NUCLEAR ENERGY INSTITUTE

January 18, 2001

Mr. David B. Matthews
Director, Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Mr. Matthews:

NEI 00-02, "Probabilistic Risk Assessment Peer Review Process Guideline" was submitted to NRC in April of last year. NEI requested NRC review of the suitability of this process to address PRA quality issues for NRC's Option 2 regulatory reform proposal. Our original submittal contained "subtier criteria" to facilitate NRC's review, and we indicated these criteria were intended for BWR applicability. NRC's letter of June 9, 2000, requested we provide subtier criteria applicable to all plants. NRC's letter of September 19, 2000, requested additional information to facilitate NRC's review of NEI 00-02. The subtier criteria and requested additional information are provided as enclosures.

Enclosure 1 provides responses to the NRC requests for additional information (RAIs). Most of the responses represent additional clarifications of the process, or general agreement with the NRC comment. Some of the RAIs were responded to by enhancing the subtier criteria, reflective of past peer reviews.

Enclosure 2 provides subtier criteria intended to replace those provided in our April 24, 2000, submittal. These criteria are applicable to all plant types, and incorporate comments from the PWR Owners Groups relative to their ongoing peer reviews, as well as a number of other improvements.

The PRA peer review process includes a feedback process to capture valuable insights to continually improve the conduct of the peer reviews. The subtier criteria document now generally reflects the criteria used in the PWR and BWR peer reviews. Nevertheless, if there are insights developed from feedback on the process, or other streamlining of the subtier criteria, then changes to the subtier criteria may result. This is not expected to affect the previous PRAs that have undergone a peer review because the anticipated changes are expected to be primarily related to efficiency, clarifications, and format.

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We will continue to work with your staff to achieve the optimal use of the industry PRA peer review process in implementation of risk-informed regulation. Please contact me at 202-739-8081 or arp@nei.org if you have any questions.

Sincerely,

Anthony R. Pietrangelo

Enclosures

cc: Rich Barrett, NRR (w/enclosures)
Tom King, RES (w/enclosures)

RESPONSES TO NRC QUESTIONS REGARDING THE NEI PRA PEER REVIEW PROCESS

NEI PREFACE

Purpose

This document provides NEI responses to the NRC Request for Additional Information (RAI) in a letter from D.B. Matthews (NRC-NRR) to S.D. Floyd (NEI), TAC. No. MA 8899, dated September 19, 2000.

Overview

The PRA Peer Review process, as described in NEI 00-02, is considered a valuable part of the industry's approach to ensure the quality of Probabilistic Risk Assessments (PRAs) used to support risk-informed applications. The PRA Peer Review process is envisioned to be used for PRA assessment, in support of specific risk-informed applications and Option 2 Risk-Informed applications. The Peer Review process has as its major focus to identify strengths and potential areas of enhancement for the individual PRAs so that these findings can be used by the utility to either improve the PRA or identify whether any compensatory measures are needed for specific risk-informed applications. The application of the PRA Peer Review to the Option 2 Risk-Informed applications involves the ability to effectively characterize the PRA as a Grade 3 or higher. Therefore, the responses to the RAI will not focus on the adequacy of distinctions in the subtier criteria between Grades 3 and 4, but will establish the desirability of achieving a Grade 3 or higher.

The PRA Peer Review process is depended upon to identify major flaws in the PRA that could compromise its ability to be used in applications. It is not the purpose of the Peer Review to perform a Quality Control audit of the PRA. The expertise of the Team is required to unravel the complexities of the model and to focus on the specific modeling and data areas that could prevent the successful use of the PRA model.

Interface with PRA Standard

A rigid template for the performance for a PRA is difficult to develop. The draft ASME PRA Standard is a major step towards examining the ability to create such an effective Standard. The Peer Review process is a method that can be used in conjunction with:

- Existing practices and methods, or
- The final PRA Standard

The PRA Peer Review process is used to ensure that the PRA represents a reasonable characterization of the risk profile and the degree to which the PRA model has the acceptable level of detail, scope, and realism to be used effectively in risk-informed applications.

Many critical PRA review items are difficult to codify without excruciating detail. The PRA Peer Review process examines the whole PRA and telescopes in on those areas that indicate weakness in supporting possible applications by using a set of criteria (checklists) and the expertise of the Peer Review Team.

The Peer Review process includes the following:

- A check on the reasonableness. This includes the following:
    1. The results
    2. The process
    3. The methods
    4. The data
    5. The assumptions
- Use of judgement. Judgement can be effectively used to focus limited time and resources of the Peer Review Team on the most important aspects of a model.

- Examination of key assumptions and implementation in models. Models and assumptions vary dramatically and judgement is required by the peer review team in how to dissect the model and the documentation.

The PRA Peer Review is a special approach to use "outside" experts in the field to provide a fresh perspective on the PRA as a whole. The Peer Review does not replace a quality program at the utility to ensure the correct inputs are used, the applicable computer codes are properly used, and the calculations are accurate and fulfill their objectives.

Continued Effort

The PRA Peer Review process includes a feedback process to capture valuable insights to continually improve the conduct of the Peer Reviews.

The subtier criteria document now generally reflects the criteria used in the PWR and BWR Peer Reviews. Nevertheless, if there are insights developed from feedback on the process or other streamlining of the subtier criteria then changes to the subtier criteria may result. This is not expected to affect the previous PRAs that have undergone a Peer Review because the anticipated changes are expected to be primarily related to efficiency, clarifications, and format.

RAI Responses

The enclosed RAI Responses were formulated by the four Owner's Groups and represent a characterization of the PRA Peer Review process as it has been applied in the past and is intended to be applied in the future.

RESPONSES TO RAI

GENERAL OBSERVATIONS

QUESTION NO. 1:

The NRC staff perspective on PRA quality (see enclosure 2 to SECY-00-0162) is one in which, rather than characterizing the "quality" of a PRA in an absolute sense, focuses on determining whether the PRA is of sufficient quality to support the use by decision-makers of the results it generates, on an application-specific basis.

RESPONSE:

As noted in the NRC's PRA Policy Statement [8], the PRA quality should be commensurate with the application. Therefore, the focus of the NEI PRA Peer Review process is to characterize the PRA in terms that allow its use in support of multiple applications. These different applications may each rely on different levels of "quality" over the spectrum of possible PRA quality. Therefore, this process is tailored to lead to a characterization of the PRA elements' quality as sufficient to support applications over four discrete categories:

Grade Category	Abbreviated Description
Grade 1	Vulnerability Identification
Grade 2	Risk-Ranking Applications
Grade 3	Risk-Informed Applications
Grade 4	Risk-Based Applications

The NEI Peer Review process examines the PRA as it stands. Because there are a large number of potential applications, not all of which are currently recognized, the NEI Peer Review process does not attempt to characterize the PRA quality as it may pertain to each specific application. There could be tens or hundreds of such applications.

Currently, the individual utility would use the results of the PRA Peer Review and then justify the appropriateness and basis for the PRA quality as it applies to a specific application. This would be part of the Integrated Decision-making Panel (IDP) process that is referenced in the NEI Option 2 methodology. [7]

QUESTION NO. 2:

NEI requested that the staff review NEI 00-02 and the draft "Industry Guideline for Risk-Informed Categorization of Structures, Systems, and Components" in tandem. For this review, it is assumed that a PRA subelement grade of 3 (the grade labeled "risk-informed decisions") is essentially the appropriate grade to support the categorization of SSCs for risk-informed Part 50 Option 2 applications. However, questions are also raised on the other grades when it is helpful to understand the philosophy behind the process.

RESPONSE:

The Grade 3 interpretation is consistent with the NEI PRA Peer Review process for the Option 2 applications. It is noted that individual subelements may be assigned grades below 3. These subelements can still be supportive of an Option 2 risk-informed application if one or more of the following are true:

- The PRA has been modified and updated to remedy the issue that prevented a Grade 3 assignment
- The individual subelement is not required to support the specific Option 2 application
- There are compensatory measures such as deterministic analyses that are performed that reduce the importance of the subelement

In other words, the RAI generalization is acceptable with the exception that certain PRA features could be allowed to be graded lower depending on the specific Option 2 application or the compensatory measures implemented by the utility recognizing the lower grade. More specifically, it is also noted that individual utilities may elect to perform specific deterministic evaluations or other compensatory measures to supplement the PRA in support of Option 2 implementation. It is also noted that individual subelements of the PRA may not be required for the assessment of some applications. In those cases, the need for a Grade 3 may not be justified.

QUESTION NO. 3:

The key to using the Peer Review process and its associated grades is in understanding what the grades mean. This understanding is strongly tied to the subtier criteria. Even though NEI did not request a review of the subtier criteria, an understanding of how they are used and interpreted is essential to NRC's review of the process, since they effectively define the standard to be used by the peer reviewers.

RESPONSE:

The grades are defined in terms of the types of applications that may be supportable to one degree or another by the PRA. These definitions are included in the NEI PRA Peer Review Guidelines, Section 3.3.

The PRA Peer Review process has proven to be consistent and reproducible in its review of PRAs using only the PRA checklists containing the element and subelement criteria. This has been demonstrated in the re-reviews of two of the "pilot" plants used in the original guideline development process.

However, NEI has supplemented those guidelines with the subtier criteria to provide a handy reference for Peer Review Teams in their implementation process. The subtier criteria are supplemental information to refine the distinctions among grades for those criteria that are sometimes difficult to interpret. They reflect the decisions that have been made by previous Peer Review Teams. This supplemental information is used to assist in establishing consistency from one Peer Review to another. The subtier criteria are written summaries of criteria that have been transmitted orally in previous PRA Peer Reviews by veteran members of the Peer Review process and are used to facilitate the peer review process. The subtier criteria describe the variation in level of detail, scope, degree of rigor, and adequacy of documentation for the subject subelement.

This means that now the following are part of the consistency process:

- Use the specific criteria for 209 of the PRA subelements.

- Incorporate veteran members of previous PRA Peer Reviews on each Peer Review Team.
- Provide training on the process and the PRA criteria to be used.
- Supplement the above with written subtier criteria that provide documented guidance regarding the distinctions among grades for the 209 criteria.

QUESTION NO. 4:

<u>Relationship of NEI 00-02 to NEI's Categorization Guidelines</u>

To review NEI 00-02 and the draft "Industry Guideline for Risk-Informed Categorization and Treatment of Structures, Systems, and Components" in tandem requires that it be clear how one document impacts the other. Section 2.4.1.2 of the draft Categorization Guideline addresses the Peer Review process in general terms. The statement is made that '"In general, the more applicable PRA information, the better."

What does this mean, and what is the role of NEI 00-02 in this determination?

RESPONSE:

The Option 2 Implementation Guideline [7], including the categorization guideline, has been updated to incorporate guidance on how the PRA Peer Review process can be used to support PRA Quality in Option 2 applications. (See also the response to the next question.)

NEI encourages utilities to use the NEI PRA Peer Review Guidelines by having a peer review performed on any PRA that is being planned to be used for an application. In this regard, the Option 2 implementation would be considered more favorably if the PRA Peer Review Guidelines had been fully implemented.

It must also be noted that there is substantial effort required in many cases for the utility to respond to the Peer Review comments in a way that would allow the PRA to be fully supportive of applications such as the implementation of Option 2.

QUESTION NO. 5:

Assuming that it is the task of the peer review team to identify where the NEI 00-02 criteria are not met and to propose adjustments (by either modifying the PRA or highlighting the differences for consideration by the integrated decision making panel [IDP]), the Categorization Guidelines should explain how the results of the peer review are to be used. For example, in several places in the Categorization Guidelines, there are tables of suggested sensitivity studies (e.g., Table 2.4-1). In addition to those suggested, these tables should include a reference to the results of the PRA peer review, and suggest sensitivity studies be performed to address whether the differences from the NEI 00-02 criteria have a potential impact on the application.

Please provide a discussion of how the industry categorization guidelines and IDP process will be tied into the results and findings of the Peer Review process of the PRA.

RESPONSE:

The NEI categorization guidelines for Option 2 [7] have been supplemented with additional guidance on the

- Use of peer certification results,
- Characterization of the PRA for the IDP, and
- Necessary information on the PRA for submittal to the NRC.

This guidance, contained in Section 2.4.1.3 [7], describes the process to be used in moving from a base PRA with a completed NEI 00-02 Peer Review to input to the IDP. This guidance will cover the role of element grades, facts and observations, and sensitivity studies in the Option 2 categorization process. In some cases, the base PRA model might be expected to be revised prior to the performance of the categorization. In other cases, sensitivity studies or additional documentation to support the existing PRA may suffice. In any case, the strengths and limitations of the PRA as identified in the PRA Peer Review will be characterized for both the IDP and the NRC as part of the process.

QUESTION NO. 6:

Minimum requirements for a PRA

As discussed in Section 3 of Enclosure 1 to SECY-00-0162, a PRA has to have certain attributes to ensure that the results are technically correct. Therefore, a set of requirements should be common to all grades of the Peer Review process, and the distinctions between the grades should only be in level of detail to which a subelement is developed. For example, the logic structure has to be correct for the level of detail incorporated. Therefore, the subtier criteria for all high-level process related issues SHALL be met for all grades. A sampling of examples from Table 5-2 of the subtier criteria document are discussed below:

RESPONSE:

It has been found in the PRA Peer Reviews performed to date that there are gradations in PRAs in terms of level of detail, scope, degree of rigor, and completeness (model and documentation). The subtier criteria reflect those gradations. The differentiation in grades is frequently in the adequacy of the supporting documentation. This requires that the experience of the review team govern the assigned grade. This emphasizes the importance of the "consensus sessions" which are a key part of the Peer Review in which the combined experience of the team members is applied. Frequently, it is known that tasks were performed by the reviewed plant, but the supporting documentation is inadequate.

Questions 7 through 10 address the specific examples cited in the RAI and their implication for the PRA Peer Review.

QUESTION NO. 7:

AS-4: All three columns should state "Event trees SHALL reflect the initiating event groups." The difference among the three columns ought to be in the level of detail, i.e., the number of initiating event groups should increase from left to right.

RESPONSE:

In general, this is a good observation. In fact, Grades 3 and 4 do state this. Nearly all plants have met these Grade 3/4 criteria and few exceptions have been found. This is not surprising given the fundamental nature of the this PRA element. Examples of distinctions that have been made in previous peer reviews are:

- Some BWRs have assumed the failure of the main condenser as a heat sink for all initiators. This type of assumption conservatively overestimates the CDF, however, depending on the plant and its risk profile, it may be a sufficiently important bias in the model to receive a Grade 2 because of the potential bias it may cause in the risk evaluation.
- The premature truncation of sequences that are likely very low or negligible contributors (e.g., large LOCA with failure to scram in a BWR) was found to be sufficient reason to assign the Grade 2, but does not invalidate the PRA for a wide spectrum of possible applications including Maintenance Rule safety significance determination or for its use if these sequences play no role in a specific application.

QUESTION NO. 8:

AS-8: Again, all columns should require that event tree structure maintain and resolve the failure paths. The difference should be in what was meant by "reasonably complete". For example, the left-hand column could afford to be less complete than the right-hand column.

RESPONSE:

In general, this is a good observation. In fact, Grades 3 and 4 do state this. Nearly all plants have met these 3/4 criteria and few exceptions have been found. This is not surprising given the fundamental nature of the this PRA element. Examples of distinctions that have been made in previous peer reviews are:

- The failure of SRVs to open in an ATWS event has not been developed because of negligible core damage frequency. This should be developed since the potential consequences in the Level 2 PRA may not be negligible.

- The loss of main feedwater event tree indicates that loss of feedwater events followed by loss of PCS were transferred to the general transient tree. However, a review of the cutsets generated from the transient sequences could not locate any such cutsets. It appears that the transfer of these cutsets may not be effectively transferred.

- The sequence transfer process did not appear to be robust enough to ensure that all transfer sequences were actually transferred to the assigned tree. The transfer process in NUPRA is manual. There should be a documentation process to ensure that all transfers are completed. In a spot check of the first transfer, the reviewers could not find a tree to which the sequence was transferred. (Significance B, resulted in a "contingent 3" grade.)

- Consequential steam generator tube rupture (i.e., SGTR resulting from a transient that causes a large pressure differential across the steam generator tubes, such as steamline rupture or inadvertently opened and stuck secondary side relief or safety valve) is not modeled in the accident sequences. The possibility of this consequential event should be addressed in the PRA since it could be important to LERF. (Significance B, resulted in a "contingent 3" grade.)

QUESTION NO. 9:

AS-I0: Dependencies among top events SHALL always be identified and addressed. How the dependencies are addressed could vary across the columns.

RESPONSE:

The proper treatment of dependencies is a crucial aspect of the PRA and a major focus of the PRA Peer Review as reflected in the fact that dependencies are treated in their own element, DE--Table 5-10 of the subtier criteria, and have specific subelements in Accident Sequence evaluation, Data, Human Reliability Analysis, and Quantification.

The distinctions among grades are made in the type of analysis performed (qualitative versus quantitative), the level of detail in the evaluation, the traceability of the analysis, and the completeness.

Some areas where plants have not met these criteria are in:

- Those cases where a weak dependency or a low probability dependency may exist that does not appreciably affect the PRA. Examples include the following:
  - Increased BWR drywell temperature (but still within the peak EQ temperature) as it affects SRV survivability.
  - Common maintenance crews as they affect diverse systems' availability.
- Those cases where human error dependencies have not been treated adequately. This is generally considered in the HR and QU elements.
- Those cases where spatial dependencies in ISLOCA or internal flooding accident sequences have been treated with limited detail and rigor.

The subtier criteria have been revised based on the NRC observation to more accurately portray the approach that has been used in past PRA Peer Reviews.

QUESTION NO. 10:

AS-13: The two right-hand columns contain a good list of issues that deserve consideration in the structure of the event trees and the related success criteria. This list should apply to all grades; it is how well they are treated that differentiates the grades. For example, since AC power recovery has a relatively big impact on loss of offsite power sequences, this capability should be included if the PRA is to be used for risk-informed decision-making.

RESPONSE:

The Grade 3 column, generally related to risk-informed applications, has a high expectation that the items identified are addressed in the PRA. Therefore, AC power recovery is expected to be treated in a best estimate quantitative fashion. Nevertheless, there may be situations where a utility uses fewer time phases than may be considered desirable by the PRA Peer Review Team, or implements the treatment in a less desirable fashion. This, of course, may be a function of the importance of loss of offsite power in the PRA. Therefore, the PRA Peer Review Team evaluates "how well the issues are treated" as the distinguishing feature between Grades 3 and 4 recognizing its potential importance in the plant risk profile.

This same concept applies to other aspects of the model also:

- Recirculation Pump Seal LOCA (PWRs and some BWRs)
- The degree of credit given to extended battery life
- The number of time phases for BWR SBLC initiation
- The time frames for RPV or IC shell makeup for BWR Isolation Condenser plants
- Internal Flooding
- Loss of Service Water

QUESTION NO. 11:

Use of "May", "Should", and "Shall"

In some cases, the subtier criteria use "action statements- to distinguish among the 3 grading categories of risk-based, risk-informed. and risk ranking (for example, subelements IE-1, IE-2, and IE-8). These action statements clearly spell out steps needed for compliance to the criterion. However, in other cases, the Subtier Criteria use the terms "shall," should" and "may" to distinguish among the 3 categories. The use of "should' means that the subtier criteria are expected to be in place and would be in place unless there are compensating actions or documentation to support the deviations from the subtier criteria.

What criteria does the Peer Review process use for accepting compensating actions? Based on past experience using the Peer Review process, provide examples of accepted compensating actions and the reason for their acceptability.

RESPONSE:

NEI has added a section to the subtier criteria document describing the meaning and significance of the terms "shall," "should" and "may". The use of may has been significantly reduced in the latest version of these supplemental guidelines based on NRC input and to reflect the actual use of the criteria in past PRA Peer Reviews.

As noted in the RAI, the use of "should' means that the sub-tier criteria are strongly expected to be in place and would be in place unless there are compensating actions or documentation to support the deviations from the sub-tier criteria. The compensating actions are left to the judgment of the PRA peer review team.

The criterion used in the application of the compensatory measures is that the alternative measure produces a similar impact on the PRA, i.e., similar PRA results are to be expected for the Base PRA and for applications.

Examples include the following:

IE-1, IE-2, IE-3 The documentation of the initiating events may be included in calculation files, Excel spread sheets, data reviews, and other less formal files. If these sources can be provided with a traceable road map to allow future PRA analysts the ability to reconstruct the process and to update it, then sufficient compensating processes are deemed to be present to support the Grade 3 assignment.

IE-2 The consistency with proven approaches can be established either numerically, qualitatively, or by reference to accepted documents to support Grade 3.

IE-8 The event groupings should be based on reviews from industry and plant specific experience. These may be variations in the scope of such reviews along with the supporting documentation. The importance of any areas where reviews have not been performed, or are not documented, is part of the Peer Review Team assessment of a Grade 3 assignment.

AS-11 The documentation of dependencies is sometimes dispersed throughout the PRA documentation and in some cases is left to the model itself to document the treatment of dependencies, e.g., support system dependencies. This approach is generally less desirable than an explicit summary of the dependency treatment. Nevertheless, if the Peer Review Team can verify the treatment then a Grade 3 can be achieved.

AS-11 There may be some conservative biases that are introduced into the dependency treatment. This may include items such as failure of components if their EQ envelopes are violated. Despite the introduction of the non-realistic (conservative) assumption, the element can still achieve a Grade 3 as long as the conservatism is recognized in the documentation.

AS-15 The treatment of event tree transfers varies with software product and from utility to utility. The transfers among event trees are sometimes truncated if they fall below a predetermined truncation level. This is contrary to the AS-15 element which requires explicit treatment. However, if the PRA explicitly recognizes this treatment and applications that could modify this frequency or truncation level are identified, then the PRA is capable of supporting Grade 3.

TH-5 This criteria indicates that for BWRs NEDO-24708A should be used to confirm the success criteria. Alternatives that have been accepted by Peer Review Teams include: (1) SAFER GESTER calculations; (2) explicit comparisons with other BWRs; (3) RETRAN calculations.

There may also be compensatory actions that are taken by a utility to support specific applications. These compensatory actions may include:

- Justifying why specific features of a PRA may not be needed for a given specific application.
- Adding the required analysis to the base model.
- Others.

These application-specific actions and the Peer Review of them is not within the scope of the NEI 00-02 Guideline.

QUESTION NO. 12:

How will decision-makers in Option 2 applications be made aware of compensatory actions which could affect the categorization process?

RESPONSE:

There are two types of measures that may be referred to as compensating measures. These are:

- Those measures already in effect at the site to support the PRA and that have been evaluated by the PRA Peer Review Team in assigning the Grades
- Those measures that need to be put in place to achieve a Grade 3 or higher

It is this second type of compensatory action that is believed to be the focus of the question.

For those specific areas of the PRA that require compensatory measures to achieve the desired Grade for a specific application, a written description of how the PRA was changed or otherwise supported is necessary. The changes or supplemental justification must also be reviewed to confirm that they satisfiy the need as required for the specific application.

It is also expected that the IDP will include a representative of the PRA Group who has the knowledge to convey such insights. It is not expected that the other IDP members will be able to completely monitor all the aspects of the PRA.

QUESTION NO. 13:

The use of "may" implies that the subtier criterion could be part of the PRA, however, it is not required and could be absent without a documented basis.

> *When a criterion uses "may" without an alternative criterion, is the subtier criterion interpreted as not requiring anything in the PRA with regard to the subelement? If so, please provide a justification for why it is not necessary to address that subelement.*

RESPONSE:

Background

The use of "may" implies a mild expectation that the specified item be included in the PRA. However, failure to meet the expectation does not automatically result in failure to meet the Grade criteria. The expectations listed as "may" indicate that latitude in the model and documentation is considered allowed. In previous PRA Peer Reviews, the use of the word "may" has been interpreted by the veteran members of the Peer Review Team in the training on a consistent basis for use by the Team.

Changes

Because of the NRC staff concerns and the apparent misinterpretations that are associated with the use of the word "may," the subtier criteria have been modified to substantially restrict the use of the word "may" in the criteria. This change in wording is meant to eliminate the confusion with its use and to retain the meaning of the criteria as they have been applied in past PRA Peer Reviews.

The places where "may" is retained are generally in Grade 2 criteria. Grade 3 criteria are the ones that apply to the Option 2 implementation.

QUESTION NO. 14:

Documentation of the Peer Review Findings

When assigning grades to a subelement, and when the subelement criterion uses the terms, "may" and/or "should," the peer reviewer will have to use subjective determination in deciding whether there is conformance to the criterion. Thus, the grade of a subelement does not provide a clear characterization of the peer review analysis, but a potentially broad range of acceptability.

RESPONSE:

Background

The Peer Review process is focused on ensuring the PRA is of sufficient quality to be effectively used in applications. The Peer Review Teams are well aware that the credibility of PRAs and PRA results are crucial to the continuing acceptance and use of PRA. The Teams have a substantial incentive to make sure the PRA is capable of meeting the goals of applications that need certain Grade characteristics. The subjective nature of the Peer Review process is required because of the differences in the PRA assumptions and wide variations in the techniques used to satisfy the ultimate goals of the PRA. The fact that there is a spectrum of acceptability is considered a desirable attribute and one that is to be expected. This is discussed in more detail in NEI 00-02.

Use of "may"

As noted in the previous response, the use of the word "may" has been severely restricted in the revised subtier criteria in order to be responsive to the NRC concerns expressed with the potential for too much latitude in the judgement process. (See also Response to Question No. 13.)

Use of "should"

The criteria using the word "should" are ones that are strongly expected to be in place and would be in place unless compensating actions or documentation is in place to support differences. (See also Question No. 11 and its response.)

Summary

Detailed findings on a subelement basis (Fact and Observations (F&Os)) are developed for individual subelements to identify to the utility those areas of the PRA that could benefit from further enhancement. These F&Os are part of the Peer Review documentation and serve to clarify the bases for the subelement grade assignments. In addition, the element summary sheets are used to qualitatively address the key results of the Peer Review. These summary sheets provide a critical review of the subelements.

Therefore, the F&Os and the qualitative element summary forms document the basis for the assignment for Grade 2 subelements. The assignment of Grade 3 and the implementation of "should" criteria can generally be considered to incorporate all of the subelement criteria unless a specific F&O is provided describing the deviation.

QUESTION NO.15:

Furthermore, in some cases, there are identical requirements across the categories (i.e., there is no discrimination between grades). For example, see subelements IE-6, IE-11, AS-4, AS-6, AS-9, AS-17, AS-18, SY-11, HR-7, HR-8, HR-13, HR-24, HR-26, and QU-6. In these cases, the basis for the grading of a subelement is not obvious.

RESPONSE:

It should be noted that the subtier criteria include criteria for Grades 2, 3, and 4. In fact, there are distinctions made among the three Grade levels for the above subelements, for example - IE-6, IE-11, AS-4, AS-6, AS-9, AS-18, HR-8, HR-13, HR-24, and HR-26.

For many of the cited subelements, the criteria may be the same or similar for Grades 3 and 4. The distinctions made by the Peer Review Team between Grades 3 and 4 are based on:

- Level of detail in the modeling of the specific features
- Nature of the documentation describing the approach and implementation

Substantial detail and superior documentation will lead to Grade 4 assignments, while adequate modeling and documentation will lead to Grade 3. The updated PRA Peer Review Subtier Criteria [9] Document include further clarification related to distinctions among grades.

Applicability to Option 2 Evaluations

The implication of Grade 3 or 4 for Option 2 is not considered substantially different. Grade 3 is considered appropriate for Option 2. Therefore, meeting the minimum end of the spectrum or the maximum would qualify the PRA for use in Option 2 evaluations.

QUESTION NO. 16:

In some other cases, there is insufficient discussion of the technical quality to ensure an adequate analysis. There is insufficient discussion of acceptable treatments for given criteria. The criteria as written specify what is needed in general terms but not how this can be adequately accomplished. Statements using terms like "accepted Industry practice", "reasonable", "applied as appropriate", and "sufficiently well" allow for flexibility to the peer reviewers but make it difficult for a third party to have a clear idea of the quality and content of the PRA, unless the review provides a detailed report of assumptions and content. For example, subelement DA-4 requires that the "use of generic data should involve the use of reasonable generic data sources that represent recent nuclear power experience, if available." It leaves unstated what is meant by "involve" and how to determine if the data are "reasonable".

RESPONSE:

Peer Review Teams include PRA experts with extensive experience and the Teams have been consistent in their interpretations of the terms identified in the RAI.

The Peer Review process is one that makes use of the collective experience of the Team to implement the criteria in a way that allows the latitude required by the varying approaches to PRA modeling while at the same time implementing a uniform measure of the quality (i.e., a grade) that can be attributed to these analyses.

Generic data sources that are well documented and represent recent characterizations of the data are considered reasonable and acceptable. There are, of course, situations where generic data sources do not have the specific failure mode or component of interest. These cases result in using older data sources or Delphi data sources such as IEEE-500. The Peer Review Teams have not had any trouble interpreting the meaning of these terms without the need for a prescriptive database that is required to be used.

It is again noted that the subtier criteria represent a set of supplemental guidance to the Team and that the experience with past Peer Reviews is that a degree of latitude in the assessment of many PRA elements is desirable to adequately address the spectrum of approaches that are observed among different utilities.

QUESTION NO. 17:

Finally, the fourth paragraph of Section 2.2 of NEI 00-02 states "The applicability of specific criteria may vary from plant to plant." This does not appear to be an appropriate statement as the criteria should relate to goals, i.e., " what you want the PRA to achieve", which should be independent of method used. However, if the applicability of the criteria is to vary from plant to plant, proper documentation of the review findings is essential.

> *How does the peer review report provide adequate justification and documentation for a given grade assignment in cases where the subtier criteria do not provide a clear and objective basis for that grade? Your response should address how sufficient information is provided to the users of the PRA information, especially the IDP for Option 2 applications.*

RESPONSE:

The complete text of the NEI 00-02 is as follows:

> The applicability of specific criteria may vary from plant to plant. This variance results from the differences in the PRA techniques and models being evaluated, including the computer modeling methodology used at the plant. The applicability of specific criteria to the plant PRA being reviewed is determined by the peer review team through their consensus discussions.

The referenced words from the NEI 00-02 Guideline document refer only to the differences in plant modeling techniques (and plant specific features). The criteria that are applicable to a plant may vary because of the modeling differences. However, once the individual criteria are determined to apply, the these <u>applicable</u> criteria are applied consistently, and therefore, not in a manner where they vary from plant to plant.

Examples of cases where the applicability of criteria vary from plant to plant include the following:

Example Element	Cause of Varying Applicability
AS-12	The applicability of the RCP seal LOCA treatment varies with PWR, the potential for BWR recirculation pump leakage varies depending on whether the plant has an Isolation Condenser used for accident mitigation.
AS-17	The success criteria will vary with plant type. Therefore all categories of success criteria may not apply.
AS-21	Plant damage states may not be used as part of the methodology for transfer of information into Level 2. Therefore, this element would not be applicable.
TH-5	The reference to specific reference generic calculations may not be applicable to a specific plant. BWR calculations are not applicable to PWRs.
SY-12	Support system dependencies can be included in the model using a number of techniques. The specific evaluation performed by the Team is different depending on the techniques used.
QU-4	The software differences among PRA tools dictates different approaches to the details of the specific approach.
QU-5 QU-6 QU-7	The software package used, the features of the package used in the PRA, and the utility-specific approach taken dictate whether there is a simplified model whether that model is used, and whether it is of importance.
L2-17	The applicability of the hydrogen deflagration treatment is a function of the plant type.

QUESTION NO. 18:

Consistency with Revision 12 of the ASME PRA Standard

In some cases, the subtier criteria do not match the criteria in Revision 12 of the ASME PRA Standard. Furthermore, there are criteria in the Standard that are not addressed in the subtier criteria.

What is NEI's intent regarding the compatibility between the peer review guidelines and a consensus standard? Assuming the ASME standard will represent a consensus standard, provide an assessment of the impact of not having subtier criteria related to these ASME Standard criteria on the ability of the NEI Peer Review process to determine the quality of a PRA for Option 2 applications.

RESPONSE:

The NEI PRA Peer Review process has been implemented to provide effective feedback to utilities in their preparation for use of the PRA in risk-informed applications. These applications are occurring now and the PRA is being used now. There is not currently a PRA Standard. When the PRA Standard becomes available, the industry and NRC will need to establish a process to reconcile any areas where the two may differ.

It is anticipated that if there are differences between the ASME Standard and the NEI 00-02 that the utilities would be required, for Option 2 applications, to address the differences and justify the PRA in view of the requirements in the Standard. This justification could include:

- Writing the basis for compliance with the Standard for those subelements not part of the Peer Review.
- Provide a separate "mini-Peer Review" to verify the applicability of the Standard items in the PRA that were not covered in the NEI PRA Peer Review.

QUESTION NO. 19:

Many of the requirements in Revision 12 of the ASME Standard are reflected in the NEI peer review criteria. However, for some of these requirements, there are disagreements on the applicability for the different PRA application categories. For example, requirement AS-A9 in the ASME Standard requires that, for all applications, the relevant systems that support each critical safety function be included in the event sequence model. The associated NEI criterion AS-7 states that all relevant systems that support a safety function only have to be included for the Risk-Based (or Category III in the PRA Standard terminology) applications. Subtier criterion AS-10 provides a similar example.

