3.7.3, 4th para. (page 48, left column): In the "Examples of flooding mechanisms and failure modes" it would be useful to identify which items are flooding mechanisms and which are failure modes, and the relationship between them.

3.3.7-7. 3.3.7.4, 1st para. This identification shall cover all potentially risk significant sources within an area, potential propagation pathways for exposing important SSCs within and without the flood area, potential mitigating actions by equipment and operators, and potential plant effects.

3.3.7-8. 3.3.7.4: In defining potential flood scenarios, flooding events initiated by maintenance actions have to be included. Currently, the only reference to it is as an example of a failure mode. It also has to be addresses in "information sources" (maintenance and isolation procedures). Historically, this is one of the more likely sources of internal flooding.

3.3.7-9. 3.3.7.4, last para. 1st sentence: replace "given" with "considered." 2nd sentence: replace "Isolation arguments" with "The isolation analysis." Last sentence: replace "harsh environments ... the ability" with "The effects of potentially harsh environments and the operators' ability."

3.3.7-10. 3.3.7.6. Subparagraph refers a number of times to "internal events" in the old way (i.e., not including flooding). Need to revise to make consistent with the definition of Section 2.

3.3.7-11. 3.3.7.6, 1st para, 3rd sentence. Replace "any one" with: "one or more." Delete last bullet. Add the item "• combination of one of the above approaches with expert judgment" to the list of items at the top of the left column.

3.3.7-12. 3.3.7.6, p. 49, 1st column, para after bullets. Insert "If a probabilistic fracture mechanics evaluation is used, the analysis shall verify that the results of the analysis are not inconsistent with relevant operational experience." Also need to define "flood precursors" in Section 2.

3.3.7-13. 3.3.7.6, p. 49, 1st column, para after bullets after para on the use of plant-specific flood experience. Insert "The probability of flood propagation and equipment damage prior to source isolation or flood mitigation should be assessed considering the issues of time and resource availability discussed in Subparagraph 3.3.7.4. The results of this propagation assessment should be compared with relevant historical experience (generic as well as plant-specific) to ensure their reasonableness."

3.3.7-14. 3.3.7.6, p. 49, 1st column, 2nd para after bullets. 1st sentence: Delete "With some modifications;" replace "use the same" with "be based upon the." 2nd sentence: replace "system fault trees shall be modified to account" with "system analyses shall" Last

sentence: replace "reviewed" with "evaluated." Note earlier comment about use of "internal events."

3.3.7-15. 3.3.7.6, p. 49, 1st column, 3rd para after bullets. Replace with "The assessment of operator actions during internal flooding scenarios shall account for scenario-specific PSFs in the same manner described in Paragraph 3.3.6. In addition to the PSFs normally considered, the following PSFs shall be explicitly addressed for control room actions and ex-control room actions, as appropriate:

(A) additional workload and stress (above that for similar sequences not caused by internal floods)

(B) uncertainties in event progression (e.g., cue availability and timing concerns caused by flood)
(C) effect of flood on mitigation, required response, and recovery activities (e.g., accessibility restrictions, possibility of physical harm)
(D) flooding-specific job aids and training (e.g., procedures, training exercises)."

3.3.7-16. 3.3.7.6, 2nd to last para. Delete last sentence. (Already covered by previous requirements.)

3.3.7-17. 3.3.7.7. General Comment. The context for this Subparagraph is not sufficiently clear. Does, as implied by the 1st sentence of 3.3.7.7, the preceding part of 3.3.7 only deal with a scoping level flooding analysis? (Is this why 3.3.7.6 does not mention flood propagation analysis? See preceding comment on p. 49, 1st column, para after bullets after para on the use of plant-specific flood experience). If so, this needs to be clearly stated early in 3.3.7, and again in 3.3.7.6. Also, 3.3.7.7 then needs to be followed by a Subparagraph dealing with the detailed analysis requirements; 3.3.7.7 only addresses screening.

3.3.7-18. 3.3.7.7, Title. Replace "Criteria" with "Analysis."

3.3.7-19. 3.3.7.7, 1st para. 1st sentence: replace "ascertain" with "identify." Last sentence: delete "Acceptable."

3.3.7-20. 3.3.7.7, list of bullets. Reword to make these criteria (e.g., "the area has no mitigating equipment modeled in the PRA"), or reword introductory sentence. More importantly, the criteria provided need to be rethought. Consider the first criterion: "An area (including adjacent "zones" [undefined] where flood sources can propagate) with no mitigating equipment modeled in the PRA." It seems that this criterion should be exercised much earlier in the analysis (e.g., prior to 3.3.7.6). Also, criteria should be grouped; an area may be screened as a source and as a target, but may be important as a propagation pathway. Or it may be important as a propagation pathway and a target but not as a source. Grouping will aid understanding. The first bullet should also include a consideration of whether the flood can result in an initiating event. The second and fourth bullets are dependent on each other and should be combined, i.e., whether or not a flood source is significant (the flooding rate) is dependent on how fast a flood can be mitigated (the flood egress rate).

3.3.7-21. 3.3.7.7, 1st para after bullets. 2nd sentence: insert "of" after "failure." Last sentence: criterion may not be consistent with 3.3.1.3 (where initiating events with frequency less than 10^{-7}/yr are screened); this criterion refers to a CDF, including flood-induced losses of mitigating equipment, of 10^{-7}/yr. Consider replacing the criteria with "Flooding areas with screening core damage frequencies which are smaller than three orders of magnitude below the CDF due to internal events can be eliminated from detailed analysis."

3.3.7-22. 3.3.7.7: The last sentence in the sections states that the total frequency screened shall be demonstrated to be less than 1% of the CDF from all "quantified" flood induced sequences. Since qualitative screening may have already taken place, this quantitative criterion does not necessarily guarantee that less than 1% of the total flood induced CDF is missed.

3.3.7-23. 3.3.7.8 (page 50, left column): Replace "Interfaces with other PRA tasks include Initiating Event Analysis, Sequence Development,..." with "Interfaces with other PRA tasks include Plant Familiarization, Initiating Event Analysis, Sequence Development,..."

Section 3.3.8

3.3.8-1. (page 50, left column): Replace "The quantification and review of results portion of a PRA shall provide an estimate of the CDF for each of the accident sequences resulting in the onset of core damage and shall ensure the physical logic of each sequence." with "The quantification and review of results portion of a PRA shall provide an estimate of the CDF for each accident sequence resulting in the onset of core damage and the total CDF of the plant, and shall ensure that the logic of each sequence has physical meaning."

3.3.8-2. Explicitly state that the review refers to activities of the PRA team to improve model quality.

3.3.8-3. (page 50, left column): Replace "The estimates may be accomplished by using either fault tree linking or an event tree with conditional split fractions." with "The estimates may be accomplished by using either fault tree linking or the event tree with conditional split fractions methodology."

3.3.8-4. (page 50, left column): Before the sentence "The quantification shall include an assessment of parameter uncertainty and should also include an assessment of modeling uncertainty." is used, the Standard should state what is the meaning of parameter uncertainty and of modeling uncertainty.

3.3.8-5. 2nd para. 1st sentence: insert "the impact of" before "parameter uncertainty" and "modeling uncertainty." 2nd sentence: delete "the resulting." Delete last sentence; this appears to require sensitivity studies, and also requires a "realistic combination" of models and sensitivity studies. Not clear what the latter means as a requirement

3.3.8-6. (page 50, left column): Replace "Alternatively, the PDS frequencies may be obtained separately." with "Alternatively, the PDS frequencies may be obtained by assigning a PDS to each sequence or minimal cut set."

Section 3.3.8.1.1

3.3.8-7. 1st sentence. Does this requirement intentionally exclude flooding?

3.3.8-8. (page 50, left and right columns): Replace "The system models, data, and HRA shall be integrated in the quantification process accounting for system dependencies to arrive at accident sequence frequencies. System integration requirements specific to the conditional split fraction and fault tree linking approaches to model quantification are presented in Subparagraphs..." with "The sequence and system models, data, and HRA shall be integrated in the quantification process accounting for all dependencies to arrive at accident sequence frequencies. System integration requirements specific to the conditional split fraction and fault tree linking approaches to conduct the quantification are presented in Subparagraphs..."

Section 3.3.8.1.2

3.3.8-9. 1st para, 2nd sentence. Delete; requirements are already stated elsewhere.

3.3.8-10. 2nd para. Correct spelling: "complementary."

3.3.8-11. 3rd para. 2nd sentence: replace "codes using ... provide" with "codes either using the minimal cut set upper bound approximation or providing." 3rd sentence: define CCDPs (including the condition).

3.3.8-12. Comment. There should be some requirement for code V&V.

3.3.8-13. 4th para. This seems too restrictive in terms of "how/when." The technical requirements are that recovery actions shall be addressed (Subparagraph 3.3.6.3) and that these actions shall be assessed with a proper context (covered - but perhaps not explicitly enough - in 3.3.6.3.3). Note that the minimum value (10^{-6}) is also provided towards the end of 3.3.6.3.3. Suggest deleting.

3.3.8-14. p. 51, 1st column, 2nd para. This overlaps with 3.3.6.3.3. The interface between HRA and sequence quantification should be more clearly defined. Should dependencies between operator actions in the same cut set be addressed in the HRA or in the sequence quantification? If they should be addressed in both, are there requirements specific to one part of the analysis or the other? Don't think requirements should be repeated. (If they are, exactly the same wording should be used to minimize confusion.)

3.3.8-15. p. 51, 1st column, 3rd para. 1st sentence: reword (very passive voice). 3rd sentence: too prescriptive in terms of how. The technical requirement is that the truncation level not affect the results (including qualitative results). How this is shown should be up to the PRA analysts (unless we think that the "how" will really affect the results).

3.3.8-16. p. 51, 1st column, exception. It's not clear what this is an exception to. By the way, the issue of using mean values for point estimates is addressed earlier under HRA (see p. 46). Note also that the Standard requires an assessment of uncertainty.

Section 3.3.8.1.3

3.3.8-17. Several types of uncertainty analysis (e.g., analytical uncertainty, aleatory uncertainty, model uncertainty, completeness uncertainty) are discussed in several sections of the text (particularly, in subparagraph 3.3.8.1.3). A definition of the different types of uncertainty would be helpful, perhaps illustrated by examples; this could be included in the definitions of Chapter 2. Alternatively, a reference containing such definitions could be provided.

3.3.8-18. This section needs to be rewritten. For example, the requirements in the first paragraph (uncertainties shall be identified evaluated) is inconsistent with some of the following paragraphs. For example, the fifth paragraph begins with "If model uncertainty is not evaluated...", and the sixth paragraph states that "completeness uncertainties are not amenable to quantification..."

3.3.8-19. 2nd para. Replace "(epistemic uncertainty)" with "(epistemic) uncertainty." Provided reference (Budnitz et al) doesn't seem to be the most fundamental one. Use the following:

G. Apostolakis, The concept of probability in safety assessments of technological systems, *Science*, *250*, 1359-1364(1990).

\+ G. Apostolakis, A commentary on model uncertainty. In *Model Uncertainty: Its Characterization and Quantification*, Eds: A. Mosleh, N. Siu, C. Smidts, and C. Lui, Center for Reliability Engineering, University of Maryland, College Park, MD, 1995, pp. 13-22.

3.3.8-20. 3rd para. End 1st sentence after "calculation." Insert 2nd sentence: "Direct Monte Carlo sampling and Latin Hypercube sampling are acceptable methods for propagating uncertainties."

3.3.8-21. There should be a requirement on V&V for tools used in uncertainty propagation. The V&V process should ensure that known problems with some of the techniques (esp. DPD) are addressed. Also, there should be some requirements on method applications, either in terms of computation options (e.g., the number of Monte Carlo samples) or, preferably, in terms of convergence. (In the big picture, these aren't that important for most of the events being analyzed, but we might as well fix those things we know we can fix.

3.3.8-22. 4th para. 2nd sentence: replace "shall not" with "should not necessarily." 3rd sentence: replace with "The PRA report shall describe the key sources of model uncertainty, their assessment, and their significance with respect to the overall PRA results." Delete the last sentence. (It requires a consideration of potential future uses of the PRA.

3.3.8-23. 5th para. 1st sentence: insert "quantitatively" before "evaluated"; insert "PRA" before "results." 2nd sentence: replace "or" with "and." 5th sentence: replace "lower a data value" with "reduce a failure probability or frequency." 6th sentence: use "For sensitivity analyses that increase a failure probability or frequency or investigate modeling assumptions, .."

3.3.8-24. Last para. Insert "generally" before "amenable;" replace "recognition" with "identification."

3.3.8-25. Exception. Delete; we should require full assessment of uncertainties in the general case of a quality PRA. Exceptions for specific applications can be raised in Section 7.

3.3.8-26. This standard does need to recognize that many model uncertainties cannot be addressed simply. They are typically addressed by making assumptions or adopting a specific model. In using PRA results to make a decision, it is useful to know the impact of such assumptions or model choices on the PRA results. It is for this purpose that sensitivity studies are most important. Therefore, include the following ideas into the discussion:

> "When the impact of model uncertainties can be represented quantitatively in the model, their impact should also be incorporated in the quantitative characterization of the results. Typically, however, model uncertainties are addressed by making specific assumptions or by choosing specific models for the elements of the PRA. If the models or assumptions are generally accepted as being appropriate, no further analysis is needed. However, if there are plausible alternate assumptions or models that are also in current use, the impact of making these choices on the results shall be assessed by performing sensitivity analyses using these plausible alternatives. If the use of alternate assumptions or models changes the decision, the analyst shall explain why he has greater confidence in those assumptions/ models that support the decision."