For subelements where the NEI subtier criteria require less than the equivalent criteria in Revision 12 of the ASME PRA Standard for any application category provide, justification for why the lesser criteria are adequate for Option 2 applications.

RESPONSE:

ASME Standard

Because the ASME Standard is not currently published as a consensus standard, it would be premature to set out a detailed discussion of the differences between the NEI 00-02 Guidelines and a draft ASME Standard.

Treatment of AS-7

AS-7 is a supplemental criteria included in the Peer Review process to address whether excessive conservatisms have been introduced into the model. The NEI PRA Peer Review checklist does not include evaluation of Grade 1 or 2 PRAs relative to this criteria. The subtier criteria document has been updated to ensure consistency with NEI 00-02.

The purpose of this subelement is to ensure that the Risk Informing and Risk Based applications of the PRA have not excluded systems that can be shown to be effective in accident mitigation. This evaluation is performed by the Peer Review Team using their collective experience and comparisons with PRAs with which they are familiar, e.g., including NUREG-1150.

The degree to which all systems are incorporated into the PRA models varies with the potential for the system interplay with the model and their impact on success criteria. The determination of what is a relevant system is somewhat subjective and depends on:

- Does the system influence success criteria used in the PRA?
- Can a system by itself result in a system success?
- If so, is it always a success (i.e., the success is independent of the power level)?
- Can the success of the system be supported by available thermal hydraulic analysis?
- Is the system independent of non-safety power or controls that may not be available when required as backup?

If all questions are answered "Yes," then the system should be included in the PRA.

Examples of systems that have not been modeled, and which do not inappropriately bias the results of the PRAs include the following:

- DW Spray for DW temperature control (BWR)
- CRD for RPV injection during the early time phase (BWR)
- Condensate Demineralized water for RPV injection (BWR)
- CS suction from the CST (BWR)
- RWCU for containment heat removal (BWR)
- Containment Fan Coolers and Sprays (for some PWRs, where there are no significant system interaction / timing issues)
- Main Feedwater as backup to auxiliary/emergency feedwater (some PWRs)

QUESTION NO. 20:

"Overall" Grade Assignment for the PRA Technical Elements

Section 1.4 of NEI 00-02 indicates that a summary grade is provided for each of the eleven PRA technical elements addressed in the report based on the grades given to each subelement. Section 3.3 of the report also emphasizes that an overall PRA grade is not assigned in the NEI Peer Review process and that the strength of the process is in the grading of sub-elements which can be used by a utility as a means of focusing future PRA update activities.

> *In light of these statements, what is the intended purpose of this overall element grade? How will grades be used in Option 2 applications?*

RESPONSE:

The NEI "Option 2 Implementation Guideline," NEI 00-04, has been updated to describe how grades are to be used in the Option 2 process:

> The NEI 00-02 peer review provides several outputs which are useful in characterizing the quality of the PRA. The first output is a set of element grades, ranging from 1 to 4, which provide a consensus assessment by the peer review team of the usability of the PRA in applications. In the terms of the NEI 00-02 grading scheme, the Option 2 categorization process is a Grade 3 application. Thus, elements receiving a grade of 3 or 4 should be expected to be sufficient to support the categorization process. Elements receiving a grade of 1 or 2 should be reviewed by the PRA team to determine whether the PRA needs to be revised to address the peer review findings or if additional sensitivity studies are called for as part of the categorization process.
>
> The second important output of the NEI 00-02 peer review process are the Fact and Observations (F&Os) which document strengths and areas of potential improvement of the PRA. F&Os that identify areas of potential improvement are classified with an importance ranging from A to D, where A is most important and D is generally editorial. All F&Os in categories A and B should be reviewed and dispositioned by either:
>
> - Incorporating appropriate changes into the PRA model prior to use,
> - Identifying appropriate sensitivity studies to address the issue identified, or
> - Providing adequate justification for the original model.

The element grades are useful summaries of the PRA quality characterization. These summaries are meant to describe the adequacy of the element relative to types of risk-informed applications. A low element grade signifies a consistent problem or a serious issue with one or more critical subelements. A subelement failure to meet the required grade may adversely impact the specific application under consideration and therefore facts and observations of an "A" or "B" priority in critical subelements need to be resolved for the IDP.

Refer also to the Response to RAI Question No. 21 for additional discussion of the element grade.

QUESTION NO. 21:

The main text of NEI 00-02 does not provide any guidance for the assignment of an overall element grade. A review of Appendix C indicates there are two tables (C.7-5 and C.7-6) that are provided to assess an overall element grade. The text in Appendix C does not provide guidance on using these tables. From the tables, it appears that an average grade is calculated based on the grades for each sub-element. That average value is reported on both forms. It appears that this value is used by the review team to subjectively assign an overall grade. The assigned grade requires a consensus of the reviewers, but the form in Table C.7-6 also documents the lowest suggested grade.

Please provide a description of how the element grade is assigned. What criteria are used to ensure that the overall grades are evaluated consistently?

RESPONSE:

Background

It is noted that the motivations for the Peer Review process were manifold and include a desire by the industry to improve the overall quality of PRAs irrespective of the regulatory process. Therefore, some of the features of the process are to allow information to be transmitted to utility management in a concise (and hopefully

It is also convenient to discuss grades on an element basis.

Element Grade and Criteria

The PRA Peer Review Team compiles the grades by subelement. Then, the Team compiles a qualitative summary of the element based on both the grades for the applicable subelements and the Fact and Observations that apply to the element. The qualitative summary provides both the strengths and key enhancement opportunities. The Team, during a consensus session, assigns a Grade to characterize the overall capability of the element to support applications. The considerations for the Element Grade assignment include: (1) when all subelement grades are at the element grade or above, (2) cases where only a few subelements with limited impact on an application are affected, or (3) extreme cases where a few poor subelement grades are of sufficient concern to the Peer Review Team that the element itself has been downgraded. The following "criteria" have been compiled by observing the process. These have been included in the subtier criteria document as guidelines for future PRA Peer Review Teams:

- Assign Grade 4 if essentially all subelements are at the Grade 4 level.
- Assign Grade 3 if all subelements are at Grade 3 or higher.
- Assign Grade 3 if all subelements that could materially impact applications are at Grade 3 or higher. This is based on the Team consensus judgement.
- Assign Grade 1 to the element if there are more than one critical subelement that is graded at the Grade 1 level.
- Assign Grade 2 if subelements that may substantially affect an application are graded at the 2 Grade level.
- Assign an NA to an element that has insufficient support to provide useful input into an application.

It is the judgement of each of the Owners' Groups that these "criteria" were applied in a Team consensus fashion at past Peer Reviews. It is also judged to be prudent for future reference that these criteria be written clearly so that future Peer Review Teams have them to rely upon.

Table 21-1

FACTS AND OBSERVATIONS LEVEL OF SIGNIFICANCE

Significance Level	Definition
A.	Extremely important and necessary to address to assure the technical adequacy of the PRA or the quality of the PRA or the quality of the PRA update process. (Consensus Item for Peer Review.)
B.	Important and necessary to address, but may be deferred until the next PRA update.
C.	Marginal importance, but considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry.
D.	Editorial or Minor Technical Item, left to the discretion of the host utility.
S.	Considered to be a major strength of a PRA that exhibits industry leadership and a good practice to be followed for PRA applications.

QUESTION NO. 22:

Additional Examples and Comments

Table IE and Table 5-1, Initiating Event Analysis

> *There are criteria to address initiating event identification, grouping and documentation.*
>
> *However, a screening criterion is not provided. How does the Peer Review process address the acceptability of initiating event screening in a PRA?*

RESPONSE:

Initiating events are approached by identifying those initiators that should be included in the assessment. The subelements that are used to address the identification of initiators include the following:

- Support system initiators (IE-5, IE-10, IE-17)
- Multi-unit site initiator (IE-6)
- Transients, LOCAs (IE-7)
- Special Initiators (IE-7)
- Internal Flooding (IE-7)
- All experienced initiators (IE-8)
- Initiators included in PSA Studies (e.g., NUREG-1150) (IE-9)
- Treatment of subsumed initiating events (IE-11, IE-12)

The expectation is that all of these aspects of the initiating event analysis will be addressed. An explicit definition of initiating event screening criteria has been included in the revised subtier criteria. The screening method is akin to that included in the ASME PRA Standard (DRAFT 11) and is typical of what has been used in past PRA Peer Reviews. The impacts on mitigation systems, phenomena, or LERF that could influence whether the initiating event should be considered are the primary effects to be considered along with the frequency of the event.

QUESTION NO. 23:

IE-12: For a Grade 2 PRA (risk ranking prioritization), there appears to be an inconsistency between the requirements in the check list and the subtier criteria for this subelement.

RESPONSE:

Agreed. The PWR review of the subtier criteria also identified this inconsistency. The subtier criteria have been revised to be consistent with the NEI 00-02 Guideline checklist which is the governing document.

No impact on past Peer Reviews has occurred because the Guideline checklists remain the document of record to be referenced by the Peer Review Team.

QUESTION NO. 24:

Table AS and Table 5-2, Accident Sequence Evaluation

AS-5: Footnote 6 states that the peer review does not have as a primary objective to confirm that the model corresponds to the as-built plant. Any review along this line occurs as a secondary result of other peer review efforts. However, the subtier criterion for AS-5 states that the models and the analysis should/shall be consistent with the as-built plant. How does the Peer Review process determine the fidelity of the model in light of the fact that it is not a primary objective of the review?

RESPONSE:

Reliance for establishing the fidelity of the as-built, as-operated plant is placed on the utility's process for the control of inputs into the analysis. This includes the desire for System Engineer review of the System Notebooks, operations review of the operator errors and the accident sequences, and an independent review of the PRA.

This is primarily a process question for the individual utility. The process that is in place should be capable of maintaining the fidelity of the model with the as-built, as-operated plant.

Nevertheless, as part of the Peer Review process, the Peer Review Team examines multiple PRA documents and supporting design basis documentation. The Team may also walk down the plant for additional insights. All of these activities interface with characterizations of the plant design and operation. When differences are identified between the model and the as-built, as-operated plant, these differences are identified as part of the Peer Review.

The nature of the Peer Review process results in examining the PRA model and its technical basis. Therefore, the Peer Review Team has a reasonable "slice" through the model to form a judgment regarding the utility process and the specifics as they relate to assuring model fidelity. Some examples of areas that have been identified in past Peer Reviews include the following:

- The evaluation of the successful external water injection without containment heat removal requires the assessment of the EOP directions on use of external water injection when above MPCWLL (BWRs).

- DC Load Shed/Battery Life

  A review of the battery life calculation was performed to conclude that the time available under SBO conditions was assessed realistically. Several observations are made:

  - The batteries have been replaced.

  - There appears to be a question of whether the battery load cycle accounts for SBO conditions and repeated diesel start attempts.

  - The battery calculation concludes that use of the batteries to support 8 hours of operation is feasible.

  The SBO evaluation has indicated the battery life to be 14 hours if load shedding on batteries occurs. This is characteristic of the previous batteries.

  It would appear that a time phase of 4 to 8 hours would be more appropriate to consider than 14 hours for SBO situations or situations dependent solely on batteries. This is based primarily on the assertion that multiple D/G start attempts will cause battery depletion.

  A calculational basis for the battery useful time and its impact on model time phases should be developed.

- The following items were identified as potential significant discrepancies between the model and the needed documentation to support these model assertions:

  a) The first AC recovery question is at 2 hours, indicating surviving without injection (on certain sequences) for 2 hours is acceptable. AC recovery at 30 min. should be included.

b) Mismatch of HPCI/RCIC mission time of 5 hours vs. the 14 hour battery life.

c) Failure modes of HPCI or RCIC that occur beyond 5-8 hours are not accounted for:

- RPV depressurization on Heat Capacity Temperature Limit (HCTL)
- RCIC back pressure trip
- Torus temperature above 240°F
- Drywell temperature
- Premature battery depletion
- Failure to transfer load from A Div. (RCIC) to B. Div. (HPCI)

- Credit for Condensate Storage Tank (CST) inventory not well documented. Cannot validate.

  Improve documentation to demonstrate CST inventory availability assumptions are consistent with as-built plant and analysis.

- The Anticipated Transient Without Scram (ATWS) event trees appear to have some issues that may be in conflict with the Emergency Operating Procedures (EOPs). These include the following:

  - High Pressure Core Spray (HPCS) is considered a successful injection source as a first choice and at high RPV pressure. The EOPs do not cite HPCS to be used in ATWS as among "first choice" systems. Depressurization to use LPCI would occur first along with the requirement to use LPCI.

  - SSW is listed as a potential injection system. This system is not included in the EOPs.

  Remove systems from the analysis that are not allowed by the EOPs or place them in their proper chronological order.

- Basis for Control Rod Drive (CRD) pump success is not documented. Thermal hydraulic analysis to support successful core cooling with two CRD pumps is not provided. Success criteria are currently based on the reference to a generic study that is not considered applicable by the Peer Review Team.

Document applicable plant specific references for the basis of success criteria;

OR

Eliminate CRD success when it alone is the only injection source from time of transient initiation, e.g., LOOP or LOFW.

<u>OR</u>

Substantiate the success criteria through actual flow measurement with two CRD pumps using the available procedure. Also, verify the other operator actions associated with this action, i.e., is this a simple action of just turning on one switch. Ensure any analytic calculations use the time required to align all aspects of the system to achieve the measured flow.

- In the discussion and calculation of CST capacity to provide AFW for the 24-hour mission time, a simplified "conservative" approach is taken, which concludes that there could be conditions in which CST capacity would only be sufficient for 20 hours instead of 24 hours. The discussion then goes on to rationalize why there really would be sufficient capacity in most cases, and even if there weren't, there are other alternatives available to the operators to align water sources. It would appear to be more appropriate, and clearer, to perform a more realistic calculation, on an event-specific basis if necessary, to definitively decide that the CST capacity is either adequate or inadequate, and, if inadequate, what the specific alternatives are that should be considered in the model

- The individual HRA calculation sheets discuss the success criteria and timing analysis. In some cases a plant specific analysis is referenced for timing. In others reference is made to the Event Tree Notebook for timing. (Table A-2 of the Event Tree Notebook lists the OG emergency procedure reference document as the basis for the operator action but its is not clear that the resulting time window is plant specific.) And in still other cases a value for the available time window is assumed with no reference to its basis.

  The available time window values checked in this review seem reasonable but they are an important PSF in the CBDT and THERP methodologies used to quantify the HEPs, and should be determined with plant specific analyses to minimize the HEP uncertainty.

  Provide or reference plant specific timing information calculations in section 3 of the individual HRA calculation sheets or in Table A-2 of the Event Tree Notebook.

- The system models contain summaries of each revision indicating which design changes have been incorporated. Also, the event sequence diagrams have been reviewed within the PRA group to verify that they are still accurate. However, system engineer review of the models is needed to confirm as-built, as-operated conditions. This is a win-win proposition because the quality of the PRA is enhanced and the PRA knowledge of the plant staff is increased. Develop a process to obtain system engineer review on a regular basis.

QUESTION NO. 25:

Table AS and Table 5-2, Accident Sequence Evaluation

AS-7 indicates that all relevant systems for each function may, should, or shall be credited for PRAs used in Risk Ranking, Risk-Informed, and Risk-Based applications, respectively. If all relevant systems do not have to be modeled for a Risk-Ranking application, the results may be overly conservative and result in skewed rankings of SSCs. How does the NEI Peer Review process determine when modeling is too conservative?

RESPONSE:

AS-7 is a supplemental criteria included in the Peer Review process to address whether excessive conservatisms have been introduced into the model. The NEI PRA Peer Review checklist does not include evaluation of Grade 1 or 2 PRAs relative to this criteria. The subtier criteria document has been updated to ensure consistency with NEI 00-02.

The purpose of this subelement is to ensure that for risk-informed and risk-based applications the PRA has not excluded systems that can be shown to be effective in accident mitigation. This evaluation is performed by the Peer Review Team using their collective experience and comparisons with PSAs with which they are familiar, e.g., including NUREG-1150.

The determination of what are the relevant systems to be modeled in the PRA is an interactive process that builds on the industry's collective experience with PRAs. The following guidance has been added to the subtier criteria.

The principal issues related to the determination of a relevant system are:

- Does the system influence success criteria used in the PRA?
- Can a system by itself result in a system success?

- If so, is it always a success (i.e., the success is independent of the power level)?
- Can the success of the system be supported by available thermal hydraulic analysis?
- Is the system independent of non-safety power or controls that may not be available when required as backup?

If all questions are answered "YES," then the system should be included in the PRA.

Examples of systems that have not been modeled, and which do not inappropriately bias the results of the PRAs include the following:

- DW Spray for DW temperature control (BWR)
- CRD for RPV injection during the early time phase (BWR)
- Condensate Demineralized water for RPV injection (BWR)
- CS suction from the CST (BWR)
- RWCU for containment heat removal (BWR)
- Containment Fan Coolers and Sprays (for some PWRs, where there are no significant system interaction/timing issues)
- Main Feedwater as backup to auxiliary/emergency feedwater (some PWRs)

QUESTION NO. 26:

Table AS and Table 5-2, Accident Sequence Evaluation

AS-13 does not require a time phased evaluation of SBO accidents for either a Risk-Ranking or Risk-Informed application. Since SBO accidents are typically dominant accident scenarios and their importance are affected by time phased events, how does excluding this time behavior in the models not significantly impact the results of a PRA?

RESPONSE:

It is the clear intent of the subtier criteria to examine the model for its use of time phased accident sequence evaluation for SBO accidents. The subtier criteria state that time phased approaches "should" or "shall" be addressed for LOOP/SBO events. This is considered the appropriate guidance for risk-informed and risk-based PRAs, respectively. No specific subtier criteria are assigned to the risk-ranking application level, i.e., Grade 2.

While SBO accident sequences are typically among the dominant accident sequences, they are not always. Therefore, an absolute requirement to perform a time phased approach for Grade 2 or Grade 3 applications is not considered appropriate.

The use of the word "should" for risk-informed applications has previously been discussed to indicate that it is a clear expectation and that deviations from such criteria need strong justifications. Some plants are not sensitive to the AC power recovery treatment because of the redundancy in offsite and on-site AC power resources. For these plants, a time phased approach may not be necessary, and realistic CDF/LERF estimates could be obtained without such modeling and without introducing significant bias in the result. Therefore, the desire for flexibility in the modeling process is desirable to maintain.

The subtier criteria are provided to supplement the more general subelement criteria. The supplemental information and guidance are provided to emphasize the types of accident scenarios that could be influenced by incorporation of time phasing. (It is obvious that all sequences could be modeled as time phased sequences if sufficient resources were available.) The Peer Review Team has as its task to discern whether there are dominant sequences included in the model, that otherwise could be eliminated if appropriate recoveries in a time phased approach were included. If such sequences are not significant contributors, whether or not a time phased approach is used, then "requiring" a time phased analysis is not considered appropriate.

The subtier criteria are generalized to address any sequence that might allow the clear delineation of time phases and that may afford reasonable methods for successful recovery (or are required for adequate assessment of plant conditions).
Time phased approaches could be considered for any or all of the following:

- SBO sequences to examine AC power recovery, effects of battery depletion, adverse containment conditions and system operation.
- LOOP sequences to examine offsite AC power recovery.
- Loss of DHR sequences where late repair and recovery actions could alter the determination of core damage or LERF.
- Loss of Service Water where substantial time may be available for recovery and degraded plant conditions may accelerate the time to core damage.
- ATWS accident sequences in BWRs.

For Grade 1 and 2 applications, the failure to include a time phased approach may result in a conservative bias for these accident sequences. However, there are a number of constraints and expectations on the utility PRA calculations that restrict the degree of conservatisms that would be tolerated. These constraints include NRC oversight, utility management expectations, and INPO risk insight reviews. The result of these outside influences are to lead to controlling conservatisms within a narrow range of "accepted" practices. Therefore, while conservatisms are generally undesirable, risk ranking applications are still considered appropriate even though some conservatisims may be present.

QUESTION NO. 27:

<u>Table AS and Table 5-2, Accident Sequence Evaluation</u>

AS-18: The requirements for the subtier criteria are described as "consistent with generic and realistic analyses but may be conservative" "based on realistic thermal hydraulic analyses," and "reflect realistic plant specific thermal hydraulic analyses" for Risk Ranking, Risk Significance, and Risk Input as Sole Basis Subtier Criteria, respectively. The requirements for subelements TH-4 through TH-7 of Table 5-3 (Success Criteria and Thermal Hydraulic Analysis) are different for similar grades. Since both AS-18 and TH-4 through TH- 7 deal with the same issues, consistent terminology and requirements should be used to avoid confusion.

RESPONSE:

Part of the Peer Review Process is to examine certain critical aspects of the PRA from different perspectives to provide a more complete assessment of those aspects. AS-18 is a subelement to ensure that the success criteria formulated for the accident sequence evaluations is based on thermal hydraulic analyses with a specified pedigree.

As noted in the subtier criteria for AS-18, the TH (Thermal Hydraulic) subelements have criteria to evaluate the support for the thermal hydraulic analyses, their models and their inputs, i.e., their technical bases.

The specific subelements cited were reviewed and the criteria included were determined to be appropriate as written. The distinctions between AS-18 and the Thermal Hydraulic Analysis (TH) are cited in the NEI 00-02 tables. Therefore, no further changes in the NEI 00-02 criteria were deemed necessary. However, based on the NRC comments, changes to the subtier criteria have been made to clarify the various Grade levels assigned to different Thermal Hydraulic support pedigrees.

These are reflected in the following grading scale for the related subelements:

Subelement	Grade			
	1	2	3	4
Generic	X	X		
Conservative	X	X		
Plant-specific		X	X	X
Realistic			X	X

QUESTION NO. 28:

Table TH and Table 5-3, Success Criteria and Thermal Hydraulic Analysis

TH-4 distinguishes between generic and best-estimate plant specific analyses for different PRA grades. TH-5, 6 and 7 discuss the use of generic and plant specific best estimate calculations, and their combinations, applicable for all grades. Please clarify the appropriate use of generic and plant-specific best-estimate calculations for the different PRA grades. In addition, MAAP, RETRAN and SAFER-GESTER are listed as examples of acceptable codes. What criteria are used to judge that the appropriate verification and validation of the codes have been performed for this use?

RESPONSE:

Clarification

Based on the NRC comment, the subtier criteria were reviewed to ensure that they are appropriate. Clarifications in the subtier criteria have been included in the revised subtier criteria to more closely match the previous application of the PRA Peer Review process on BWRs and PWRs. These clarifications are believed to address the identified need for clarification. (See response to question No. 27.)

Verification and Validation

The PRA Peer Review process has not identified a criteria for the verification and validation of codes. This is a utility-specific process task.

The PRA Peer Review process examines the utility process, comparisons with other similar plant results and identifies any deficiencies in the process or in specific applications of the process that are revealed by the Peer Review. Some examples include the following:

- The technical basis for the success criteria used for sequences using only CRD injection could not be identified. A plant-specific analysis (possibly including a test) is believed to be required to establish whether adequate CRD flow is available.

Remove CRD credit as the sole injection source for successful core damage prevention unless plant-specific calculations consistent with procedures are available to support.

- Reliance on plant specific analysis should include consideration of whether the code is capable of providing the necessary information. For example, two items are believed not to be well modeled using MARCH or BWRSAR:

  a) The need for RPT to prevent reactivity and pressure excursion in the RPV within the initial 20 seconds of an ATWS.

  b) The ability of a DBA LOCA to be mitigated in the short term (71 min.) by operation of condensate.

- RPT success criteria are not defined with any reference. The specific short term issue is the RPV pressure response given a failure to scram. It is generally found that a computer code such as REDY or ODYN will yield pressure responses of approximately 1600 psig or higher within 9 seconds if RPT fails. This pressure is above the assumed RPV pressure success criteria in the PRA documentation.

  It is also observed that from previous GE analyses using REDY, even a failure of a single recirculation pump to trip will cause the RPV pressure to exceed service Level C & D.

- Available calculations provide some indication that Fire Protection System (FPS) may be adequate to provide makeup on a long term basis. However, the calcs. do not reflect the following:

  - Coincident LOCA conditions

  - Emergency depressurization at Minimum Steam Cooling Water Level (MSCWL) with all SRVs

  - Availability of only a single SRV at MSCWL

Each of these cases presents a unique challenge to the FPS to supply flow. A dynamic calc. such as MAAP could provide the results for these cases. Barring this, it is judgment whether FPS is adequate for the above cases.

- The use of the FPS for successful mitigation is not referenced to a specific calculation and it is applied in the Success Criteria table to different cases such as:

  - Transient
  - Small LOCA

  The technical basis for the assigned success of the FPS is required to use it as part of the PRA success criteria.

- The technical basis for the definition of core damage as 2 feet above BAF does not appear in the documentation reviewed by the Certification Team. The definition is not directly correlated with the technical basis provided generically in BWROG documents.

- Time to key events (e.g., core damage) or operator action levels (e.g., emergency blowdown directive) are important inputs to a quality PSA. Realistic thermal hydraulic calculations to support these timing estimates should be used in the HRA evaluations. This connection between realistic thermal hydraulic calculations and HRA timing estimates could not be verified by the Team during the visit.

  The BWR LTAS calculation provided had a number of inconsistencies that could not be explained and were not supportive of the HRA timing.

- Thermal hydraulic calculations are not available to support success criteria for core cooling with Suppression Pool Cooling and Cleanup system, Fire Protection Water injection and Service water system cross tie.

  These calculations or a comparative assessment regarding the adequacy of the pumps to supply sufficient head to overcome friction and elevation differences are desirable to support success criteria.

- The assessment of thermal hydraulic analysis results sensitivity to MAAP parameter variability is a positive feature of the analysis.

BWRs have available a BWROG report using the SAFE code which calculated the core response under a wide spectrum of accidents and for each of the product lines. This generic analysis is one of the appropriate methods for the use of generic analysis, if the inputs can be considered representative of the specific plant under consideration.

MAAP is a tool used by a substantial number of utilities to support the PRA process. MAAP has undergone extensive scrutiny including:

- NRC sponsored review by Brookhaven National Laboratory (J.A. Valente and J. W. Wang, MAAP 3.0B Code Evaluation, FIN L-1499, October 1992)
- GKA - SLI Thermal Hydraulic Qualifications (EPRI TR-100743, June 1992)
- GKA Uncertainty Approach - Critical Parameters for Sensitivity (EPRI TR-100167)
- Benchmarks documented in MAAP 3B Manual (EPRI-NP-7071-CCML, November 1990)
  - Code to code
  - Code to experiment

These efforts are believed to have resulted in a code that is adequate when used on a plant specific basis for analyzing, selected success criteria. However, MAAP has limitations which must be addressed in the PRA -- e.g., MAAP cannot accurately calculate the RPV power-pressure response following a BWR-ATWS. Therefore, the PRA success criteria basis needs to cite the reference calculation to support the success criteria. Reviewers have consistently commented when there is an inappropriate use of the MAAP code during peer reviews performed to date. Examples of comments include:

QUESTION NO. 29:

Table SY and Table 5-4, Systems Analysis

It does not appear that guidance is provided for the elimination of components, component failure modes, and support systems from systems models? What are the screening criteria used in the Peer Review process?

RESPONSE:

There are no screening criteria in the systems analysis for the elimination of components, component failure modes, and support systems.

The Peer Review Team has extensive PRA experience and is familiar with the level of detail that is desirable in a PRA. The Peer Review Team is guided to look at a number of specific model features to assess model scope, degree of rigor, and level of detail. It is expected that the following criteria are more than adequate to address the breadth and depth of the base system models:

SY-6: Major Components, "black box"

SY-7: Passive Components

SY-8: Failure modes

SY-10: Failure modes

SY-11: Failure modes

SY-12: Support System Requirements

SY-13: Support System Requirements

SY-15: Failure modes

SY-16: Failure modes

SY-23: Failure modes

QUESTION NO. 30:

Table DA and Table 5-5. Data Analysis

DA-4: The requirement for risk-informed decisions only suggests "some limited plant-specific data" and ties the requirement to "specific risk informed applications." How does the peer review team determine the extent of plant-specific data required absent knowledge of the specific applications? How much plant-specific data is required for RIP-50 Option 2 applications?

RESPONSE:

Plant specific data incorporation into the PRA has been an emphasis of the Peer Review Teams. The desire is to have the PRA as reflective of the plant operation and its SSC reliabilities as necessary to accurately portray the risk.

The subtier criteria have been modified slightly and the specific words cited in the question are no longer part of the guidance provided in the subtier criteria.

The number of components that should have plant specific data input has not been defined. The reviews look for the technical basis for this selection. In the Fact and Observation forms, it is often recommended to consider the use of the best available plant specific data for components that have relatively high Fussell-Vesely values. This is generally found to be major pumps, valves, diesels, turbine driven systems. It has not included relays, contacts, solid state devices. In addition, it is well known that the collection of plant specific data on low failure rate items (control rods, safety valves, etc.) is not very fruitful unless failures have been observed.

Finally, the use of plant specific data five or more years old may not be reflective of current plant operation. Therefore, the expenditure of excessive resources to gather, analyze, and manipulate "old" plant specific data may be of questionable benefit. As a result, the Peer Review Teams have noted that the Maintenance Rule data can provide a valuable resource that is both current and readily available. In some reviews, it has been noted that plants have included more than 25 years of plant specific evidence in their data analysis without any consideration or evidence that temporal trends in the equipment performance have been examined. In such cases, some negative findings in the form of Fact and Observations would occur. In addition, the grading of the cited subelement would be unfavorably impacted in comparison with cases in which five years of data are included. The key point is that the PRA quality is not proportional to the quantity of plant specific data. The use of many years of plant specific data has the downside of including information that may not be relevant to current plant maintenance practices and equipment performance.

The degree to which plant specific data is required to support Option 2 is strongly dependent on the function being analyzed and the degree of participation of the SSC in the safety significance determination.

Attachment 2 to SECY-00-164 summarizes in a lucid fashion the fact that the specific application will determine the appropriateness of the plant specific data collection. As an example, if SGTS is a system determined currently to be safety related and its risk significance in the PRA is to be used to assess whether it can be moved to RISC-3, then it can be argued that the PRA significance (based on all BWRs reviewed to date) does not require any plant specific data for the safety significance determination.

QUESTION NO. 31:

Table DA and Table 5-5. Data Analysis

DA-8: An "up-to-date" data source is suggested for CCF data. There are no criteria for the quality of the data source. If nonstandard data bases are used, is additional review of those data required?

RESPONSE:

Requiring specific data sources and specific methods has been avoided in the checklists and subtier criteria to avoid paralyzing the PRA technology as the state of the technology continues to improve.

The Peer Review Team has consistently noted that the NRC sponsored common cause database is the latest, and best available common cause data source. Use of this data is suggested by the Peer Review Team. However, the individual utility can still make use of other data sources or can justify not using the NRC sponsored research. A justification, including comparative studies, and sensitivity studies would likely be desired to justify other data sources for Grades 3 or 4. The degree to which such deviations may influence the PRA are subject to the differences in specific component failure probabilities and the individual PRAs risk profile.

QUESTION NO. 32:

Table DA and Table 5-5. Data Analysis

DA-15: The subtier criterion states that "AC recovery may/should/shall be based on available and applicable data." It is not apparent what else could be used in place of available and applicable data.

RESPONSE:

The treatment of AC Power recovery varies substantially among plants. The DA-15 criterion is to identify that the Peer Review Team should specifically examine how the individual utility has treated this sensitive area. Examples of the variation in treatment have included the following:

- Use of analytic curves derived by the NRC on a generic basis. (NUREG 1032)
- Use of all offsite AC recovery data (including data points that could be considered atypical for the region).
- Use of region specific data.
- Use of out-of-date data reports.
- Discarding data points using arguments that varied in quality from supportive to incorrect.

To cover all these eventualities, a broad request to the Team is made to check the derivation of the AC power recovery data used.

Examples of related Fact and Observations (F&O) that have been formulated for individual plants during the peer review process may help to elucidate the application of these criteria:

- <u>No AC recovery was included.</u> This received a "B" F&O and resulted in contributing to a subelement Grade of 1 for this subelement.

- <u>Treatment of AC Recovery.</u> A "B" level significance was assigned based on the following:

  There are two issues related to the offsite power recovery assessment:

  1. The elimination of LOOP events for nonapplicability to xxxx is questioned for the following:

     - Icing and heavy wind-related failures of transmission lines
     - Hurricane effects.

     The editing of the data must be justified to allow the elimination of the stated data occurrences.

  2. The mathematical curve-fitting that is used in the estimation of the nonrecovery curve results in extremely low nonrecovery at times greater than 10 hours.

     - 1E-3 at 10
     - 5E-5 at 24 hours

     This despite the existence of:

     - A 19 hour data point
     - A 130 hour data point
     - One 11 hour data point that has the potential for inclusion
     - Grid related failure data point at 6.5 hours
     - Plant related data point at 7.5 & 6 hours

  Using a very crude estimate of the cumulative nonrecovery probability one can obtain the following assuming approximately 68 events with durations evaluated:

Time Duration	No. of Events With Duration or Greater	Approximate Cumulative Probability	RBS Curve
6 Hours	6	.088	8E-3
10 Hours	3	.044	1.8E-3
24 Hours	1	.014	5E-5

- Data

  Subsequent to the Certification visit, it is noted that a tornado at Davis-Besse created a long term loss of offsite power event that would also indicate that events of greater than 24 hours are difficult to discount.

- Methodology

  The Peer Review Guidelines NEI 00-02 does reference NUREG-1032 for the purpose of conceptually addressing plant centered, grid centered, and severe weather related loss of offsite power events. However, the curve fit technique is not considered a correct or viable technique as used in NUREG-1032. Therefore, the curve fit process is explicitly considered questionable and would need justification to support its use in representing recoveries at 20-30 hours.

QUESTION NO. 33:

Table DA and Table 5-5. Data Analysis

DA-15: The subtier criteria on repair and recovery deal with modeling, rather than data to support such modeling. Also, since these "unique...items" call for special consideration, then some details in the criteria are called for, but few are provided. How is the basis for the grading of this subelement documented?

RESPONSE:

Repair and recovery modeling in PRAs is still an evolving methodology. The techniques and data used have not reached a stage that can be considered mature. Therefore, specific criteria to sanction still immature approaches are not considered appropriate.

In general, very little data has been found in any of the PSAs reviewed that would support a definitive criteria.

QUESTION NO. 34:

Table HA and Table 5-6, Human Reliability Analysis

Shouldn't the subelement criteria HR-5, HR-9, and HR-26 and all subelement criteria that relate to the application of systematic processes be required (i.e., SHALL) for all grades? This question is broader in scope than the HRA element, but is included here as an example.

RESPONSE:

General Overview

As noted previously, the distinctions across Grade levels associated with the interpretation of descriptions such as "systematic process" relates to the scope, degree of rigor, and the documentation of the process. Therefore, while similar words are used, the expectations for Grade 4 systematic processes are substantially higher than would be expected for Grade 1 or 2 processes.

Applicability to HRA: HR-5, HR-9

A systematic process is always a desirable feature of any endeavor. The words "systematic process" are used in the two specific criteria, HR-5 and HR-9, because of the difficulty generally encountered with assuring a reasonably complete set of operator actions for inclusion in the PRA. The process used to identify operator actions for inclusion in PRA models (HR-5, HR-9) is a difficult one and one that usually involves a number of iterations and in the past has been subject to lack of a systematic approach.

Specific Grade Expectations

Grade 4: The use of a systematic process for HR-5 and HR-9 shall be included for a Grade 4 application. Such a systematic process shall include:

- Extensive documentation
- A potentially resource intensive method (see below).

A comprehensive and systematic process is one that includes the following steps:

Step 1: Methodically review the critical safety functions and the procedures used as part of the safety function implementation;

Step 2: Quantitatively assess the model to identify additional actions that could prove to be necessary to reduce dominant accident sequences;

Step 3: Discuss the operator actions with training and operating crews to validate the set of actions;

Step 4: Observe simulator evaluations.

Step 5: Continue at Step 1 now recognizing the "important" accident sequences and with the mission of identifying and quantifying critical operator actions that can be legitimately credited for the accident sequences.

This iteration may continue more than once.

Grade 3: The level of detail, degree of rigor, and the precise method may, however, vary and still achieve a Grade 3. The process would still be considered a systematic process.

Grade 2: Finally, Grade 2 applications may have a systematic process that lacks the rigor, level of detail, and number of iterations that are expected for Grade 3 and 4 applications. An example of the least resource intensive process for these criteria is the identification of those operator actions previously identified by the NRC or industry for similar plants. This approach builds on the experience of the industry and with high likelihood covers the dominant contributors of the operator actions to the risk profile. This qualifies as a systematic process. Other approaches will tend to be much more resource intensive and iterative in nature.

Therefore, the distinction among grade levels is in the comprehensiveness and level of detail that is part of the process.

<u>Applicability</u>

In general, the processes employed in the PRA are expected to be systematic. In the criteria of NEI 00-02, the word "systematic" has not been used extensively, i.e., it could be used for nearly every subelement. However, it is generally understood and appreciated that the distinctions that are drawn among Grade levels are due to scope, degree of rigor, and documentation all of which could be construed as gradations within a systematic process.

QUESTION NO. 35:

Table HA and Table 5-6, Human Reliability Analysis

HR-18: This criterion indicates that the performance shaping factor for the time available for an action and the time required to take an action do not have to be developed for either Risk-Ranking and Risk-Informed applications. Provide examples of what the Peer Review process would accept in place of this plant-specific information.

RESPONSE:

Refer to HR-19 and HR-20 for additional guidance on the treatment of these performance shaping factors. The Grade 3 subtier criteria states that "The performance shaping factor for time available for an action and the time required to take an action should be developed on a plant specific basis." Therefore, there is a strong expectation that there is a plant specific basis to support each of these times for the evaluated post initiator HEPs.

For Grade 3 applications, the time available to take an action could be computed using generic models or could be based on estimates of time available for similar plants if it can be shown that the plant responses and timings are expected to be similar. In any case, these estimates need to be justified to be reasonable replacements for the plant specific analysis.

Examples of Fact & Observations found in implementing these subtier criteria include the following:

- Allowable Times

  The PSA includes a local manual action to allow opening LPCI injection valves after they fail to open automatically or remotely. However, all allowable times used for NR-MANVLV derivations appear to be too long. The cue for this action appears to assume it is at t = 0 or the initiator. In fact, the cue to begin this action is when the injection valves do not open as RPV pressure drops below 450 psig. Then, and only then, will the time clock for this action begin for the diagnosis and manipulation clock.

- The Job Performance Measure (JPM) and testing performed on some of the local reactor building actions involve walkthroughs of the procedure steps but not the actual manual opening and closing of valves. This observation is applicable to:

  - LPCI injection valves are not manual stroked

  - FPS backup to ESW for the Diesels

  - FPS backup to the RHRSW for Hx cooling

  Because of this, there needs to be a conditional probability that the manual action cannot physically be performed. This could be related to crud buildup or a design problem with the manual operator being inadequate for valve movement.

- <u>Success Criteria for Available Operator Action Times</u>

  Core Damage is assigned if Level cannot be restored above 2 ft. above BAF (ABAF). This appears to be optimistic. Most utilities use definitions consistent with the PSA Applications Guide such as:

  - Above 1/3 core height and being recovered
  - Below peak temperatures of 1500 to 2200°F

  The use of 2 ft ABAF or equivalent calculations of 4130°F (melt temperature) are believed to be nonconservative and result in using operator times for actions that are longer than that which can be justified to prevent core damage.

- <u>Accident Allowed Time</u>

  The times allowed for operator diagnosis and operator action are identified in the HRA in Appendix E. This is a strength. However, the relationship of these T&H calculations to specific scenarios and to specific HRA actions is needed. Examples of questionable cases are:

  - Alternative Boron injection assumes 130 min. are available before initiation is required.

This does not include time for injection nor is it then translated into plant conditions that would exist if ATWS had progressed for 2 hours and 10 min. without boron injection.

- Time available to manually open LPCI injection valves, e.g., Large LOCA time to core damage when ECCS fails of 71 min. (Condensate would appear not capable of reflood of the core as assumed in the HRA)

- Alignment of FPS to cool the diesel generator gives in excess of 600 min.

Ensure that the allowed times are supported by specific calculations, especially those that are significantly different than those that have been confirmed by a number of generic sources.

The Peer Review Team did not agree that the Thermal Hydraulic calculations using MARCH supported any of these timing estimates.

- <u>Time to Core Damage</u>

The calculated time to core damage cited in RAI and IPE documentation is 83 minutes. This would appear optimistic and could not be confirmed with a calculation during the Peer Review Team review. Two cases are found to be in question:

- RPV inventory boildown at high pressure which is expected to be on the order of 50 to 60 min.

- RPV inventory boildown to TAF or MSCWLL and then a required emergency depressurization which is expected to be on the order of 35 to 45 minutes.

These times are measured from accident initiation. More recent HRA techniques such as the EPRI SHARP methodology have recognized that cues to the performance of time-limited actions may occur substantially after time zero, and therefore, the total time for diagnosis may be substantially less than the total times cited here. For example, the cue for emergency depressurization may occur as RPV level approaches TAF and the allowed time is between 35 minutes and 50 minutes, or a time of 15 minutes to diagnose and implement.

Modify the credit (HEP) for FPS alignment and offsite power recovery given that the above times are available for recognition, diagnosis, alignment, and manipulation; and the technical basis for a time of 83 min. is apparently not available.

- Align CRD for high pressure injection

  There appear to be several issues related to this evaluation:

  - The 83 min. is stated to be based on BWSAR but this could not be verified by the Certification Team
  - There is no T&H calculation that indicates CRD initiation at 80 min. is sufficient to turn the event and recover level--i.e., prevent core damage
  - Given a failure to depressurize, it appears optimistic to believe that this action could be considered independent

QUESTION NO. 36:

<u>*Table QU and Table 5-8, Quantification and Results Interpretation*</u>

Although there are a number of criteria on quantification and review of results, there does not appear to be any on result interpretation. What subtier criteria are used to judge the reasonableness of the results?

RESPONSE:

Results interpretation is a vitally important aspect of the PRA. The techniques and methods used to perform an adequate interpretation of results varies among analysts. The codified criteria in the NEI Peer Review process to address results interpretation include the following:

QU-27:	Unusual sources of uncertainty
QU-28:	Sensitivity evaluation for results
QU-30:	Parametric uncertainty evaluation and search for differences among similar plants
QU-31:	Dominant contributors; Identify and evaluate
QU-33:	Independent review
QU-34:	Traceability

Each of these criteria has its contribution to the interpretation of the results.

The PRA Peer Review Team uses these criteria in conjunction with their own experiences to assess the reasonableness of the results and the process used to interpret the results. It is noted that, in general, utilities have expended substantial efforts to understand and interpret the results of the PRA.

As an example of the Peer Team input, the following F&Os are identified:

- The RISKMAN model is very comprehensive and covers the spectrum of potential risk significant sequences identified in BWRs. The level of detail in the model demonstrates that there has been a substantial amount of effort to investigate plant unique features and interfaces including the EOPS. The HRA, system analysis, and data evaluation are well integrated into the model.

  Nevertheless, the RISKMAN model is very difficult to trace and the assumptions and quantification basis for individual situation are not well documented. The documentation of the model is most difficult to trace when the model rules, the MACROs, and the bin rules are used in combination with the split fractions to determine the failure probability used to insert in a given accident sequence. The documentation appears to be marginal to support use by someone not involved in the model development. This represents an exposure for management and potential difficulty in responding to regulatory issues (Maintenance Rule) if review of documentation is required.

- Most of the transient sequences have a dominant cutset which involves failure of solid state protection system trains A and B. All subsequent functions in these sequences are then assigned guaranteed failure. There is no credit for manual action or other recovery. These sequences account for about 20% of core damage, and are overly conservative in comparison with results for similar plants. Due to the importance of these sequences, it is suggested that these sequences need to either be better explained and justified in detail, or modified to include recovery or modified to allow mitigation after failure of both protection system trains. (F&O Significance B)

- The calculation file for the most recent PRA update and the information contained in the self assessment was strong in the compilation of numerical details of the risk quantification and included some information on the sources of changes since the last update, mostly created by the PRA software output reports; but it was rather weak in the qualitative development and discussion of insights about the risk contributions and importances, what they mean, and how they should be interpreted by those outside the PRA group. The discussion of the top ranking sequences from the last update with the Peer Review Team did not provide convincing evidence that a deep understanding of the nature of some of the top ranking sequences has yet been completed. In addition the detailed nature of the information contained in the calculation file, while meaningful to the PRA team, is not particularly useful to those outside the team to develop appropriate risk insights for managing the plant. Therefore it is highly recommended that the PRA team develop a summary report that exhibits and promotes a deeper understanding of the risk contributions from sequences, sequence classes, and risk importances as well as specific insights that can be used for day to day risk management activities. In developing this summary, it is recommended that development of functional sequence groups be considered to provide insights about important classes of accident sequences such as high pressure core melts, ATWS, RCP seal LOCAs, transient induced LOCAs, etc. Such grouping helps organize the detailed sequence information inherent in this type of PSA. The reviewers note that the most recent update was prepared so recently that there was not sufficient time to prepare a summary report on the results. The review team recommends that such a summary be developed so that risk insights can be more effectively communicated to plant personnel outside the PRA group. (F&O Significance B)

The subtier criteria for QU-31 have been modified to reflect the way that past PRA Peer Reviews have been performed, i.e., to include a thorough assessment of the quantification results to ensure that the quantification is accurate and that the interpretation of the PRA results is also accurate and appropriate.

QUESTION NO. 37:

Table QU and Table 5-8, Quantification and Results Interpretation

QU-4: Since the disallowed maintenance "files can fundamentally change the model results" shouldn't the review of the house event and DAM file be mandatory?

RESPONSE:

Agreed. The PRA model input needs to be documented and justified as part of the PRA. These reviews are conducted as part of the following Peer Review subelements:

- Disallowed maintenance: QU-26
- Mutually exclusive QU-26
- Recovery files: QU-18, QU-19
- Flag Files: QU-8. QU-15
- House Events: QU-8, QU-15

The PRA Peer Review Team has recognized this consistently on past PRA Peer Reviews. When deficiencies were identified, the PRA Peer Review report has requested utility enhanced documentation and traceability of the computer code files. As an example, consider the following fact and observations at past Peer Reviews:

- The flag files in the linked fault tree approach provide the definition of the final quantified logic. The Flag Files contained in the Quantification Notebook (Appendices D and G) do not provide a complete discussion of the rationale for setting of the flag.

- Develop documentation which supports the development of the quantified logic model. Include discussions of the accident sequences under consideration. An initiating event dependence matrix (annotated) could provide a framework for the documentation of the initiating event flag settings.

The Peer Review process needs to be aware of the treatment of each of these and how it influences the results of the model. Past Peer Reviews have examined the model input files and provided feedback on the adequacy of the approaches used for quantification and documentation.

The subtier criteria have been modified slightly to make these aspects of the review cleaner.

QUESTION NO. 38:

Table QU and Table 5-8, Quantification and Results Interpretation

QU-7: Why is the paragraph that begins "The RISKMAN ...." not included for the risk ranking application column? Also, since all PRA computer codes have limitations, it seems inappropriate to flag one such code and no others.

RESPONSE:

Risk Ranking Criteria

As noted in Question No. 2 and its response, the Option 2 process is anticipated to use PRAs that are graded at Grade 3 or above. Therefore, the criteria for risk-ranking is not specifically applicable to the Option 2 evaluation.

The Grade levels represent a varying level of scope and level of detail. The omission of the cited paragraph from the Risk Ranking (Grade 2) category is only an indication that the level of detail and lucidity of required documentation of code limitations to achieve a Grade 2 is not substantial.

Other Computer Codes

The cited paragraph begins with "The RISKMAN "saved sequence" model or fault tree linked code cutset models have a number of limitations..." Therefore, this paragraph covers the PRA computer models currently in use. No further action is considered appropriate.

QUESTION NO. 39:

Table QU and Table 5-8, Quantification and Results Interpretation

QU-15: The review of non-dominant cutsets provides guidance for ensuring that truly dominant cutsets are not overlooked due to modeling assumptions. However, they provide no guidance or requirements for finding important sequences and cutsets that are not showing up because of errors in data entry or misuse of the PRA computer code. The table should include criteria to require the search for sequences and cutsets that should be contributing, but may not be due to various errors. Techniques for finding such problems should also be provided.

RESPONSE:

The Peer Review Guideline is meant to be a usable, streamlined tool that can be effective in the time constrained forum of the one week on-site Peer Review. A conscious effort was made to not make the Guideline a tutorial on PRA methods and techniques. The clear intent of the criteria is to identify any non-dominant cutsets that have been misquantified, regardless of the reason.

In addition, subcriteria for QU-30 specifically identifies that the results evaluation and interpretation process should ensure that they are compared with similar plants to identify whether any "missing" sequences (exceptions) can be identified.

It is also noted that the uncertainty evaluation process is expected to look for modeling and other issues associated with the specific plant that may not be reflected in the results of similar plants but should be part of this plant's results.

QUESTION NO. 40:

Table L2 and Table 5-9, Level 2 / LERF Evaluation

There is insufficient discussion of the technical quality needed (acceptable treatments for the given criteria) to ensure an adequate LERF analysis. For many cases, general statements are made and not explained further. For example, in Criterion L2-11, "HEP" and "System Performance," it is not clear what is an acceptable treatment of these issues in the Level 2 analysis. The requirement here is simply that "...have been evaluated to account for the adverse conditions". Other requirements, such as those specified for Level 1 in Table 5-4 (for System analysis) and Table 5-6 (for HRA) are needed. This could be addressed by expanding Table 5-9, Criterion L2-11 and providing more specific descriptions on the requirements, or by expanding Table 5-4 and 5-6 to cover the issues that are specific to Level 2 analysis.

RESPONSE:

The principal area of incremental difference associated with systems and human actions used in the Level 2 analysis is the potential for adverse conditions imposed by the severe accident progression. Therefore, this is the additional requirement imposed on the systems and operator actions.

Nevertheless, the comment is worthwhile. A more formal way to connect the criteria specified in the SY and HR tables is useful in interpreting and clarifying the implementation of the Peer Review approach for Level 2.

The Peer Review Teams in the past have applied the criteria from elements SY and HR on the Level 2 systems and actions, respectively.

To formalize this process, the subtier criteria document has been updated to explicitly note that the criteria for Level 1 systems and human actions also apply to the Level 2 analysis.

QUESTION NO. 41:

Table L2 and Table 5-9, Level 2/LERF Evaluation

It is not clear what the requirements are in the Level 2 / LERF analysis for CET quantification, results interpretation, and the treatment of uncertainty and sensitivity. Again, other tables could be expanded to cover Level 2 issues, i.e., Tables 5-5 (Data Analysis) and Table 5-8 (Quantification and Results Interpretation) could be expanded to cover Level 2 issues if needed, or these requirements could be described specifically in Table 5-9.

RESPONSE:

As noted in the previous discussion, the process approach used in the applicable Level 1 elements are expected to be reviewed as part of the Level 2 Peer Review Process. There are specific aspects of Elements 2 through 9 that have called out the Level 2 explicitly for evaluation. These include:

- AS-14
- ST-5
- ST-7
- ST-8
- QU-22
- QU-23
- QU-24

In addition, the Level 2/LERF Criteria (Table 5-10) marches through each of the elements 2 through 9 to provide a convenient point at which to discuss the applicability:

L2-4 & L2-5 & L2-6:	Discuss the success criteria and their technical basis.
L2-7	Discusses the Level 1/2 interface. Tables 5-3 and 5-9 also provide additional insights and criteria in the interpretation of this subelement.
L2-8 & L2-9 & L2-10	The phenomena considered are principally a Level 2 issue.
L2-11	The system performance evaluation for Level 2 is consolidated under this topic. The Peer Review process examines all systems and their documentation under the SY element (Table 5-4). Therefore, the Peer Review process for implementation of the criteria in Table 5-4 is already applied to Level 1 and Level 2 systems. L2-11 is used to focus on those aspects of system operation in Level 2 that are required for their use under degraded core conditions. This includes survivability considerations and applicability of data. In general, there is little or no data that is available to support component data evaluation beyond their survivability envelop. Therefore, a data analysis similar to Level 1 is not included. If the system operates in an environment similar to the design basis condition, then the Level 1 data analysis has generally been considered applicable by utilities. When the severe accident conditions affect the component operating conditions, the adverse impacts have generally been included by judgement. This is addressed in L2-11.
L2-12 L2-25	The operating crew actions evaluation is consolidated under this topic for Level 2. The operator actions for Level 1 and 2 are assessed using the checklist for the Human Reliability Analysis (Table 5-6). Therefore, the Peer Review Process for implementation of the criteria in Table 5-6 are already

applied to Level 1 and Level 2 operator actions.

L2-12 is used to focus on those aspects of operator actions in Level 2 that are required for their use under degraded core conditions.

L2-13, L2-14, L2-15, L2-16, L2-17, L2-18, L2-19 & L2-20	These subelement criteria provide supplementary criteria for the purposes of evaluating the containment boundary response to severe accidents.
L2-21, L2-22 & L2-23	Provide the basis for the treatment of the Level 2 end state.
L2-24 & L2-25	These subelement criteria are specifically related to the structure of the containment event tree models. They discuss the basis for:

- Functional events
- Phenomena
- Systems and HEPs
- EOP consistency

As suggested by the NRC, the subtier criteria for L2 have been enhanced to formalize the need for the Peer Review Team to examine the Level 2 process for systems, dependencies, and operator actions in a manner similar to that used in Level 1. While this is considered a useful addition to the subtier criteria, it is believed that this process has been used in all past PRA Peer Review based on the inputs from the veteran members of the Peer Review Teams.

QUESTION NO. 42:

Table L2 and Table 5-9, level 2 / LERF Evaluation

L2-1: For a Grade 2 PRA (risk ranking prioritization), there appears to be an inconsistency between the requirements in the checklist and the subtier criteria for this subelement.

RESPONSE:

The inconsistency noted by the comment is that a Grade 2 subtier criteria was not included. This has been remedied.

The Checklists for Level 2/LERF indicate that the Grades of 1, 2, 3, or 4 can be assigned to the L2-1 subelement, "Guidance: Describes the process used".

The subtier criteria provide distinctions that can be used by the Peer Review Team to assign different Grades for the Level 2/LERF guidance.

QUESTION NO. 43:

Table L2 and Table 5-9, level 2 / LERF Evaluation

L2-8: A list of issues to be considered is provided, but no details are given as to what is an appropriate way of considering these issues. For instance, how should pressure rise from combinations of phenomena be treated? In column 1 the first paragraph refers to qualitative treatment while the second paragraph refers to quantitative ways to address issues. Please provide additional details regarding appropriate treatment of issues and clarify the qualitative versus quantitative statements in column 1.

RESPONSE:

The PRA Peer Review criteria do not specify the explicit methods to treat the phenomena identified. The burden of proof for the treatment of these phenomena is on the utility. The Level 2/LERF model and documentation needs to specify how these phenomena are treated including the combination of severe accident effects where appropriate along with the technical bases to support their treatment.

The following clarifications have been added to the subtier criteria:

- Many of the phenomena are sufficient in and off themselves to fail containment. Therefore, the combination of the phenomena with other severe accident conditions are not necessary. This applies to phenomena such as:
  - ISLOCA
  - Steam Explosions
  - Hydrodynamic Loads
  - Recriticality (BWRs)
  - Multiple Containment Boundary Failures
  - Vapor Suppression Failure
  - DCH (Direct Containment Heating)
  - TISGTR (Temperature Induced Steam Generator Tube Rupture)
  - Hydrogen Detonation

- Other Phenomena or failure modes affect the core melt progression and can be modeled using typical severe accident computer codes such as MAAP. These include:

  - In-vessel recovery
  - RPV vent and containment vent
  - Containment flooding
  - Containment isolation failure
  - IC multiple tube rupture
  - Vacuum breaker failure

- Combinations of phenomena with other severe accident conditions should be performed in certain cases. The method of combination shall be justified by the PSA documentation. Specific phenomena in this group include:

  - Hydrogen deflagration
  - Transient Pressurization due to debris quenching

- Grade 2: "qualitatively" was incorrectly included in the subtier criteria. It has been changed to "quantitatively."

QUESTION NO. 44:

Table L2 and Table 5-9, level 2/LERF Evaluation

L2-9: The subtier criteria do not provide any additional guidance. Please provide additional guidance on the appropriate inclusion of accident management actions under severe accident conditions.

RESPONSE:

The ability to reflect accident management actions is a useful attribute for the PSA. These phenomena are identified in L2-8.

Additional guidance is not considered necessary.

QUESTION NO. 45:

Table L2 and Table 5-9, level 2/LERF Evaluation

L2-17: The criteria state that geometric details impacting hydrogen related phenomena should / shall be documented for BWR Mark III and PWR ice condenser containments, but no guidance is provided as to how these geometric details are to be used in the treatment of hydrogen phenomena. Please provide guidance on appropriate use of geometric details of containments in treating hydrogen phenomena.

RESPONSE:

The following additional guidelines are provided in the subtier criteria:

A deflagration-to-detonation transition may be a means of creating a hydrogen detonation. The configuration of the ice condenser (a vertically oriented enclosed compartment with obstacles in the flow path) can promote flame acceleration and initiate a detonation in upper portions of the ice bed or the upper plenum.

Specific features that promote deflagration-to-detonation transition shall be considered in containment analysis:

- Small, enclosed spaces with a hydrogen source
- Lack of transverse vents along the length of tubular enclosures
- Obstacles in the flow paths of tubular encloses
- Presence of solid floors to promote localized hydrogen accumulation
- Unvented compartments

The burden for the evaluation, the technical bases, references, and the appropriate documentation is on the utility. This information needs to be part of the Level 2 technical bases.

QUESTION NO. 46:

Table L2 and Table 5-9, Level 2/LERF Evaluation

L2-26: For a Grade 2 PRA (risk ranking prioritization), there appears to be an inconsistency between the requirements in the checklist and the subtier criteria for this subelement.

RESPONSE:

The inconsistency noted by the comment is that a Grade 2 subtier criteria was not included. This has been remedied.

The Checklists for Level 2/LERF indicates that the Grades of 1, 2, 3, or 4 can be assigned to the L2-26 subelement.

The subtier criteria provide distinctions that can be used by the Peer Review Team to assign different Grades.

QUESTION NO. 47:

Role of Completed Peer Reviews

We understand that the industry has already completed a large number of peer reviews. It is important that we understand what standing you believe these reviews have for application to Option 2. The Peer Review process has evolved over time, so that the standard attained for more recent reviews is different than that set by the early efforts. This evolution leads us to question whether all reviews fulfill a consistent standard that would be appropriate for application to Option 2.

RESPONSE:

The Peer Review process has been consistently applied to all plants that have undergone the Peer Review process. No significant changes to the process have occurred since the Pilot Process established the basis in 1997. It would, therefore, not be accurate to describe the process as an evolving process.

The Peer Review process was established in 1996 via a pilot program sponsored by the BWROG. Based on the Pilot program the Guidelines for the Peer Review were developed and issued to the public in January 1997. These Guidelines have been used in all subsequent Peer Reviews until the NEI 00 02 Guidelines superceded these. The NEI 00 02 Guidelines are identical in content to those used by the BWROG. The differences are in the following areas:

- Specific subelements that have been added to address PWRs
- Editorial corrections to wording
- Clarifications on the specific subelements (in 3 cases split into multiple subelements)

In 1999 as part of an EPRI effort to assist in the PRA Standard development the subtier criteria were compiled into a single document. Prior to this time, the method of transmitting this information was through use of experienced PRA personnel on each review who had written the Guidelines and through training for the entire Team on the interpretation of the criteria.

Note that the PWR Owners' Group included, at least in their initial reviews, some veteran reviewers with BWROG PRA Peer Review experience to further ensure consistency of application. Subsequent reviews have "re-used" reviewers to a significant extent, such that there has continued to be review-to-review consistency in interpretation of the review criteria.

The conclusion that has been reached by NEI is that a consistent process has been applied in a uniform and reproducible manner and that the process applied to the first plants is not different that the process applied to the most recently reviewed plants.

QUESTION NO. 48:

We are concerned that peer review efforts have been completed without consistent guidance on what information will be provided to an integrated decision making panel responsible for making SSC classification decisions under Option 2.

RESPONSE:

Consistent guidance has been used in the Peer Review process regarding documentation of results and their potential implications for applications. This information is contained in the PRA Peer Review Report presented to the utility. The PRA Peer Review report includes: subelement grades, the element grades, the detailed fact and observations (prioritized by severity), and the qualitative summary for each element.

The PRA Peer Review provides input into the utility's characterization of the PRA input quality.

The Integrated Decision-making Panel (IDP) is discussed in the NEI Report: Option 2 Implementation Guideline, NEI 00-04. [7]

Information to be provided to the IDP can be considered in several categories:

- The written report from the PRA Peer Review for internal events. This report has been developed with a consistent format and technical content for all Peer Reviews.
- The utility PRA Groups' interpretations of the Peer Review results as they apply to a specific application.
- The characterization of other PRA inputs from external events, etc.

The first set of information is clear. The second and third sets of information are the subject of the NEI Categorization Guidelines and the Rules of Conduct of the IDP. [7]

QUESTION NO. 49:

Finally, it is not clear how completed peer reviews will incorporate changes which may result from our guideline review effort.

Please provide a discussion of the role NEI expects completed peer reviews to have for Option 2 applications, addressing changes in the review procedures, and the basis for any conclusion that reviews have been performed to a consistent standard adequate for Option 2.

How will completed reviews incorporate changes which may result from the guideline review effort?

RESPONSE:

It is anticipated that if there are changes in the review procedures or the basis for establishing grades or conclusions from that in the NEI 00-02 that the utilities would be required, in preparing Option 2 applications, to address the differences and justify the PRA in view of NRC recommended changes that arise from the NRC review effort. This justification could include:

- Writing the basis for compliance with the Standard for those subelements not part of the Peer Review
- Provide a separate "mini-Peer Review" to verify the applicability of the Standard items in the PRA

Therefore, we recommend consistent with NEI 00-04 [7] that all significant changes to the original guidelines resulting from this review effort be summarized and each plant PRA group be required to revisit those criteria and reassess the grades. If an independent peer review team is used, the independent team members do not necessarily have to belong to an outside organization, but should consist of members who did not participate in the PRA effort.

REFERENCES

[1] BWROG PRA Peer Review Certification Implementation Guidelines, BWROG, January 1997.

[2] NEI PSA Certification Workshop, Renaissance Harborplace, Baltimore, Maryland, April 7-8, 1998.

[3] Gregory A. Krueger, Edward T. Burns, Richard A. Hill, Results of Applying the BWROG PRA Peer Review Certification Guidelines, PSA 99, Washington D.C., August 22-26, 1999.

[4] Transmittal of BWR Owner's Group Document, "PRA Peer Review Certification Implementation Guidelines," Letter from Kevin P. Donovan, Chairman BWR Owner's Group, to U.S. Nuclear Regulatory Commission Document Control Desk, J.H. Wilson, dated January 31, 1997.

[5] PRA Peer Review Guidelines, NEI 00-02 (DRAFT), April 2000.

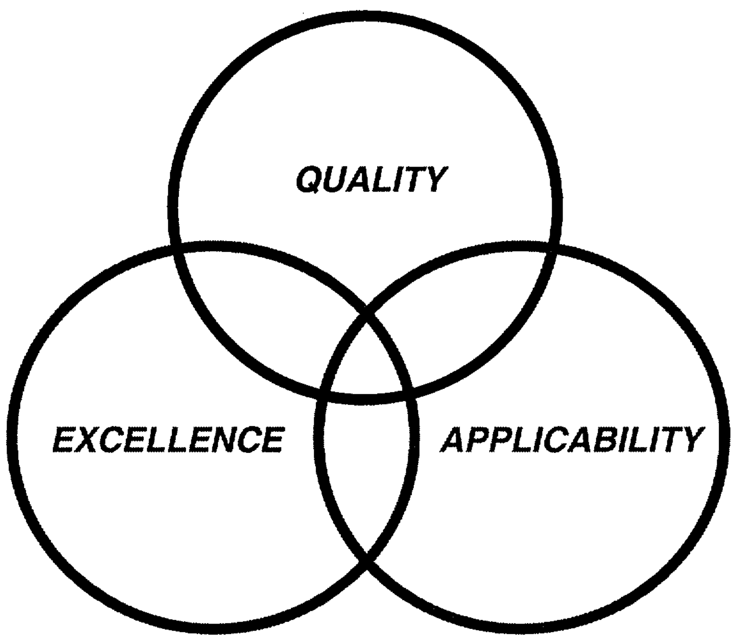
[6] PSA Applications Guide, EPRI-TR105396, August 1995.

[7] Option 2 Implementation Guideline, NEI 00-04 (DRAFT – Revision A2), December 2000.

[8] PRA Policy Statement, PRA Policy Statement, Federal Register, Volume 60, No. 158, Wednesday, August 16, 1995, Notices.

PRA Peer Review

Subtier Criteria



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Section 1
INTRODUCTION

1.1 BACKGROUND

NEI has provided coordination for the industry to develop PRA Peer Review Guidelines to be used to monitor the quality of PRAs. [1,2,3,4,5]

These Peer Review Guidelines have been used at approximately 30 sites accounting for approximately 40 individual units. The PRA Peer Review Guidelines define a process. This process consists of the following:

- The organization of the Team
- The Team membership and qualifications
- The organization of the Peer Review process including scheduling of events
- The elements for review
- The subelement criteria along with the supplemental subtier criteria
- The definition of grades to assign given the criteria
- The interaction process with the utility
- The report format

Refer to NEI 00-02 (Ref. 5) for the details of the process.

The PRA Peer Review Teams are trained in the use of the following:

- 11 PRA Elements
- 209 PRA Criteria
- Subtier Criteria for each of the 209 PRA Criteria

As a supplement to the PRA Peer Review process, a documented set of subtier criteria was published in June 1999 under the sponsorship of EPRI. This supplement served to formally document the subtier criteria that had been used in the early implementation of the BWROG PRA Peer Review Process.