3.3.8-27. In the fifth paragraph (the one beginning with "If model uncertainty...), it is stated that sensitivity studies that increase a data value shall be performed by requantifying the entire model. Perhaps the "shall" should be changed to a "should."

Section 3.3.8.2

3.3.8-28. 1st para. Replace "an event tree.." with "the conditional split fractions shall be developed to address key path dependencies. These conditional split fractions may be based on system fault tree models." Alternatively, delete paragraph; the same requirements are provided (in more detail) further down.

Section 3.3.8.2.1

3.3.8-29. Title. Replace with "Modeling of Frontline and Support Systems Functions."

3.3.8-30. 1st para. 1st sentence: replace with "One or more support system event trees shall be used to describe the status of support system trains." 3rd sentence: replace "front-line mitigating systems event tree shall provide" with "frontline systems event tree shall be used to provide." (Section 2 provides a definition of frontline systems.) Note: this discussion seems to belong in Paragraph 3.3.2 and not under quantification (this Paragraph).

Section 3.3.8.2.2

3.3.8-31. Comment. The first requirement (that CSFs are dependent on initiating event) should but doesn't have an analog in a linked fault tree analysis (under 3.3.8.3.1 or 3.3.8.3.2).

3.3.8-32. (a) and (b). These seem too prescriptive; the issue is that sequences with mutually exclusive events should not be included. Is a particular approach trying to be avoided? Helpful hints should probably be somewhere else (e.g., Appendix A)

3.3.8-33. 1st para after examples. Use standard terminology (e.g., "post-initiator HFEs").

3.3.8-34. 2nd para after examples. 1st sentence: delete; this is covered in Paragraph 3.3.6. 2nd sentence: delete if preceding paragraph remains; recovery actions are a type of post-initiator human action. 3rd sentence: replace with "If event tree rules are used to automatically assign conditional split fractions to event sequences, the content and application of these rules shall be independently reviewed."

3.3.8-35. 3rd para after examples. 1st sentence: replace "cutsets of a frequency" with "cut sets of a probability." (When computing CSFs, the cut sets are for system fault trees.) 2nd sentence: this applies to both linked fault trees and event trees w/CSFs. Move to 3.3.8.1.2.

Section 3.3.8.2.3

3.3.8-36. Insert "Analysis" in title after "Uncertainty." Replace with "The parameter uncertainty analysis may be limited to those sequences whose total mean frequency (i.e., the sum of the mean sequence frequencies) is greater than or equal to **[value]** of the mean CDF."

Section 3.3.8.3.1

3.3.8-37. 1st para. This appears to be too prescriptive as to "how." The technical requirements are provided in (a) and especially (b). Reword to focus on requirement. Also consider moving or deleting; the requirement has to do with how the model is constructed, not how it is quantified.

3.3.8-38. 1st para after bullets. Reference (to 3.4.4.6.3) is incorrect.

3.3.8-39. 2nd para after bullets. The requirement is similar to those given in 3.3.8.2.2; the fault tree should appropriately reflect path-dependencies in system requirements. (This is a requirement on modeling, not on quantification.

3.3.8-40. 1st para after example (p. 53). Provide additional discussion in Appendix A on "concerns."

Section 3.3.8.3.2

3.3.8-41. There is a requirement that truncation limit used for solution of system equations be the same as that used for the solution of the accident sequences. This should not be a

rigid requirement for those initiating events that are represented by single basic events that have no dependencies with the mitigating systems, e.g., LOCAs, SGTR, some LOOP events, etc.

3.3.8-42. 1st para after examples. Use standard terminology (e.g., "post-initiator HFEs"). 3rd sentence: replace "model" with "fault tree." (If the action is the same across systems, the HFE should have the same name. If the actions are different, the HFEs should have different names. Could use explanatory material in Appendix A.) 4th sentence: delete. Requirement on screening HEPs (independent of which event tree methodology is used) is already provided in Paragraph 3.3.6. Last sentence: put phrase "see ..." in parentheses. Also see earlier question on boundary between HRA and accident sequence analysis. Note that the event tree w/CSF approach is apparently not required to deal with cut set level dependencies.

3.3.8-43. 2nd para after examples plus bullets. The requirement to do recovery analysis and associated restrictions are already covered in Paragraph 3.3.6. Suggest deleting. If retained in some version, eliminate jargon in first bullet. (Literally, the nonrecovery probability shouldn't be added to the sequence frequency.) Use 2nd bullet as pattern.

3.3.8-44. 1st para after bullets. 1st sentence: replace "sequences" with "sequence frequencies." Last sentence: replace "responses and impacts" with "impacts."

3.3.8-45. 2nd para after bullets. Insert "sequence" before "cut set." Move requirement regarding cut set truncation based on order to a general section; it applies to both event tree linking and event tree w/CSF approaches.

3.3.8-46. Last 2 paras. The wording can be difficult to follow. Need to clarify.

Section 3.3.8.3.3

3.3.8-47. Insert "Analysis" in title after "Uncertainty." 1st sentence: replace with "The parameter uncertainty analysis may be limited to those sequence cut sets whose total mean frequency (i.e., the sum of the mean sequence cut set frequencies) is greater than or equal to [**value**] of the mean CDF." 2nd sentence: requirement seems too restrictive (it's presumably aimed at the correlated failures problem, since the modules are supposed to be stochastically independent). Suggest replacing "shall" with "should", and provide a requirement to assure that module uncertainties are treated with a single distribution only when SOK dependencies are not important

Section 3.3.8.4

3.3.8-48. 3.3.8.4, 1st para, 2nd sentence. Replace "under" with "for."

Section 3.3.8.4.1

3.3.8-49. Not clear what "high level results" other than CDF are to be reviewed under this section. The CDF contributions from different initiators?

Section 3.3.8.4.2

3.3.8-50. 1st para. 1st sentence: delete "either" and replace "or" by "and." 3rd sentence: replace "may" with "should." 4th sentence: replace "were" with "are."

3.3.8-51. 2nd para, last sentence. Find a replacement for "probing."

3.3.8-52. Example questions. Add: "Are the PRA's intermediate results consistent with historical experience (e.g., accident precursors)?"

Section 3.3.9

3.3.9-1. Replace "carried over" with "provided as input."

3.3.9-2. (Page 55, left column): Add the item "status of support systems" to the "Examples of accident sequence characteristics that should be considered in the Level 2 analysis because they can influence LERF."

3.3.9-3. 3.3.9. examples. Should indicate that the various statuses are at the onset of core damage. Should also provide examples of characteristics which can "directly influence the potential radionuclide source term associated with LERF."

3.3.9-4. 3.3.9.1.3. last sentence. It isn't clear if this is a requirement on the Level 1/Level 2 interface, or a requirement for Level 2 analysis.

3.3.9-5. 3.3.9.1.5. Need to specify what kind of information needs to carried forward. Also need to note that the issue is with post-initiator HFEs.

3.3.9-6. 3.3.9.2. It isn't clear what this requirement is aimed at. Why wouldn't the entire CDF be carried over into the Level 2 analysis?

3.3.9-7. 3.3.9.3, 1st sentence. Does this requirement present a problem for most event tree w/CSF applications?

3.3.9-8. 3.3.9.3: This section distinguishes between "cutset level" and "sequence level." I think that what you are trying to say is that you shall carry over the sequence cutsets into the interface trees, not just consider sequence characteristics. However, the Standard is not clear on this. Also, it is unclear if the cutsets should/shall be carried forward to the containment event trees.

3.3.9-9. 3.3.9.3 (page 56, right column): Replace "Rather, their failure *frequencies* are estimated in a manner that preserves relevant support system dependencies." with "Rather, their failure *probabilities* are estimated in a manner that preserves relevant support system dependencies." Also, the meaning of these sentences is not clear.

3.3.9-10. 3.3.9.3: In the last paragraph and in the example, a case was presented where system status cannot be determined from the sequence cutsets. It is not clear what the "standard" is here. Presumably, it is expected that a fault tree be constructed and the resultant sequences merged so that the sequence cutsets can be used in the Level 2 analyses.

3.3.9-11. ~~3.3.9.4~~. 1st sentence and 3rd sentence don't seem to be compatible. In which PRAs are hydrogen igniters modeled in Level 1? 5th sentence: replace "Fault tree models (or other techniques)" with "System models."

3.3.9-12. 3.3.9.4 (page 56, right column): The sentence "The reliability of systems whose primary function is to maintain containment integrity during accident conditions is incorporated into the accident sequence analysis performed during a Level 1 PRA." Such systems may not always be incorporated in a Level 1 PRA.

3.3.9-13. 3.3.9.4 (page 57, left column): Replace "An assessment of the reliability of these systems shall be incorporated into a Level 2 analysis to ascertain whether they would operate as designed to mitigate containment *response* during core damage accidents." with "An assessment of the reliability of these systems shall be incorporated into a Level 2 analysis to ascertain whether they would operate as designed to mitigate containment *challenges* during core damage accidents."

SECTION 3.4, LEVEL 2 TECHNICAL REQUIREMENTS

General Comments

3.4-1. Overall, the document identifies the major elements of Level 2 analysis, and discusses them in an appropriate context. However, the discussions are at a high level and not prescriptive enough to justify that reviewers take a hands-off approach when reviewing a submittal (e.g., the phenomena to be addressed are identified but not much is said about the level to which each phenomenon should be treated).

3.4-2. Both this section and NUREG/CR-6595 lack standards for some very basic issues. For example, the definition of "early" is not provided and it could mean early relative to core damage or early relative to effective evacuation. If "early" means relative to effective evacuation, then a calculational guideline for determining the start time for a general emergency would be helpful. Finally, guidance on what constitutes a "large" release is not given. It has been demonstrated that early fatalities can result from 3% or greater Cs and/or I releases, but a 10% threshold has also been used.

3.4-3. Criteria to be used to define which CET endstates comprise a large early release are missing. This is perhaps the single most important factor in accepting LERF as a measure of containment performance, and needs to be pinned down.

3.4-4. Document seems to call for rigorous treatment of source term uncertainties (p62, col2 and p64, col2 and p65, col1), a complete definition of source terms (p62, col1), and a Level 3 analysis (p57, col2), when all that is really required is an assessment of LERF. For example, Sec 3.4.4: The fourth paragraph states that "Uncertainties in the processes governing radionuclide release, transport, and deposition shall be quantified." Why is quantification needed in this case when in most other cases, they should only be understood and accounted for?

3.4-5. Section 3.4 frequently refers to the characteristics that a detailed Level 2 PRA should or shall have. However, the Standard does not discuss when such a detailed PRA should or shall be conducted.

3.4-6. In certain places, the treatment of systems important to level 2 are described as if part of the level 1 analysis (discussion of system recovery on p55, col2 and discussion of containment system performance on p56, col2). This treatment should be considered part of the level 2 analysis, but would rely on level 1 type models (fault trees) that would be linked to the level 1 sequences.

3.4-7. Section 3.4 frequently refers to the characteristics that a detailed Level 2 PRA should or shall have. However, the Standard does not discuss when such a detailed PRA should or shall be conducted.

3.4-8. There should be a brief discussion on how to extract the Regulatory Guide 1. 174 equivalent [large, early release frequency (LERF)] from the results of the detailed Level 2 PRA analysis.

Specific Comments:

3.4-9. 3.4.2 Mapping of Level 1 Sequences. These risk assessments depend on the adequacy of the users modeling of the physical response of the entire system to accident conditions. For example, whether or not a fan cooler fails due to internal waterhammer, or waterhammer in a piece of pipe to which it is connected, depends on many details of the piping geometry, ups and downs, water storage tanks, starting transients of pumps when connected to the entire system of pipes, valves, tees and components, the rate of rise of containment temperature and humidity, etc. A technical analysis, including evaluation of uncertainties in modeling, plays the biggest role in assessing failure probability, rather than some characteristics of the device itself. The PRA is fragile if it is not based on the comprehensive analysis of system response. The Standard should reflect this dependence.

3.4-10. 3.4.2 (page 57, right column): The sentences from "As noted in Paragraph 3.3.9, the reliability of systems whose primary function is to maintain" to ."..Examples include support system dependencies, such as electrical power, component cooling water, and instrument/control air." were mentioned at the beginning of Subsection 3.3.9.4. Suggest deleting the sentences on Subsection 3.4.2, and just keeping the reference to Subsection 3.3.9.4.

3.4-11. 3.4.2 (page 57, right column): Replace "Indirect failure of containment systems caused by harsh environmental conditions (resulting from failure of a support system) should represented in the assessment of containment system reliability." with "Indirect failure of containment systems caused by harsh environmental conditions (resulting, for example, from failure of a support system) should be represented in the assessment of containment system reliability."

3.4-12. 3.4.2 (page 58, left column): In the sentence "The long-term performance of containment systems shall be evaluated," what is meant by long-term? It is relevant to clarify this point since a mission time needs to be evaluated, and the failure probability of components may increase rapidly during accident progression.

3.4-13. 3.4.3.3 (page 61, left column): Replace "The primary function of the containment event tree is to provide a structured framework for organizing and ranking the alternative

accident progressions that evolve from a given core damage sequence." with "The primary function of the containment event tree is to provide a structured framework for organizing and ranking the alternative accident progressions that evolve from each core damage sequence or PDS."

3.4-14. 3.4.3.3. p. 61, last bullet. Is this relevant to LERF?

3.4-15. 3.4.3.3 (page 61, right column): Replace "The following time frames are of particular interest and therefore should be included in a detailed Level 2 analysis:" with "The following time frames are of particular interest, and therefore shall be included in a detailed Level 2 analysis:." The change from should to shall is because such time frames have to be evaluated.

3.4-16. 3.4.3.3 (page 61, right column, and page 62, left column): Replace "For example, the prior burnup of hydrogen reduces the overall level available for later combustion. Therefore, the logic for evaluating the probability of containment failure associated with a large combustion event occurring at the time of vessel breach should be able to distinguish this and preclude the possibility of a large combustion event if hydrogen was consumed during an earlier time frame." with "For example, the prior burnup of hydrogen reduces the overall amount available for later combustion. Therefore, the logic for evaluating the probability of containment failure associated with a large combustion event occurring at the time of vessel breach should be able to take this time behavior into account, and preclude the possibility of a large combustion event if hydrogen was consumed during an earlier time frame (unless, of course, enough hydrogen is generated later on, leading to the possibility of a large combustion event."

3.4-17. 3.4.3.3. p. 62, 1st column, 3rd para. Replace "a convolution" with "the convolution." Last sentence: this is a very loose definition of what the convolution integral is. Either give a more formal definition or delete the sentence.

3.4-18. 3.4.4 (page 62, right column): Replace "Uncertainties related to radionuclide behavior under severe accident conditions shall be quantified to characterize uncertainties in the radionuclide source term associated with individual accident sequences." with "Uncertainties related to radionuclide behavior under severe accident conditions shall be quantified to characterize uncertainties in the radionuclide source term associated with individual accident sequences or PDSs."

3.4-19. 3.4.4. Page 62: The last bullet calls for "the size distribution of radioactive material released in the form of an aerosol." Isn't this a time-dependent parameter? Is it to be specified as a function of time or an average?

3.4-20. 3.4.4. Table 3.4.4-1 may be overkill with respect to the needs for determining LERF. Not all of the fission products are significant for LERF although they can be for a full Level 2 PRA analysis.

3.4-21. 3.4.4. Page 64: Calls for including the release <u>energy</u> in the radionuclide source term. Is this the temperature, the enthalpy, the internal energy? Does it include radioactive energy?

3.4-22. 3.4.4. p. 64, 3rd para. This is apparently referring to some alternative methodology, but it isn't clear what the methodology is. (The paragraph only appears to cover what the methodology can do.) Does the methodology exist? Has it been applied in realistic situations? Reviewed/evaluated? What are the appropriate references?

3.4-23. 3.4.4 (page 64, right column): Replace "This uncertainty is significant and should be quantified with a similar level of rigor afforded to severe accident progression uncertainties." with "These uncertainties are significant, and should be quantified with a similar level of rigor as that used to assess severe accident progression uncertainties."

3.4-24. 3.4.4. Table 3.4.4-2 does not contain all of the key uncertainties. It should be expanded.

3.4-25. 3.4.4. Page 65: Under the first example, the comment is made that "higher retention efficiencies were attributed to sequences involving low coolant system pressure than those involving high pressure." Is this correct? Was it not the inverse?

SECTION 3.5, EXPERT JUDGEMENT

3.5-1 As discussed at the workshop, this section would be better written in terms of general principles rather than in terms of the SSHAC method. As a suggestion, this section could concentrate on high level requirements for use of expert judgement such as:

- there shall be a clear definition of the issue
- the expert(s) shall have the appropriate credentials (as a minimum there must be subject matter expertise, and, if the issue requires estimates of probabilities or a probabilistic representation of uncertainty, normative expertise)
- the knowledge base shall be relevant and cover the generally accepted range of opinion (It's not clear to what extent we can demand completeness), and documented
- the process by which the conclusion was reached shall be documented
- the conclusions shall be documented

3.5-2 These high level requirements can be argued to be valid for the simple cases such as that involving a "data analyst" assessing a failure rate for which there is no applicable data, as well as more complex cases. This is what is needed so that the analysis and the use made of that analysis in making a decision can be judged to be adequate.

3.5-3 1st para. Need to better define the "specific technical issue" (i.e., the development of a single distribution for a single parameter).

3.5-4 In a number of earlier portions of Section 3, Subsection 3.5. is referred to in cases where expert judgment (but not expert elicitation) is needed. This should be cleaned up. Where will the broader issue of expert judgment be addressed?

3.5-5 3.5.1(c). Are there any criteria for determining whether a TI or TFI should be used? If so, these should be in the Standard, at least in general terms.

3.5-6 3.5.2.1(b), 1st bullet. Replace "narrowly limited" with "detailed."

3.5-7 3.5.4. Need to define what Level A, B, C and D elicitations are. (Shouldn't rely on the Appendix to provide key definitions.)

3.5-8 Section 3.5 sometimes appears to use the terms "experts", "evaluators", and "panelists" as synonymous. A more precise use and/or definition of these terms would enhance the correct application of these terms.

3.5-9 The proposed standard would effectively require the use of one particular elicitation methodology -- an approach based on the use of a Technical Integrator (TI) or a Technical Facilitator/Integrator (TFI). This TI/TFI approach was developed in connection with the Senior Seismic Hazard Analysis Committee (SSHAC) effort and is only one of several methodologies for eliciting expert judgement that have been and are used in risk assessments and that are found in the technical literature. It is inappropriate to require a single method (i.e., the TI/TFI methodology,) to the exclusion of all others.

3.5-10 The various existing elicitation methodologies (including the TI/TFI approach) each have their particular strengths and weaknesses. Within certain broad constraints, practitioners should have the flexibility to choose a methodology that fits the particular situation at hand. The NRC/NMSS report, "Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program" (BTP), NUREG-1563, has been used in the high-level waste program since 1996. The BTP establishes such constraints and has been used by the U.S. Department of Energy as guidance for acceptable applications of the TI/TFI approach. At the same time, it is flexible enough to admit other appropriately conducted elicitations, as well.

3.5-11 The TI/TFI approach that is effectively required by the proposed standard is the approach used by a particular firm, Geomatrix, Inc (and a limited number of practitioners who have had business relationships with Geomatrix, Inc.). This raises a question about whether it is appropriate for a standard to adopt a single approach that would likely result in a competitive advantage for a small number of practitioners when there appears to be no technical basis for the standard's exclusive acceptance of the TI/TFI approach.

3.5-12 We recommend that the standard have the flexibility of the BTP and designate the TI/TFI approach as one acceptable approach. Accordingly, the proposed standard should be revised to be consistent with the following line-in, line-out text

3.5 Expert Judgment
This Subsection defines the criteria for the use of expert judgment to resolve one specific technical issue. Expert judgment shall be conveyed in the form of a community distribution that represents ~~the expert's or experts' assessment of the distribution of~~ the entire relevant (informed) technical community of experts knowledgeable about the given issue. Appendix A, "A-3.5, Expert Judgment", provides nonmandatory information and guidance that may be used to apply or implement the requirements contained in this Subsection.

3.5.1 Identification Of Expert Judgment Process. The PRA analysis team shall explicitly and clearly:

(a) define the specific issue to be addressed by the experts;

(b) ~~determine the degree of importance and the level of complexity of the issue~~ define the objectives of the elicitation explicitly and in a manner that reflects a

clear understanding of how the judgements obtained will be used; and

(c) ~~determine whether the process will use a Technical Integrator (TI), [a single entity (individual, team, company, etc.) responsible for developing the community distribution] or a Technical Facilitator/Integrator (TFI), [a single entity responsible for aggregating the judgments and community distributions of a panel of experts to develop the composite distribution of the informed technical community]~~Using a normative expert [an individual or individuals with a sound theoretical and conceptual knowledge of probability and practical experience in the elicitation of judgements from individuals] and a generalist [an individual with substantial technical background in one or more of the disciplines needed to solve the problem of interest -- but whose understanding of the problem typically spans beyond the particular discipline -- and is well versed on how the judgements will be used in the solution of the problem], a consistent and systematic procedure that will ensure that the results obtained by elicitation accurately reflect what is known and not known about the topic in question shall be specified.

3.5.2 Identification and Selection of Subject Matter Experts. The ~~PRA analysis team shall identify one or more evaluators (experts capable of evaluating the relative credibility of multiple alternative hypotheses to explain the available information). The evaluators shall evaluate all potential hypotheses and bases of inputs from the literature, and from proponents and resource experts, and shall provide:~~

~~*(a)* their own input; and~~

~~*(b)* their representation of the community distribution for integration by the TI or TFI.~~

Working together, the normative expert and generalist shall generate and apply criteria for the selection of the subject-matter experts [the individuals from whom the expert judgements will be elicited. A subject-matter expert is recognized by his or her peers as an authority in a specific subject matter or topic.]

~~*3.5.2.1 Technical Issue Experts.* The PRA analysis team shall also identify other experts needed for each technical issue identified:~~

~~*(a)* proponents (experts who advocate particular hypotheses or technical positions, (e.g., an individual who evaluates data and develops a particular hypothesis to explain the data); and~~

~~*(b)* resource experts (technical experts with knowledge of a particular technical area of importance to the issue). Resource experts should: · have narrowly limited knowledge and/or experience that will be of use to the evaluators (e.g., a resource expert for a study of motor-operated-valve failure rates at a particular plant might be the individual who has compiled the relevant industry-wide data set), or · have expertise in particular methodologies or procedures (e.g., a resource expert might be the individual who has developed new procedures for evaluating the completeness of the catalog of certain valve failures or for processing failure data from diverse sources.)~~

3.5.3 Determination Of The Need For Outside Expert Judgment. The PRA analysis team may elect to resolve a technical issue using their own expert judgment. In these situations, the team should itself follow the requirements herein. The PRA analysis team shall use outside experts when the needed expertise on the given technical issue is not available within the analysis team. The PRA analysis team should use outside experts, even when such expertise is available within the analysis team, if there is a need to obtain broader perspectives, for any of the following or related reasons:

· complex experimental data exist that the analysts know have been interpreted differently by different outside experts

· more than one conceptual model exists for interpreting the technical issue, and judgment is needed as to the applicability of the different models

· judgments are required to assess whether bounding assumptions or calculations are appropriately conservative

· uncertainties are large and significant, and judgments of outside technical experts are useful in illuminating the specific issue

3.5.4 ~~Utilization Of~~ The ~~TI Or TFI~~ Elicitation Process. The normative expert and generalist, shall work with the subject-matter experts using the procedure specified in accordance with 3.5.1(c) above to establish a community distribution.

~~*3.5.4.1 TI Process.* If the PRA analysis team has chosen a Level A, B, or C type of elicitation, then the TI Process shall be used. This includes:~~

~~*(a)* identifying available information and analyses and information retrieval methods;~~

~~*(b)* accumulating information relevant to the issue;~~

~~*(c)* performing the analyses and the data diagnostics; and~~

~~*(d)* developing the community distribution.~~

~~*3.5.4.2 TFI Process.* If the PRA analysis team has chosen a Level D type of elicitation, then the TFI Process shall be used. This includes:~~

~~*(a)* following all of the TFI process principles;~~

~~*(b)* working toward one of the four possible outcomes (consensus; equal weights; explicit quantitative weights; or "weighing" instead of "weighting");~~

~~*(c)* implementing the two-stage elicitation procedure (Stage I with panelists as independent evaluators representing themselves; Stage II with panelists as integrators, representing the overall expert community);~~

~~*(d)* performing analysis;~~

~~*(e)* resolving disagreements;~~

~~*(f)* aggregating; and *(g)* developing the composite distribution of the evaluators' estimates of the community distribution.~~

~~3.5.5 Responsibility For The Expert Judgment. The PRA analysis team shall assign explicit responsibility or "ownership" for the resulting judgments, either to the TI (when a TI is used) or shared with the experts (when a TFI is used). Each individual expert shall accept full responsibility or "ownership" for his individual judgments and interpretations.~~

3.5-13 Section A.3.5 should state that elicitation procedures that are consistent with the BTP, including the TI/TFI approach as described therein, may be used to satisfy the requirements of the standard

3.5-14 There would appear to be a bias introduced by having proponent experts also act in the role of evaluator experts:

- Because the TFI plays such an influential role in the elicitation, the TFI must be particularly disciplined to avoid introducing his/her own biases; and
- hat assurance is there that after the extensive interaction between experts that occurs during this process, the "state-of-knowledge" that is achieved is representative of the "state-of-knowledge" of a broader community of informed experts?
- Appendix A.3.5 should be modified to address these concerns.

3.5-15 There is no reference 3.3.5-20 on p43 as stated in section 3.3.5.4.1 p40 2nd column.

Section 4, Documentation

4-1. 4.3.3: Use of the word "all" in the first sentence. Removal of the word does not change the meaning of the sentence.

4-2. 4.3.3: In items (f), (g), (j), and (n) of the 1st para., note the use of the word "all."

4-3. 4.3.3: In the 1st para., item (f), change "versus for each accident..." to "versus each accident...."

4-4. 4.3.4: Consider adding "fault trees, system notebooks, and common cause failure events" to the list.

4-5. 4.3.6: Consider adding "methods for accounting for dependencies" to the list.

4-6. 4.3.6: In items (b) and (g) of the 1st para., note the use of the word "all."

4-7. 4.3.7: In item (a) consider adding "system capacities and flow rates" to the list. In item (i) consider adding flood growth and egress rates, flow out of piping, etc.