The subtier criteria have been further reviewed for the purposes of clarifying the way that Peer Review Teams have implemented the Peer Review Process in past reviews. The result of this review and the need to ensure understanding of the use of specific wording (e.g., "may") is a revised subtier criteria document that incorporates both PWR and BWR criteria within a single document. The enclosed document is this revised subtier criteria for PWRs and BWRs.

1.2 DEVELOPMENT OF THE PROCESS

This document has been compiled by the four Owners' Groups to distill information developed from previous Peer Reviews using NEI 00-02 Guidelines or its predecessor, the BWROG PRA Peer Review Certification Process [1] and place it in a form of subtier criteria. This supplemental information is one of several techniques that the Owners' Groups have used to assist in establishing consistency from one Peer Review to another. The subtier criteria are written summaries of criteria that have been transmitted orally in previous PRA Peer Reviews and are used to facilitate the peer review process. The subtier criteria describe the variation in level of detail, scope, degree of rigor, and adequacy of documentation, corresponding to suggested grade levels for each of the subject subelements.

1.3 SUMMARY

The PRA Peer Review process incorporates a number of structured features. One aspect of this process that has been addressed via participation by veteran Peer

Review members in many of the initial peer reviews has been the distinction among grades for subelements. To provide a more formal record of these distinctions, the supplemental subtier criteria have been documented as an attachment to the NEI 00-02.

These subtier criteria were developed to document the interpretations of the 209 PRA Criteria as they are generally applied in the PRA Peer Reviews. The subtier criteria document can be used to help ensure consistency in the application of the peer review process.

This means that now the following are part of the review-to-review consistency process within the PRA Peer Review process described in NEI 00-02:

- Use the specific NEI 00-02 criteria for each of the PRA subelements.
- Incorporate veteran members of previous PRA Peer Reviews on each Peer Review Team.
- Provide training on the process and the PRA criteria to be used.
- Supplement the above with written subtier criteria that provide documented guidance regarding the recommended distinctions among grades for the subelement criteria.

Section 2
PURPOSE

The purpose of the subtier criteria is to establish a documented basis for distinctions among the PRA grades to be assigned for each PRA Element Criteria.

This document contains the subtier, or supplementary, criteria to assist the PRA Peer Review Teams in establishing consistent grades from one peer review to another. Here the term "criteria," consistent with the Webster Dictionary, is used:

> *"A means by which items can be compared and judged."*

i.e., a "measuring stick" regarding the attributes of the PRA.

The subtier criteria have been developed as supplemental guidance originated as a part of the NEI 00-02 process. The supplemental guidance isa documented version of the guidance used previously on BWR PRA Peer Reviews. The BWR PRA Peer Reviews before June 1999, when the original version of this subtier criteria document was prepared, had the equivalent of the subtier criteria provided in training sessions between the Peer Review Team members and one of the authors of the Peer Review Guidelines. In addition, a veteran reviewer was a member of each Team to ensure that these subtier criteria were accurately reflected in the PRA evaluation being performed. The PWR Owners Groups' PRA peer reviews performed prior to the issuance of this current version of the subtier criteria document have also made use, on each review, of reviewers with experience using the NEI 00-02 process on prior reviews for either PWRs or BWRs.

The subtier criteria represent a distillation of discussions, decisions, and gradations with respect to PRA quality that have been used in previous PRA Peer Reviews. Codifying these criteria is an enhancement to the PRA Peer Review process to promote continued consistency in the process in the future, particularly if veteran Peer Reviewers are not available.

The effective implementation of the subtier criteria still requires that they be used by an expert Peer Review Team because judgement is required in the interpretation of these criteria.

Section 3
SCOPE

The scope of this document addresses both PWR and BWR plant PRAs. The applicability of the details of each subtier criteria is determined by the Peer Review Team.

There are two interrelated sets of inputs provided to the host utility as a result of the Peer Review Process:

- The subelement and element grades.
- The Fact and Observation Sheets (F&Os) related to the subelements prioritized by importance.

Each of these inputs is complementary and has a rating scale that expresses the urgency or importance with which the Peer Review finding should be viewed.

3.1 GRADES

Grades are assigned, as part of the PRA Peer Review process, to each of the applicable subelements evaluated. In addition, each of the eleven elements is also given a grade reflecting the consensus of the Peer Review Team.

The structure of PRA Peer Review grades was formulated by NEI through an interactive process and following presentations to ACRS and NRC. It involved the consideration of the applications that are desired to be treated with the PRA. The "grades" can be distinguished based on certain attributes. The following distinctions in grade level are assigned based on example applications. However, it is important to note that in the risk-informed environment PRA applications will likely be a blend of probabilistic and deterministic assessments. Therefore, the grades will also implicitly define the required level of deterministic assessments that are needed in conjunction with the PRA. These grade levels draw on distinctions made in the PRA Applications Guide[6]. The peer review grades that have been used and are currently envisioned are the following:

Grade 1

This grade represents a minimum that has generally satisfied NRC expectations for responding to Generic Letter 88-20. Most PRAs are expected to be capable of meeting these requirements.

Inherent in the lowest sanctioned grade for PRA, Grade 1, is the recognition that there may be substantial conservatisms included in the modeling, analysis, and data. These conservatisms may still allow the identification of outliers and vulnerabilities, and the prioritization of certain issues. However, these conservatisms and other related items create a situation which makes some applications less supportable using the Grade 1 categorization.

A PRA whose attributes are generally Grade 1 is considered acceptable for:

- Satisfying the GL 88-20 requirement
- Assessing Severe Accident Vulnerabilities
- Resolving selected generic issues (e.g., A-45)
- Prioritizing Licensing Issues

Grade 2

The next highest grade for PRA attributes, Grade 2, would generally support risk-ranking of systems, structures, and components, that is, would result in higher confidence than Grade 1 in the ranking process based on PRA input. Based on such risk-ranking, certain allocation of resources and timing of initial inspections are possible. However, these grades are judged not sufficient in and of themselves to support plant changes without additional effort to ensure the focused PRA is adequate to support such applications.

Categorization of PRA attributes at this grade would provide a high degree of confidence that, on a relative basis, the PRA methods and models yield meaningful rankings for the assessment of systems, structures, and components, when combined with deterministic insights (i.e., a blended approach).

Grade 2 is acceptable for Grade 1 applications and for applications that involve the risk-ranking of certain systems, structures, and components. Examples of such applications may include the following:

- MOV ranking for GL 89-10
- NRC Inspection Activities
- Maintenance Rule

<u>Grade 3</u>

This grade extends the requirements to ensure that risk significance determinations made by the PRA are adequate to support regulatory applications, when combined with deterministic insights.

Therefore, Grade 3 can support physical plant changes when it is used in conjunction with other deterministic approaches that ensure that adequate defense-in-depth is preserved.

Grade 3 is acceptable for Grade 1 and 2 applications, and is also usable to assess safety significance of equipment and operator actions. This assessment can be used in licensing submittals to the NRC to support positions regarding absolute levels of safety significance if supported by deterministic evaluations. Examples of such applications may include the following:

- Graded QA
- In-service Testing (IST)
- In-service Inspection (ISI)
- Backfit Calculations (See also Grade 4)
- Reduction or elimination of licensing commitments
- On-line maintenance evaluations

Grade 4

This grade requires a comprehensive, intensively reviewed study which has the scope, level of detail, and documentation to assure the highest quality of results. Routine reliance on the PRA as the basis for certain changes is expected to be possible with this grade. It is expected that few plants would currently be eligible for this grade.

Grade 4 is acceptable for Grade 1, 2, and 3 applications, and is also usable as a primary basis for developing licensing positions that may change hardware, procedures, requirements, or methods (inside or outside the licensing basis). Examples of such applications may include the following:

- Reduce or Eliminate Licensing Commitments (sole basis)
- Modify Technical Specifications (sole basis)
- Replace Technical Specifications with an On-Line Risk Monitor
- Backfit calculations
- Reclassify the quality category of some equipment

Figure 3-1 compares some of the attributes of the PRA grade levels and how these attributes vary with grade.

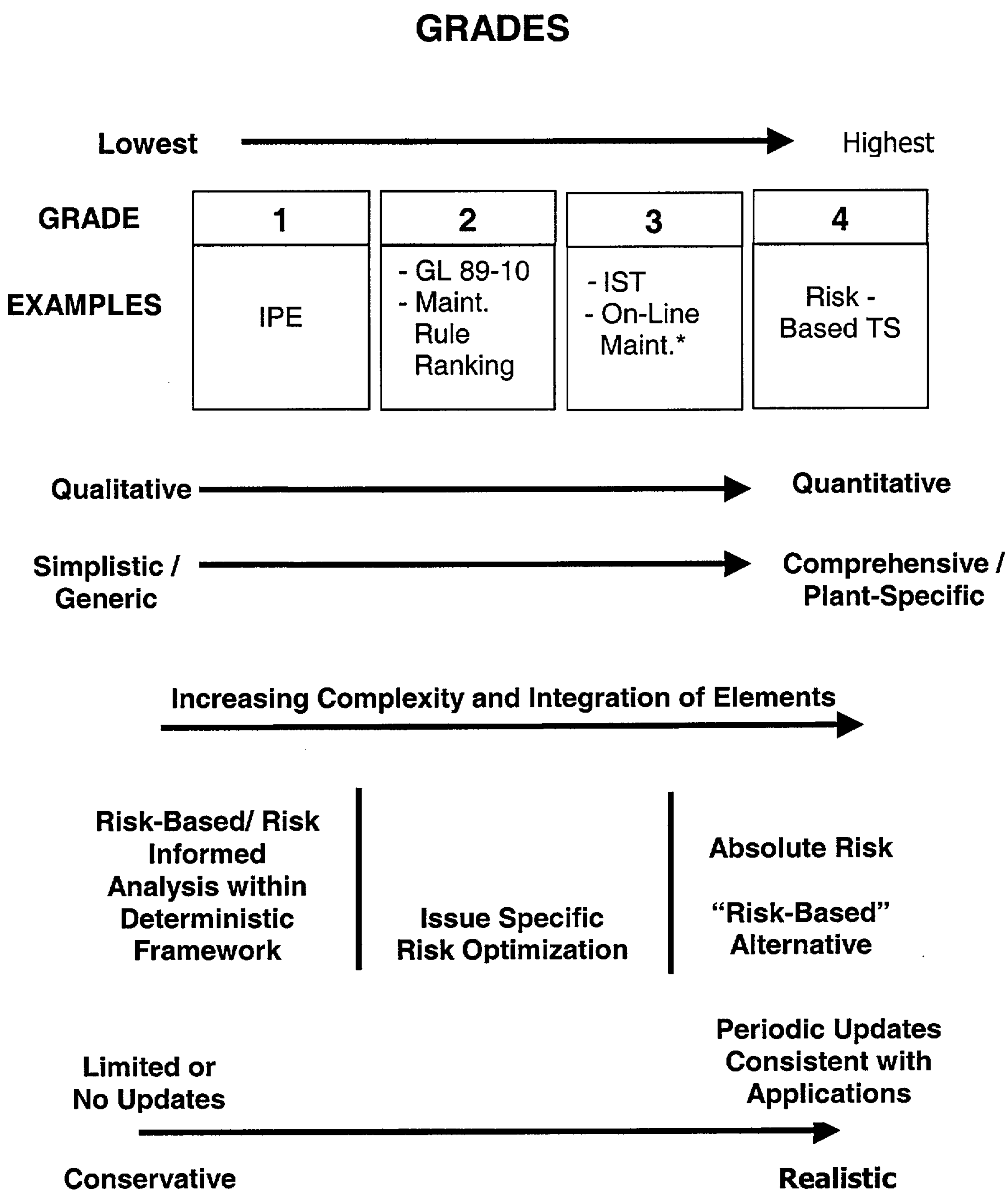
Figure 3-2 shows a graphical representation of the expected spectrum of applications that can be performed effectively using a PRA whose attributes are rated at each grade level.

Grades are assigned both on a subelement basis and on an overall Element basis. The following discussion focuses principally on the grading of subelements followed by a short discussion of how these guidelines are applied to the overall Element grade.

The subtier criteria provide a written record of the general distinctions among peer review subelement grade assignments. The subtier criteria provide distinctions including the following areas:

- level of detail
- scope
- methods
- data (generic versus plant-specific)
- degree of documentation

A general statement can be made that the higher grades represent greater levels of detail, more complete scope, increasingly refined methods (e.g., current state of the technology), most applicable data available, and increased levels of documentation and traceability.



***On-Line Maintenance safety evaluation is specified as part of the Maintenance Rule.**

Figure 3-1 Attributes of the PRA Grades

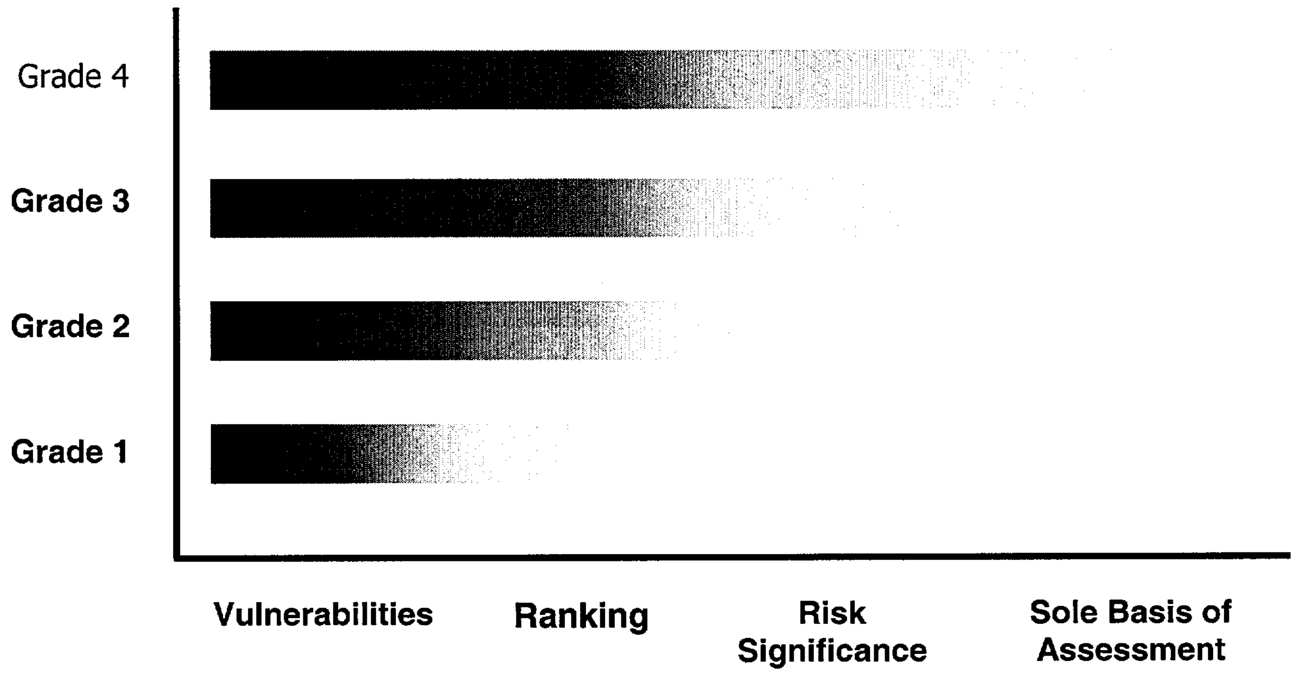


Figure 3-2 Spectrum of Applications Effectively Supported by the PRA

The subtier development process performs the following:

- documents the distinctions among the Grades for the PRA criteria consistent with that implemented in the early PRA Peer Reviews.

- distinguishes among the top 3 grade categories:

Category	Qualitative Characterization
2	Risk-Ranking Prioritization
3	Risk-Informed Decisions
4	Risk-Based Decisions

The lowest grade category (Grade 1) has not been explicitly broken out with separate subtier criteria. By process of elimination, it can be assumed that if the PRA subelements (attributes) of the PRA being reviewed are inadequate to meet Grade 2, then they would be placed in Grade 1 or possibly be identified as "Not Applicable," if the particular criteria does not apply, or if there is a sufficiently serious error such that Grade 1 is judged not applicable. Such a serious situtión would be noted with one or more "A" Priority Fact and Observations, and would be noted in the qualitative summary.

Figure 3-3 shows a simplified flow diagram that is sometimes used by members of the Peer Review Team and within consensus sessions to provide a final check on the Grade assignments.

The subtier criteria are provided for Grades 2, 3, and 4, which are considered the primary characterizations to be used in future applications. Therefore, the subtier criteria are focused on these grade distinctions. For many of the subelements, the criteria may be the same or similar for Grades 3 and 4. The distinctions made by the Peer Review Team between Grades 3 and 4 are based on:

- Level of detail in the modeling of the specific features
- Nature of the documentation describing the approach and implementation

Substantial detail and superior documentation will lead to Grade 4 assignments, while adequate modeling and documentation will lead to Grade 3. The NEI 00-02 Guidelines and the updated Subtier Document include further clarification related to distinctions among grades.

The Grade 2 subtier criteria descriptions in Tables 5-1 through 5-11 represent a minimum set of criteria that apply to Grades 2, 3, and 4. Once it is established that these minimum criteria for Grade 2 are met, then the Peer Review Team can assess whether the more difficult criteria for Grades 3 or 4 are also met. Assignment to Grade 3 or 4, respectively, can be made if the Grade 2 criteria are met and the criteria for Grade 3 or 4 are met.

The purpose of the subtier criteria document is to provide additional information for the PRA Peer Review Team. The subtier criteria were developed and reviewed by veteran members of previous PRA Peer Review Teams from each of the four Owners' Groups. Therefore, the technical content and consistency of the subtier criteria with guidance provided in previous reviews is ensured. Use of the documented subtier criteria has subsequently been confirmed by the peer review teams during the application of these subtier criteria to be beneficial.

Element Grade and Criteria

The PRA Peer Review Team compiles the grades by subelement. Then, the Team compiles a qualitative summary of the element based on both the grades for the applicable subelements and the Fact and Observations that apply to the element. The qualitative summary provides both the strengths and key enhancement opportunities.

The Team, during a consensus session, assigns a Grade to characterize the overall capability of the element to support applications. The following "criteria" have been compiled to provide guidance on the overall Element Grade assignment:

- Assign Grade 4 if essentially all subelements are at the Grade 4 level.
- Assign Grade 3 if all subelements are at Grade 3 or higher.
- Assign Grade 3 if all subelements that could materially impact applications are at Grade 3 or higher. This is based on the Team consensus judgement.
- Assign Grade 1 to the element if there are more than one critical subelement that is graded at the Grade 1 level.
- Assign Grade 2 if subelements that may substantially affect an application are graded at the 2 Grade level.
- Assign an NA to an element that has insufficient support to provide useful input into an application.

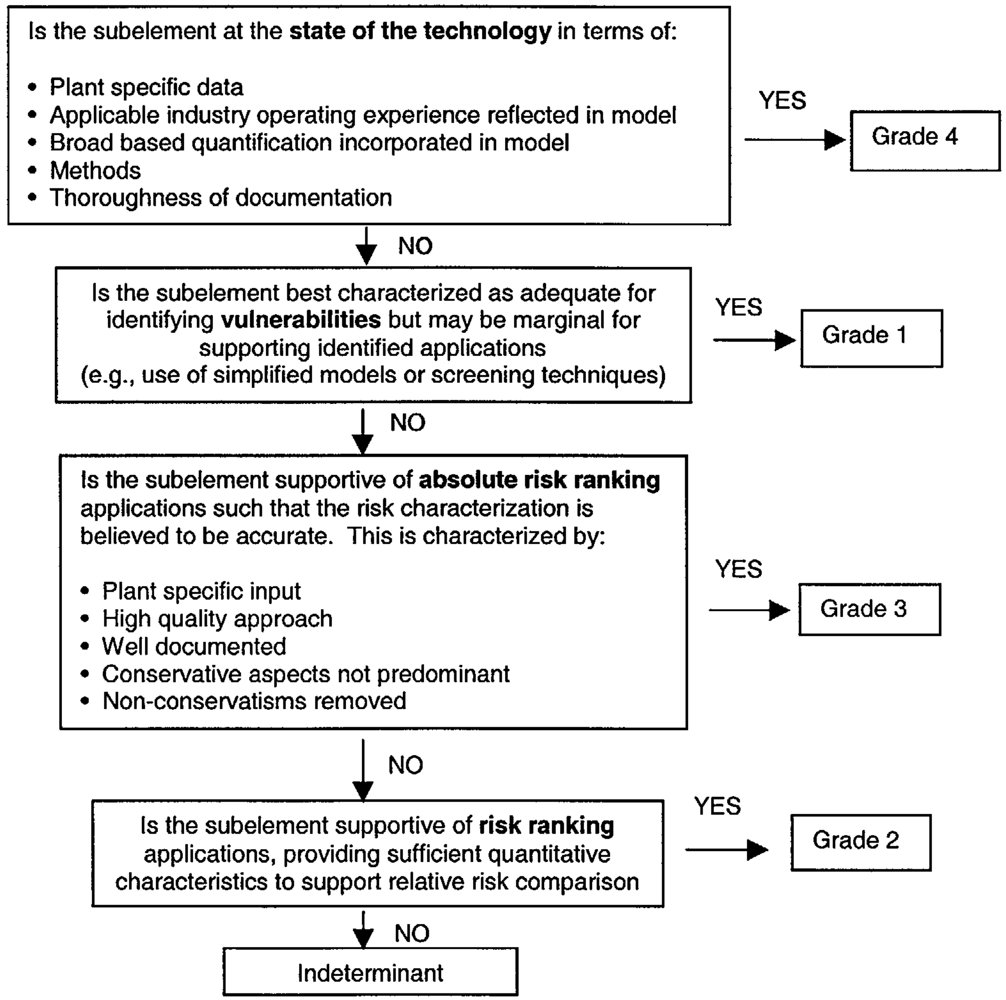


Figure 3-3 Generalized Criteria Flowchart

3.2 INTERFACE OF LEVEL 2 ELEMENT WITH OTHER CRITERIA

The criteria are formulated into eleven separate elements. The eleven elements are:

Element	Table No.	PRA Element
1	IE	Initiating Events
2	AS	Accident Sequence Evaluation
3	TH	Thermal Hydraulic Analysis
4	SY	System Analysis
5	DA	Data Analysis
6	HR	Human Reliability Analysis
7	DE	Dependencies
8	ST	Structural Response
9	QU	Quantification
10	L2	Containment Performance
11	MU	Maintenance and Update Process

However, there is a relationship of the Level 2 criteria to the other technical elements. This relationship is reflected in the fact that the Level 2 – Containment Performance Element makes use of the applicable portion of the other technical elements in formulating the Level 2 summary review, the Facts and Observations, and the grade assignments. This relationship is summarized in the following short description.

The first element, initiating events, applies principally to the Level 1 PRA, except as noted that it may impact LERF.

Elements 2 through 9 are equally applicable to the features of Level 1 and Level 2. Therefore, the assessment of the element criteria should also address the Level 2 implementation of each of these criteria.

Element 10 is the Level 2 evaluation. It summarizes how the criteria for the Elements 2 through 9 are applied in the Level 2.

The Level 2 Peer Review evaluation process has as its major focus the accurate modeling of the severe accident progression and its interface with the following to accurately assess radionuclide releases:

- Containment
- Systems
- Operator actions
- Thermal hydraulic analysis

For ease of reference, the Level 2 criteria that can be supported by the associated Level 1 criteria are listed in the following table:

Level 2 Topic	Level 2 Criteria	Associated Level 1 Criteria Used for Guidance
Accident Sequences	L2-24	AS
Success Criteria	L2-4, L2-5, L2-6	TH
Operator Actions	L2-12, l2-25	HR
System Response	L2-11	SY
Containment Structural	L2-22, L2-14, L2-15, L2-16, L2-17, L2-18, L2-19, L2-20	ST
Quantification and Results Interpretation	L2-26	QU

The Level 2 criteria are a second check that this has been performed and that, in addition, the impact of severe accident progression effects are accounted for.

3.3 FACTS AND OBSERVATIONS

An important supplement to the grading process is the specific feedback provided by the Peer Review Team on actions that can be taken to enhance portions of the PRA. These specific feedback items are documented with "Facts and Observations" Sheets (F&Os). They are a qualitative description of a specific PRA attribute and how it can be enhanced to support higher grade levels.

These F&Os are prioritized in terms of their importance as they relate to the ability to effectively use the PRA to support different levels of applications.

Table 3-1 summarizes the prioritization rating used to describe the level of significance.

Table 3-1

LEVEL OF SIGNIFICANCE

Significance Level	Definition
A.	Extremely important and necessary to address to ensure the technical adequacy of the PRA or the quality of the PRA or the quality of the PRA update process. (Consensus of Peer Review Team Required.)
B.	Important and necessary to address, but may be deferred until the next PRA update.
C.	Marginal importance, but considered desirable to maintain maximum flexibility in PRA Applications and consistency in the Industry.
D.	Editorial or Minor Technical Item, left to the discretion of the host utility.
S.	Considered to be a major strength of a PRA that exhibits industry leadership and a good practice to be followed to support most envisioned PRA application.

Section 4
FORMAT

The format selected for the subtier criteria incorporates the following:

- The subtier criteria are provided in tabular format.
- Each NEI 00-02 PRA element and its subelements (criteria) are expressed in terms of the subtier criteria.
- Three grade levels are distinguished.

The subtier criteria format (e.g., numbering scheme) is developed to coincide with the NEI PRA Peer Review Process elements. Because there are slight differences in the subelement numbering between the BWROG and the NEI Peer Review criteria, the user needs to be aware that the subtier criteria will need to be matched to the correct subelement. This has not presented any problems in the application of these criteria to either implementation of the BWROG criteria tables or the NEI PRA Peer Review criteria tables, both of which have been used by the BWROG in Peer Reviews of BWRs.

Gradation in PRA quality is considered to be a continuous spectrum. This continuous spectrum has been broken into discrete "grades" for the purpose of summarizing the strengths of a PRA within a commonly understood framework. The subtier criteria are used to provide means to compare or judge whether the constituent elements of a PRA meets certain grade levels. In certain cases (for some subtier criteria), the gradations in the quality of a PRA's elements are not clearly articulated by the subtier criteria, rather the distinctions among the grades are left to the judgement of the Peer Review Team using their experience with other PRAs as the basis for this determination. The Peer Review Team considers the methodology used, the technique and completeness of its implementation, and the level of documentation (traceability) supporting the implementation. This reliance on peer review expertise is consistent with the use of peer reviews in the past and is sufficient to identify the quality of PRAs.

The subtier criteria are to be used as guidance to assist the Peer Review Team in (a) distinguishing between grades, and/or (b) establishing the proper context of the subelement. The use of "shall," "should," and "may" helps to underscore the need to evaluate the degree of completeness and the depth to which a subelement was developed, rather than absolute requirements upon which the grades were developed.

The subtier criteria are provided for three (3) of the grades used in the NEI PRA Peer Review process. These criteria make use of specific words to describe the degree of expectations regarding specific attributes. The wording of the subtier criteria are meant to be similar to their usage in ASME Standards as follows:

- Shall -- Indicates that the criterion is met or an equivalent method of meeting the criterion is available as part of the PRA and substantial documented justification is available to support the equivalent method.
- Should -- means that the subtier criterion is expected to be in place and would be in place unless there are compensating actions or documentation to support deviations from the subtier criterion, i.e., the criterion is strongly expected to be part of the PRA to satisfy the grade level; otherwise, documentation regarding the adequacy of the PRA given that it does not meet this specific criterion is expected.

Based on a public information exchange meeting with the NRC Staff (October 18, 2000) regarding the Subtier Criteria, NRC has pointed out and NEI recognizes the ambiguous nature of the use of the word "may" in the DRAFT subtier criteria submitted in April 2000. In an effort to minimize the use of the word "may," to clarify how this word has been interpreted, and to ensure that it is interpreted correctly in future Peer Reviews, the subtier criteria have been revised to reflect more clearly the interpretation of "may" in past Peer Reviews.

As in all peer review processes, the expertise of the Peer Review Team is an essential element of the process. The determination of whether the criteria are met is made by the Peer Review Team. The Peer Review Team report documents meeting the criteria by virtue of the Grades assigned to the individual subelements of the process, along with any supplemental footnotes that may be provided by the reviewers. No further documentation is considered necessary.

Not all aspects of a PRA can be written down in a concise manner that would allow the process to be implemented within a short time frame. Therefore, the criteria and subtier criteria have been implemented in a manner that allows the Team to provide a thorough review of the critical criteria within a one-week review process.

Section 5

SUBTIER CRITERIA

This section includes the tabular information on the PRA Peer Review Process subtier criteria for the following:

Table	Element
5-1	Initiating Event Assessment
5-2	Accident Sequence Evaluation
5-3	Success Criteria and Thermal Hydraulic Analysis
5-4	Systems Analysis
5-5	Data Analysis
5-6	Human Reliability Analysis
5-7	Dependency
5-8	Structural Response
5-9	Quantification & Results Interpretation
5-10	Level 2/LERF Evaluation
5-11	PRA Maintenance and Update

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-1	GUIDANCE • Describes the process used	General description of the initiating event process is provided.	The documentation of the initiating events and its quantification should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for initiating event development and quantification including the updating process.
IE-2	• Consistent with industry practices	General adherence to accepted industry approaches is included.	The documentation or separate specific guidance should provide a reasonable basis for performing the initiating event analysis and should maintain consistency with proven approaches.	The guidance for initiating event analyses should be complete and detailed and should maintain consistency with proven approaches.
IE-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-4	IDENTIFICATION AND GROUPING • Grouped initiators by plant response consistent with event tree structure and success criteria.	Grouping criteria from Grade 3 apply except there may be a relatively high level of conservatism encountered by subsuming initiating events into broad categories.	Grouping of initiating events is limited to the following conditions: • Events can be considered similar in terms of: - plant response - success criteria - timing - recovery probability <u>OR</u> • Events can be subsumed into a group and bounded by the worst case impacts within the "new" group. However, to avoid excess conservatism, low-frequency events are not subsumed if the subsumed initiating event consequences are far worse than those of more frequent group contributors Initiating events with significantly different plant response impacts or which may have more severe radionuclide release potential (e.g., LERF) should be treated separately from other initiating event groups. This includes such initiators as: • excessive LOCA • ISLOCA • Unisolated breaks outside containment Non-conservative grouping (subsuming of initiators into broader categories whose modeled consequences would then be less severe than the event with the most severe consequences) shall not be performed.	Criteria from Grade 3 apply except grouping of initiating events should be minimized to the maximum practical extent to limit conservatisms in the best estimate model.

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
IE-5	• The class of initiating events that is caused by failure of part or all of a system that supports the front-line safety function are addressed: - Cooling water systems (e.g., service water, component cooling water, etc.) - AC Power - DC Power - HVAC - Instrument/Station Air	Support system failures are addressed, but these may be truncated or subsumed within broader groups if it can be shown that the quantitative contribution is expected to be small.	Support system failures should be quantitatively included in the PRA in a realistic fashion. This means that the individual support systems (or trains) whose failure can cause a scram should be treated explicitly in the initiating event quantification.	In addition to the Grade 3 requirements, detailed fault tree quantifications should be included in the model for quantification of this class of events. This quantification should be checked against plant specific and generic experience with similar events, and any significant discrepancies identified and technical bases for resolution identified. Model initiating events (especially those that result from the loss of support systems) using a fault tree (or equivalent) approach so that system dependencies are fully understood and accounted for.
IE-6	• For multi-unit sites with shared systems, the impact of initiators requiring simultaneous response (e.g., LOOP, loss of cooling source due to ice, loss of an AC or DC bus, etc.) are included.	Multi-unit sites with shared systems should acknowledge that dual unit initiators may impact the model. A qualitative evaluation should be performed.	Multi-unit site initiators such as dual unit LOOP events or total loss of service water should be treated and quantified explicitly.	Multi-unit site initiators such as dual unit LOOP events or total loss of service water should be treated and quantified explicitly

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
IE-7	• Initiators considered cover the spectrum of internal event challenges	A structured process for identifying initiating event groups is used, but it provides minimal detail and has a more limited scope than that for Grades 3 and 4 as noted under Grades 3 and 4.	A structured process for identifying initiating event groups should be used. The spectrum of internal event challenges should include the following general categories and within each category should be quantitatively incorporated in the model: • Transients - Separate events with different impacts on PCS[4] and PCS[4] recovery - LOOP/SBO - Manual Shutdowns (resulting in inducing a transient or manual scram) • LOCAs - Small [3] - Medium[3] -- Include stuck open safeties (to the drywell for BWRs) - Large -- Include inadvertant ADS(BWRs) -- Include component ruptures	A structured process for identifying initiating event groups shall be used. The spectrum of internal event challenges shall include at least the following general categories and within each category the events shall be quantitatively incorporated in the model: • Transients - Separate events with different impacts on PCS[4] and PCS[4] recovery - LOOP/SBO - Manual Shutdowns (resulting in inducing a transient or manual scram) • LOCAs - Small [3] - Medium [3] -- Include stuck open safeties (to the drywell for BWRs) - Large -- Include inadvertant ADS(BWRs) -- Include component ruptures

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-7 (cont'd)			- Excessive LOCA -- Include RPV Rupture - LOCAs Outside Containment -- BOC (Break Outside Containment) -- ISLOCA (See NSAC-154) • Special Initiators - Support system failures - Instrument line breaks Internal Flood contributors should be quantified for all non-screened compartments.	- Excessive LOCA -- Include RPV Rupture - LOCAs Outside Containment -- BOC (Break Outside Containment) -- ISLOCA (See NSAC-154) • Special Initiators - Support system failures - Instrument line breaks Internal Flood contributors should be quantified for all non-screened compartments.
IE-8	• All experienced initiators are accounted for in the model	Qualitatively assess and consider the operating experience reviews cited in the Grade 3 requirements. Incorporate those events that are considered important. Document the dismissal of any observed events, including any credit for rectification .	The modeled event groupings reflect the results of the following: A review of plant specific operating experience of all initiators should be performed to assess whether the list of challenges accounts for plant experience. A review of similar plants should be performed to assess whether the list of challenges included in the model accounts for industry experience. Document the dismissal of any observed events, including any credit for rectification .	The modeled event groupings reflect the results of the following: A review of plant specific operating experience of all initiators shall be performed to assess whether the list of challenges accounts for plant experience A review of similar plants shall be performed to assess whether the list of challenges included in the model accounts for industry experience. Document the dismissal of any observed events, including any credit for rectification .
IE-9	• If typical initiators cited in NUREG-1150 or industry PSAs have been excluded, the basis is documented	Exclusion of initiators previously identified in the industry PSAs or NUREG-1150 are justified qualitatively.	Initiators previously identified in industry PSAs or NUREG-1150 should be included; bases for any exclusions should be provided.	Initiators previously identified in industry PSAs or NUREG-1150 shall be included.