4-8. 4.3.7: Add a new item on walkdown scope and results.

4-9. 4.3.8: In item (c) of the 1st para, a list of dominant accident sequences AND cut sets for these sequences is required. The event tree with conditional split fraction approach produces sequences, but does not produce "cut sets" as normally thought of in the fault tree linking method. Thus, this requirement should be modified to allow the dominant sequences for the conditional split fraction approach and to require both sequence and cut sets for the fault tree linking approach.

4-10. 4.4.2: Each item, (a) - (c), references cut sets. Does the event tree with conditional split fraction approach produce cut sets? If not, will need to modify this requirement?

4-11. 4.4.3: The structure of this section (i.e., letters with bullets) is different than the structure (i.e.,sentences with letters) used in other sections. If possible, structures should be consistent.

4-12. 4.4.3: In item (b), the requirements go beyond those of the level 1 requirements, e.g., asking for unique calculation identifier by name, asking for "extensive" references, reference for archived records, etc. These kinds of documentation are needed for all calculations or they are not. Also, the use of the word "all" is noted in the second bullet.

4-13. 4.4.3 item (e): In the first bullet, is the parenthetical meant as a example of what would satisfy the requirement. If so, should it by italicized?

4-14. 4.4.3 item (e). In the 2nd bullet, note the use of the word "all."

4-15. 4.4.4: Note the use of the word "all" in items (a) and (e).

Section 4, Documentation

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4-14. 4.4.3 item (e). In the 2nd bullet, note the use of the word "all."

4-15. 4.4.4: Note the use of the word "all" in items (a) and (e).

4-16. 4.4 3 item (c): Us of the word "all" is noted. Also, there is no need to reference peer review as it has already been covered in the 1st para of Section 4.4.

4-17. 4.5: Since each assumption made in a PRA technically represents the use of expert judgment, does this imply this level of detail for each assumption? If so, is this really wanted?

4-18. 4.5: Suggest the following replacement:

If expert judgment is used in the PRA each utilization shall be documented. The documentation for each use of expert judgment shall include a description of the expert judgment process, the qualifications of the experts used in the process, and the associated results. Specific documentation shall include:
(a) the definition of each technical issue and associated objective of the expert judgment process for that issue;
(b) the selected ~~TI or TFI for each issue~~ normative expert and generalist and ~~his~~ their respective qualifications;
(c) the selected subject matter experts for evaluating each issue, the selection criteria, and the~~ir~~ qualifications of the subject matter experts;
d) ~~the classification of the degree of complexity of each issue and the level of analysis selected~~the determination of the need for outside expert judgement and the specified elicitation procedure;
(e) a description of the published literature pertinent to the issue and used in the expert judgment process;
(f) the technical positions of ~~proponents of various positions related to the technical issues and the integrated informed technical community view of each issue~~ the subject matter experts;and
(g) the resulting ~~composite~~community distribution for each issue.

Section 5, PRA Configuration Control

5-1. 5.3.2 Currently bullet 2 is written awkwardly and needs to be modified. It is not clear what is required by this bullet. It seems to imply some requirement to revisit old regulatory decisions. The standard should not include any regulatory requirements. In addition, bullets should be replaced with a) and b) so they can be referenced.

5-2. 5.3. Provisions should be made to allow use of current model until the next reasonably prescheduled update time. Allow analyst to insure current issues under consideration would not be impacted during the interval from when the decision is made that a update is needed until accomplishment of update. Failure to allow this might result in decertification of the PRA for its application at the time it is determined that an update is needed.

5-3. 5.4. This section is repetitive and not very informative. It could be significantly reduced in length without any loss of content. For example, it does very little good to repeat the list of the key elements of each of the PRA tasks and say they shall be evaluated to see if they've changed. Perhaps more useful would be a list of the changes that would require the model to be reevaluated, and an indication of which parts of the model might be affected. For example:

(A) New or Modified Operating Procedures: the following shall be assessed: are any new operator actions introduced; are system success criteria changed, is the HEP of an existing HEP changed, etc.?

(B) Change in component design for a modeled component: are the parameter estimates for the failure modes of the component still valid; are there new failure modes; are there new dependencies, etc.?

5-4. 5.4. This section and subsection refer to the need to incorporate the "most recent" events, understanding, etc. It may be more practical to update based on a cut-off date or a revision of changes than to attempt to pursue the "most recent." Just ensure the update is defined in terms of its incorporated basis. For example, Revision 2, incorporating design changes thru 99-124, etc.

5-5. 5.4.3 item (b): Note the use of the word "all."

5-6. 5.4.3 item (c): It is unclear what is meant by the phrase "or all."

5-7. 5.4.6 item (d): Note the use of the word "all."

5-8. 5.4.7: In the first sentence the phrase ."..of the risk related to internal hazards." should be changed to ."..of the risk related to internal flooding hazards." Internal hazards is too broad without the use of the modifier flooding.

5-9. 5.4.9: Suggest the following rewrite for the 1st sentence: The development and control of the Level 1 and Level 2 interface in the PRA shall be updated in accordance with the Owner's Configuration Control Program such that the PRA represents the most recent understanding of the Level 1 information needed to be carried forward to the Level 2 analysis.

5-10. 5.6. In the 1st sentence, is the phrase "for any reason" necessary? If not, it should be removed.

Section 6, Peer Review

6-1. Peer Review Requirements": The peer review process is crucial to assess the results of the PRA at each plant. In this context, the establishment of a review team with highly qualified experts is essential. Therefore, the following examples should be attached as appendices to facilitate the implementation effectively:

Model constituents of the peer review team with required expertise for each team member. Model work plans with a time schedule for the peer review. Model contents of the peer review report.

In addition, an example of the qualification process for peer review team members might be also beneficial to keep the quality of expertise in the team members if added in the standard.

Section 6.1

6-2. Should point out that the peer review is beyond and independent of the internal review currently covered in Paragraph 3.3.8.

Section 6.2

6-3. Agree that peer review is important, and that the peer reviewers be well qualified to perform the review. The requirements for the reviewers given in Section 6.2 should be revisited to determine whether there are better measures of knowledge and skill than time. Measures that emphasize review skills as well as PRA experience may be important.

6-4. 1st para, bottom of para. Should add "nuclear power plant" before "PRA" in most places. May wish to add qualification that allows PRAs for related facilities (e.g., K Reactor)

6-5. 1st para, 1st sentence. Need to operationally define "indoctrination." A short course by an organization with appropriate credentials? A 15-minute overview by the team leader? Should members be familiar with the material covered by a particular set of sections of a particular report? Experts in narrow areas need an introduction to PRA to ensure they understand the role of their expertise in the integrated PRA.

6-6. 1st para, 2nd sentence. Seems to require that each reviewer must have experience with all PRA technical elements. Is this intended? Suggest deleting and replacing 3rd sentence with: "Each review team member shall have 5 years of experience in performing activities related to their area of review, and shall be knowledgeable with this Standard's requirements in their area of review."

6-7. Does the last sentence in the 1st para. imply that one member must have 10 years of combined experience in "all" of the identified areas?

6-8. Add a exception to the requirements of 6.2:
Exception. If a reviewer generally meets the requirements of this section, with only minor discrepancies, compensating factors may be cited to demonstrate the competence of the reviewer. For example, high quality, intensive experience provides compensation for being

Section 6.4.1

6-20. Since documentation of the PRA is a requirement, there should be few or no cases with no documentation. Therefore, suggest the following: Change the title to "Detailed Review of PRA Technical Elements." Replace the first sentence by "A detailed review shall be performed for each PRA technical element for which the documentation is inadequate to demonstrate that the Standard has been met."

6-21. 2nd sentence: delete; this is covered in 6.5. 3rd sentence: replace "accurately" with "appropriately" or "satisfactorily." Similar comment for analogous passages in other technical element reviews.

6-22. Need to check to make sure the scope of the detailed review as described here matches the scope of the detailed review as described in 6.5. See later comment on 6.5. The scope appears to be as follows:

No PRA methodology documentation for a given technical element => do a detailed review for that element.

Methodology documentation exists and methodology is appropriate => do detailed review on selected aspects of technical element.

Methodology documentation exists but methodology is inappropriate => detailed review on "a larger group of selected attributes" for the element.

Section 6.4.2

6-23. 3rd sentence. Delete; the last sentence says what is intended. The notion that a limited review covers the "essential attributes" begs the question why do the detailed review?

6-24. How does a limited review of the technical element differ from the second review path under 6.4.1?

Section 6.5

6-25. 1st sentence. This appears to be inconsistent with the 1st sentence of 6.4.1; here, the detailed review covers all technical elements. In 6.4.1, detailed reviews are performed for those technical elements where there is no methodology documentation.

Section 6.5.1

6-26. Is there such a thing as a limited review for the Initiating Event Analysis?

Section 6.5.2

6-27. p. 84, 2nd para after bullets. Need to provide clarification as to what the larger group of event trees should be. Just one more tree than would have been covered if the methodology was judged to be adequate.

6-28. p. 84, 3rd para after bullets, 2nd sentence. Delete "essential." Similar comment for analogous passages in other Paragraphs.

6-29. 4th para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be).

6-30. p. 84, list of bullets. Needs editing.

6-31. p. 84, last bullet. This seems to call for the reviewers to look at the plant's EOPs and AOPs relevant to each event tree for a limited review. This is a good thing for the review, but clearly could require significant effort.

Section 6.5.3

6-32. 1st para, 2nd sentence. How are success criteria to be selected for review? Or should "selected" be deleted?

6-33. 3rd para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be)?

6-34. 4th para., 4th bullet: What happens if the assumptions do result in conservative results)? Is this enough to "reject" the analysis.

6-35. (d). Does this call for a review of all human actions, or for a review of the success criteria associated with each post-initiator HFE.

6-36. p. 85, 1st para after lettered bullets. Need to provide clarification as to what the larger group of success criteria evaluations should be.

Section 6.5.4

6-37. (a). Recognizing the uncertainties in importance measures for systems, how are "dominant systems" defined.

6-38. (c)and (d). Should make these lists as definitive as possible (instead of examples).

6-39. 2nd para after lettered bullets. 1st sentence: need to provide clarification as to what the larger group of system models should be. 2nd sentence: are there some examples from our past reviews?

6-40. 4th para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be)? The purpose of the last sentence is unclear. It appears to be restating what has already been stated in the 1st sentence of the 1st para.

6-41. p. 86, 1st column, last bullet. Delete "of the model evaluation."

6-42. p. 86, list of bullets. Should add bullets or at least explicitly address issues involving modularization (to check for independence), CCF, and system failure modes (e.g., flow

diversion modeling). By the way, I don't recall an explicit discussion of flow diversion in Section 3; this is one place where variability can be reduced.

Section 6.5.5

6-43. 2nd para.: Note use of the word "all" in items (b), (c), (e), and (f).

6-44. (e). Example doesn't clarify what "unique data values" are.

6-45. Lettered bullets. Add a bullet calling for the review of at least one important parameter for which there are no plant-specific events. Add another bullet calling for the review of at least one important parameter for which there is reason to believe that the generic data are inapplicable.

6-46. 1st para after lettered bullets. Need to provide clarification as to what the larger group of data values should be.

6-47. 3rd para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be)?

6-48. Bullet on Bayesian Updating. Replace with: "Parameter Estimation. Have the generic evidence and the plant-specific evidence been reviewed for consistency? Have appropriate parameter estimation methods been used when they are inconsistent? Have appropriate estimation methods been used when the evidence is sparse?

6-49. Unlettered bullets. Add the following bullet: "Parameter Uncertainties. Do the distributions quantifying parameter uncertainties adequately reflect the strength of the available evidence?"

6-50. The Standard calls for derivation of full distributions for each model parameter. The review should consider these full distributions, and not just point estimates. (The reader may not read this into the term "data value." Should reword.)

Section 6.5.6

6-51. 2nd para, item (d): It is unclear what is meant by "failure to recover equipment" for pre-accident HEs. Is this suppose to be for "failure to restore equipment?"

6-52. 3rd para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be)?

6-53. (e). Replace with: "HEPs for the same nominal activities performed under different conditions (i.e., different PSFs)." Timing isn't the only important PSF.

6-54. Lettered bullets. Add a bullet covering recovery actions which have a major impact on CCDP (i.e., turns an important cut set or sequence into a no never mind). Add another bullet for situations where procedural guidance and/or training is weak. (Need to make sure elsewhere in the Standard that the PRA explicitly points out such situations, if they exist.)

6-55. 1st para after lettered bullets. Need to provide clarification as to what the larger number (or group) of HEPs should be.

6-56. 4th unlettered bullet. Delete. Modify next bullet: Performance Shaping Factors - Are the PSFs (e.g., timing, availability of cues, workload) reflective of the expected conditions?

Section 6.5.7

6-57. Lettered bullets. Add a bullet for one flooding scenario for which the CDF is large if no credit is taken for operator actions needed to mitigate the flood.

6-58. 1st para after lettered bullets. Need to provide clarification as to what the larger number of internal flooding scenarios should be.

6-59. 2nd para, item (c): Note the use of the word "all."

6-60. 3rd para.: What are the criteria for determining how large this "larger" group should be (i.e. how much larger should the review be).

6-61. Walkdowns bullet. Replace with "Walkdowns - What additional information is provided by the walkdowns and how is this information included in the analysis?

6-62. Unlettered bullets. Add a bullet: "Operator Actions - Are the influences of flooding scenarios on operator flood mitigation, accident response, and recovery actions adequately addressed in the analysis?" Add a bullet: "Flood Propagation - Is the potential for barrier failures adequately addressed in the analysis?"