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-10	• A structured approach for plant support systems is performed to determine if a loss of support system initiator presents a unique challenge to the plant	At least a qualitative review of system impacts should be performed to identify possible initiating events.	A structured approach (such as a system by system review of initiating event potential, or an FMEA or fault tree) should be used to assess and document the possibility of an initiating event resulting from support system failures. The search for initiating events should consider initiating event precursors and should consider each system alignment and alignments of supporting systems.	A detailed model of system interfaces including fault tree development should be performed. An FMEA shall be performed to assess and document the possibility of an initiating event resulting from individual systems or train failures.
IE-11	<u>Subsumed Initiating Events</u> • Treatment of subsumed initiating events is traceable	A general description of subsumed initiating events is available.	The documentation should provide a detailed accounting of discrete plant upsets and how they transfer into the final initiating event categories, including a focus on numerical details.	The documentation should provide a detailed accounting of discrete plant upsets and how they transfer into the final initiating event categories, including a focus on numerical details.
IE-12	• Subsumed initiating events are included <u>OR</u> • Subsumed initiating events are included, in non-risk significant sequences or non-risk significant initiators <u>OR</u> • Complete list of initiating events within the state of the technology. Detailed plant specific development.	Reflects a substantial degree of subsuming of initiating events and potentially limited traceability in how this was performed. The subsumed initiating events are not risk significant. This includes the consideration that if the initiating events were explicitly treated they would <u>remain</u> non-risk significant.	Initiating events that are subsumed should not be risk significant. This includes the consideration that if the initiating events were explicitly treated they would <u>remain</u> non-risk significant.	Complete list of initiating events within the state of the technology. Detailed plant specific development. Certain groups of subsumed initiators are still possible, e.g., turbine trip events will subsume a number of different potential causes leading to turbine trips.

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-13	<u>DATA</u> • Initiating event frequencies and recovery are consistent with industry experience or analysis	There is limited documentation to support a consistency check of the plant specific initiating event frequencies and recoveries with industry experience or analysis <u>AND</u> specific initiating event frequencies or recoveries are substantially conservative or non-conservative compared with typical values.	The process for comparing initiating events and recovery probabilities should be formalized and documented. The calculated frequencies and any associated recovery should be consistent with industry experience unless a design or procedural difference exists that would provide the basis for a difference. The results of the initiating event analysis should be compared with generic data sources, and documented, to provide a reasonableness check of the quantitative and qualitative results. A documented review/comparison with industry generic data should be performed.	The process for comparing initiating events and recovery probabilities shall be formalized and the results documented. The calculated frequencies and any associated recovery should be consistent with industry experience unless a design or procedural difference exists that would provide the basis for a difference. The results of the initiating event analysis shall be compared with generic data sources, and documented, to provide a reasonableness check of the quantitative and qualitative results. A documented review/comparison with industry generic data should be performed.
IE-14	• The features that lead to the frequency of interfacing system LOCA (e.g., surveillance test practices, start up procedures, etc.) are modeled explicitly or identified in the PRA documentation.	Interfacing system LOCA analysis is performed at a screening level or does not provide a plant specific analysis of the typical dominant contributors to ISLOCA.	Interfacing system LOCA analysis should address the most dominant features of plant and procedures that may influence the ISLOCA frequency.	The ISLOCA frequency should explicitly address the plant and procedural features that influence the calculation: • Surveillance procedure steps should be evaluated • Surveillance test intervals should be explicitly included • On-line surveillance testing should be quantitatively assessed • Pipe rupture probability should be quantified • Valve design (e.g., air operated testable check valves) are explicitly addressed • Valve isolation capability given the high to low pressure differential should be quantitatively included

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
IE-15	• Plant specific features are reflected in the initiating event frequency and recovery inputs where appropriate	The plant specific features that influence initiating events and recovery probabilities should be included in the quantification. For rare events, industry generic data are used or augmented with a plant specific fault tree evaluation which accounts for plant specific features. For extremely rare events, engineering judgement is used and should be augmented by applicable generic data sources, or extremely rare events have been screened out of the analysis based on judgement.	The plant specific features that influence initiating events and recovery probabilities should be included in the quantification. Examples of plant specific features which should be included are the following: • Plant location & climatic features for LOOP and LOOP recovery • Service water intake characteristics and plant experience • LOCA frequency calculation is performed using pipe segment failure rates (e.g., EPRI TR-102266) For rare events, industry generic data should be investigated and augmented with a plant specific fault tree evaluation which accounts for plant specific features. For extremely rare events, engineering judgement is used and should be augmented by applicable generic data sources, or extremely rare events have a traceable description regarding the basis for their exclusion in the quantification model. (5)	The plant specific features that influence initiating events and recovery probabilities should be included in the quantification. Examples of plant specific features which should be included are the following: • Plant location for LOOP and LOOP recovery • Service water intake characteristics and plant experience • LOCA frequency calculation is performed using pipe segment failure rates (e.g., EPRI TR-102266) For rare events, industry generic data shall be investigated and its appropriateness evaluated. In addition, for some events, a plant specific fault tree evaluation which accounts for plant specific features shall be developed. The use of the generic data and the fault tree shall be documented and the comparison provided. For extremely rare events, engineering judgement is used and should be augmented by applicable generic data sources, or extremely rare events have a traceable description regarding the basis for their exclusion in the quantification model.(5)

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
IE-16	• Plant specific experience is reflected in the initiating event definitions and frequency plus recovery inputs where appropriate	The most recent and applicable plant specific data is not used to characterize the initiating event frequency; or, recovery probabilities are not effectively reflected in plant specific features or procedures.	A rational process is defined for quantification of initiating event frequencies based on available plant-specific and generic data. The initiating event frequency should be calculated directly from plant specific data, if sufficient data is available. The initiating event frequency should use the most recent available data to quantitatively characterize the initiating event frequencies. Rectification actions that are credited should be documented. The initiating event frequency should use a Bayesian update process of generic industry data if only limited plant data is available. The initiating event frequency should not use data from the initial year of commercial operation. Recovery data may be even more difficult to justify. However, plant specific information should be used in the assessment where available.	A rational process is defined for quantification of initiating event frequencies based on available plant-specific and generic data. Plant specific data shall be used for all initiating events that have occurred. The initiating event frequency should use the most recent available data to quantitatively characterize the initiating event frequencies. Rectification actions that are credited should be documented. The initiating event frequency should use a Bayesian update process of generic industry data if only limited plant data is available. The initiating event frequency should not use data from the initial year of commercial operation. Recovery data may be even more difficult to justify. However, plant specific information should be used in the assessment where available.
IE-17	• A systematic process is used to identify the need for and application of techniques such as plant specific models or FMEAs, to quantify initiating event frequencies and recovery. (See also SY-21)	---	A systematic evaluation should be performed to ascertain whether a technique such as an FMEA or fault tree should be used for a given system with the intent of quantifying the initiating event. The method chosen should be implemented.	A systematic evaluation should be performed using a defined process (FMEA or Fault tree analysis) for quantifying the initiating event.

Table 5-1

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: INITIATING EVENT

		SUBTIER CRITERIA		
Designator	CRITERIA	Grade 2	Grade 3	Grade 4
IE-18	DOCUMENTATION • Documentation provides the basis of the quantified values and is traceable	The initiating event frequencies shall be documented.	The initiating event frequencies shall be documented. Documentation should provide the derivation of the initiating event frequencies and the recoveries used in conjunction with the initiating event.	The initiating event frequencies shall be documented. Documentation should provide the derivation of the initiating event frequencies and the recoveries used in conjunction with the initiating event.
IE-19	• Documentation reflects the process used	Documentation reflects general process features.	Documentation should provide the basis for meeting each of the criteria IE-4 through IE-17. The documentation shall describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria IE-4 through IE-17. The documentation shall describe the results consistent with the process.
IE-20	• Documentation provides the basis for the initiating event frequency groupings	Documentation should provide the basis for grouping of initiating events.	Documentation should provide the basis for grouping of initiating events.	Documentation shall provide the basis for grouping of initiating events.
IE-21	• Independent review provided for the documented results	The initiating event analysis should be reviewed.	Independent review should be performed and documented by knowledgeable personnel.	Independent review should be performed and documented by knowledgeable personnel. Independent review of the initiating event interpretation and categorization process should be performed by operations personnel or equivalent.

NOTES TO TABLE 5-1:

(1) Conservatively treat the spectrum with at least bounding analysis. This could include the use of generalized groups and the "conservative" treatment of the plant response.

(2) LOOP frequency based on NUREG-1032 or equivalent; ISLOCA frequency based on plant specific features and NSAC-154 or equivalent.

(3) For PWRs, random RCP seal LOCA, stuck open primary safety valves, and stuck open primary power operated relief valves are included in the small or medium LOCA categories, as appropriate to the equipment and category definitions, unless treated explicitly

(4) Power conversion Systems (PCS)

(5) The following characteristics may be used as screening criteria to eliminate events from further evaluation:

- The frequency of the event is less than 1E-7 per reactor-year(/ry) and the event doews not involve either an ISLOCA, containment bypass, or vessel rupture
- The frequency of the event is less than 1E-6/ry and core damage could not occur unless at least two active trains of diverse mitigating systems are independently failed
- The resulting reactor trip is not an immediate occurrence. That is, the event does not require the plant to go to shutdown conditions until sufficient time has expired during which the initiating event conditions, with a high degree of certainty (based on supporting calculations), are detected and corrected before normal plant operation is curtailed (either administratively or automatically)

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-1	GUIDANCE • Describes the process used	General description of the accident sequence analysis process is provided.	The documentation of the accident sequence analysis should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for accident sequence analysis including the updating process.
AS-2	• Consistent with industry practices	General adherence to accepted industry approaches is included.	The documentation or separate specific guidance should provide a reasonable basis for performing the accident sequence analysis and should maintain consistency with proven approaches.	The guidance for accident sequence analysis should be complete and detailed and should maintain consistency with proven approaches.
AS-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
AS-4	ACCIDENT SCENARIO EVALUATION • The event trees reflect the initiating event groupings	Event trees should reflect the initiating event groups. The plant response to the different initiating event groups shall be modeled. This includes: timing, system success criteria, operator actions. The level of detail, scope and completeness may be less than that for Grades 3 and 4. There should be a direct correlation between the initiating event groups and the event tree modeled response. Note: while event trees should be developed, other logic models may be justified to replace the event tree structure (e.g., single top fault tree).	Event trees shall reflect the initiating event groups. The plant response to the different initiating event groups shall be modeled. This includes: timing, system success criteria, operator actions. The level of detail, scope and completeness should be at the current state of the technology with few, if any, exceptions which must be determined to be inconsequencial. There should be a direct correlation between the initiating event groups and the event tree modeled response. The event trees should reflect the initiating events and their potential for impact on mitigation systems. Note, while event trees should be developed, other logic models may be justified to replace the event tree structure (e.g., single top fault tree).	Event trees shall reflect the initiating event groups. The plant response to the different initiating event groups shall be modeled. This includes: timing, system success criteria, operator actions. The level of detail, scope and completeness shall be at the current state of the technology. There shall be a direct correlation between the initiating event groups and the event tree modeled response. The event trees should reflect the initiating events and their potential for impact on mitigation systems. Note: While event trees should be developed, other logic models may be justified to replace the event tree structure (e.g., single top fault tree).

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-5	• The models and analysis are consistent with the as-built plant (as could be confirmed during the Peer Review process)[6]	The models and analysis should be consistent with the as-built plant. Conservative modeling of the as-built plant results from lack of available information. System analysis and dependency evaluation tasks of the PRA shall provide input to the accident sequence model development.	The models and analysis shall be consistent with the as-built plant. Realistic modeling of the as-built plant should be performed as supported by available information. System analysis and dependency evaluation tasks of the PRA shall provide input to the accident sequence model development.	The models and analysis shall be consistent with the as-built plant. Realistic modeling of the as-built plant shall be performed as supported by available information. System analysis and dependency evaluation tasks of the PRA shall provide input to the accident sequence model development.
AS-6	• The necessary critical safety functions are modeled in each sequence	The necessary critical safety functions to reach a safe stable state shall be included in the model. Critical safety functions are addressed either quantitatively or qualitatively in the PRA. *Example for BWRs* Typical critical safety functions that may be left out of a risk ranking model may include: • Vapor Suppression • RPT • ARI • Containment heat removal following: - successful ATWS mitigation - successful AC power recovery	The necessary critical safety functions to reach a safe stable state shall be included in the model. Each necessary critical safety function should be explicitly included in the quantitative model. Exceptions to the critical safety functions should be clearly defined.	The necessary critical safety functions to reach a safe stable state shall be included in the model. Each necessary critical safety function shall be explicitly included in the quantitative model. Exceptions to the critical safety functions should be clearly defined.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-7	• All relevant systems are credited for each function	--	All relevant systems should be credited in the quantified model. The principal issues related to the determination of a relevant system are: • Does the system influence success criteria used in the PRA? • Can a system by itself result in a system success? • If so, is it always a success (or is the success dependent on the power level)? • Can the success of the system be supported by available thermal hydraulic analysis? • Is the system independent of non-safety power or controls that may not be available when required as backup? If all questions are answered "Yes," then the system should be included in the PRA.	All relevant systems to support the critical safety functions shall be included in the quantified model. The principal issues related to the determination of a relevant system are: • Does the system influence success criteria used in the PRA? • Can a system by itself result in a system success? • If so, is it always a success (or is the success dependent on the power level)? • Can the success of the system be supported by available thermal hydraulic analysis? • Is the system independent of non-safety power or controls that may not be available when required as backup? If all questions are answered "Yes," then the system should be included in the PRA.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-8	• The branching structure and transfers among event trees maintain and resolve the failure paths	The branching structure and transfers among event trees should maintain and resolve the failure paths. A reasonably complete set of event sequences involving core damage that could result from each modeled initiating event should be developed. The level of discrimination in the event tree structure should be sufficient to represent the critical safety function challenges. The transfers among event trees should preserve the dependencies that are part of the transferred sequence. This includes functional, system, initiating event, operator, and spatial or environmental dependencies.	The branching structure and transfers among event trees shall maintain and resolve the failure paths. Transfers between event trees should be clearly defined and may be treated quantitatively or qualitatively. A reasonably complete set of event sequences involving core damage that could result from each modeled initiating event shall be developed. The level of discrimination in the event tree structure should be sufficient to represent the critical safety function challenges. The transfers among event trees should preserve the dependencies that are part of the transferred sequence. This includes functional, system, initiating event, operator, and spatial or environmental dependencies.	The branching structure and transfers among event trees shall maintain and resolve the failure paths. Transfers between event trees shall be clearly defined and treated quantitatively. A reasonably complete set of event sequences involving core damage that could result from each modeled initiating event shall be developed. The level of discrimination in the event tree structure should be sufficient to represent the critical safety function challenges. The transfers among event trees shall preserve the dependencies that are part of the transferred sequence. This includes functional, system, initiating event, operator, and spatial or environmental dependencies.
AS-9	• Success paths are defined correctly	Success paths shall be defined correctly. Conservative bias to the treatment of success paths are included.	Success paths shall be defined correctly. Realistic treatment of success paths should be implemented.	Success paths shall be defined correctly. Realistic treatment of success paths shall be implemented.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-10	• Dependencies among top events are identified and addressed	Dependencies among top events should be identified and are treated quantitatively or qualitatively. Accident sequence dependencies should be accounted for. <u>Functional</u>: Functional failures due to the accident sequence should be addressed, e.g.: a) LOCA initiator causes debris clogging of ECCS Suction b) turbine driven system dependency on SORV, depressurization, and containment heat removal (suppression pool cooling). (BWRs) c) low pressure system injection success dependent on need for RPV depressurization. d) Unavailability of TBV due to loss of condenser vacuum (PWRs). <u>Intra and Intersystem</u>: Common cause may be treated per dependency criteria. System dependencies can be assessed in system notebooks, dependency matrices, or linked fault trees. <u>Human</u>: Adverse environment or sequence timing influences on operator actions are treated in general ways without sufficient detail to establish traceability and reproducibility in the HRA. <u>Spatial/Environmental</u>: Spatial/ Environmental dependencies that may result from initiating events and subsequent sequences are treated in general ways without sufficient detail to establish traceability and reproducibility in the accident sequence evaluation.	Dependencies among top events shall be identified and should be included quantitatively in the model. Accident sequence dependencies shall be accounted for. <u>Functional</u>: Functional failures due to the accident sequence should be addressed, e.g.: a) LOCA initiator causes debris clogging of ECCS Suction b) turbine driven system dependency on SORV, depressurization, and containment heat removal (suppression pool cooling). (BWRs) c) low pressure system injection success dependent on need for RPV depressurization. d) Unavailability of TBV due to loss of condenser vacuum (PWRs). <u>Intra and Intersystem</u>: Common cause shall be treated per dependency criteria. System dependencies should be assessed in system notebooks, dependency matrices, or linked fault trees. <u>Human</u>: Adverse environment or sequence timing influences on operator actions shall be included in the HRA. <u>Spatial/Environmental</u>: Spatial/Environmental dependencies that may result from initiating events and subsequent sequences shall be included in the accident sequence evaluation.	Dependencies among top events shall be identified and shall be quantitatively included in the model. Accident sequence dependencies shall be accounted for. <u>Functional</u>: Functional failures due to the accident sequence shall be addressed, e.g.: a) LOCA initiator causes debris clogging of ECCS Suction b) turbine driven system dependency on SORV, depressurization, and containment heat removal (suppression pool cooling). (BWRs) c) low pressure system injection success dependent on need for RPV depressurization. d) Unavailability of TBV due to loss of condenser vacuum (PWRs). <u>Intra and Intersystem</u>: Common cause shall be treated per dependency criteria. System dependencies shall be assessed in system notebooks, dependency matrices, or linked fault trees. <u>Human</u>: Adverse environment or sequence timing influences on operator actions shall be included in the HRA. <u>Spatial/Environmental</u>: Spatial/ Environmental dependencies that may result from initiating events and subsequent sequences shall be included in the accident sequence evaluation.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-11	• The method of treating dependencies is documented and consistently applied to capture the dependencies among top events.	The method of treating dependencies should be documented and consistently applied to capture the dependencies among top events. Conservative bias to the treatment of dependencies are incorporated into the model.	The method of treating dependencies should be documented and consistently applied to capture the dependencies among top events. A realistic treatment of the dependencies should be implemented.	The method of treating dependencies shall be documented and consistently applied to capture the dependencies among top events. A realistic treatment of the dependencies shall be implemented.
AS-12	• PWRs: An appropriate model for the reactor coolant pump seal LOCA, which may result from a loss of seal cooling due to various causes, is used and documented. Appropriate seal cooling dependencies are considered. OR • BWRs: The recirculation pump seal LOCA which may result after a loss of offsite power, or a loss of seal cooling is addressed for the isolation condenser plants	Pump seal LOCA should be explicitly incorporated in the PSA model.	Pump seal LOCA should be explicitly incorporated in the PSA model.	Pump seal LOCA shall be explicitly incorporated in the model.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-13	• Time phased evaluation is included for sequences with significant time dependent failure modes (e.g., batteries for SBO, PWR RCP seal LOCA) and significant recoveries (e.g., AC recovery for SBO)	--	Time phased analysis for accident sequences with well defined potential for recovery should be included in the quantified model. The following time phased events may be included in a realistic assessment of the accident sequences and the procedurally directed operator actions resulting for LOOP/SBO; • AC power recovery • DC battery adequacy (time dependent discharge) • Environmental conditions (e.g., room cooling) for operating equipment and the control room • Suppression pool temperature (i.e., HCTL) (BWRs) • Containment pressure • CST or RWST or BWST inventory • Drywell temperature (BWR) • Recirc Pump Seal Failure • RPV Pressure (as it is needed for turbine driven systems, IC effectiveness, low pressure injection systems) • Isolation Condenser Makeup (BWR) Similarly, for ATWS/failure to scram events, key time dependent actions which may be included: • SBLC initiation (BWR) • RPV level control (BWR) • ADS inhibit (BWR)	Time phased analysis for accident sequences with well defined potential for recovery shall be included in the quantified model. The following time phased events should be included in a realistic assessment of the accident sequences and the procedurally directed operator actions resulting for LOOP/SBO; • AC power recovery • DC battery adequacy (time dependent discharge) • Environmental conditions (e.g., room cooling) for operating equipment and the control room • Suppression pool temperature (i.e., HCTL) (BWRs) • Containment pressure • CST or RWST or BWST inventory • Drywell temperature (BWR) • Recirc Pump Seal Failure • RPV Pressure (as it is needed for turbine driven systems, IC effectiveness, low pressure injection systems) • Isolation Condenser Makeup (BWR) Similarly, for ATWS/failure to scram events, key time dependent actions which should be included: • SBLC initiation (BWR) • RPV level control (BWR) • ADS inhibit (BWR)

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-13 (cont'd)			Other events that may be subject to strong time dependent characterization include: • CRD as an adequate RPV injection source (BWR) As part of the time dependence assessment, the following should be addressed: • Mission time of diesel generators • Mission time of RPT, ARI, scram system (BWR) • Component Cooling surge tank leaks causes loss of closed Loop cooling NPSH	Other events that may be subject to strong time dependent characterization include: • CRD as an adequate RPV injection source (BWR) As part of the time dependence assessment, the following should be addressed: • Mission time of diesel generators • Mission time of RPT, ARI, scram system (BWR) • Component Cooling surge tank leaks causes loss of closed Loop cooling NPSH
AS-14	• Functions and structure are adequate to discriminate among plant conditions necessary for Level 2 analysis	LERF should be able to be determined from the Level 1 end state results. The degree of accident sequence discrimination should be sufficient to allow LERF determination in the Level 2 Evaluation.	LERF shall be able to be determined from the Level 1 end state results. Accident sequences with significantly different plant response impacts or which may have more severe radionuclide release potential (e.g., LERF) should be treated explicitly. This includes: • excessive LOCA • ATWS • ISLOCA • Breaks in high energy lines outside containment • Steam generator tube rupture (PWR) These should be evaluated in a realistic manner and have the capability to be assessed in sensitivity studies. Non-conservative grouping (subsuming of sequences into broader categories not bounded by the worst case accident) shall not be performed.	LERF shall be able to be determined from the Level 1 end state results. Accident sequences with significantly different plant response impacts or which may have more severe radionuclide release potential (e.g., LERF) should be treated explicitly. This includes: • Excessive LOCA • ATWS • ISLOCA • Breaks in high energy lines outside containment • Steam generator tube rupture (PWR) These shall be evaluated in a realistic manner and have the capability to be assessed in sensitivity studies. Non-conservative grouping (subsuming of sequences into broader categories not bounded by the worst case accident) shall not be performed.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-15	• Transfers among event trees are performed correctly to avoid loss of information in the transfer	Transfers among event trees should be explicitly treated in the quantification except for cases that are noted in the documented descriptions of the sequences. Treatment of single top fault tree as the base model shall conform to all applicable requirements. Requirements that cannot be met should be identified and justification provided.	Transfers among event trees should be explicitly treated in the quantification and shall be documented. Treatment of single top fault tree as the base model shall conform to all applicable requirements. Requirements that cannot be met should be identified and justification provided.	Transfers among event trees shall be explicitly treated in the quantification and documented. Treatment of single top fault tree as the base model shall conform to all applicable requirements. Requirements that cannot be met should be identified and justification provided.
AS-16	• System/component repair and recovery, if included in the accident sequences, are correctly modeled	Conservative evaluations of repair and recovery are incorporated in the model.	Repair and recovery included in the PSA model should be based on data or accepted models applicable to the plant and should account for accident sequence dependencies such as time available, adverse environment, and lack of access, lighting, or room cooling.	Repair and recovery included in the PSA model shall be based on data or accepted models applicable to the plant and shall account for accident sequence dependencies such as time available, adverse environment, and lack of access, lighting, or room cooling.
AS-17	SUCCESS CRITERIA • Functional success criteria are identified	Functional success criteria should be identified and documented. The critical safety functions(*) that should have technical bases developed to support the probabilistic analyses examples include the following: • Reactivity Control - Control Rods - Boron Injection - RPV Water Level Control - Moderator Temperature Coefficient Treatment (PWR)	Functional success criteria should be identified and documented. The critical safety functions(*) that should have technical bases developed to support the probabilistic analyses examples include the following: • Reactivity Control - Control Rods - Boron Injection - RPV Water Level Control - Moderator Temperature Coefficient Treatment (PWR)	Functional success criteria should be identified and documented. The critical safety functions(*) that should have technical bases developed to support the probabilistic analyses examples include the following: • Reactivity Control - Control Rods - Boron Injection - RPV Water Level Control - Moderator Temperature Coefficient Treatment (PWR)

(*) Optional critical safety functions that may be applicable to specific plant risk profiles incude:
- Containment temperature control
- Containment water level control (applicable to loss of torus/suppression pool water)--BWRs

Distinctions between Grade 2 and 3 are based on the level of detail provided in the model and the traceability of the critical safety function to a logical and structured examination of the accident response functions.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-17 (cont'd)		• RPV Makeup Injection for Core Cooling - High Pressure Injection - Low Pressure Injection - Depressurization - Containment Flooding (BWR) - Feed and Bleed (PWR) • RPV Pressure Control - SRVs/SVs/TBVs/PORVs - Feedwater Trip - RPT (BWR) - ARI (BWR) - Control rods - IC (BWR) - Steam Generator Level Control (PWR) • Containment Pressure Control - Vapor Suppression (BWR) - Containment Heat Removal - Containment Venting	• RPV Makeup Injection for Core Cooling - High Pressure Injection - Low Pressure Injection - Depressurization - Containment Flooding (BWR) - Feed and Bleed (PWR) • RPV Pressure Control - SRVs/SVs/TBVs/PORVs - Feedwater Trip - RPT (BWR) - ARI (BWR) - Control rods - IC (BWR) - Steam Generator Level Control (PWR) • Containment Pressure Control - Vapor Suppression (BWR) - Containment Heat Removal - Containment Venting	• RPV Makeup Injection for Core Cooling - High Pressure Injection - Low Pressure Injection - Depressurization - Containment Flooding (BWR) - Feed and bleed (PWR) • RPV Pressure Control - SRVs/SVs/TBVs/PORVs - Feedwater Trip - RPT (BWR) - ARI (BWR) - Control rods - IC (BWR) - Steam Generator Level Control (PWR) • Containment Pressure Control - Vapor Suppression (BWR) - Containment Heat Removal - Containment Venting

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-18	SUCCESS CRITERIA BASES • Success criteria are consistent with generic and realistic analyses but may be conservative OR • Success criteria are based on realistic thermal hydraulic analyses OR • Success criteria reflect plant specific thermal hydraulic analysis	Success criteria should be consistent with generic analyses but may be conservative. The success criteria used for the initiating event group and its associated event tree shall represent the most limiting of the initiating events and system failures encompassed by the initiating event group and accident sequence representation. The TH Element addresses the technical bases to support these success criteria.	Success criteria should be based on realistic thermal hydraulic analyses. The success criteria used for the initiating event group and its associated event tree shall represent the most limiting of the initiating events and system failures encompassed by the initiating event group and accident sequence representation. The TH Element addresses the technical bases to support these success criteria.	Success criteria should reflect realistic plant specific thermal hydraulic analysis. The success criteria used for the initiating event group and its associated event tree shall represent the most limiting of the initiating events and system failures encompassed by the initiating event group and accident sequence representation. The TH Element addresses the technical bases to support these success criteria.
AS-19	INTERFACE WITH EOPs/AOPs • Reflects the EOPs and AOPs. (The functions and structure of the event trees are consistent with the EOPs and abnormal procedures). (See also SY-5)	The functions and structure of the event trees should be consistent with the EOPs and abnormal procedures. Exceptions may be noted; or level of detail may be reduced compared with Grades 3 and 4.	The functions and structure of the event trees shall be consistent with the EOPs and abnormal procedures. Procedurally directed operator actions (both positive and negative impacts) that substantially influence the accident sequence progression or its probability should be accounted for in the accident sequence structure or the supporting fault tree analysis. This should include operator or training input on the interpretation of proceduralized steps.	The functions and structure of the event trees shall be consistent with the EOPs and abnormal procedures. Procedurally directed operator actions (both positive and negative impacts) that substantially influence the accident sequence progression or its probability shall be accounted for in the accident sequence structure or the supporting fault tree analysis. This shall include operator or training input on the interpretation of proceduralized steps.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
AS-20	ACCIDENT SEQUENCE END-STATES (PLANT DAMAGE STATES) (5) • The development of plant damage states, their relationship to functional failures, and their relationship to Level 1 event tree end states or linked fault tree cut sets is documented.	The Level 1 end states shall be clearly defined as core damage or a safe stable state. Other end states such as "core vulnerable" should be resolved into core damage or safe stable states. This resolution should clearly address the treatment of the impact of containment failure or vent on continued RPV makeup capability.	The Level 1 end states shall be clearly defined as core damage or a safe stable state. The core damage definition should be consistent with the PSA Applications Guide. The PSA Applications Guide has identified definitions of core damage that would meet the intent of a core damage to be used for PRA applications as follows: • Collapsed liquid level less than 1/3 core height (BWR) • Collapsed liquid level below top of active fuel (PWR) • Core peak nodal temperature > 1800°F • Core exit thermocouple reading > 1200°F (PWR) • Core maximum fuel temperature approaching 2200°F Other end states such as "core vulnerable" shall be resolved into core damage or safe stable states. This resolution shall clearly address the treatment of the impact of containment failure or vent on continued RPV makeup capability.	The Level 1 end states shall be clearly defined as core damage or a safe stable state. The core damage definition shall be consistent with the PSA Applications Guide. The PSA Applications Guide has identified definitions of core damage that would meet the intent of a core damage to be used for PRA applications as follows: • Collapsed liquid level less than 1/3 core height (BWR) • Collapsed liquid level below top of active fuel (PWR) • Core peak nodal temperature > 1800°F • Core exit thermocouple reading > 1200°F (PWR) • Core maximum fuel temperature approaching 2200°F Other end states such as "core vulnerable" shall be resolved into core damage or safe stable states. This resolution shall clearly address the treatment of the impact of containment failure or vent on continued RPV makeup capability.
AS-21	• Plant damage states are sufficient to support the transfer of information to Level 2	Level 1 plant damage states should provide adequate information to support Level 2 analysis with minimal loss of information. If individual sequence cut sets are assigned to Plant Damage States (PDS), sufficient information are not imbedded in the cutset basic events to unambiguously assign a unique PDS but the PDS assignment is based on a process that is traceable and yields reasonable results.	Level 1 plant damage states shall provide adequate information to support Level 2 analysis with minimal loss of information. If individual sequence cut sets are assigned to Plant Damage States (PDS), sufficient information should be imbedded in the cutset basic events to unambiguously assign a unique PDS.	All accident sequences are transferred directly to Level 2 for processing with no loss of information. If individual sequence cut sets are assigned to Plant Damage States (PDS), sufficient information shall be imbedded in the cutset basic events to unambiguously assign a unique PDS.