Section 6.5.8

6-63. Lettered bullets. Need some items for event tree w/CSF approach, e.g., "several examples of conditional split fraction assignments for the same system under different support and frontline system state conditions." Or "all rules used to assign conditional split fractions for selected event trees."

6-64. 1st para after lettered bullets. Need to provide clarification as to what the larger portion of the Level 1 quantification process should be.

6-65. 2nd para., item (c): If the detailed review is to examine the recovery analysis process, then the item should be made more explicit by adding the word "process" at the end of the phrase. Otherwise, the item should be clarified.

6-66. 3rd para.: What are the criteria for determining how large this "larger" group should be (i.e., how much larger should the review be)?

Section 6.5.9

6-67. This section differs from the prior sections in that it contains detailed review of selected PRA activities and then a blanket statement of a limited review of the remaining PRA

activities. Is this what was intended? (No paragraphical mention is made of the review of the PRA methodology documentation (i.e., the PRA Program Plan) as is made in other sections.

6-68. (b). Not clear what the "interface mechanism" refers to.

Section 6.6

6-69. This Subsection appears to call for a detailed review of the entire Level 2 analysis; there is no such thing as a graded review. It seems that a graded review is also appropriate and should be developed.

6-70. 6.9.2 Another requirement should be added to the peer review documentation section to explicitly address the characterization of methods and assumptions used. It should be a requirement that, when a particular method is used that is not universally used (e.g., an HRA method), an assessment be made as to the impact of using this model, by, for example, assessing whether it might be conservative with respect to other methods, or does not take into account some aspects of scenarios. Similarly, if a particular assumption has been made, that appears to have an influence on the results, the impact of making this assumption should be characterized in comparison with others that might have been made. To achieve this, add to 6.9.2 an item "(d) an identification of the assumptions and/or modeling approach used and an assessment of its influence on the PRA results."

Section 7, Risk Assessment Application Process

General Comments:

7-1. Need to define "application" as it is used in this Section (i.e., the notion that the PRA is going to be used to assess the risk impact of a proposed change to plant design or operations).

7-2. *Comments on Figure 7.1-1:* On Figure 7.1-1, should there be NOs and YESes on the decision points? In Box 3, should include the definition of the acceptance criterion as this will lead directly to the results and scope needed.

Specific Comments:

7-3. 7.2. example, last para. Should there be a mention of LERF as well? The actual decision criteria (e.g., RG 1.174)?

7-4. 7.3. p. 94, 1st column, 1st para. 1st sentence: replace "modeled" with "included." Note that the discussion seems to use "elements" in a manner different from Section 3 (see Figure 3.1-1). Here, it appears that a particular initiator can be an "element;" in Section 3, the entire initiating event analysis is an "element." Need to ensure consistency in terminology. Last sentence: delete or move to Appendix A; by definition, the discussion is outside the scope of the Standard.

7-5. 7.3. example. Point about not needing to assess CCW initiators. Is this correct? It seems reasonable that there is no significant change in the frequency of these initiators, but doesn't the application have to include an assessment of baseline CDF and LERF? (At least in a 1.174 framework.)

7-6. 7.4. In section 7.4, it should be stated that one of the important elements to model is the SW system itself, at least to the level of the train at which the AOT will apply.

7-7. 7.4, title. Insert "in" before "the."

7-8. 7.4, 1st para, last sentence. Last sentence: delete or move to Appendix A; by definition, the discussion is outside the scope of the Standard.

7-9. 7.3 and 7.4. Comment. The distinction between these two Subsections, especially after reading the examples, is not very clear. (See earlier comment on "elements.") Both seem to be focused on the PRA's treatment of SSCs. (7.3 deals with the effect of particular SSC failures on the modeled initiators.) It would be useful to provide examples which show a greater difference.

7-10. 7.6. The tone of the opening sentence in Section 7.6 is more like an NRC reviewer's statement. Turn it around into, "The owner shall determine if his PRA meets the tech reqs etc." Should also add, "He shall identify those assumptions that are most significant in his demonstration that the acceptance criteria have been met."

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7-11. 7.6, 1st bullet. Need to define "functional level dominant sequences." Don't think that the notion of functional level sequences has been mentioned earlier in the Standard. This criterion will require additional aggregation of sequences. Need to insert "mean" before "CDF/LERF." Need to operationally define "not affected" (less than 1%?).

7-12. 7.6, 1st bullet. Important Comment. It would seem that this criterion would allow the avoidance of uncertainty analysis (except in those few situations where formal uncertainty analysis is needed to correctly calculate the mean.) Is this important? (Probably; but if not, do not have the requirement.) More generally, it could be used to avoid many of the few specifics provided in the Standard unless "appropriate sensitivity studies or bounding evaluations" are carefully defined. The Standard definitely needs to be expanded here; the peer reviewers should not make all the decisions.

7-13. 7.6, 2nd bullet. See earlier comment about the need to compute baseline CDF/LERF, as well as changes.

7-14. 7.6, 1st para after bullets. Delete "deterministic methods ... analyses and." This analysis option is already stated in the 1st bullet.

7-15. 7.6, 2nd para after bullets. Delete; is outside of the Standard.

7-16. 7.6, 4th para after bullets. Delete last sentence; this is outside of the Standard.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

Attachment 6

March 25, 1999

Dr. William D. Travers
Executive Director for Operations
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Dr. Travers:

SUBJECT: PROPOSED ASME STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER PLANT APPLICATIONS (PHASE 1)

During the 460th meeting of the Advisory Committee on Reactor Safeguards, March 10-13, 1999, we met with representatives of the American Society of Mechanical Engineers (ASME) Committee on Nuclear Risk Management (CNRM) to discuss the proposed Standard for Probabilistic Risk Assessment (PRA) for Nuclear Power Plant Applications (Phase 1). The purpose of this Standard is to provide a means to ensure that the technical quality of PRAs is sufficient to support the regulatory review and approval of licensee risk-informed applications. We also had the benefit of the documents referenced.

Conclusions and Recommendations

1. The proposed Standard has the potential of being very useful to both the industry and the NRC. Although additional work remains, the overall approach to defining necessary PRA requirements is good.

2. Subsection 3.5 on the use of expert judgment and the associated nonmandatory guidance in Appendix A are inconsistent with other parts of the Standard and should be revised. Subsection 3.5 should identify the major issues involving the use of expert opinion in a PRA and not focus on a particular approach.

3. We agree with the CNRM decision to move Section 7 to the beginning of the Standard to present the risk assessment application process early in the document.

4. Consideration should be given in the Standard to recommending participatory peer review throughout the development or application of the PRA in preference to a *posteriori* review.

Discussion

The move toward a risk-informed regulatory system has increased awareness of the need to examine the quality of PRA methodologies. Risk information used for regulatory decisions must be based on credible models and methods.

The lack of confidence in the quality of PRAs will impede their use in the regulatory process. For example, the Individual Plant Examination (IPE) Insights Report (NUREG-1560) showed that there is variability in PRA results that can be attributed to different analytical tools used by licensees. On the basis of its review of licensee IPEs, the staff determined that assumptions used by some licensees were unacceptable and requested those licensees to improve their analyses. The development of a Standard that defines the necessary and minimum requirements for acceptable PRA quality is, therefore, essential.

Developing this Standard is not a straightforward process. If the Standard is too prescriptive, it could impede the further development and refinement of PRA models. On the other hand, simply listing all the methods and models that analysts have used or proposed in the past is not helpful because it presents all such tools as being equally credible or useful when, in fact, experience has shown that they are not.

We believe that the CNRM, who developed the proposed Standard, has established an appropriate balance between specificity and flexibility. The proposed Standard provides requirements that the CNRM believes are necessary for a quality PRA. Although there are references to methods in which there is broad consensus on their appropriateness, the CNRM has wisely refrained from being overly prescriptive in areas where the choice of methods is less clear. Because the actual methods for satisfying the requirements are not prescribed, merely meeting the requirements does not guarantee that a PRA will be of acceptable quality. Thus, the Standard also requires a peer review process to ensure acceptable quality. We agree with the CNRM that a robust peer review process is at present the best way to assess quality. Consideration should be given in the Standard to recommending participatory peer review throughout the development or application of the PRA in preference to just a review after completion of the work.

An exception to the CNRM decision not to specify methods is the treatment of expert judgment. Expert judgment has proven to be a ubiquitous element of modern PRAs for nuclear power plants. Overall, the proposed treatment of expert judgment in the Standard and in the nonmandatory Appendix A touches on nearly all the points that are needed. It puts an unwarranted emphasis on a particular approach to expert judgment. Subsection 3.5 should be revised to be consistent with the remainder of the Standard. Also, since it is not common practice to employ formal expert judgment methods in Level 1 PRAs, a discussion of the conditions requiring such treatment, with examples, would be very useful.

Subsection 7.5 requires that the users determine whether the scope and level of detail of the Standard are sufficient for an application and to provide a technical basis for this determination. Additional guidance should be provided in the Standard to clarify what is expected of the users.

To date, the work done to develop the proposed Standard and associated guidance is commendable. The Standard, when integrated with other industry and NRC initiatives, should greatly enhance progress toward risk-informed nuclear operations and regulatory decisionmaking. We applaud the staff for initiating this effort and for actively participating in the working committees.

We offer detailed comments in the attachment to this letter for the benefit of the CNRM in developing the proposed final version of the Standard and the NRC staff in considering possible endorsement. We look forward to reviewing the proposed final Standard following the reconciliation of public comments.

Sincerely,

Dana A. Powers

Dana A. Powers
Chairman

References:

1. American Society of Mechanical Engineers, ASME RA-S-1999 Edition Draft #10, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," draft released for public comment, dated February 1, 1999.
2. American Society of Mechanical Engineers, "White Paper and Guidance for Reviewers of the Draft ASME Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," received February 8, 1999.
3. U.S. Nuclear Regulatory Commission, NUREG-1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," Vols. 1-3, December 1997.
4. U.S. Nuclear Regulatory Commission, NUREG-1150, "Severe Accident Risks - An Assessment for Five U.S. Nuclear Power Plants," December 1990.
5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998.

Attachment: As Stated

ATTACHMENT

Detailed Comments on Proposed ASME Standard for PRA for Nuclear Power Plant Applications (Phase1)

1.1 Scope

Subsection 1.1 states that the Standard sets forth criteria and methods for developing and applying PRA. It should be made clear that the emphasis is on criteria and that particular methods are not prescribed.

2. DEFINITIONS

A. Section 2 requires a thorough review. Considering the broad range of potential applications for this Standard, close scrutiny should be given to ensuring that the definitions are consistent with generally accepted reactor and risk terminology and that terminology used in each section of the Standard is appropriately addressed.

B. Many of the listed definitions are not needed. For example, there is no need to describe a mathematical method such as Monte Carlo simulation. Similarly, there is no need to define a "severe accident." The inclusion of the words "beyond design basis" in the definition is not appropriate.

C. Some of the listed definitions are not useful. For example, an "importance measure" is called a mathematical expression that defines a quantity of interest.

D. Several of the listed definitions are inaccurate or incorrect. Examples of the former are the definitions of "station blackout," "core damage frequency," "unavailability," and "cut sets." An example of the latter is the definition of the "failure rate."

E. Many terms in the text, which should be included in the definitions, are not defined in Section 2. Examples are: EOPs, I&C, ECCS, safety-related SSCs, aleatory and epistemic uncertainties, and single-failure criterion.

3.1 Scope

"Internal Flooding Analysis" is located in the wrong place in Fig. 3.1-1, "Technical Elements of a PRA Model."

3.2 Plant Familiarization

Page 18: An important example of the plant familiarization that should be made explicit is crew performance on simulators during known, generic, time-critical sequences. This provides an appropriate understanding of man-machine interaction.

3.3.1 Initiating Event Analysis

A list of the initiating events that have been used in PRAs should be included with appropriate guidance.

3.3.2 Sequence Development

The explicit description of conditional split fractions and of fault tree linking is appropriate because they are established and accepted approaches. Similarly, a portion of the discussion on event sequence diagrams and system dependency matrices should be removed from the nonmandatory Appendix A and relocated into the main body of the Standard.

3.3.3 Success Criteria

A. Page 23: The list of high-level functions should also include neutronic shutdown.

B. Page 23: Criteria resulting from neutronic analyses should be added to the list of requirements.

C. Page 23: The statement that bounding analyses can be used conflicts with Subparagraph 3.3.4.3, "Use of Realistic Success Criteria."

D. Page 23: Second column: specifies that "Bounding thermal-hydraulic analyses from the plant's SAR ... may be used when detailed analyses are not practical." This statement conflicts with the word "shall" used in Subparagraph 3.3.4.3 to ensure that realistic criteria are used.

3.3.4 Systems Analysis

A. The Standard should caution users that the calculation of the average unavailability of systems with redundant trains is not the product of the average unavailabilities of the individual trains. The time-averaging process introduces dependencies among train unavailabilities.

B. Page 32: The definition of the term "common-cause equipment failure" is not consistent with the definition provided in Section 2.

3.3.5 Data Analysis

A. Page 35: Although it is stated that the subjectivist approach to probability ought to be adopted, the Standard proceeds to discuss frequentist methods (Subparagraphs 3.3.5.1.4 and 3.3.5.3.5) that are inconsistent with this recommendation on the subjectivist approach.