Table 5-2

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: ACCIDENT SEQUENCE EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
AS-22	• Plant damage states are based on a clear, consistent definition of CDF that is consistent with industry usage	The CDF definition is conservative and the results of the quantified model are biased.	The CDF definition should be realistic and avoid biasing the results of the Level 1 PRA.	The CDF definition shall be realistic and avoid biasing the results of the Level 1 PRA.
AS-23	• Plant damage states are based on mission time of 24 hours or separately justified	The mission time represents the accident sequence. Alternative mission times may be included if additional justification is provided.	The mission time should be defined to be 24 hours or an appropriate representation for the accident sequence. Alternative mission times may be included if additional justification is provided.	The mission time should be defined to be 24 hours or an appropriate representation for the accident sequence. Alternative mission times may be included if additional justification is provided.
AS-24	<u>DOCUMENTATION</u> • Documentation provides the basis of event tree structure and is traceable to plant specific or generic analysis	Examples of methods of documentation include: event sequence diagrams, text descriptions dependency matrices.	Examples of methods of documentation include: event sequence diagrams, text descriptions, and dependency matrices. Documentation should provide the basis for meeting each of the criteria AS-4 through AS-23. The documentation shall describe the results consistent with the process.	Examples of methods of documentation include: event sequence diagrams, text descriptions, and dependency matrices. Documentation shall provide the basis for meeting each of the criteria AS-4 through AS-23. The documentation shall describe the results consistent with the process.
AS-25	• Documentation reflects the process used	Documentation reflects general process features.	Documentation should provide the basis for accident sequence process.	Documentation shall provide the basis for accident sequence process.
AS-26	• Documentation includes an independent review for the documented results	The accident sequence analysis should be reviewed.	A documented summary of the treatment of each initiator and event tree should be available to support applications. Independent review should be performed and documented by knowledgeable personnel.	A documented summary of the treatment of each initiator and event tree should be available to support applications. Independent review should be performed and documented by knowledgeable personnel. Independent review of the initiating event interpretation and categorization process should be performed by operations personnel or equivalent.

Notes to Table AS:

(1) Not all event trees are required to be quantified. There may be initiating events and event trees that are screened from consideration.

(2) Vulnerabilities may be identified even with extreme definitions of what constitutes a core damage event, e.g.,

Water Level Below Top of Active Fuel

OR

Large core melt event

(3) Mission times other than 24 hours can be effectively used to identify vulnerabilities.

(4) The PSA Applications Guide has identified definitions of core damage that would meet the intent of a core damage to be used for PRA applications as follows:

- Collapsed liquid level less than 1/3 core height (BWR)
- Collapsed liquid level below top of active fuel (PWR)
- Core peak nodal temperature > 1800°F
- Core exit thermocouple reading > 1200°F (PWR)
- Core maximum fuel temperature approaching 2200°F

These definitions are provided as general guidelines. In some cases, alternative definitions can be justified.

(5) Plant damage states are collections of accident sequence end states according to plant conditions at the onset of severe core damage. The plant conditions considered are those that determine the capability of the containment to cope with a severe core damage accident. The plant damage states represent the interface between the Level 1 and Level 2 analyses. (Also refer to Element L2).

(6) The peer review process does not have as a primary objective to confirm that the model corresponds to the as-built plant. The "as-built" review is one that examines the model applicability as information is presented to the peer review group. The peer review does not provide an independent review of the as-built features of the plant to ensure that they are included except as it may result from the PRA peer review process. This may occur if information becomes available as a result of the review that indicates the model is different than the as-built plant and there is limited or no basis to support the differences; in such a case, substantially lower grades can be assigned. The Maintenance and Update of the PRA is the element that ensures that a process is in place to capture changes in plant configuration practices, or procedures.

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-1	GUIDANCE • Describes the process used	General description of the derivation of success criteria and the use of thermal hydraulic calculations is provided.	The documentation of the derivation of success criteria and the use of thermal hydraulic calculations should be sufficiently well described in the documented results to act as guidance for future updates and revisions. A description of the approach to be used for determining the need for thermal hydraulic (T&H) calculations and the type of T&H calculation to perform along with the output needed should be provided.	A specific guidance document should be available that specifies the process for derivation of success criteria and the use of thermal hydraulic calculations including the updating process. A description of the approach to be used for determining the need for thermal hydraulic (T&H) calculations and the type of T&H calculation to perform along with the output needed should be provided. An overall guidance document on the construction and maintenance of the PRA should include a description of the types of thermal-hydraulic analyses needed and their applicability.
TH-2	• Consistent with industry practices	General adherence to accepted industry approaches is included.	The documentation or separate specific guidance should provide a reasonable basis for performing the derivation of success criteria and the use of thermal hydraulic calculations and should maintain consistency with proven approaches.	The guidance for derivation of success criteria and the use of thermal hydraulic calculations should be complete and detailed, and should maintain consistency with proven approaches.
TH-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance should be sufficiently detailed to reproduce the results.

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-4	<u>T&H ANALYSES</u> • FSAR analyses are used exclusively as basis for Thermal Hydraulic analysis <u>OR</u> • Generic assessments are used as sole basis for Thermal Hydraulic analysis <u>OR</u> • Plant specific best-estimate (e.g., MAAP, RETRAN, etc.) models or equivalent are used for support of Thermal Hydraulic analysis (supported by FSAR or generic analysis)	AS-17 provides the criteria that functional success criteria should be established for all critical safety functions. AS-20 provides the criteria that core damage prevention should be the basis for assuring successful end states. This element and subtier criteria establish the technical analysis used to support these success criteria. Generic assessments are used as the sole basis for thermal hydraulic analysis. <u>OR</u> Conservative analyses are used exclusively as basis for Thermal Hydraulic analysis	AS-17 provides the criteria that functional success criteria should be established for all critical safety functions. AS-20 provides the criteria that core damage prevention should be the basis for assuring successful end states. This element and subtier criteria establish the technical analysis used to support these success criteria. Realistic generic assessments may be used as sole basis for Thermal Hydraulic analysis as long as the generic analyses are shown to be representative of the plant. The use of some conservative (e.g., FSAR) analyses is not precluded, but some attempt should have been made to understand and minimize the impact on the PRA results. These may be supplemented by realistic plant specific analysis on selected sequences.	AS-17 provides the criteria that functional success criteria shall be established for all critical safety functions. AS-20 provides the criteria that core damage prevention shall be the basis for assuring successful end states. This element and subtier criteria establish the technical analysis used to support these success criteria. Plant specific best-estimate (e.g., MAAP, RETRAN, etc.) models or equivalent should be used for support of Thermal Hydraulic analysis (supported by FSAR or generic analysis). The limited use of some conservative (e.g., FSAR) analyses is not precluded, but some attempt should have been made to understand and minimize the impact on the PRA results.
TH-5	<u>MULTIPLE T&H INPUTS</u> • A combination of plant specific, generic and FSAR calculations are used to support success criteria and HRA timing.	The as-built, as-operated thermal hydraulic analyses are not explicitly compared with other calculations in the available documentation, however, it appears that the utility process is adequate to ensure that the models represent the current plant.	The review of the as-built, as-operated plant performed as part of the AS, SY, and HRA elements should be used to confirm that the inputs and outputs of the thermal hydraulic analyses are current with the plant.	The review of the as-built, as-operated plant performed as part of the AS, SY, and HRA elements shall be used to confirm that the inputs and outputs of the thermal hydraulic analyses are also current with the plant.

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-5 (cont'd)		The analysis should include consideration of whether the code is capable of providing the necessary information, and the model is representative of the specific plant to which the results are to be applied.	Reliance on plant specific analysis should include consideration of whether the code is capable of providing the necessary information and the model is representative of the specific plant to which the results are to be applied. For example, for PWRs, the MAAP code is generally not suitable for use in analysis of the blowdown phase of large break LOCAs, or for events requiring the ability to accurately model rapid core reactivity transients. For BWRs, two items are believed not to be well modeled. *For BWR only* For example, two items are believed not to be well modeled using MARCH, OR BWRSAR, or MAAP: a) The need for RPT to prevent reactivity and pressure excursion in the RPV within the initial 20 seconds of an ATWS b) The ability of a DBA LOCA to be mitigated in the short term by operation of condensate.	Reliance on plant specific analysis shall include consideration of whether the code is capable of providing the necessary information and the model is representative of the specific plant to which the results are to be applied. For example, for PWRs, the MAAP code is generally not suitable for use in analysis of the blowdown phase of large break LOCAs, or for events requiring the ability to accurately model rapid core reactivity transients. For BWRs, two items are believed not to be well modeled. *For BWR only* For example, two items are believed not to be well modeled using MARCH or BWRSAR, or MAAP: a) The need for RPT to prevent reactivity and pressure excursion in the RPV within the initial 20 seconds of an ATWS b) The ability of a DBA LOCA to be mitigated in the short term by operation of condensate.

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-5 (cont'd)			*For BWRs only* The generic BWROG document NEDO-24708A using the code SAFE is judged to be usable for the generic inputs to the T&H assessment. This calculation may also be used to support results from codes such as MAAP. An example of an area where the use of the NEDO-24708A would prove useful is to identify that RCIC alone as an injection source is not adequate under SORV conditions. Generic calculations from NEDE-24222 or equivalent are usable to provide ATWS success criteria or check plant specific calculations.	For BWRs only The generic BWROG document NEDO-24708A using the code SAFE is judged to be a useful reference for confirming plant specific analyses. This calculation should be used to support results from codes such as MAAP. An example of an area where the use of the NEDO-24708A would prove useful is to identify that RCIC alone as an injection source is not adequate under SORV conditions. Generic calculations from NEDE-24222 or equivalent should be used to check ATWS success criteria and plant specific calculations.
TH-6	GENERIC ASSESSMENTS • Application of the generic assessments account for limitations of the generic analysis when applied to the specific plant	Reliance on generic analysis should include consideration of whether the code and methods are capable of providing the necessary information.	Reliance on generic analysis should include consideration of whether the code and methods are capable of providing the necessary information.	Reliance on generic analysis for comparison or confirmation purposes shall include consideration of whether the code and methods are capable of providing the necessary information.
TH-7	BEST ESTIMATE CALCULATIONS (e.g., MAAP, RETRAN, SAFER-GESTER) • Application of the T & H codes account for the limitations of each of the codes	Confidence in the thermal hydraulic analysis used to support the success criteria is established by limited degrees of the following: • comparison with similar plant results • accounting for differences in the unique plant features • comparison with other plant specific code results	Confidence in the thermal hydraulic analysis used to support the success criteria should be established. This should be accomplished by one or more of the following or their equivalent: • comparison with similar plant results • accounting for differences in the unique plant features • comparison with other plant specific code results	Confidence in the thermal hydraulic analysis used to support the success criteria shall be established. This shall be accomplished by one or more of the following or their equivalent: • comparison with similar plant results • accounting for differences in the unique plant features • comparison with other plant specific code results

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-7 (cont'd)			Success criteria are generally based on models that simulate the conditions during postulated scenarios. However, the adequacy of the simulation varies with the computer model and the scenario. A description of the limitations of the model should be documented for those cases in which the model is used. This should include both potential conservatisms and limitations that may void the use of the computer model. The success criteria should provide a proper basis for the probabilistic analysis. General references should be provided, and the specific case references for each success criteria should be provided to assure traceability if needed in the future.	Success criteria are generally based on models that simulate the conditions during postulated scenarios. However, the adequacy of the simulation varies with the computer model and the scenario. A description of the limitations of the model should be documented for those cases in which the model is used. This should include both potential conservatisms and limitations that may void the use of the computer model. The success criteria should provide a proper basis for the probabilistic analysis. General references should be provided, and the specific case references for each success criteria should be provided to assure traceability if needed in the future.
		Conservative thermal hydraulic calculations to support timing estimates are used in the HRA evaluations.	Realistic, generic, thermal hydraulic calculations to support timing estimates should be used in the HRA evaluations. Plant specific realistic analysis may also be used. The use of some conservative (e.g., FSAR) analyses is not precluded, but some attempt should have been made to understand and minimize the impact on the PRA results.	Realistic thermal hydraulic calculations to support timing estimates shall be used in the HRA evaluations. The limited use of conservative (e.g., FSAR) analyses is not precluded, but some attempt shall be made to understand and minimize the impact on the PRA results.

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-8	ROOM HEATUP CALCULATIONS • Documented evaluation available to support the modeling decisions, OR • Plant specific realistic calculations or tests are available to support the modeling decisions regarding room heatup.	System success criteria to ensure adequate mission time capability should be established with room cooling calculations or tests. These calculations or tests should coincide with the accident sequence conditions or be justified.	System success criteria to ensure adequate mission time capability should be established with calculations or tests. These calculations or tests should coincide with the accident sequence conditions or be justified.	System success criteria to ensure adequate mission time capability should be established with plant specific realistic calculations or tests. These calculations or tests should coincide with the accident sequence conditions or be justified. Room heatup calculations should be performed using a computer code such as the GOTHIC code.
TH-9	DOCUMENTATION • Documentation provides the basis of the Thermal Hydraulic Analysis, is traceable to plant specific or generic analysis, and demonstrates the reasonableness of the success criteria.	Documentation should provide the basis for meeting each of the criteria TH-4 through TH-8. The documentation shall describe the results consistent with the process. Conservative, optimistic, or simplifying assumptions or conditions are identified but limited justification is available to support their use.	Documentation should provide the basis for meeting each of the criteria TH-4 through TH-8. The documentation shall describe the results consistent with the process. Conservative, optimistic, or simplifying assumptions or conditions should be identified and specific justification shall be provided for their use. Specific Success Criteria related items that should be documented including the following: • room cooling treatment • DFP alignment success probability when performed under SBO conditions involving load shedding of all essential lighting (if applicable)	Documentation should provide the basis for meeting each of the criteria TH-4 through TH-8. The documentation shall describe the results consistent with the process. Conservative, optimistic, or simplifying assumptions or conditions shall be identified and specific justification shall be provided for their use. Specific Success Criteria related items that should be documented including the following: • room cooling treatment • DFP alignment success probability when performed under SBO conditions involving load shedding of all essential lighting (if applicable)

Table 5-3

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SUCCESS CRITERIA AND THERMAL HYDRAULIC ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
TH-9 (cont'd)			*For BWRs Only* • RCIC & DFP success given SBO • RCIC success following Emergency Depressurization • Depressurization requirement for Medium LOCA with RCIC initially available (conservative assumption)	*For BWRs Only* • RCIC & DFP success given SBO • RCIC success following Emergency Depressurization • Depressurization requirement for Medium LOCA with RCIC initially available (conservative assumption)
TH-10	• Documentation reflects the process used	Documentation reflects the general process features.	Documentation should provide the basis for the thermal hydraulic analysis methodology and the success criteria development process.	Documentation shall provide the basis for the thermal hydraulic analysis methodology and the success criteria development process.
TH-11	• Documentation includes an independent review for the documented results	Independent review should be performed and documented.	Independent review should be performed and documented by knowledgeable personnel.	Independent review should be performed and documented by knowledgeable personnel.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
SY-1	<u>GUIDANCE</u> • Describes the process used	The Fault Tree Handbook or equivalent is used to provide general guidance on the logic model construction.	The documentation of the system analysis should be sufficiently well described in the documented results to act as guidance for future updates and revisions. The development and content of the system notebooks (including the system modeling, e.g., fault trees) and their relationship to the event tree models should be provided by the documentation. This should include: • the operating experience for the system • the system fault tree • model assumptions • the various model uses of the system with its values • the success criteria and bases • supports required • system operation under accident conditions • effects on initiating events • common cause groups identified and included in the system • relationship to critical safety functions The Fault Tree Handbook or equivalent should be used to provide general guidance on the logic model constriction.	A specific guidance document should be available that specifies the process for system analysis including the updating process. The development and content of the system notebooks (including the system modeling, e.g., fault trees) and their relationship to the event tree models should be provided by the documentation. This should include: • the operating experience for the system • the system fault tree • model assumptions • the various model uses of the system with its values • the success criteria and bases • supports required • system operation under accident conditions • effects on initiating events • common cause groups identified and included in the system • relationship to critical safety functions The Fault Tree Handbook or equivalent should be used to provide general guidance on the logic model constriction.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
SY-1 (cont'd)			Guidance for modeling systems, such as naming conventions or standard component failure models, should be included in the guidance and documentation.	Guidance for modeling systems, such as naming conventions or standard component failure models, should be included in the guidance and documentation.
SY-2	• Consistent with industry practices	General adherence to accepted industry approaches is included.	The documentation should provide a reasonable basis for performing the system analysis and should maintain consistency with proven approaches.	The guidance for system analysis should be complete and detailed and should maintain consistency with proven approaches.
SY-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance may be available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
SY-4	<u>SYSTEM MODELS (e.g., Fault Trees)</u> • The system models are available for review	The system descriptions should address all trains of a redundant system, not just a single train. The fault tree models are only available electronically and have not been separated out of the larger fault tree or do not have support system interfaces defined.	The system descriptions should address all trains of a redundant system, not just a single train. The fault tree models are available in both electronic and "hard copy" form for inspection and review for all trains of the systems.	The system descriptions shall address all trains of a redundant system, not just a single train. The fault tree models are available in both electronic and "hard copy" form for inspection and review for all trains of the systems.
SY-5	• The models and analyses are consistent with the as-built, as-operated plant including EOPs and AOPs (See also AS-19)	The models and analyses should be consistent with the as-built, as-operated plant including EOPs and AOPs (See also AS-19)	The models and analyses should be consistent with the as-built, as-operated plant including EOPs and AOPs (See also AS-19)	The models and analyses shall be consistent with the as-built, as-operated plant including EOPs and AOPs (See also AS-19)

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
		Exceptions may be noted; or level of detail is reduced, if justified. The operating experience with the system may be reviewed to ensure that important system characteristics are modeled appropriately.	Procedurally directed operator actions (both positive and negative impacts) that substantially influence the fault tree structure or its probability should be accounted for. This should include operator training input on the interpretation of proceduralized steps. The operating experience with the system should be reviewed to ensure that important system characteristics are modeled appropriately.	Procedurally directed operator actions (both positive and negative impacts) that substantially influence the fault tree structure or its probability shall be accounted for. This shall include operator training input on the interpretation of proceduralized steps. The operating experience with the system shall be reviewed to ensure that important system characteristics are modeled appropriately.
SY-6	• The structure of the system model provides detail down to at least the major active component level (e.g., pumps and valves)	The fault tree models should provide detail down to the major active component level. Exceptions for some systems may occur when they are dominated by operator actions, specific phenomenological effects, or are "black-boxed," such as the scram system. Systems that have sometimes not been modeled in detail include: • Power conversion system • Instrument Air • Keep fill system The justification for limited modeling should be documented. The component boundaries used in the fault tree model shall be consistent with the boundary definition used in the data analysis element.	The fault tree models should provide detail down to the major active component level. Exceptions for some systems may occur when they are dominated by operator actions, specific phenomenological effects, or are "black-boxed," such as the scram system. Systems that have sometimes not been modeled in detail include: • Power conversion system • Instrument Air • Keep fill system The justification for limited modeling should be documented. The component boundaries used in the fault tree model shall be consistent with the boundary definition used in the data analysis element.	The fault tree models should provide detail down to the major active component level. Exceptions for some systems may occur when they are dominated by operator actions, specific phenomenological effects, or are "black-boxed," such as the scram system. Systems that have sometimes not been modeled in detail include: • Power conversion system • Instrument Air • Keep fill system The justification for limited modeling should be documented. The component boundaries used in the fault tree model shall be consistent with the boundary definition used in the data analysis element. Limited modeling detail is generally not characteristic of Grade 4.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-7	• The level of detail of the system models reflects certain passive components that may impact CDF.(6)	--	Critical passive components such as check valves, strainers, and tanks should be included if they can influence the CDF or LERF. Generally, the individual pipe segments of a system are not required to be modeled. (This is based on historical comparisons with high quality PRAs.)	Critical passive components such as check valves, strainers, and tanks shall be included if they can influence the CDF or LERF. Generally, the individual pipe segments of a system are not required to be modeled. (This is based on historical comparisons with high quality PRAs.)
SY-8	• The system models contain at a minimum the following (if applicable): - Common cause failure contributors - Test and maintenance unavailabilities - Operator errors that can influence system operability (where appropriate) - False instrument signals that can cause failures of the system(8) - Operator interface dependencies across systems or trains	The system models have treated one or more of the following in manner that reduces the PRA level of discrimination or ability to accurately calculate a realistic CDF or LERF. This judgement is documented by the Peer Review Team in one of the following areas: • Common cause failure contributors • Test and maintenance unavailabilities • Operator errors that can influence system operability (where appropriate) • False instrument signals that can cause failures of the system(8) • Operator interface dependencies across systems or trains	The system models should contain at a minimum the following (if applicable): • Common cause failure contributors • Test and maintenance unavailabilities • Operator errors that can influence system operability (where appropriate) • False instrument signals that can cause failures of the system(8) • Operator interface dependencies across systems or trains	The system models shall contain at a minimum the following (if applicable): • Common cause failure contributors • Test and maintenance unavailabilities • Operator errors that can influence system operability (where appropriate) • False instrument signals that can cause failures of the system(8) • Operator interface dependencies across systems or trains
SY-9	• Modules used in the system models are well correlated to their constituent components and capable of providing importance and parametric effects on a component level.	The traceability of basic events to modules and to cutsets is not readily present in the model and documentation.	The traceability of basic events to modules and to cutsets should be transparent to the user and a reviewer.	The traceability of basic events to modules and to cutsets shall be transparent to the user and a reviewer.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-10	• Spatial or environmental dependencies (e.g., internal floods, room cooling, etc.) are addressed for each system within the system model or in the accident sequence evaluation.[(5)]	Spatial hazards that may impact system operation are not identified in the system notebook or are not explicitly accounted for in the system fault tree or the accident sequence evaluation. Environmental hazards that may impact system operation are not identified in the system notebook or are not explicitly accounted for in the system fault tree or accident sequence evaluation. Results of plant walkdowns are not available for review to determine whether they are used as a source of information and resolution of issues. Explicit treatment of containment vent effects (BWRs) and containment failure effects on system operation should be included. Conservative evaluations of impacts on systems are part of the model.	Spatial hazards that may impact system operation should be identified in the system notebook and accounted for in the system fault tree or the accident sequence evaluation. Environmental hazards that may impact system operation should be identified in the system notebook and accounted for in the system fault tree or accident sequence evaluation. Results of plant walkdowns should be used as a source of information and resolution of issues. Explicit treatment of containment vent effects (BWRs) and containment failure effects on system operation shall be included. Conservative evaluations should not distort the CDF, LERF, or the risk profile.	Spatial hazards that may impact system operation shall be identified in the system notebook and accounted for in the system fault tree or the accident sequence evaluation. Environmental hazards that may impact system operation shall be identified in the system notebook and accounted for in the system fault tree or accident sequence evaluation. Results of plant walkdowns shall be used as a source of information and resolution of issues. Explicit treatment of containment vent effects (BWRs) and containment failure effects on system operation shall be included. Conservative evaluations should be avoided. This may require substantial deterministic evaluations.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-11	In some accident sequences, systems are expected to perform in degraded environments (e.g., inside containment after a LOCA). While equipment is generally qualified for such an environment, there should be some evidence that a search has been made for equipment that is not so qualified (e.g., statements that necessary equipment is qualified). Other examples of degraded environments include: • SRV Operability (small LOCA, drywell spray, severe accident) (for BWRs) • Steamline breaks outside containment • Debris that could plug screens/filters (both internal and external to the plant), and heating of the water supply (e.g., BWR suppression pool, PWR containment sump) that could affect pump operability • Loss of NPSH • Steam binding of pumps	In some accident sequences, systems are expected to perform in degraded environments (e.g., inside containment after a LOCA). While equipment is generally qualified for such an environment, there should be some evidence that a search has been made for equipment that is not so qualified (e.g., statements that necessary equipment is qualified). Other examples of degraded environments include: • SRV Operability (small LOCA, drywell spray, severe accident) (for BWRs) • Steamline breaks outside containment • Debris that could plug screens/filters (both internal and external to the plant), and heating of the water supply (e.g., BWR suppression pool, PWR containment sump) that could affect pump operability • Loss of NPSH • Steam binding of pumps The evaluation of plant or accident sequence conditions that may adversely impact system operation should be included.	In some accident sequences, systems are expected to perform in degraded environments (e.g., inside containment after a LOCA). While equipment is generally qualified for such an environment, there should be evidence that a search has been made for equipment that is not so qualified (e.g., statements that necessary equipment is qualified). Other examples of degraded environments include: • SRV Operability (small LOCA, drywell spray, severe accident) (for BWRs) • Steamline breaks outside containment • Debris that could plug screens/filters (both internal and external to the plant), and heating of the water supply (e.g., BWR suppression pool, PWR containment sump) that could affect pump operability • Loss of NPSH • Steam binding of pumps The evaluation of plant or accident sequence conditions that may adversely impact system operation should be included.	In some accident sequences, systems are expected to perform in degraded environments (e.g., inside containment after a LOCA). While equipment is generally qualified for such an environment, there shall be evidence that a search has been made for equipment that is not so qualified (e.g., statements that necessary equipment is qualified). Other examples of degraded environments include: • SRV Operability (small LOCA, drywell spray, severe accident) (for BWRs) • Steamline breaks outside containment • Debris that could plug screens/filters (both internal and external to the plant), and heating of the water supply (e.g., BWR suppression pool, PWR containment sump) that could affect pump operability • Loss of NPSH • Steam binding of pumps The evaluation of plant or accident sequence conditions that may adversely impact system operation shall be included.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-11 (cont'd)		There may be conditions in which the system or its components are required to operate beyond the licensing design basis. The degree to which this is justified by the following is considered less than needed for a Grade 3 PRA: • expert judgement • test or operational data • calculations • vendor input Examples include: • room temperatures above EQ limits • minimum flow valve fails closed	There may be conditions in which the system or its components are required to operate beyond the licensing design basis. This should be included in the model if justified based on: • expert judgement • test or operational data • calculations • vendor input Examples include: • room temperatures above EQ limits • minimum flow valve fails closed	There may be conditions in which the system or its components are required to operate beyond the licensing design basis. This shall be included in the model if justified based on: • expert judgement • test or operational data • calculations • vendor input Examples include: • room temperatures above EQ limits • minimum flow valve fails closed
SY-12	• Support system requirements are accounted for	Support systems should be explicitly accounted for in the modeling process. This may include: • fault tree linking • dependency matrices that are translated into event tree structure or event tree logic rules or into dependent failure probabilities. Conservative treatment of support system dependencies are included in the model evaluation.	Support systems should be explicitly accounted for in the modeling process. This may include: • fault tree linking • dependency matrices that are translated into event tree structure or event tree logic rules or into dependent failure probabilities. Support system treatment should be realistic based on realistic success criteria and realistic timing.	Support systems shall be explicitly accounted for in the modeling process. This may include: • fault tree linking • dependency matrices that are translated into event tree structure or event tree logic rules or into dependent failure probabilities. Support system treatment shall be realistic based on realistic success criteria and realistic timing.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-13	• The inventories of air, power, and cooling sufficient to support the mission time (or potential deficiencies) are identified and included in the model as appropriate. (Also refer to Elements TH and DE regarding definition of success criteria.)	The inventories of air, power, and cooling sufficient to support the mission time (or potential deficiencies) are identified and included in the model as appropriate. (Also refer to Elements TH and DE regarding definition of success criteria.) However, conservative evaluations of impacts on systems are part of the model.	The inventories of air, power, and cooling sufficient to support the mission time (or potential deficiencies) should be identified and included in the model as appropriate. (Also refer to Elements TH and DE regarding definition of success criteria.) Conservative evaluations should not distort the CDF, LERF, or the risk profile.	The inventories of air, power, and cooling sufficient to support the mission time (or potential deficiencies) shall be identified and included in the model as appropriate. (Also refer to Elements TH and DE regarding definition of success criteria.) Conservative evaluations should be avoided. This may require substantial deterministic evaluations.
SY-14	• The system boundary included in the system model is clearly discerned from a simplified schematic of system	The system boundary included in the system model is not clearly discerned from a simplified schematic of system.	The system boundary included in the system model should be clearly discerned from a simplified schematic of system.	The system boundary included in the system model should be clearly discerned from a simplified schematic of system.
SY-15	• The system model analysis considered generic system failure modes observed in industry[9]	The system model analysis excludes certain generic system failure modes observed in industry[9] without adequate justification.	The system model analysis should consider generic system failure modes observed in industry[9]	The system model analysis shall consider generic system failure modes observed in industry[9]
SY-16	• The system model analysis included plant specific failure modes[7], [9]	Plant specific search of system operating experience is not documented.	Plant specific search of system operating experience should be performed and the results may be used to identify plant specific failure modes for the system. An FMEA or equivalent technique may be used to identify component or system failures that are plant specific.	Plant specific search of system operating experience shall be performed and the results may be used to identify plant specific failure modes for the system. An FMEA or equivalent technique should be used to identify component or system failures that are plant specific

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
SY-17	• The success criteria for the system are based on: - Generic thermal hydraulic analysis <u>OR</u> - Realistic thermal hydraulic analysis <u>OR</u> - Plant specific thermal hydraulic analysis	The success criteria for the system are based on generic thermal hydraulic analysis. <u>OR</u> Conservative treatment of system success criteria are included in the following: • A review of sequence specific conditions (e.g., RPV, containment, reactor building, steam tunnel, control room) to ensure that system operation is not adversely impacted due to those conditions (e.g., trip signal, exhausted inventories, unacceptable operating conditions). • As part of the success criteria assessment, there may be cases where the success criteria change during the accident progression. • System success criteria consistent with the accident sequence demands, e.g., number of pumps, HRA timing, interlocks necessary to be bypassed.	The success criteria for the system should be based on realistic thermal hydraulic analysis. Certain conservative success criteria may be included in non-risk significant sequences as follows if they do not distort the risk profile: • A review of sequence specific conditions (e.g., RPV, containment, reactor building, steam tunnel, control room) should be used to ensure that system operation is not adversely impacted due to those conditions (e.g., trip signal, exhausted inventories, unacceptable operating conditions). • As part of the realistic success criteria assessment there may be cases where the success criteria change during the accident progression. This aspect of time phase analysis should be included for a realistic evaluation. • System success criteria should be consistent with the accident sequence demands, e.g., number of pumps, HRA timing, interlocks necessary to be bypassed.	The success criteria for the system shall be based on realistic plant specific thermal hydraulic analysis. • A review of sequence specific conditions (e.g., RPV, containment, reactor building, steam tunnel, control room) shall be used to ensure that system operation is not adversely impacted due to those conditions (e.g., trip signal, exhausted inventories, unacceptable operating conditions). • As part of the realistic success criteria assessment there may be cases where the success criteria change during the accident progression. This aspect of time phase analysis shall be included for a realistic evaluation. • System success criteria shall be consistent with the accident sequence demands, e.g., number of pumps, HRA timing, interlocks necessary to be bypassed.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-18	• The system model nomenclature is developed in a consistent manner to allow model manipulation and to represent the same designator when a component failure mode is used in multiple systems or trains.	---	---	The system model nomenclature shall be developed in a consistent manner to allow model manipulation and to represent the same designator when a component failure mode is used in multiple systems or trains.
SY-19	• The systems used in the event trees have detailed system model development to support them unless they are generally treated with point estimate values, e.g.: - SRVs (for BWRs) - RPS - Diesel Generators - Switchyard The following impact on Grades is suggested for the above sample items: - Point Estimates - Conditional Probabilities (Split Fractions) - Linked Fault Trees or Cutsets	The systems used in the event trees have reduced level of details in some system models compared with the level of detail expected for Grade 3.	The systems used in the event trees should have detailed system model development to support them. Exceptions may include: • SRVs (for BWRs) • RPS • Diesel Generators • Switchyard	The systems used in the event trees shall have detailed system model development to support them. Exceptions may include: • SRVs (for BWRs) • RPS • Diesel Generators • Switchyard
SY-20	• The system models are used to quantify the accident sequences by: - Point Estimates Only - Conditional Probabilities (Split Fractions) - Linked Fault Trees or Cut Sets	• The system models are used to quantify the accident sequences by: - Point Estimates Only	The system models are used to quantify the accident sequences by • Conditional Probabilities (Split Fractions) • Linked Fault Trees or Cut Sets	The system models are used to quantify the accident sequences by • Conditional Probabilities (Split Fractions) • Linked Fault Trees or Cut Sets
SY-21	• The impact of the system model on initiating events has been examined (see also IE-10, IE-17)		• The impact of the system model on initiating events should be examined (see also IE-10, IE-17) and should be incorporated into the model in a realistic manner.	• The impact of the system model on initiating events shall be examined (see also IE-10, IE-17) and should be incorporated into the model in a realistic manner.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
SY-22	• The assumptions for the system logic model are identified	• The assumptions for the system logic model should be identified, however, the assumptions are not easily traceable to the model or to a reasonable basis.	• The assumptions for the system logic model should be identified.	• The assumptions for the system logic model shall be identified.
SY-23	• The system operation under accident conditions is identified in the system notebook	• The system operation under accident conditions should be identified in the system notebook and may be incorporated into the model in a conservative manner.	• The system operation under accident conditions should be identified in the system notebook and should be incorporated into the model in a realistic manner.	• The system operation under accident conditions shall be identified in the system notebook and should be incorporated into the model in a realistic manner.
SY-24	• System/component repair and recovery actions and modeling, if used, are identified and documented (see also QU-18)	• System/component repair and recovery actions and modeling, if used, should be identified and documented (see also QU-18) • Conservative evaluations of impacts on systems are part of the model.	• System/component repair and recovery actions and modeling, if used, should be identified and documented (see also QU-18) • Conservative evaluations should not distort the CDF, LERF, or the risk profile.	• System/component repair and recovery actions and modeling, if used, shall be identified and documented (see also QU-18) • Conservative evaluations should be avoided. This may require substantial deterministic evaluations.
SY-25	<u>DOCUMENTATION</u> • Reflects the process used	Documentation reflects the general process features.	Documentation should provide the basis for meeting each of the criteria SY-4 through SY-24. The documentation should describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria SY-4 through SY-24. The documentation shall describe the results consistent with the process.

Table 5-4

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: SYSTEMS ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
SY-26	• Includes an independent review for the documented results	The system analysis should be reviewed.	Independent review should be performed and documented by knowledgeable personnel, such as the system engineer. Guidance for modeling systems, such as naming conventions or standard component failure modes, should be included in the guidance and documentation.	Independent review shall be performed and documented by knowledgeable personnel, such as the system engineer. Guidance for modeling systems, such as naming conventions or standard component failure modes, shall be included in the guidance and documentation.
SY-27	• Provides the basis of the system model and is traceable to plant specific or generic analysis	Documentation reflects the general process features.	Documentation should provide the basis for system analysis process.	Documentation shall provide the basis for system analysis process.

NOTES FOR TABLE SY:

(1) System models can be performed at a super component level and still identify vulnerabilities.

(2) Not required for successful ranking or dominant contributor determination.

(3) It is noted that to attain the highest Grade assignments it is judged necessary to account for support or front line system failures that can cause initiating events and/or multiple system failures.

(4) PRA that relies heavily on point estimates would generally be rated lower while PRA that uses detailed fault tree modeling would generally be rated higher.

(5) The spatial or environmental dependencies included within each individual system include the following examples:

- Room cooling
- False trip signals caused before or during accident progression
- NPSH dependencies
- Accident progression impacts of temperature, pressure
- Rupture disk failures
- Sufficient water or air capacity
- Real trip signals caused by accident progression
- Internal flooding

(6) Passive failures that do not impact CDF are not required to be modeled in fault trees for a Grade 3.

(7) Observed plant specific failure modes should be represented in the models and rectification included if appropriate. Such failure modes may include: ice frazil; leaf clogging; covering BWR SRV solenoids with insulation; hard seat check valves in air system; explosive valve firing circuits; bio-fouling.

(8) The criterion is to investigate whether false isolation and trip signals are present in the models (e.g., high pressure injection, recirculation cooling) to account for latent failure modes that may exist and persist to defeat safety system success. Spurious actuation evaluation is not examined in this criterion.

(9) The generic or plant-specific failure data used for quantification (see Element DA) and the modeled failure modes must be consistent.

(10) There is no reasonable gradation in this sub-element, because inconsistencies in nomenclature can affect the results.

Table 5-5

INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DA-1	<u>GUIDANCE</u> • Describes the process used	General description of the data analysis is provided. The data guidance document provides general guidance on the selection of generic data from industry sources. The treatment of rectification in the data analysis should have clear guidance. Guidance should be provided on the development of the disallowed maintenance or mutually exclusive maintenance file.	The documentation of the data analysis should be sufficiently well described in the documented results to act as guidance for future updates and revisions. The document should provide guidance on the use of plant specific data, common cause data and methods, and the selection of generic data from industry sources. The document should provide guidance in the assignment of the proper error factor to assign for particular component failure rates when the error factors are not provided in the reference. The document should include guidance on data compilation and interpretation, component boundaries, Bayesian approach, and examples. The treatment of rectification in the data analysis should be clearly stated. Guidance should be provided on the development of the disallowed maintenance or mutually exclusive maintenance file.	A specific guidance document should be available that specifies the process for data analysis including the updating process. Guidance on the incorporation of plant specific data into initiating event frequencies, component failure rates, and common cause data shall be provided. The data guidance document shall provide guidance on the selection of generic data from industry sources. The data guidance document may provide guidance in the assignment of the proper error factor to assign for particular component failure rates when the error factors are not provided in the reference. The data guidance document should include direction on data compilation and interpretation, component boundaries, Bayesian approach, and examples. A description of the overall process used for selecting and applying data should be provided. The treatment of rectification in the data analysis should have clear guidance. Guidance should be provided on the development of the disallowed maintenance or mutually exclusive maintenance file.

Table 5-5

INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-2	• Consistent with industry practices	General adherence to accepted industry approaches is included.	The documentation should provide a reasonable basis for performing the data analysis and should maintain consistency with proven approaches.	The guidance for data analysis should be complete and detailed, and should maintain consistency with proven approaches.
DA-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance may be available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
DA-4	<u>FAILURE PROBABILITIES</u> • The random independent component failure probability data used in the evaluation are based on generic data sources that may be conservative. <u>OR</u> • The random independent component failure probabilities are realistic compared with past generic data evaluations at least for dominant contributors. <u>OR</u>	The random independent component failure probability data used in the evaluation are based on generic data sources that may be conservative. The use of generic data should involve the use of reasonable generic data sources that represent recent nuclear power experience, if available. The definition of component failures should encompass only those failures that would disable the component function over the PRA mission time.	The random independent component failure probabilities should be realistic compared with past generic data evaluations at least for dominant contributors unless sufficient plant specific evidence is available to the contrary. The use of generic data should involve the use of reasonable generic data sources that represent recent nuclear power experience, if available. The definition of component failures should encompass only those failures that would disable the component function over the PRA mission time.	The random independent component failure probability data used in the evaluation and where it can be justified shall be based on accumulated plant specific experience; otherwise, realistic generic data is used. The plant specific data evaluation should be based on a plant specific Bayesian update of accumulated industry experience for similar components. The definition of component failures shall encompass only those failures that would disable the component function over the PRA mission time.

Table 5-5

INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-4 (cont'd)	• The random independent component failure probability data used in the evaluation and where it can be justified is based on accumulated plant specific experience; otherwise, realistic generic data is used.	Some limited plant specific data are incorporated into the PRA as it supports specific risk ranking applications. This data analysis shall be consistent with the risk-informed decision requirements.	The treatment of rectification in the data analysis should have clear guidance. Plant specific data should be incorporated into the PRA as it supports specific risk informed applications. This data analysis shall be consistent with the risk-informed decision requirements. SSCs with the highest Fussell-Vesely importance should be the leading candidates for plant specific data.	Plant specific data collection shall include failures of equipment coupled with either data on success or reasonable estimates of total demands. "Run" failure rates may be difficult to obtain because of limited run times of equipment. Plant specific estimates may therefore be unrealistic. The data collection period should be generally consistent with the as-built, as-operated plant being analyzed. The treatment of rectification in the data analysis should be realistic and the bases well documented. Selection of components requiring plant specific data shall be based on a stated criteria, e.g., RAW > 2 or FV > 0.005.
DA-5	• For plant specific data development, similar components have been grouped together in a reasonable manner and the grouping is supported by the documentation.	--	Grouping of components for data collection purposes should account for the following: • Size • Service condition • Frequency of demands • Environmental condition The groups should be sufficiently similar to justify the derivation of plant specific data. The component boundary should be explicitly defined such that the PRA model, the data collection, the use of common cause BETA or MGL factors, and the use of generic data for Bayesian update are all consistent.	Grouping of components for data collection purposes shall account for the following: • Size • Service condition • Frequency of demands • Environmental condition The groups shall be sufficiently similar to justify the derivation of plant specific data. The component boundary shall be explicitly defined such that the PRA model, the data collection, the use of common cause BETA or MGL factors, and the use of generic data for Bayesian update are all consistent.

Table 5-5

INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-6	• For basic events derived using standby failure rate data, the plant specific surveillance test intervals have been identified and used in the analysis.	--	Surveillance test intervals identified in maintenance procedures or surveillance test requirements should be used to estimate the intervals between component testing. For components not normally tested or tested at relatively long intervals, the demand failure rates from generic data sources may not be appropriate. To account for the longer surveillance intervals, a standby failure rate (/ hr) and the approximation λ T/2 for the failure probability should be used.	Surveillance test intervals identified in maintenance procedures or surveillance test requirements shall be used to estimate the intervals between component testing and this evaluation shall be augmented by confirmation of these results with plant staff. For components not normally tested or tested at relatively long intervals, the demand failure rates from generic data sources may not be appropriate. To account for the longer surveillance intervals, a standby failure rate (/ hr) and the approximation λ T/2 for the failure probability should be used.
DA-7	SYSTEM/TRAIN MAINTENANCE UNAVAILABILITIES [(1)] • The system/train maintenance unavailabilities are derived based on generic data sources. OR • The maintenance unavailabilities reflect plant specific practices and are reasonable or are higher than the projected maintenance goals used by the utility. OR • The system/train maintenance unavailabilities are derived based on plant specific data.	The maintenance unavailabilities reflect plant specific practices and should be reasonable or higher than the projected Maintenance Rule goals used by the utility. The disallowed maintenance (or mutually exclusive) file should be developed based on plant Technical Specifications or procedures.	The system/train maintenance unavailabilities should be derived based on plant specific data representing the as-built, as-operated plant. The use of vendor data bases should be avoided. The disallowed maintenance (or mutually exclusive) file should be developed based on plant Technical Specifications or procedures.	The system/train maintenance unavailabilities shall be derived based on plant specific data representing the as-built, as-operated plant. The use of vendor data bases should be avoided. The disallowed maintenance (or mutually exclusive) file should be developed based on plant Technical Specifications or procedures.

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INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-8	COMMON CAUSE FAILURE PROBABILITIES • The common cause failure probabilities are referenced to acceptable data sources.(2)	The CCF data should reference a reasonable CCF data source. The latest NRC compilation of CCF probabilities is considered to be the best available CCF assessment. (See NUREG/CR-6268) The component boundaries should be consistent with the common cause data used to characterize the component.	The CCF data should reference an up to date source, e.g., the NRC INEL report. This latest NRC compilation of CCF probabilities is considered to be the best available CCF assessment. (See NUREG/CR-6268) The component boundaries shall be consistent with the common cause data used to characterize the component.	The CCF data should reference an up to date source, e.g., the NRC INEL report. This latest NRC compilation of CCF probabilities is considered to be the best available CCF assessment. (See NUREG/CR-6268) The component boundary should be explicitly defined such that the PRA model, the data collection, the use of common cause BETA or MGL factors, and the use of generic and plant specific data for Bayesian update are all consistent.
DA-9	• The common cause failure probabilities are realistic based on generic data source comparisons.	---	Mostly realistic common cause failure probabilities and modeling should be used consistent with available data. Common cause failure modes of "fail to run" and "fail to start" should be applied as appropriate and as available data would support.	Realistic estimates of common cause failure probabilities shall be used including plant specific mapping of failure modes. Common cause failure modes of "fail to run" and "fail to start" shall be applied as appropriate and as available data would support.
DA-10	• Common cause groups to which the common cause failure probability applies have been derived based on sound judgment and are documented.	Common cause groups should be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions	Common cause groups shall be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions	Common cause groups shall be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions

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INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-11	• Justification is provided for treatment of common cause failure of on-site AC sources that include consideration of: - Design diversity - Common maintenance crews - Common I&C technicians - Similarity of procedures - Common fuel oil - Common lube oil - Common heating/cooling designs	The consideration of CCF of on-site AC power sources should specifically address all the on-site diesels in detail. While there may be design diversity, there are important CCF considerations remaining including: • Common maintenance crews • Common I&C Techs. • Similarity of Procedures • Common fuel oil • Common lube oil • Possible similarity of heating/ cooling loops • Testing similarities (e.g., unloaded)	The consideration of CCF of on-site AC power sources should specifically address all the on-site diesels in detail. While there may be design diversity, there are important CCF considerations remaining including: • Common maintenance crews • Common I&C Techs. • Similarity of Procedures • Common fuel oil • Common lube oil • Possible similarity of heating/ cooling loops • Testing similarities (e.g., unloaded)	The consideration of CCF of on-site AC power sources shall specifically address all the on-site diesels in detail. While there may be design diversity, there are important CCF considerations remaining including: • Common maintenance crews • Common I&C Techs. • Similarity of Procedures • Common fuel oil • Common lube oil • Possible similarity of heating/ cooling loops • Testing similarities (e.g., unloaded) The common cause failure probability for all on-site diesels shall include a quantitative assessment that shall be reflected in the PRA model.
DA-12	• NUREG/CR-4780 (EPRI NP-5613 or equivalent) systematic approach used to provide plant specific grouping of similar system components for CCF treatment	--	NUREG/CR-4780 (EPRI NP-5613 or equivalent) systematic approach should be used to provide plant specific grouping of similar system components for CCF treatment	NUREG/CR-4780 (EPRI NP-5613 or equivalent) systematic approach shall be used to provide plant specific grouping of similar system components for CCF treatment
DA-13	• Dominant contributors for sequences include MGL for more than 2 redundant trains	--	--	Dominant contributors for sequences shall include the MGL or equivalent methodology for more than 2 redundant trains
DA-14	• Full intent of NUREG/CR-4780 (EPRI NP-5613 or equivalent) included: - Plant specific screening of common cause data	--	--	Full intent of NUREG/CR-4780 (EPRI NP-5613 or equivalent) shall be included: • Plant specific screening of common cause data

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INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-15	UNIQUE UNAVAILABILITIES OR MODELING ITEMS • Documentation of the failure probabilities from plant specific or generic sources that do not fit into the basic event database, e.g.: - AC Power Recovery - EDG Mission Time - Repair and Recovery Model - LOOP Given Transient	The bases for the unique unavailability items are based on generic data, conservative estimates, or plant specific data. AC recovery are based on available generic data.	The unique unavailabilities should be based on plant specific data (if available) otherwise realistic estimates based on plant specific as-built, as-operated features. AC recovery should be based on available and applicable data.	The unique unavailabilities shall be based on plant specific data (if available) otherwise realistic estimates based on plant specific as-built, as-operated features. AC recovery shall be based on available and applicable data.
	- BOP Unavailability - Pipe/tank Rupture Failure Probability - ATWS-related RPS Failures - RCP Seal Failure (for PWRs) - % of time Pressurizer PORVs blocked during operation (PWRs) - PORV demand probability given an initiating event - % of time SG PORVs or atmospheric dump valves blocked during operation - ARI (for BWRs) - RPT (for BWRs) - PCS Recovery (for BWRs) - SORV (for BWRs)	Repair modeling should in general be applied only if extended times are available. Recovery modeling shall be tied with repair modeling when equipment must be restored to a usable condition. Recovery modeling addresses issues related to operator interaction (HRA), repair (failure mode dependent), access, environment, etc., but the level of detail is marginal and insufficient for a Grade 3.	Repair modeling should in general be applied only if extended times are available. Recovery modeling shall be tied with repair modeling when equipment must be restored to a usable condition. Recovery modeling should address issues related to operator interaction (HRA), repair (failure mode dependent), access, environment, etc.	Repair modeling should in general be applied only if extended times are available. Recovery modeling shall be tied with repair modeling when equipment must be restored to a usable condition. Recovery modeling shall address issues related to operator interaction (HRA), repair (failure mode dependent), access, environment, etc.

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INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DA-16	• Conservatively biased values OR • The values are judged conservative only for those contributors of non-dominant sequences OR • These failure probabilities are justified to the current state of the technology	Conservatively biased values are used.	The values should be conservative only for those contributors of non-dominant sequences	These failure probabilities shall be justified to the current state of the technology
DA-17	DOCUMENTATION • Reflects the process used	Documentation generally describes the process.	Documentation should provide the basis for meeting each of the criteria DA-4 through DA-16. The documentation shall describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria DA-4 through DA-16. The documentation shall describe the results consistent with the process.
DA-18	• Includes an independent review for the documented results	An independent review should be performed.	Independent review should be performed and documented by knowledgeable personnel.	Independent review shall be performed and documented by knowledgeable personnel.
DA-19	• Provides the basis of the data treatment and is traceable to plant specific or generic analysis.	The documentation generally describes the analysis methods and should provide a traceable link between the raw data and the data used in the model.	Documentation should provide the basis for data analysis process and should provide a traceable link between the raw data and the data used in the model.	Documentation shall provide the basis for data analysis process and should provide a traceable link between the raw data and the data used in the model.

Table 5-5

INDUSTRY PRA PEER REVIEW PROCESS SUBTIER CRITERIA: DATA ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DA-20	• The generic and plant specific data bases are available for inspection and use.	The data base should be documented and traceable.	The data base should be documented and traceable to the sources of plant specific, and generic data sources for failure and maintenance events, demands and operating time, common cause events, treatment of restoration of components in the maintenance data, and the assumptions and methods used to derive data parameter values.	The data base shall be documented and traceable to the sources of plant specific, and generic data sources for failure and maintenance events, demands and operating time, common cause events, treatment of restoration of components in the maintenance data, and the assumptions and methods used to derive data parameter values.

Notes to Table DA:

(1) The data evaluation grade varies with how the train unavailabilities are set.

- The highest grades or pedigree is assigned to use of plant specific train unavailability data. This may result in unavailabilities which are best estimates and below the Performance Criteria selected for the Maintenance Rule.
- An alternative to use the PC from the Maintenance Rule is given nearly equivalent grades.
- A third alternative which uses very conservative unavailabilities, larger than the Performance Criteria, is considered to represent a conservative assessment that could be classified as a Grade 2.
- A fourth alternative of using generic sources is assumed to have a marginal pedigree and is given the lowest grade.

(2) The quantification of common cause effects has been a continuing area of uncertainty in PSA development and application. The NRC (AEOD in INEL 94/0064) has sponsored research on the collection and analysis of data to support common cause model quantification. It is judged that one "preferable" source of common cause data in the future may be the NRC sponsored data base for common cause failures.

Table 5-6

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-1	<u>GUIDANCE</u> • Describes the process used	General description of the HRA methods and techniques are provided.	The documentation of the HRA should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for HRA including the updating process. Guidance on the rules used for replacing screening HEPs with best estimate HEPs in Post Processors (so-called "Recovery" substitutions) shall be provided (if applicable). The explanation should include the specific steps performed in the recovery process. The guidance should address the PSF for complexity, limited resources, time, stress, and uncertainty in instrumentation.
HR-2	• Consistent with industry practices	General adherence to accepted industry approaches should be included.	The documentation, or separate specific guidance, should provide a reasonable basis for performing the HRA and should maintain consistency with proven approaches.	The guidance for HRA should be complete and detailed and should maintain consistency with proven approaches.
HR-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance may be available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
HR-4	<u>PRE-INITIATOR HUMAN ACTIONS</u> • Pre-initiator Human Interactions (HIs) were considered in the PRA	Pre-initiators should be included in the PRA, either explicitly, especially for latent failures that can cause multiple redundant components to fail, or with failure rate data for independent latent failures.	Pre-initiators shall be included in the PRA explicitly, especially for latent failures that can cause multiple redundant components to fail.	Pre-initiators shall be included in the PRA explicitly, especially for latent failures that can cause multiple redundant components to fail.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-5	• A systematic process is used to identify the Pre-Initiator Human Errors to be included in the PRA (e.g., miscalibration of instruments)	A process is used to identify the Pre-Initiator Human Errors to be included in the PRA (e.g., miscalibration of instruments) that successfully identifies critical preinitiators found in PRAs for similar plants.	A systematic process should be used to identify the Pre-Initiator Human Errors to be included in the PRA (e.g., miscalibration of instruments) This should include a review of plant procedures and training in order to identify those latent failures that may defeat multiple redundant equipment.	A systematic process shall be used to identify the Pre-Initiator Human Errors to be included in the PRA (e.g., miscalibration of instruments) This shall include a review of plant procedures and training in order to identify those latent failures that may defeat multiple redundant equipment.
HR-6	• Screening HEPs are used in the quantification of the pre-initiator HEPs OR • Best estimate HEPs are used in the quantification of pre-initiator HEPs for dominant contributors OR • Assessment of plant procedures and plant specific operating experience are explicitly included in the identification and quantification process for the HIs.	Preinitiator HEPs may be screened from further consideration if: • Equipment position is monitored • Equipment is automatically re-aligned • Post maintenance functional test is performed. Screening HEPs may be used in the quantification of the pre-initiator HEPs.	Preinitiator HEPs may be screened from further consideration if: • Equipment position is monitored • Equipment is automatically re-aligned • Post maintenance functional test is performed. Best estimate HEPs should be used in the quantification of pre-initiator HEPs for dominant contributors, including recovery.	Preinitiator HEPs may be screened from further consideration if: • Equipment position is monitored • Equipment is automatically re-aligned • Post maintenance functional test is performed. Best estimate HEPs shall be used in the quantification of pre-initiator HEPs for dominant contributors, including recovery Assessment of plant procedures and plant specific operating experience shall be explicitly included in the identification and quantification process for the HIs.
HR-7	• Those pre-initiator actions with the possibility of adversely impacting baseline CDF or LERF are included in the quantification.	Those pre-initiator actions with the possibility of adversely impacting baseline CDF or LERF should be included in the quantification.	Those pre-initiator actions with the possibility of adversely impacting baseline CDF or LERF shall be included in the quantification.	Those pre-initiator actions with the possibility of adversely impacting baseline CDF or LERF shall be included in the quantification.
HR-8	POST-INITIATOR HUMAN ACTIONS • Post-Initiator HIs were considered in the PRA	HEPs for initiation, control, isolation, and alignment of prevention and mitigation systems should be included.	HEPs for initiation, control, isolation, and alignment of prevention and mitigation systems shall be included.	HEPs for initiation, control, isolation, and alignment of prevention and mitigation systems shall be included.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-9	• A systematic process is used to identify the Post-Initiator Human Errors to be included in the PRA.	A process is used to identify the Post-Initiator Human Errors to be included in the PRA that successfully identifies critical post initiator HEPs found in PRAs for similar plants.	A systematic process should be used to identify the Post-Initiator Human Errors to be included in the PRA. As an example: the least resource intensive process for these criteria is the identification of those operator actions previously identified by the NRC or industry for similar plants. This approach builds on the experience of the industry and with high likelihood covers the dominant contributors of the operator actions to the risk profile.	A systematic process shall be used to identify the Post-Initiator Human Errors to be included in the PRA. As an example, a more comprehensive and systematic process is one that includes the following steps: <u>Step 1</u>: Methodically review the critical safety functions and the procedures used as part of the safety function implementation; <u>Step 2</u>: quantitatively assess the model to identify additional actions that could prove to be necessary to reduce dominant accident sequences; <u>Step 3</u>: Discuss the operator actions with training and operating crews to validate the set of actions; <u>Step 4</u>: Observe simulator evaluation.
HR-10	• Assessment of plant procedures and plant specific operating experience are explicitly included in the identification and quantification process for the HIs.	Assessment of plant procedures and plant specific operating experience should be explicitly included in the identification and quantification process for the HIs.	Assessment of plant procedures and plant specific operating experience should be explicitly included in the identification and quantification process for the HIs. Interviews with operators, trainers, or supervisors should be included in the assessment.	Assessment of plant procedures and plant specific operating experience shall be explicitly included in the identification and quantification process for the HIs. Interviews with operators, trainers, or supervisors shall be included in the assessment.
HR-11	• The symptoms available during the postulated accident sequence are evaluated and input into the HRA process.	The accident sequence specific symptoms should be used as part of the input to the HRA process.	The accident sequence specific symptoms shall be used as part of the input to the HRA process.	The accident sequence specific symptoms shall be used as part of the input to the HRA process.
HR-12	• HEP values are internally consistent within the PRA.	HEP values should provide the correct relative error probabilities within the PRA. This means that the use of screening HEPs should be minimized.	HEP values should provide the correct relative error probabilities within the PRA. This means that the use of screening HEPs shall be minimized.	HEP values shall provide the correct relative error probabilities within the PRA.
HR-13 (1)	• Screening HEPs are used in the quantification of dominant contributors.	Screening HEPs shall not be used in the quantification of dominant contributors to CDF or LERF.	Screening HEPs shall not be used in the quantification of dominant contributors to CDF or LERF.	Screening HEPs shall not be used in the quantification of dominant contributors to CDF or LERF.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-13 (cont'd)		Engineering judgment or best estimate generic HEPs may be used.		Detailed HEP analysis shall be required.
HR-14	• Operator actions have been reviewed by the operating staff and their impact is included in the HRA evaluation; **<u>OR</u>** • Dominant operator actions have been reviewed by the operating staff and their input has been included in the HRA evaluation.	Dominant operator actions should be reviewed with the operating staff and their input has been included in the HRA evaluation.	A. Operator actions should be reviewed with the operating staff and their impact is included in the HRA evaluation; <u>OR</u> Dominant operator actions shall be reviewed by the operating staff and their input has been included in the HRA evaluation. <u>AND</u> B. HRA assumptions and assertions should be consistent with operator training and procedures. One way to ensure the assumptions are consistent with training and actual conditions is to obtain a review by operations or training personnel. Therefore, the operating staff (or equivalent personnel) should review the HRA calculations, especially the assumptions made in the analysis.	A. Operator actions shall be reviewed by the operating staff and their impact is included in the HRA evaluation; <u>AND</u> B. HRA assumptions and assertions should be consistent with operator training and procedures. One way to ensure the assumptions are consistent with training and actual conditions is to obtain a review by operations or training personnel. Therefore, the operating staff (or equivalent personnel) should review the HRA calculations, especially the assumptions made in the analysis
HR-15 (1)	• Best estimate HEPs are used in the quantification of dominant contributors.	Conservative HEPs are used in the PRA quantification.	Best estimate HEPs shall be used in the quantification of dominant contributors.	Best estimate HEPs shall be used in the quantification of dominant contributors.
HR-16	• Emphasis of the Human Reliability Analysis is to identify that the HI is folded correctly into the model and that the HI: - Reflects the procedures (EOPs & AOPs) - Reflects training - Reflects simulator results (if applicable)	The HEP should be developed such that it accurately reflects the: • Procedures (EOPs and AOPs) These should all be reflective of the accident sequence that is being modeled. The HEP should then be included in the model to represent those sequence specific actions for which it was developed.	The HEP should be developed such that it accurately reflects the: • Procedures (EOPs and AOPs) • Training on the implementation • Simulator Responses These should all be reflective of the accident sequence that is being modeled. The HEP should then be included in them model to represent those sequence specific actions for which it was developed.	The HEP shall be developed such that it accurately reflects the: • Procedures (EOPs and AOPs) • Training on the implementation • Simulator Responses These shall all be reflective of the accident sequence that is being modeled. The HEP shall then be included in them model to represent those sequence specific actions for which it was developed.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-17	• The performance shaping factors such as time available, time to perform, stress, complexity, etc. are included in the quantification.	Performance shaping factors formulated for the specific accident sequence and the associated HEP (including time available, time to perform, stress, complexity, available indication, resource limitations on the back shift, etc.) may be included in the quantification as applicable. Contributors to the total HEP should be incorporated in the assessment; e.g.: • Diagnosis • Manipulation	Performance shaping factors formulated for the specific accident sequence and the associated HEP (including time available, time to perform, stress, complexity, available indication, resource limitations on the back shift, etc.) should be included in the quantification as applicable. Contributors to the total HEP shall be incorporated in the assessment; e.g.: • Diagnosis • Manipulation The post-initiator HEP should address the: • Accident sequence specific timing • Accident sequence specific procedural guidance • Adverse environment associated with the accident sequence • The instrumentation availability for the accident sequence These factors may then result in sequence specific HEPs. The HRA assessment should account for potential delays in the cues to begin actions and account for competing effects if multiple failures have occurred. Ex-control Room human action times for travel and manipulation should be supported by operator interviews, JPMs, or observations.	Performance shaping factors formulated for the specific accident sequence and the associated HEP (including time available, time to perform, stress, complexity, available indication, resource limitations on the back shift, etc.) shall be included in the quantification as applicable. Contributors to the total HEP shall be incorporated in the assessment; e.g.: • Diagnosis • Manipulation The post-initiator HEP shall address the: • Accident sequence specific timing • Accident sequence specific procedural guidance • Adverse environment associated with the accident sequence • The instrumentation availability for the accident sequence These factors may then result in sequence specific HEPs. The HRA assessment shall account for potential delays in the cues to begin actions and account for competing effects if multiple failures have occurred. Ex-control Room human action times for travel and manipulation should be supported by operator interviews, JPMs, or observations.

Table 5-6

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-17 (cont'd)			Assumptions to be confirmed by operations, training or a walkdown should include: • Number of personnel available • Indication availability • Availability of keys for key locks (control room or remote) • Security access • Pathway hazards for remote access	Assumptions to be confirmed by operations, training or a walkdown shall include: • Number of personnel available • Indication availability • Availability of keys for key locks (control room or remote) • Security access • Pathway hazards for remote access
HR-18	• The performance shaping factor for time available for an action and the time required to take an action are developed on a plant specific basis.	---	The performance shaping factor for time available for an action and the time required to take an action should be developed on a plant specific basis.	The performance shaping factor for time available for an action and the time required to take an action shall be developed on a plant specific basis.
HR-19	• The time available for action is based on: - generic T & H analysis <u>OR</u> - plant specific T & H analysis	The times available for action are based on: • generic T & H analysis Power uprate effects should be included. The time of cues for taking an operator action are identified in marginal detail for review by the Peer Review Team.	The time available for an action to be taken should be based on plant specific thermal hydraulic analysis or appropriate generic analysis that accounts for plant specific features. Power uprate effects should be included. The time of cues for taking an operator action should be identified.	The time available for an action to be taken shall be based on plant specific thermal hydraulic analysis. Power uprate effects shall be included. The time of cues for taking an operator action shall be identified.
HR-20	• The time required to complete the actions is based on observation or operations staff input.	The times required to complete the actions are based on judgement.	The time required to complete the actions should be based on observation or operations staff input.	The time required to complete the actions shall be based on observation or operations staff input.

Table 5-6

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-21	• The recovery actions are included systematically in the model; OR The recovery actions are included selectively in the model for dominant cut sets.	The recovery actions are included selectively in the model for dominant cut sets.	The recovery actions should be included systematically in the model. Model coding of basic events should allow the identification of operator actions: pre-initiators, post-initiators, repair and recovery.	The recovery actions shall be included systematically in the model. Model coding of basic events should allow the identification of operator actions: pre-initiators, post-initiators, repair and recovery.
HR-22	• The models and analysis are consistent with the operating procedures and training.	The models and analysis should be consistent with the operating procedures and training.	The models and analysis shall be consistent with the operating procedures and training.	The models and analysis shall be consistent with the operating procedures and training.
HR-23	• Operator actions including recovery are not credited unless a procedure is available or operator training has included the action as part of crew's training.	Operator actions including recovery should not be credited unless a procedure is available or operator training has included the action as part of crew's training or it can be considered "skill-of-the-trade".	Operator actions including recovery should not be credited unless a procedure is available or operator training has included the action as part of crew's training or it can be considered "skill-of-the-trade".	Operator actions including recovery shall not credited unless a procedure is available or operator training has included the action as part of crew's training or it can be considered "skill-of-the-trade".
HR-24	• Inter-unit cross ties are only credited if procedures and training are available.	Inter-unit cross ties should only be credited if procedures and training are available.	Inter-unit cross ties should only be credited if procedures and training are available.	Inter-unit cross ties shall only be credited if procedures and training are available.
HR-25	• Inter-unit cross ties are accurately accounted for under conditions of outage for the other unit and special initiating events.	Inter-unit cross ties should be accurately accounted for under conditions of outage for the other unit and special initiating events.	Inter-unit cross ties should be accurately accounted for under conditions of outage for the other unit and special initiating events.	Inter-unit cross ties shall be accurately accounted for under conditions of outage for the other unit and special initiating events.

Table 5-6

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: HUMAN RELIABILITY ANALYSIS

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
HR-26	DEPENDENCE AMONG ACTIONS • The dependence among human actions is evaluated in the PSA process. (See QU-10)	The dependence among human actions should be evaluated in the PSA process.	The dependence among human actions shall be evaluated in the PSA process.	The dependence among human actions shall be evaluated in the PSA process.
HR-27	• Identification of sequences that, but for low human error rates in recovery actions, would have been dominant contributors to core damage frequency is included as a test of modeling adequacy. Equivalent techniques may also be used. (See QU-10)	Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency may be included as a test of modeling adequacy. A sensitivity study to generate sequences or cutsets with the HEPs set to values of 0.1 to 1.0 is one potential technique. Equivalent techniques may also be used. For those HEPs quantified, the total operating crew failure probability in a single cutset or sequence should not be less than 1E-6 unless additional justification is provided. For example, sequences with time lines greater than 24 hours could be justified to have a total HEP contribution less than 5E-7.	Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency should be included as a test of modeling adequacy. A sensitivity study to generate sequences or cutsets with the HEPs set to values of 0.1 to 1.0 is one potential technique. Equivalent techniques may also be used. For those HEPs quantified, the total operating crew failure probability in a single cutset or sequence should not be less than 1E-6 unless additional justification is provided. For example, sequences with time lines greater than 24 hours could be justified to have a total HEP contribution less than 5E-7.	Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency shall be included as a test of modeling adequacy. A sensitivity study to generate sequences or cutsets with the HEPs set to values of 0.1 to 1.0 is one potential technique. Equivalent techniques may also be used. For those HEPs quantified, the total operating crew failure probability in a single cutset or sequence should not be less than 1E-6 unless additional justification is provided. For example, sequences with time lines greater than 24 hours could be justified to have a total HEP contribution less than 5E-7.
HR-28	DOCUMENTATION • Reflects the process used	Documentation provides the general basis for HRA process.	Documentation should provide the basis for meeting each of the criteria HR-4 through HR-10. The documentation should describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria HR-4 through HR-10. The documentation shall describe the results consistent with the process.
HR-29	• Includes an independent review for the documented results	Independent review is performed and documented.	Independent review should be performed and documented by knowledgeable personnel. This should include operations personnel.	Independent review should be performed and documented by knowledgeable personnel. This should include operations personnel.
HR-30	• Provides the basis of the HRA and is traceable to plant specific or generic analysis.	---	Documentation should provide the basis for HRA process using principally plant specific analysis.	Documentation shall provide the basis for HRA process using plant specific analysis.