B. Page 35: The Standard should be clarified to state when frequentist methods can be used and for what purpose. It should state that no PRA that has uncertainty analysis has considered these methods useful.

C. Page 40: The Standard should be clarified to state that the analysis of common-cause failures will require the use of generic data that are applicable to the specific plant under analysis.

3.3.6 Human Reliability Analysis

Page 45: The statement in Subparagraph 3.3.6.3.1 that recovery actions shall be limited to those actions for which some procedural guidance is provided or for which operators receive frequent training is inconsistent with the statement in 3.3.7.6 that extraordinary recovery actions that are not proceduralized shall be justified in the analysis.

3.3.8 Level 1 Quantification and Review of Results

A. Page 51: It is not clear what the CNRM means in Paragraph 3.3.8.1.2 by the exception stating, "If only point estimate quantification is completed, that point estimate shall be the mean." Does this mean that the "mean value" should be calculated using rigorous methods? What does the CNRM mean by "point estimates"?

B. Page 51: The requirement in Subparagraph 3.3.8.1.3 that model uncertainty be evaluated needs additional discussion. This evaluation can range from a quick estimate of uncertainty to the use of formal methods for expert opinion elicitation, as was done in NUREG-1150. Furthermore, additional guidance should be provided to clarify how the sensitivity studies should be done and how the results may be used.

3.3.9 Level 1 and Level 2 Interface

A. The determination of uncertainty should be given more discussion and a more prominent position in the Standard.

B. Page 55: The second example of accident sequence characteristics that should be considered refers to the "RCS pressure at core damage." This should be replaced with the "RCS pressure at the time of vessel penetration."

C. There should be a brief discussion on how to extract the Regulatory Guide 1.174 equivalent [large, early release frequency (LERF)] from the results of the detailed Level 2 PRA analysis.

3.4.2 Mapping of Level 1 Sequences

These risk assessments depend on the adequacy of the user's modeling of the physical response of the entire system to accident conditions. For example, whether or not a fan

cooler fails due to internal waterhammer, or waterhammer in a piece of pipe to which it is connected, depends on many details of the piping geometry, ups and downs, water-storage tanks, starting transients of pumps when connected to the entire system of pipes, valves, tees and components, the rate of rise of containment temperature and humidity, etc. A technical analysis, including evaluation of uncertainties in modeling, plays the biggest role in assessing failure probability, rather than some characteristics of the device itself. The PRA is fragile if it is not based on the comprehensive analysis of system response. The Standard should reflect this dependence.

3.4.4 Radionuclide Release

A. Page 62: The last bullet calls for "the size distribution of radioactive material released in the form of an aerosol." Isn't this a time-dependent parameter? Is it to be specified as a function of time or an average?

B. Table 3.4.4-1 may be overkill with respect to the needs for determining LERF. Not all of the fission products are significant for LERF although they can be for a full Level 2 PRA analysis.

C. Page 64: Calls for including the release energy in the radionuclide source term. Is this the temperature, the enthalpy, the internal energy? Does it include radioactive energy?

D. Table 3.4.4-2 does not contain all of the key uncertainties. It should be expanded.

E. Page 65: Under the first example, the comment is made that "higher retention efficiencies were attributed to sequences involving low coolant system pressure than those involving high pressure." Is this correct? Was it not the inverse?

F. There is a need to discuss the release and effects of non-radioactive aerosols from the core.

3.5 Expert Judgment

A. What are the criteria for deciding when expert judgment must not be used in order to have a PRA of acceptable quality?

B. When are higher level treatments of expert judgment necessary to ensure that a PRA of acceptable levels of quality is produced? If there are not definable occasions when higher order treatment is needed to ensure adequate quality, why does not the Standard specify the minimum acceptable level of treatment and leave to guidance (i.e., in the Appendix) the discussion of higher levels of treatment that are not likely to ever be used?

C. The Standard requires that the problem to be addressed by the experts be specified in advance. Why is it not required that the experts be allowed to modify

the problem? This is allowed in the nonmandatory guidance in Appendix A and would seem to be wise since the experts are very likely to know more about the issue than the PRA team.

D. The Standard requires that the degree of importance of the issue be determined, but provides no quantitative indication of the measure of importance. How can this be omitted if the goal is to have a PRA of adequate quality? The nonmandatory guidance provides some qualitative indications of importance that are sufficiently vague to ensure that all issues can be relegated either to the lowest or to the highest category of importance. Is it not possible to provide a specification of the measure of importance of an issue?

E. The Standard requires also that the complexity of the issue be determined. Here even the nonmandatory guidance is of no help. In the nonmandatory guidance, levels of complexity are described. In some cases these levels are described as "... levels of complexity of the issue under consideration..." (p.103-A-3.5.1[2.2]). But elsewhere these are described as "... levels of complexity in the use of experts..." (p.101-A) and it is apparent that this is the real meaning of the terms. What is the meaning of the "level of complexity of the issue" as specified in Paragraph 3.5.1(b)? What is the measure of complexity to be used?

F. Paragraph 3.5.3: The decision to use outside experts rather than relying on the collective wisdom of the PRA analysis team would seem to be a step in the direction of the quality of the PRA that may not be needed. The decision to do this is left completely to the judgment of the team. Surely, it must be known that there are issues that can be resolved properly for the purposes of producing a PRA of adequate quality only by using outside experts. Why are the characteristics of these issues not described?

G. Paragraph 3.5.4: A crucial step in the formulation of the expert judgment for the PRA is the aggregation of the various expert judgments. No requirements for this step are provided. How is this absence of any specification for such a crucial step consistent with the goal of having a PRA that has adequate quality?

H. Subparagraphs 3.5.4.1 and 3.5.4.2: Regarding Levels A, B, C, and D, there is no indication in the Standard of what these Levels are. The nonmandatory guidance provides some idea of what they are for those who choose to follow this guidance. What are the meanings of Levels A, B, C, and D for those who elect not to follow the nonmandatory guidance? People familiar with the formulation of standards should be added to the group preparing this Standard. Similar flaws arise throughout the discussion in these Subparagraphs. What are four levels of consensus? If the guidance in Appendix A is to be followed, the Standard should require it. Otherwise, revise the Standard so that it stands alone.

I. Why are requirements for documentation of the expert judgment process not mentioned by reference in Subsection 3.5?

4. Documentation

The CNRM provides a listing of specific documentation requirements for a PRA that reflects, one-for-one, the listing of Risk Assessment Technical Requirements provided in Section 3. Although this listing is redundant, a concise listing of these documentation requirements would be helpful in avoiding diverse assessments of the Section 3 requirements. A careful review of Section 4 should follow the rewrite of Section 3. Also, where documentation requirements are stated in Section 4, a more specific statement of the kind of assessments necessary to satisfy these requirements should be useful, e.g., in the evaluation of the consequences of a residual heat removal system train failure, an adequate thermal-hydraulics analysis of system response is needed.

6.2 Review Team Personnel Qualifications

A. Define or describe the requirements for "indoctrination on the PRA process."

B. How were the various experience requirements established? e.g., "The team, collectively, shall have 15 years of experience in performing the activities related to the technical elements of the nuclear power plant PRA identified in Section 3 of this Standard."

C. The last paragraph is a documentation requirement, which may not belong in Subsection 6.2.

6.5 Review of Technical Elements

Consider a generic approach to defining when detailed or limited review is required. Consider reducing the redundancy of review guidance.

7.6 Determination of Scope and Level of Detail of Standard are Sufficient for Application

We are perplexed by the suggestion in Subsection 7.5 that the users determine whether the Standard is sufficient. Subsection 7.5 should be expanded to provide detailed guidance regarding the determination that the Standard is not sufficient to support a particular application and why alternative methods are needed. Also, a new section should be added to provide guidance on how users may recommend improvements to the Standard and for ASME to maintain and update the Standard.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 13, 1999

Dr. Dana Powers, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: PROPOSED ASME STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER PLANT APPLICATIONS (PHASE 1)

Dear Dr. Powers:

Your March 25, 1999, letter to me, on the subject topic, summarized, in four points, and discussed in more detail your conclusions and recommendations on the draft ASME PRA standard. Your letter supported the need for a standard and noted the issue of PRA quality was of concern in some of the Individual Plant Examination (IPE) reviews. Accordingly, to move towards a risk-informed regulatory system will require risk information based on credible models and methods. With one exception, we agree with your summary points as well as your discussion of these points. This exception is with respect to the practicality of a participatory peer review during the development of a PRA. As we envision this concept, such a peer review would take placed at appropriate stages as the initial PRA is done (e.g., initiating event identification stage, etc.). However, since all licensed nuclear power plants now have PRAs, there may be little practical value in including this concept in this version of the standard. We will, however, ensure this topic is discussed among the members of the ASME writing group, since it could be of interest when a major update of a PRA is done.

Your letter also provided a number of detailed comments; we will provide these to ASME along with the staff's comments for their review and consideration. If the staff's and your comments are adequately addressed in the final Standard, we intend to endorse the Standard in an update of Regulatory Guide (RG) 1.174 as one acceptable means of achieving PRA quality. As indicated in RG 1.174, another acceptable approach is a peer review program. We believe that this Standard can also support industry's peer review programs in providing a definition of PRA quality. If using a peer review approach, RG 1.174 states that the licensee should submit the standard or guidelines to which the PRA is compared for staff review. This Standard can provide the technical basis for that determination used in the peer review program.

We agree with your conclusion that "the Standard, when integrated with other industry and NRC initiatives, should greatly enhance progress toward risk-informed nuclear operations and regulatory decisionmaking." Therefore, we plan to continue actively participating in the ASME effort (Phase 1) and start on Phase 2 (shutdown and external events) with ANS in developing a consensus PRA standard. In addition, in parallel with development of the standard, the staff will initiate an effort to define how it intends on implementing the standard and will develop an implementation strategy in cooperation with industry and other stakeholders.

The staff will keep the ACRS updated on this activity and forward you our detailed comments on this draft when finalized.

Sincerely,

William D. Travers
Executive Director
for Operations

cc: Chairman Jackson
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

The staff will keep the ACRS updated on this activity and forward you our detailed comments on this draft when finalized.

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Executive Director
for Operations

cc: Chairman Jackson
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
SECY

CF	Y	N
PDR	Y	N

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*** Previously concurred.**
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DATE	04/05/99		04/05/99		04/05/99		04/21/99		04/23/99	
OFFICE	RES		RES		EDO					
NAME	*M. Federline		*A. Thadani		W. Travers					
DATE	04/27/99		04/28/99		05/13/99		05/ /99		05/ /99	

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RESEARCH ACTION ITEM

March 30, 1999 MAIL CONTROL FORM 3:38 pm

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ROM: DANA A. POWERS
TO: TRAVERS, EDO
CTION NECES/APPR?: N FOIA No.:

RES No.: **990089**
EDO No.: 990162
WITS No.:

ESCRIPTION: **PROPOSED ASME STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER....**

PECIAL INSTRUCTIONS:

TATUS:

DOCUMENT DATE: March 25, 1999
RIG. DUE TO RES: April 22, 1999
NEW DUE TO RES:

RECEIVED BY RES: March 30, 1999
ORIG. DUE TO EDO: April 26, 1999
NEW DUE TO EDO:

SSIGNED TO: **KING, DRA&A**
OR SIGNATURE OF: TRAVERS, EDO

Cunningham

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ATM10 - part of RES M10 series

ACTION

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GREEN TICKET #: 19990162 DUE DATE: 4/26/99

ASSIGN TO: ☐ DSA&RE ☑ DRA&A ☐ DET ☐ FMPAS ☐ F.O.

CONCUR WITH: ☐ NRR ☐ NMSS ☐ AEOD ☐ OGC ☐ CFO ☐ CIO ☐ ___ ☐ ___

COORDINATE WITH NRR AT DISSOLIATE DIRECTOR LEVEL / CONCURRENCE NOT NECESSARY

MEET EARLY TO RESOLVE ISSUES WITH CONCURRING OFFICES? ☐ YES ☐ NO

	To be Reviewed by	Signature Block:	To be Signed by:
A. Thadani	☑	☐	☐
M. Federline	☑	☐	☐
B. Morris	☐	☐	☐
C. Ader	☐	☐	☐

DATE DUE TO F.O. 4/22/99 DATE RECEIVED IN F.O. _____

D. GUIDANCE: ☐ None. Specify: _____

EDO Principal Correspondence Control

ROM: DUE: 04/26/99

EDO CONTROL: G19990162
DOC DT: 03/25/99
FINAL REPLY:

ana A. Powers, ACRS

O:

Travers, EDO

OR SIGNATURE OF : ** GRN **

CRC NO:

Travers, EDO

ESC:

PROPOSED ASME STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER PLANT APPLICATIONS (PHASE 1)

ROUTING:

Travers
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Collins, NRR
Mitchell, OEDO
ACRS File

ATE: 03/26/99

SSIGNED TO: RES

CONTACT: Thadani

PECIAL INSTRUCTIONS OR REMARKS:

Prepare response to ACRS for EDO signature. Add Commissioners and SECY as cc's.

USE SUBJECT LINE IN RESPONSE.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

March 25, 1999

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Conclusions and Recommendations

1. The proposed Standard has the potential of being very useful to both the industry and the NRC. Although additional work remains, the overall approach to defining necessary PRA requirements is good.

2. Subsection 3.5 on the use of expert judgment and the associated nonmandatory guidance in Appendix A are inconsistent with other parts of the Standard and should be revised. Subsection 3.5 should identify the major issues involving the use of expert opinion in a PRA and not focus on a particular approach.

3. We agree with the CNRM decision to move Section 7 to the beginning of the Standard to present the risk assessment application process early in the document.

4. Consideration should be given in the Standard to recommending participatory peer review throughout the development or application of the PRA in preference to *a posteriori* review.

Discussion

The move toward a risk-informed regulatory system has increased awareness of the need to examine the quality of PRA methodologies. Risk information used for regulatory decisions must be based on credible models and methods.

The lack of confidence in the quality of PRAs will impede their use in the regulatory process. For example, the Individual Plant Examination (IPE) Insights Report (NUREG-1560) showed that there is variability in PRA results that can be attributed to different analytical tools used by licensees. On the basis of its review of licensee IPEs, the staff determined that assumptions used by some licensees were unacceptable and requested those licensees to improve their analyses. The development of a Standard that defines the necessary and minimum requirements for acceptable PRA quality is, therefore, essential.

Developing this Standard is not a straightforward process. If the Standard is too prescriptive, it could impede the further development and refinement of PRA models. On the other hand, simply listing all the methods and models that analysts have used or proposed in the past is not helpful because it presents all such tools as being equally credible or useful when, in fact, experience has shown that they are not.

We believe that the CNRM, who developed the proposed Standard, has established an appropriate balance between specificity and flexibility. The proposed Standard provides requirements that the CNRM believes are necessary for a quality PRA. Although there are references to methods in which there is broad consensus on their appropriateness, the CNRM has wisely refrained from being overly prescriptive in areas where the choice of methods is less clear. Because the actual methods for satisfying the requirements are not prescribed, merely meeting the requirements does not guarantee that a PRA will be of acceptable quality. Thus, the Standard also requires a peer review process to ensure acceptable quality. We agree with the CNRM that a robust peer review process is at present the best way to assess quality. Consideration should be given in the Standard to recommending participatory peer review throughout the development or application of the PRA in preference to just a review after completion of the work.

An exception to the CNRM decision not to specify methods is the treatment of expert judgment. Expert judgment has proven to be a ubiquitous element of modern PRAs for nuclear power plants. Overall, the proposed treatment of expert judgment in the Standard and in the nonmandatory Appendix A touches on nearly all the points that are needed. It puts an unwarranted emphasis on a particular approach to expert judgment. Subsection 3.5 should be revised to be consistent with the remainder of the Standard. Also, since it is not common practice to employ formal expert judgment methods in Level 1 PRAs, a discussion of the conditions requiring such treatment, with examples, would be very useful.

Subsection 7.5 requires that the users determine whether the scope and level of detail of the Standard are sufficient for an application and to provide a technical basis for this determination. Additional guidance should be provided in the Standard to clarify what is expected of the users.

To date, the work done to develop the proposed Standard and associated guidance is commendable. The Standard, when integrated with other industry and NRC initiatives, should greatly enhance progress toward risk-informed nuclear operations and regulatory decisionmaking. We applaud the staff for initiating this effort and for actively participating in the working committees.

We offer detailed comments in the attachment to this letter for the benefit of the CNRM in developing the proposed final version of the Standard and the NRC staff in considering possible endorsement. We look forward to reviewing the proposed final Standard following the reconciliation of public comments.

Sincerely,

Dana A. Powers
Chairman

References:

1. American Society of Mechanical Engineers, ASME RA-S-1999 Edition Draft #10, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," draft released for public comment, dated February 1, 1999.
2. American Society of Mechanical Engineers, "White Paper and Guidance for Reviewers of the Draft ASME Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," received February 8, 1999.
3. U.S. Nuclear Regulatory Commission, NUREG-1560, "Individual Plant Examination Program: Perspectives on Reactor Safety and Plant Performance," Vols. 1-3, December 1997.
4. U.S. Nuclear Regulatory Commission, NUREG-1150, "Severe Accident Risks - An Assessment for Five U.S. Nuclear Power Plants," December 1990.
5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," July 1998.

Attachment: As Stated

ATTACHMENT

Detailed Comments on Proposed ASME Standard for PRA for Nuclear Power Plant Applications (Phase1)

1.1 Scope

Subsection 1.1 states that the Standard sets forth criteria and methods for developing and applying PRA. It should be made clear that the emphasis is on criteria and that particular methods are not prescribed.

2. DEFINITIONS

A. Section 2 requires a thorough review. Considering the broad range of potential applications for this Standard, close scrutiny should be given to ensuring that the definitions are consistent with generally accepted reactor and risk terminology and that terminology used in each section of the Standard is appropriately addressed.

B. Many of the listed definitions are not needed. For example, there is no need to describe a mathematical method such as Monte Carlo simulation. Similarly, there is no need to define a "severe accident." The inclusion of the words "beyond design basis" in the definition is not appropriate.

C. Some of the listed definitions are not useful. For example, an "importance measure" is called a mathematical expression that defines a quantity of interest.

D. Several of the listed definitions are inaccurate or incorrect. Examples of the former are the definitions of "station blackout," "core damage frequency," "unavailability," and "cut sets." An example of the latter is the definition of the "failure rate."

E. Many terms in the text, which should be included in the definitions, are not defined in Section 2. Examples are: EOPs, I&C, ECCS, safety-related SSCs, aleatory and epistemic uncertainties, and single-failure criterion.

3.1 Scope

"Internal Flooding Analysis" is located in the wrong place in Fig. 3.1-1, "Technical Elements of a PRA Model."

3.2 Plant Familiarization

Page 18: An important example of the plant familiarization that should be made explicit is crew performance on simulators during known, generic, time-critical sequences. This provides an appropriate understanding of man-machine interaction.

3.3.1 Initiating Event Analysis

A list of the initiating events that have been used in PRAs should be included with appropriate guidance.

3.3.2 Sequence Development

The explicit description of conditional split fractions and of fault tree linking is appropriate because they are established and accepted approaches. Similarly, a portion of the discussion on event sequence diagrams and system dependency matrices should be removed from the nonmandatory Appendix A and relocated into the main body of the Standard.

3.3.3 Success Criteria

A. Page 23: The list of high-level functions should also include neutronic shutdown.

B. Page 23: Criteria resulting from neutronic analyses should be added to the list of requirements.

C. Page 23: The statement that bounding analyses can be used conflicts with Subparagraph 3.3.4.3, "Use of Realistic Success Criteria."

D. Page 23: Second column: specifies that "Bounding thermal-hydraulic analyses from the plant's SAR ... may be used when detailed analyses are not practical." This statement conflicts with the word "shall" used in Subparagraph 3.3.4.3 to ensure that realistic criteria are used.

3.3.4 Systems Analysis

A. The Standard should caution users that the calculation of the average unavailability of systems with redundant trains is not the product of the average unavailabilities of the individual trains. The time-averaging process introduces dependencies among train unavailabilities.

B. Page 32: The definition of the term "common-cause equipment failure" is not consistent with the definition provided in Section 2.

3.3.5 Data Analysis

A. Page 35: Although it is stated that the subjectivist approach to probability ought to be adopted, the Standard proceeds to discuss frequentist methods (Subparagraphs 3.3.5.1.4 and 3.3.5.3.5) that are inconsistent with this recommendation on the subjectivist approach.

B. Page 35: The Standard should be clarified to state when frequentist methods can be used and for what purpose. It should state that no PRA that has uncertainty analysis has considered these methods useful.

C. Page 40: The Standard should be clarified to state that the analysis of common-cause failures will require the use of generic data that are applicable to the specific plant under analysis.

3.3.6 Human Reliability Analysis

Page 45: The statement in Subparagraph 3.3.6.3.1 that recovery actions shall be limited to those actions for which some procedural guidance is provided or for which operators receive frequent training is inconsistent with the statement in 3.3.7.6 that extraordinary recovery actions that are not proceduralized shall be justified in the analysis.

3.3.8 Level 1 Quantification and Review of Results

A. Page 51: It is not clear what the CNRM means in Paragraph 3.3.8.1.2 by the exception stating, "If only point estimate quantification is completed, that point estimate shall be the mean." Does this mean that the "mean value" should be calculated using rigorous methods? What does the CNRM mean by "point estimates"?

B. Page 51: The requirement in Subparagraph 3.3.8.1.3 that model uncertainty be evaluated needs additional discussion. This evaluation can range from a quick estimate of uncertainty to the use of formal methods for expert opinion elicitation, as was done in NUREG-1150. Furthermore, additional guidance should be provided to clarify how the sensitivity studies should be done and how the results may be used.

3.3.9 Level 1 and Level 2 Interface

A. The determination of uncertainty should be given more discussion and a more prominent position in the Standard.

B. Page 55: The second example of accident sequence characteristics that should be considered refers to the "RCS pressure at core damage." This should be replaced with the "RCS pressure at the time of vessel penetration."

C. There should be a brief discussion on how to extract the Regulatory Guide 1.174 equivalent [large, early release frequency (LERF)] from the results of the detailed Level 2 PRA analysis.

3.4.2 Mapping of Level 1 Sequences

These risk assessments depend on the adequacy of the user's modeling of the physical response of the entire system to accident conditions. For example, whether or not a fan

cooler fails due to internal waterhammer, or waterhammer in a piece of pipe to which it is connected, depends on many details of the piping geometry, ups and downs, water-storage tanks, starting transients of pumps when connected to the entire system of pipes, valves, tees and components, the rate of rise of containment temperature and humidity, etc. A technical analysis, including evaluation of uncertainties in modeling, plays the biggest role in assessing failure probability, rather than some characteristics of the device itself. The PRA is fragile if it is not based on the comprehensive analysis of system response. The Standard should reflect this dependence.

3.4.4 Radionuclide Release

A. Page 62: The last bullet calls for "the size distribution of radioactive material released in the form of an aerosol." Isn't this a time-dependent parameter? Is it to be specified as a function of time or an average?

B. Table 3.4.4-1 may be overkill with respect to the needs for determining LERF. Not all of the fission products are significant for LERF although they can be for a full Level 2 PRA analysis.

C. Page 64: Calls for including the release energy in the radionuclide source term. Is this the temperature, the enthalpy, the internal energy? Does it include radioactive energy?

D. Table 3.4.4-2 does not contain all of the key uncertainties. It should be expanded.

E. Page 65: Under the first example, the comment is made that "higher retention efficiencies were attributed to sequences involving low coolant system pressure than those involving high pressure." Is this correct? Was it not the inverse?

F. There is a need to discuss the release and effects of non-radioactive aerosols from the core.

3.5 Expert Judgment

A. What are the criteria for deciding when expert judgment must not be used in order to have a PRA of acceptable quality?

B. When are higher level treatments of expert judgment necessary to ensure that a PRA of acceptable levels of quality is produced? If there are not definable occasions when higher order treatment is needed to ensure adequate quality, why does not the Standard specify the minimum acceptable level of treatment and leave to guidance (i.e., in the Appendix) the discussion of higher levels of treatment that are not likely to ever be used?

C. The Standard requires that the problem to be addressed by the experts be specified in advance. Why is it not required that the experts be allowed to modify

the problem? This is allowed in the nonmandatory guidance in Appendix A and would seem to be wise since the experts are very likely to know more about the issue than the PRA team.

D. The Standard requires that the degree of importance of the issue be determined, but provides no quantitative indication of the measure of importance. How can this be omitted if the goal is to have a PRA of adequate quality? The nonmandatory guidance provides some qualitative indications of importance that are sufficiently vague to ensure that all issues can be relegated either to the lowest or to the highest category of importance. Is it not possible to provide a specification of the measure of importance of an issue?

E. The Standard requires also that the complexity of the issue be determined. Here even the nonmandatory guidance is of no help. In the nonmandatory guidance, levels of complexity are described. In some cases these levels are described as "... levels of complexity of the issue under consideration..." (p.103-A-3.5.1[2.2]). But elsewhere these are described as "... levels of complexity in the use of experts..." (p.101-A) and it is apparent that this is the real meaning of the terms. What is the meaning of the "level of complexity of the issue" as specified in Paragraph 3.5.1(b)? What is the measure of complexity to be used?

F. Paragraph 3.5.3: The decision to use outside experts rather than relying on the collective wisdom of the PRA analysis team would seem to be a step in the direction of the quality of the PRA that may not be needed. The decision to do this is left completely to the judgment of the team. Surely, it must be known that there are issues that can be resolved properly for the purposes of producing a PRA of adequate quality only by using outside experts. Why are the characteristics of these issues not described?

G. Paragraph 3.5.4: A crucial step in the formulation of the expert judgment for the PRA is the aggregation of the various expert judgments. No requirements for this step are provided. How is this absence of any specification for such a crucial step consistent with the goal of having a PRA that has adequate quality?

H. Subparagraphs 3.5.4.1 and 3.5.4.2: Regarding Levels A, B, C, and D, there is no indication in the Standard of what these Levels are. The nonmandatory guidance provides some idea of what they are for those who choose to follow this guidance. What are the meanings of Levels A, B, C, and D for those who elect not to follow the nonmandatory guidance? People familiar with the formulation of standards should be added to the group preparing this Standard. Similar flaws arise throughout the discussion in these Subparagraphs. What are four levels of consensus? If the guidance in Appendix A is to be followed, the Standard should require it. Otherwise, revise the Standard so that it stands alone.

I. Why are requirements for documentation of the expert judgment process not mentioned by reference in Subsection 3.5?

4. Documentation

The CNRM provides a listing of specific documentation requirements for a PRA that reflects, one-for-one, the listing of Risk Assessment Technical Requirements provided in Section 3. Although this listing is redundant, a concise listing of these documentation requirements would be helpful in avoiding diverse assessments of the Section 3 requirements. A careful review of Section 4 should follow the rewrite of Section 3. Also, where documentation requirements are stated in Section 4, a more specific statement of the kind of assessments necessary to satisfy these requirements should be useful, e.g., in the evaluation of the consequences of a residual heat removal system train failure, an adequate thermal-hydraulics analysis of system response is needed.

6.2 Review Team Personnel Qualifications

A. Define or describe the requirements for "indoctrination on the PRA process."

B. How were the various experience requirements established? e.g., "The team, collectively, shall have 15 years of experience in performing the activities related to the technical elements of the nuclear power plant PRA identified in Section 3 of this Standard."

C. The last paragraph is a documentation requirement, which may not belong in Subsection 6.2.

6.5 Review of Technical Elements

Consider a generic approach to defining when detailed or limited review is required. Consider reducing the redundancy of review guidance.

7.6 Determination of Scope and Level of Detail of Standard are Sufficient for Application

We are perplexed by the suggestion in Subsection 7.5 that the users determine whether the Standard is sufficient. Subsection 7.5 should be expanded to provide detailed guidance regarding the determination that the Standard is not sufficient to support a particular application and why alternative methods are needed. Also, a new section should be added to provide guidance on how users may recommend improvements to the Standard and for ASME to maintain and update the Standard.

ACTION

EDO Principal Correspondence Control

FROM: DUE: 04/26/99

EDO CONTROL: G19990162
DOC DT: 03/25/99
FINAL REPLY:

Dana A. Powers, ACRS

TO:

Travers, EDO

FOR SIGNATURE OF : ** GRN ** CRC NO:

Travers, EDO

DESC:

PROPOSED ASME STANDARD FOR PROBABILISTIC RISK ASSESSMENT FOR NUCLEAR POWER PLANT APPLICATIONS (PHASE 1)

ROUTING:

Travers
Knapp
Miraglia
Norry
✓ Blaha
Burns
Collins, NRR
Mitchell, OEDO
ACRS File

DATE: 03/26/99

ASSIGNED TO: CONTACT:

RES Thadani

SPECIAL INSTRUCTIONS OR REMARKS:

Prepare response to ACRS for EDO signature. Add Commissioners and SECY as cc's.

USE SUBJECT LINE IN RESPONSE.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

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EDO --G19990162

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Sincerely,

Dana A. Powers

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Chairman

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Attachment: As Stated

ATTACHMENT

Detailed Comments on Proposed ASME Standard for PRA for Nuclear Power Plant Applications (Phase1)

1.1 Scope

Subsection 1.1 states that the Standard sets forth criteria and methods for developing and applying PRA. It should be made clear that the emphasis is on criteria and that particular methods are not prescribed.

2. DEFINITIONS

A. Section 2 requires a thorough review. Considering the broad range of potential applications for this Standard, close scrutiny should be given to ensuring that the definitions are consistent with generally accepted reactor and risk terminology and that terminology used in each section of the Standard is appropriately addressed.

B. Many of the listed definitions are not needed. For example, there is no need to describe a mathematical method such as Monte Carlo simulation. Similarly, there is no need to define a "severe accident." The inclusion of the words "beyond design basis" in the definition is not appropriate.

C. Some of the listed definitions are not useful. For example, an "importance measure" is called a mathematical expression that defines a quantity of interest.

D. Several of the listed definitions are inaccurate or incorrect. Examples of the former are the definitions of "station blackout," "core damage frequency," "unavailability," and "cut sets." An example of the latter is the definition of the "failure rate."

E. Many terms in the text, which should be included in the definitions, are not defined in Section 2. Examples are: EOPs, I&C, ECCS, safety-related SSCs, aleatory and epistemic uncertainties, and single-failure criterion.

3.1 Scope

"Internal Flooding Analysis" is located in the wrong place in Fig. 3.1-1, "Technical Elements of a PRA Model."

3.2 Plant Familiarization

Page 18: An important example of the plant familiarization that should be made explicit is crew performance on simulators during known, generic, time-critical sequences. This provides an appropriate understanding of man-machine interaction.

3.3.1 Initiating Event Analysis

A list of the initiating events that have been used in PRAs should be included with appropriate guidance.

3.3.2 Sequence Development

The explicit description of conditional split fractions and of fault tree linking is appropriate because they are established and accepted approaches. Similarly, a portion of the discussion on event sequence diagrams and system dependency matrices should be removed from the nonmandatory Appendix A and relocated into the main body of the Standard.

3.3.3 Success Criteria

A. Page 23: The list of high-level functions should also include neutronic shutdown.

B. Page 23: Criteria resulting from neutronic analyses should be added to the list of requirements.

C. Page 23: The statement that bounding analyses can be used conflicts with Subparagraph 3.3.4.3, "Use of Realistic Success Criteria."

D. Page 23: Second column: specifies that "Bounding thermal-hydraulic analyses from the plant's SAR ... may be used when detailed analyses are not practical." This statement conflicts with the word "shall" used in Subparagraph 3.3.4.3 to ensure that realistic criteria are used.

3.3.4 Systems Analysis

A. The Standard should caution users that the calculation of the average unavailability of systems with redundant trains is not the product of the average unavailabilities of the individual trains. The time-averaging process introduces dependencies among train unavailabilities.

B. Page 32: The definition of the term "common-cause equipment failure" is not consistent with the definition provided in Section 2.

3.3.5 Data Analysis

A. Page 35: Although it is stated that the subjectivist approach to probability ought to be adopted, the Standard proceeds to discuss frequentist methods (Subparagraphs 3.3.5.1.4 and 3.3.5.3.5) that are inconsistent with this recommendation on the subjectivist approach.

B. Page 35: The Standard should be clarified to state when frequentist methods can be used and for what purpose. It should state that no PRA that has uncertainty analysis has considered these methods useful.

C. Page 40: The Standard should be clarified to state that the analysis of common-cause failures will require the use of generic data that are applicable to the specific plant under analysis.

3.3.6 Human Reliability Analysis

Page 45: The statement in Subparagraph 3.3.6.3.1 that recovery actions shall be limited to those actions for which some procedural guidance is provided or for which operators receive frequent training is inconsistent with the statement in 3.3.7.6 that extraordinary recovery actions that are not proceduralized shall be justified in the analysis.

3.3.8 Level 1 Quantification and Review of Results

A. Page 51: It is not clear what the CNRM means in Paragraph 3.3.8.1.2 by the exception stating, "If only point estimate quantification is completed, that point estimate shall be the mean." Does this mean that the "mean value" should be calculated using rigorous methods? What does the CNRM mean by "point estimates"?

B. Page 51: The requirement in Subparagraph 3.3.8.1.3 that model uncertainty be evaluated needs additional discussion. This evaluation can range from a quick estimate of uncertainty to the use of formal methods for expert opinion elicitation, as was done in NUREG-1150. Furthermore, additional guidance should be provided to clarify how the sensitivity studies should be done and how the results may be used.

3.3.9 Level 1 and Level 2 Interface

A. The determination of uncertainty should be given more discussion and a more prominent position in the Standard.

B. Page 55: The second example of accident sequence characteristics that should be considered refers to the "RCS pressure at core damage." This should be replaced with the "RCS pressure at the time of vessel penetration."

C. There should be a brief discussion on how to extract the Regulatory Guide 1.174 equivalent [large, early release frequency (LERF)] from the results of the detailed Level 2 PRA analysis.

3.4.2 Mapping of Level 1 Sequences

These risk assessments depend on the adequacy of the user's modeling of the physical response of the entire system to accident conditions. For example, whether or not a fan

cooler fails due to internal waterhammer, or waterhammer in a piece of pipe to which it is connected, depends on many details of the piping geometry, ups and downs, water-storage tanks, starting transients of pumps when connected to the entire system of pipes, valves, tees and components, the rate of rise of containment temperature and humidity, etc. A technical analysis, including evaluation of uncertainties in modeling, plays the biggest role in assessing failure probability, rather than some characteristics of the device itself. The PRA is fragile if it is not based on the comprehensive analysis of system response. The Standard should reflect this dependence.

3.4.4 Radionuclide Release

A. Page 62: The last bullet calls for "the size distribution of radioactive material released in the form of an aerosol." Isn't this a time-dependent parameter? Is it to be specified as a function of time or an average?

B. Table 3.4.4-1 may be overkill with respect to the needs for determining LERF. Not all of the fission products are significant for LERF although they can be for a full Level 2 PRA analysis.

C. Page 64: Calls for including the release energy in the radionuclide source term. Is this the temperature, the enthalpy, the internal energy? Does it include radioactive energy?

D. Table 3.4.4-2 does not contain all of the key uncertainties. It should be expanded.

E. Page 65: Under the first example, the comment is made that "higher retention efficiencies were attributed to sequences involving low coolant system pressure than those involving high pressure." Is this correct? Was it not the inverse?

F. There is a need to discuss the release and effects of non-radioactive aerosols from the core.

3.5 Expert Judgment

A. What are the criteria for deciding when expert judgment must not be used in order to have a PRA of acceptable quality?

B. When are higher level treatments of expert judgment necessary to ensure that a PRA of acceptable levels of quality is produced? If there are not definable occasions when higher order treatment is needed to ensure adequate quality, why does not the Standard specify the minimum acceptable level of treatment and leave to guidance (i.e., in the Appendix) the discussion of higher levels of treatment that are not likely to ever be used?

C. The Standard requires that the problem to be addressed by the experts be specified in advance. Why is it not required that the experts be allowed to modify

the problem? This is allowed in the nonmandatory guidance in Appendix A and would seem to be wise since the experts are very likely to know more about the issue than the PRA team.

D. The Standard requires that the degree of importance of the issue be determined, but provides no quantitative indication of the measure of importance. How can this be omitted if the goal is to have a PRA of adequate quality? The nonmandatory guidance provides some qualitative indications of importance that are sufficiently vague to ensure that all issues can be relegated either to the lowest or to the highest category of importance. Is it not possible to provide a specification of the measure of importance of an issue?

E. The Standard requires also that the complexity of the issue be determined. Here even the nonmandatory guidance is of no help. In the nonmandatory guidance, levels of complexity are described. In some cases these levels are described as "... levels of complexity of the issue under consideration..." (p.103-A-3.5.1[2.2]). But elsewhere these are described as "... levels of complexity in the use of experts..." (p.101-A) and it is apparent that this is the real meaning of the terms. What is the meaning of the "level of complexity of the issue" as specified in Paragraph 3.5.1(b)? What is the measure of complexity to be used?

F. Paragraph 3.5.3: The decision to use outside experts rather than relying on the collective wisdom of the PRA analysis team would seem to be a step in the direction of the quality of the PRA that may not be needed. The decision to do this is left completely to the judgment of the team. Surely, it must be known that there are issues that can be resolved properly for the purposes of producing a PRA of adequate quality only by using outside experts. Why are the characteristics of these issues not described?

G. Paragraph 3.5.4: A crucial step in the formulation of the expert judgment for the PRA is the aggregation of the various expert judgments. No requirements for this step are provided. How is this absence of any specification for such a crucial step consistent with the goal of having a PRA that has adequate quality?

H. Subparagraphs 3.5.4.1 and 3.5.4.2: Regarding Levels A, B, C, and D, there is no indication in the Standard of what these Levels are. The nonmandatory guidance provides some idea of what they are for those who choose to follow this guidance. What are the meanings of Levels A, B, C, and D for those who elect not to follow the nonmandatory guidance? People familiar with the formulation of standards should be added to the group preparing this Standard. Similar flaws arise throughout the discussion in these Subparagraphs. What are four levels of consensus? If the guidance in Appendix A is to be followed, the Standard should require it. Otherwise, revise the Standard so that it stands alone.

I. Why are requirements for documentation of the expert judgment process not mentioned by reference in Subsection 3.5?

4. Documentation

The CNRM provides a listing of specific documentation requirements for a PRA that reflects, one-for-one, the listing of Risk Assessment Technical Requirements provided in Section 3. Although this listing is redundant, a concise listing of these documentation requirements would be helpful in avoiding diverse assessments of the Section 3 requirements. A careful review of Section 4 should follow the rewrite of Section 3. Also, where documentation requirements are stated in Section 4, a more specific statement of the kind of assessments necessary to satisfy these requirements should be useful, e.g., in the evaluation of the consequences of a residual heat removal system train failure, an adequate thermal-hydraulics analysis of system response is needed.

6.2 Review Team Personnel Qualifications

A. Define or describe the requirements for "indoctrination on the PRA process."

B. How were the various experience requirements established? e.g., "The team, collectively, shall have 15 years of experience in performing the activities related to the technical elements of the nuclear power plant PRA identified in Section 3 of this Standard."

C. The last paragraph is a documentation requirement, which may not belong in Subsection 6.2.

6.5 Review of Technical Elements

Consider a generic approach to defining when detailed or limited review is required. Consider reducing the redundancy of review guidance.

7.6 Determination of Scope and Level of Detail of Standard are Sufficient for Application

We are perplexed by the suggestion in Subsection 7.5 that the users determine whether the Standard is sufficient. Subsection 7.5 should be expanded to provide detailed guidance regarding the determination that the Standard is not sufficient to support a particular application and why alternative methods are needed. Also, a new section should be added to provide guidance on how users may recommend improvements to the Standard and for ASME to maintain and update the Standard.