Notes to Table HR:

(1) Sub-elements 13 and 15 are complementary and should be evaluated together. If a grade is assigned for one, then no grade is needed for the other.

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DE-1	GUIDANCE • Describes the process used	General description of the process is provided.	The documentation of the dependency analysis should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for the dependency analysis development and quantification including the updating process.
DE-2	• Consistent with industry practices	General adherence to accepted industry approaches is included	The documentation or separate specific guidance should provide a reasonable basis for performing the dependency analysis and should maintain consistency with proven approaches.	The guidance for dependency analyses should be complete and detailed and should maintain consistency with proven approaches.
DE-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
DE-4	INTER SYSTEM DEPENDENCIES • The dependencies of the front-line system to support systems and support systems to support systems are identified. This is typically done by a dependency matrix. Dependency matrices are useful tools but are not considered necessary if sufficient documentation is available to assure quality of dependency assessments.	The documentation or computer model should provide a traceable pathway to describe the dependency relationship among systems.	A method to display the dependency relationship among systems should be provided in a documented fashion.	A dependency matrix or set of matrices (or their equivalent) shall be available to describe the dependency relationship among systems. The level of detail shall be at least to the train level. Documentation of the matrices should be quite thorough.

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DE-5	<u>SYSTEM / INITIATOR DEPENDENCIES</u> • The dependencies of the support systems and front-line systems to the initiating events are identified	The initiating event effects on front line and support systems can be inferred from the documentation. Support system initiating events may be treated conservatively by subsuming into more restrictive groups.	The initiating event effects on front line and support systems should be well documented via a matrix or equivalent. Critical support system initiating events should not be subsumed into more general initiating events.	The initiating event effects on front line and support systems shall be well documented via a matrix or equivalent. Critical support system initiating events shall not be subsumed into more general initiating events.
DE-6	<u>METHODOLOGY</u> • Support system and system to system interactions are treated in the event trees or linked fault trees. (See Element AS-6)	The explicit treatment of system to system dependencies should be modeled and there is clear traceable documentation	The explicit treatment of system to system dependencies should be modeled and there is clear traceable documentation	The explicit treatment of system to system dependencies shall be modeled and there is clear traceable documentation

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DE-7	HUMAN INTERACTIONS • The human interactions that can cut across system trains and can cause failure of multiple trains due to pre-initiator and post initiator human interactions (HIs) are identified and documented. (See Element HR-26) Examples include: - Common cause miscalibration of similar sensors - Operator procedure-based actions to terminate injection - RPV external injection termination above MPCWLL (for BWRs)	Human interactions affecting multiple systems or safety functions should be • Searched for • Quantified in a best estimate fashion • Well documented	Human interactions affecting multiple systems or safety functions should be • Searched for • Quantified in a best estimate fashion • Well documented	Human interactions affecting multiple systems or safety functions shall be • Searched for • Quantified in a best estimate fashion • Well documented
DE-8	COMMON CAUSE • Similar components within a system are included in a common cause group. (See Element DA-10)	Common cause groups should be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions	Common cause groups shall be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions	Common cause groups shall be established using a logical, systematic process that considers similarity in: • service conditions (standby vs. running) • environment • design • maintenance • lubrication • fuel • spatial interactions

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DE-8 (cont'd)			For the critical PRA systems, similar redundant components (i.e., pumps, MOVs, AOVs) within the system should either: a) be modeled for CCF OR b) Have an analysis to specify why CCF modeling is not necessary	For all systems modeled, similar redundant components within the system shall either: a) be modeled for CCF OR b) Have an analysis to specify why CCF modeling is not necessary
DE-9	• NUREG/CR-4780 methodology or equivalent is used to develop the component groups, OR • NUREG/CR-4780 methodology or equivalent supported by plant specific operating experience is used to ensure grouping is adequate, OR • Full NUREG/CR-4780 Application or its equivalent (See Elements DA-12 and DA-14)	---	NUREG/CR-4780 (EPRI NP-5613 or equivalent) systematic approach should be used to provide plant specific grouping of similar system components for CCF treatment	NUREG/CR-4780 (EPRI NP-5613 or equivalent) systematic approach shall be used to provide plant specific grouping of similar system components for CCF treatment

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
DE-10	SPATIAL DEPENDENCIES • Spatial challenges that can result in dependencies among components are included in the model for: - Flooding - High temperature - Inadvertent sprinkler operation - Missiles (HPCI/RCIC turbines for BWRs, turbine-driven EFW/AFW pumps for PWRs) - Intake anomalies (e.g., ice frazil, bio-fouling)	Flooding initiators and subsequent accident sequences should be traceable to their disposition. Documentation of the "other" effects may be weak and complete analysis may not be available.	Flooding initiators and subsequent accident sequences should be traceable to their disposition. This should include identification of: • Flood sources • Flood initiating event frequency including maintenance induced flooding. • Propagation pathways. • Affected mitigation equipment. • Flood scenarios Other spatial dependencies should be noted in the System Notebook or the plant walkdown.	Flooding initiators and subsequent accident sequences shall be traceable to their disposition. This shall include identification of: • Flood sources • Flood initiating event frequency including maintenance induced flooding. • Propagation pathways. • Affected mitigation equipment. • Flood scenarios Other spatial dependencies shall be noted in the System Notebook or the plant walkdown.
DE-11	WALKDOWN • Specifically examines the spatial dependencies that could affect the system or intersystem reliabilities or initiating events.	A walkdown of critical plant areas should be performed.	A walkdown of critical plant areas should be performed and documented.	A complete plant walkdown of critical areas shall be performed and well documented, including photographs.
DE-12	DOCUMENTATION • Reflects the process used	The documentation should be adequate to identify the type of process used.	The documentation level of detail shall be adequate for a general confirmation of the model and its approach. The documentation shall describe the results consistent with the process.	The process used in the dependency analysis shall be accurately reflected in the documentation. The documentation shall describe the results consistent with the process.
DE-13	• Includes an independent review for the documented results	An independent review should be performed.	Independent review should be performed and documented by knowledgeable personnel.	Independent review shall be performed and documented by knowledgeable personnel.

Table 5-7

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: DEPENDENCY

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
DE-14	• Provides the basis of the dependency treatment and is traceable to plant specific or generic analysis.	The level of detail of the documentation should be sufficient for independent reviewers to confirm the process and the inputs and outputs of the analysis	The details of the dependency treatment should be traceable to accepted methods and data sources.	The details of the dependency treatment shall be traceable to accepted methods and data sources.

Table 5-8

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: STRUCTURAL RESPONSE

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
ST-1	GUIDANCE • Describes the process used	General description of the structural analysis for each of the items cited below is provided.	The documentation or separate specific guidance of the structural analysis should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for structural analysis including the updating process. Guidance for the structural evaluation for the following should be included for both Level 1 and Level 2 challenges: • RPV (ATWS and non-ATWS) • Containment • Pipe • Flood Barriers • Reactor Buildings
ST-2	• Consistent with industry practices	General adherence to accepted industry approaches should be included.	The documentation should provide a reasonable basis for performing the structural analysis and should maintain consistency with proven approaches.	The guidance for structural analysis should be complete and detailed and should maintain consistency with proven approaches.
ST-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance may be available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.

Table 5-8

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: STRUCTURAL RESPONSE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
ST-4	RPV CAPABILITY (ATWS) • Failure Limit considered, OR • Best estimate failure condition considered (ASME Service Level C used)	The definition of the RPV ultimate capacity for various challenges should be provided. This should include: • Overpressure • Debris attack (Level 2/LERF only) This definition includes conservatisms in the evaluation. This may include UFSAR evaluations of Service Level C or number of SRVs required for different challenges (e.g., transient, ATWS).	The definition of the RPV ultimate capacity for various challenges should be provided. This should include: • Overpressure • Pressurized thermal shock • Debris attack (Level 2/LERF only) This definition includes conservatisms in the evaluation but they do not substantially influence the PRA results or PRA success criteria.	A best estimate of the RPV ultimate capacity for the following challenges shall be provided. This shall include: • Overpressure • Pressurized thermal shock • Debris attack (Level 2/LERF only)
ST-5	CONTAINMENT • Conservative estimate of failure probability is used OR • Realistic estimate of failure probability is used based on detailed plant specific structural examination	The containment ultimate capacity for the various challenges that are evaluated in the PRA should be provided. This may include: • Overpressure • High pressure and temperature • Dynamic loading • Combustible gas events • Debris Contact • Steam Explosion • Direct Containment Heating This containment capacity includes conservatisms in the evaluation and is based on comparison of the plant specific features with a reference plant analysis. Containment failure paths and size of failures are included in the evaluation if they influence LERF assessment.	The containment ultimate capacity for the various challenges that are evaluated in the PRA should be provided. This should include: • Overpressure • High pressure and temperature • Dynamic loading • Combustible gas events • Debris Contact • Steam Explosion • Direct Containment Heating This containment capacity includes conservatisms in the evaluation but they do not substantially influence the PRA results or PRA success criteria. The evaluation of the containment capacity should be plant specific. Generic containment failure modes should be used as a starting point for the containment failure mode assessment.	A best estimate plant specific containment ultimate capacity evaluation for the following challenges shall be provided: • Overpressure • High pressure and temperature • Dynamic loading • Combustible gas events • Debris Contact • Steam Explosion • Direct Containment Heating Generic containment failure modes should be used as a starting point for the containment failure mode assessment.

Table 5-8

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: STRUCTURAL RESPONSE

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
ST-5 (cont'd)			Behavior of containment seals, penetrations, and hatches should be fully addressed beyond the design basis temperature and pressure for contributing failure modes and failure pathways. The PRA should provide a best estimate evaluation of containment structural capability which assesses all potential impacts. This includes: • Impact on Level 1 -- adverse impacts on core damage prevention • Impact on radionuclide release • Impact on suppression pool bypass (BWR) Unique containment characteristics should be explicitly assessed in the plant specific analysis. Examples include the following: 1. External Ring Header (BWR) 2. External Wetwell to Drywell Vacuum Breaker Lines (BWR) 3. Single Ply external expansion bellows 4. Dynamic Torus Loading (BWR) 5. Reactor Building to torus vacuum breakers 6. Free Standing Steel vs. Concrete (BWR) 7. Ice Condenser Containment Containment failure paths and size of failures should be included in the evaluation if they may influence LERF assessment.	Behavior of containment seals, penetrations, and hatches should be fully addressed beyond the design basis temperature and pressure for contributing failure modes and failure pathways. The PRA shall provide a best estimate evaluation of containment structural capability which assesses all potential impacts. This includes: • Impact on Level 1 -- adverse impacts on core damage prevention • Impact on release • Impact on suppression pool bypass (BWR) Unique containment characteristics shall be explicitly assessed in the plant specific analysis. Examples include the following: 1. External Ring Header (BWR) 2. External Wetwell to Drywell Vacuum Breaker Lines (BWR) 3. Single Ply external expansion bellows 4. Dynamic Torus Loading (BWR) 5. Reactor Building to torus vacuum breakers 6. Free Standing Steel vs. Concrete (BWR) 7. Ice Condenser Containment Containment failure paths and size of failures shall be included in the evaluation if they may influence LERF assessment.

Table 5-8

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: STRUCTURAL RESPONSE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
ST-6	• Level 2 analysis considers multiple pathways from the containment	---	Multiple containment failure pathways shall be included in the evaluation of containment performance for Level 2. (Specifically for BWRs, DW head, DW shell, wetwell airspace, and wetwell waterspace failures shall all be included in the probabilistic assessment and Level 2 evaluation.) In addition, if coincident multiple failure modes are possible during a single accident scenario, the impact on radionuclide release should be incorporated.	Multiple containment failure pathways shall be included in the evaluation of containment performance for Level 2. (Specifically for BWRs, DW head, DW shell, wetwell airspace, and wetwell waterspace failures shall all be included in the probabilistic assessment and Level 2 evaluation.) In addition, if coincident multiple failure modes are possible during a single accident scenario, the impact on radionuclide release shall be incorporated.
ST-7	REACTOR BUILDING • Blowout panels considered	Reactor building or auxiliary buildings should be assessed to determine the failure location given a release from the RPV or the containment. This should include the blowout panels.	Reactor building or auxiliary buildings should be assessed to determine the failure location given a release from the RPV or the containment. This should include the blowout panels.	Reactor building or auxiliary buildings should be assessed to determine the failure location given a release from the RPV or the containment. This should include the blowout panels.
ST-8	• Level 2 analysis considers multiple pathways from the reactor building	Reactor Building or Auxiliary Building failure modes that can lead to reduced decontamination factors and higher releases to the environment should be considered. This should include failure modes involving failures low in the reactor building and coincident failures higher in the Reactor Building leading to accelerated air flow and low DF.	Reactor Building or Auxiliary Building failure modes that can lead to reduced decontamination factors and higher releases to the environment should be considered. This should include failure modes involving failures low in the reactor building and coincident failures higher in the Reactor Building leading to accelerated air flow and low DF.	Reactor Building or Auxiliary Building failure modes that can lead to reduced decontamination factors and higher releases to the environment shall be considered. This shall include failure modes involving failures low in the reactor building and coincident failures higher in the Reactor Building leading to accelerated air flow and low DF.
ST-9	<u>PIPE OVERPRESSURE (ISLOCA)</u> • Conservative estimate is used <u>OR</u> • Generic realistic estimate is used <u>OR</u> • Plant specific realistic estimate is used	The pipe ultimate capacity under the conditions of exposure to high pressure (e.g., RPV pressure for incipient ISLOCA) should be provided. This includes conservatisms in the evaluation.	The pipe ultimate capacity under conditions of exposure to high pressure (e.g., RPV pressure for incipient ISLOCA) shall be provided on a realistic basis using methods specified by NRC in NUREG/CR-5603, NUREG/CR-5124, or their equivalent and uses typical pipe configuration and sizes in the evaluation to provide a realistic but generic or typical failure probability.	The pipe ultimate capacity under conditions of exposure to high pressure (e.g., RPV pressure for incipient ISLOCA) shall be provided on a realistic basis using methods specified by NRC in NUREG/CR-5603, NUREG/CR-5124, or their equivalent and shall use plant specific pipe parameters.

Table 5-8

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: STRUCTURAL RESPONSE

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
ST-10	<u>FLOOD BARRIER INTEGRITY</u> • Internal flooding analysis considers flood barrier (e.g., doors) structural capability and features when these barriers are credited for limiting flood propagation	As part of the containment flooding accident sequence evaluation, the spatial effects of flooding should address the flood propagation paths. These path investigations should include: • Flood barrier penetration, failure, or inadvertent openings (e.g., doors) • Ventilation penetration pathways • Spray of the flood waters • Floor gratings • Drains • Drain system check valves Flood propagation should consider the failure modes of each in the assessment of flood accident sequences.	As part of the containment flooding accident sequence evaluation, the spatial effects of flooding should address the flood propagation paths. These path investigations should include: • Flood barrier penetration, failure, or inadvertent openings (e.g., doors) • Ventilation penetrations • Spray of the flood waters • Floor gratings • Drains • Drain system check valves Flood propagation should consider the failure modes of each in the assessment of flood accident sequences.	As part of the containment flooding accident sequence evaluation, the spatial effects of flooding shall address the flood propagation paths. These path investigations shall include: • Flood barrier penetration, failure, or inadvertent openings (e.g., doors) • Ventilation penetrations • Spray of the flood waters • Floor gratings • Drains • Drain system check valves Flood propagation shall consider the failure modes of each in the assessment of flood accident sequences.
ST-11	<u>DOCUMENTATION</u> • Reflects the process used	Documentation should provide the basis for meeting each of the criteria ST-4 through ST-10. The documentation should describe the results consistent with the process.	Documentation should provide the basis for meeting each of the criteria ST-4 through ST-10. The documentation should describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria ST-4 through SY-10. The documentation shall describe the results consistent with the process.
ST-12	• Includes an independent review for the documented results	The system analysis should be reviewed.	Independent review should be performed and documented by knowledgeable personnel, such as a structural engineer.	Independent review should be performed and documented by knowledgeable personnel, such as a structural engineer.
ST-13	• Provides the basis of the treatment and is traceable to plant specific or generic analysis.	Documentation reflects the general process features.	Documentation should provide the basis for structural analysis process.	Documentation shall provide the basis for structural analysis process.

Table 5-9

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-1	GUIDANCE • Describes the process used	General description of the quantification process should be provided.	The documentation of the quantification process should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for quantification including the updating process.
QU-2	• Consistent with industry practices	General adherence to accepted industry approaches should be included.	The documentation should provide a reasonable basis for performing the quantification and should maintain consistency with proven approaches.	The guidance for quantification should be complete and detailed and should maintain consistency with proven approaches.
QU-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results. (See also QU-4, QU-6, QU-7)	• The documentation or separate specific guidance should be sufficient to provide a means to obtain equivalent results. • The mutually exclusive event file presents the combinations which are assumed not to occur in the final cutset result due to plant maintenance practices or operation. Examples include technical specifications, administrative procedures and non-physical cutsets. Entries in the mutually exclusive file should be documented regarding the basis for their removal from the final solution.. (See also QU-4, QU-6, QU-7)	• The guidance shall be sufficiently detailed to reproduce the results. • The guidance should include the specific steps performed. • The mutually exclusive event file presents the combinations which are assumed not to occur in the final cutset result due to plant maintenance practices or operation. Examples include technical specifications, administrative procedures and non-physical cutsets. Entries in the mutually exclusive file should be documented regarding the basis for their removal from the final solution.

Table 5-9

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-3 (cont'd)				• Guidance should be provided regarding: (1) the treatment of non-minimal sequences and/or cutsets as part of the results interpretation and use of the model; (2) establishing maximum fault tree truncation limits, based on a number of decades below the FT quantification, the number of cutsets obtained, or convergence; (3) The sensitivity/uncertainty analysis to be performed should be identified; (4) description of levels of detail for ET nodes; (5) when and how to use transfers; (6) how to set up the computer files, what truncation limits to use. • This should ensure consistency between updates. (See also QU-4, QU-6, QU-7)
QU-4	<u>CODE</u> • The base computer code and its inputs have been tested and demonstrated to produce reasonable answers.[(3), (4)]	Cutset truncation based on cutset order shall not be performed. For evaluations in which the rare event approximation does not apply, the computer code or its application to the PRA should properly account for this situation. If success branches of event trees are less than 0.9, the numerically correct estimate should be used.	Cutset truncation based on cutset order shall not be performed. For evaluations in which the rare event approximation does not apply, the computer code or its application to the PRA should properly account for this situation. If success branches of event trees are less than 0.9, the numerically correct estimate shall be used. The same truncation limit used in evaluating system failures shall be used in the complementary success branches. Use of independent modules should not allow reduction in the truncation limit.	Cutset truncation based on cutset order shall not be performed. For evaluations in which the rare event approximation does not apply, the computer code or its application to the PRA should properly account for this situation. If success branches of event trees are less than 0.9, the numerically correct estimate shall be used. The same truncation limit used in evaluating system failures shall be used in the complementary success branches. Use of independent modules should not allow reduction in the truncation limit.

Table 5-9

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
QU-4 (Cont'd)			The review and confirmation of the house event file and the disallowed maintenance (DAM) file should be performed to ensure quality. These files can fundamentally change the model results and are difficult to check intuitively.	The review and confirmation of the house event file and the disallowed maintenance (DAM) file shall be performed to ensure quality. These files can fundamentally change the model results and are difficult to check intuitively.
QU-5	• The simplified model (cutset model) is demonstrated to produce reasonable results for typical applications.(2)	The simplified model (cutset model) should demonstrated to produce reasonable results for typical applications or is not used.	The simplified model (cutset model) should be demonstrated to produce reasonable results for typical applications or is not used.	The simplified model (cutset model) shall be demonstrated to produce reasonable results for typical applications or is not used.
QU-6	• Applications are not limited by the capabilities of the computer code.	Each computer code in use has its own inconsistencies that make it difficult for inexperienced users. There should be written guidance or set of code limitations that treat such issues as: • Transfers between event trees may not carry the success terms or previous failure terms • Truncation limits in fault trees different than sequence truncation values • K of N gate limits • For high conditional failure probabilities in event trees, some codes may not quantitatively account for the success branch probability being less than 1.0.	Each computer code in use has its own inconsistencies that make it difficult for inexperienced users. There should be written guidance or set of code limitations that treat such issues as: • Transfers between event trees may not carry the success terms or previous failure terms • Truncation limits in fault trees different than sequence truncation values • K of N gate limits • For high conditional failure probabilities in event trees, some codes may not quantitatively account for the success branch probability being less than 1.0.	Each computer code in use has its own inconsistencies that make it difficult for inexperienced users. There shall be written guidance or set of code limitations that treat such issues as: • Transfers between event trees may not carry the success terms or previous failure terms • Truncation limits in fault trees different than sequence truncation values • K of N gate limits • For high conditional failure probabilities in event trees, some codes may not quantitatively account for the success branch probability being less than 1.0.

Table 5-9

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-7	SIMPLIFIED MODEL • The simplified model (e.g., solved cutset) limitations are clearly identified.	The use of the "cutset" model or the "saved sequence" model, or any other simplified model should have a set of limitations documented that allow the user to check whether the limitations would impact the application.	The use of the "cutset" model or the "saved sequence" model, or any other simplified model should have a set of limitations documented that allow the user to check whether the limitations would impact the application. The RISKMAN "saved sequence" model or fault tree linked code cutset models have a number of limitations when it comes to applications. These limitations are in general well known. However the limitations should be documented for both future members of the PSA group or the users of the PSA such as the Maintenance Rule Expert Panel. These limitations include issues related to asymmetry in the model or in conditions related to truncation limits that lead to incorrect or misleading importance measures.	The use of the "cutset" model or the "saved sequence" model, or any other simplified model should have a set of limitations documented that allow the user to check whether the limitations would impact the application. The RISKMAN "saved sequence" model or fault tree linked code cutset models have a number of limitations when it comes to applications. These limitations are in general well known. However the limitations should be documented for both future members of the PSA group or the users of the PSA such as the Maintenance Rule Expert Panel. These limitations include issues related to asymmetry in the model or in conditions related to truncation limits that lead to incorrect or misleading importance measures.
QU-8	DOMINANT SEQUENCES/ CUTSETS • The dominant cut sets or sequences[1] - Make physical sense	A review of the dominant cutsets should be performed to demonstrate the reasonableness of the cutset results and to identify that there are no anomalies in the cutset results.	A review of the dominant cutsets shall be performed to demonstrate the reasonableness of the cutset results and to identify that there are no anomalies in the cutset results. Missing sequences that could be anticipated from reviews of similar plants should be explainable. A review of the House Events (or Flag Files) should be performed to ensure sequences are not being inappropriately deleted.	A review of the dominant cutsets shall be performed to demonstrate the reasonableness of the cutset results and to identify that there are no anomalies in the cutset results. Missing sequences that could be anticipated from reviews of similar plants should be explainable. A review of the House Events (or Flag Files) should be performed to ensure sequences are not being inappropriately deleted.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-9	- Include common cause potential where appropriate (See DA-8,9,10,12,13,14)	The common cause treatment should be included into the quantification process.	Common cause failure probabilities should be included for key groups and the latest common cause data should be used. The common cause treatment should be included into the quantification process for dominant contributors to CDF and LERF.	Common cause failure probabilities shall be included for key groups and the latest common cause data shall be used, plus a search for plant specific applicability of the common cause data shall be performed consistent with NUREG/CR-4780. The common cause treatment shall be included in the quantification process.
QU-10	- Include dependency among human actions when multiple HEPs are in the same cutset or sequence (See HR, 26,27)	The dependence among human actions should be evaluated in the PSA process. Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency included as a test of modeling adequacy. Equivalent techniques may also be used.	The dependence among human actions shall be evaluated in the PSA process. Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency should be included as a test of modeling adequacy. Equivalent techniques may also be used.	The dependence among human actions shall be evaluated in the PSA process. Identification of sequences that, but for low human error rates in, would have been dominant contributors to core damage frequency shall be included as a test of modeling adequacy. Equivalent techniques may also be used.
QU-11	- Are not missing potentially dominant cut sets or sequences for similar plants. Possible reasons for differences include: (a) physical plant or procedural differences among plants; (b) documented assumptions; (c) detailed modeling or data to supplant assumptions.	The cutsets or sequences from similar plants are not reviewed or are not documented to ensure that dominant cutsets which have been observed at other plants should not be present in the analyzed plant.	The cutsets or sequences from similar plants should be reviewed to ensure that dominant cutsets which have been observed at other plants should not be present in the analyzed plant.	The cutsets or sequences from similar plants shall be reviewed to ensure that dominant cutsets which have been observed at other plants should not be present in the analyzed plant.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	SUBTIER CRITERIA Grade 3	SUBTIER CRITERIA Grade 4
QU-12	• Asymmetry: The model asymmetry is well described in terms of: - modeling - plant support systems - normally running equipment - cross-ties to an adjacent unit	The system notebooks, the event tree notebook, or the results summary do not provide a description of the asymmetries in systems or in the modeling of systems adequate for a complete evaluation of the asymmetries.	The system notebooks, the event tree notebook, or the results summary should provide a description of the asymmetries in systems or in the modeling of systems. The design, data, operating philosophy, and operating conditions that can lead to asymmetries in the importance of components, systems, or system trains should be documented. This information should be useful in assessing implications of failures, on-line outage decisions, modifications, and accident response.	The system notebooks, the event tree notebook, or the results summary shall provide a description of the asymmetries in systems or in the modeling of systems. The design, data, operating philosophy, and operating conditions that can lead to asymmetries in the importance of components, systems, or system trains should be documented. This information should be useful in assessing implications of failures, on-line outage decisions, modifications, and accident response.
QU-13	• Asymmetry: Any modeling quantitative asymmetry (e.g., one train of dual-train system modeled as in-service, other in standby) is documented and is well understood so that applications affected by asymmetry can be determined.	Asymmetries in quantitative modeling are not explained and examined to provide application users the necessary understanding regarding why such asymmetries are present in the model.	Asymmetries in quantitative modeling should be explained and examined to provide application users the necessary understanding regarding why such asymmetries are present in the model.	Asymmetries in quantitative modeling shall be explained and examined to provide application users the necessary understanding regarding why such asymmetries are present in the model.
QU-14	• Circular logic can sometimes occur when using linked fault trees. The PSA process appropriately accounts for support system dependencies in a consistent fashion that avoids so-called circular logic.	The methods of eliminating circular logic may result in incorrect quantitative results, e.g., non-conservative. The cutting of circular logic in the model should be explained and should not introduce non-conservatisms in the model.	The methods of eliminating circular logic may result in incorrect quantitative results, e.g., non-conservative. The cutting of circular logic in the model should be explained and shall not introduce non-conservatisms in the model.	The methods of eliminating circular logic may result in incorrect quantitative results, e.g., non-conservative. The cutting of circular logic in the model should be explained and shall not introduce non-conservatisms in the model.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	SUBTIER CRITERIA Grade 3	SUBTIER CRITERIA Grade 4
QU-15	NON-DOMINANT SEQUENCES/CUTSETS(1) • The non-dominant cut sets or sequences - Make physical sense	The non-dominant accident sequence review used to ensure the cutsets are reasonable and have physical meaning is not available for examination by the Peer Review Team.	Non-dominant accident sequences should be reviewed to ensure the cutsets are reasonable and have physical meaning. A review of the House Events (or Flag Files) should be performed to ensure sequences are not being inappropriately deleted. The use of conservatisms in the IPE search for vulnerabilities is appropriate. However, in evolving the PSA to be used for risk-informed applications , overly conservative assumptions (even in non-dominant sequences) should be eliminated to avoid biasing the results.	Non-dominant accident sequences shall be reviewed to ensure the cutsets are reasonable and have physical meaning. A review of the House Events (or Flag Files) should be performed to ensure sequences are not being inappropriately deleted. The use of conservatisms in the IPE search for vulnerabilities is appropriate. However, in evolving the PSA to be used for risk-informed applications , overly conservative assumptions (even in non-dominant sequences) should be eliminated to avoid biasing the results.
QU-16	- Include common cause potential or there are equivalent cutsets that do include the common cause potential	Common cause failure probabilities may be included for key groups and the use of the latest common cause data may be used.	Common cause failure probabilities should be included for key groups and the use of the latest common cause data should be used.	Common cause failure probabilities shall be included for key groups and the use of the latest common cause data shall be used.
QU-17	- Include dependency among human actions when multiple HEPs are in the same cutset or sequence	The dependence among human actions should be evaluated in the PSA process. Because these actions occur in non-dominant sequences, there may less rigor in the evaluation and documentation. Examples include the fact that the operating crew may be expected to perform many steps and actions to maintain the BOP in a condition that would avoid distractions in the future. These actions are considered to have low failure probabilities and to be only loosely tied to the success of critical operator actions.	The dependence among human actions shall be evaluated in the PSA process. Because these actions occur in non-dominant sequences, there may less rigor in the evaluation and documentation. Examples include the fact that the operating crew may be expected to perform many steps and actions to maintain the BOP in a condition that would avoid distractions in the future. These actions are considered to have low failure probabilities and to be only loosely tied to the success of critical operator actions. Identification of sequences that, but for low human error rates, would have been dominant contributors to core damage frequency should be included as a test of modeling adequacy. Equivalent techniques may also be used.	The dependence among human actions shall be evaluated in the PSA process. Because these actions occur in non-dominant sequences, there may less rigor in the evaluation and documentation. Examples include the fact that the operating crew may be expected to perform many steps and actions to maintain the BOP in a condition that would avoid distractions in the future. These actions are considered to have low failure probabilities and to be only loosely tied to the success of critical operator actions. Identification of sequences that, but for low human error rates in, would have been dominant contributors to core damage frequency shall be included as a test of modeling adequacy. Equivalent techniques may also be used.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
QU-18	RECOVERY ANALYSIS • Recovery actions credited in the evaluation are either proceduralized or have reasonable likelihood of success when the TSC/EOF are manned.	Recovery actions credited in the evaluation should be proceduralized or be part of training or be a recognized skill-of-the-trade, or have reasonable likelihood of success when the TSC/EOF are manned.	Recovery actions credited in the evaluation shall be proceduralized or be part of training or be a recognized skill-of-the-trade, or have reasonable likelihood of success when the TSC/EOF are manned.	Recovery actions credited in the evaluation shall be proceduralized or be part of training or be a recognized skill-of-the-trade, or have reasonable likelihood of success when the TSC/EOF are manned.
QU-19	• Recovery actions that are included in the quantification process are included on selected dominant accident sequences; **OR** • Recovery actions that are included in the quantification process are included in all applicable sequences and cut sets	Recovery actions that are included in the quantification process are included on selected dominant accident sequences.	Recovery actions that are included in the quantification process should be included in all applicable sequences and cut sets.	Recovery actions that are included in the quantification process shall be included in all applicable sequences and cut sets.
QU-20	• Transfers of sequences among event trees are treated explicitly.	Transfers of sequences among event trees are treated either quantitatively or in a qualitative manner in the documentation.	Transfers of sequences among event trees should be treated explicitly.	Transfers of sequences among event trees shall be treated explicitly.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
QU-21	TRUNCATION • The truncation of accident sequences based on frequency is a key decision made by PSA analysts that may affect the future PRA applications. The PSA Applications Guide implies that truncation limits be low enough to support the evaluation of dependencies among systems, structures, and components.	The truncation of accident sequences from the model eliminates some dependencies that are judged insignificant for CDF or LERF.	The truncation of accident sequences should be performed at a sufficiently low cutoff value that significant dependencies that may affect applications are not eliminated. Entire groups of sequences (e.g., ATWS, LOOP) should not be completely truncated unless thorough documentation is provided regarding the technical bases for truncation. It is noted that accident sequences may have been eliminated from the quantified model before the truncation test is applied. The elimination of certain sequences (e.g., LOCA * Failure to scram, or Breaks outside containment) should not be done using the GL 88-20 type screening (or equivalent) and without consideration of the impact on Level 2.	The truncation of accident sequences shall be performed at a sufficiently low cutoff value that significant dependencies that may affect applications are not eliminated. Entire groups of sequences (e.g., ATWS, LOOP) should not be completely truncated unless thorough documentation is provided regarding the technical bases for truncation. It is noted that accident sequences may have been eliminated from the quantified model before the truncation test is applied. The elimination of certain sequences (e.g., LOCA * Failure to scram, or Breaks outside containment) should not be done using the GL 88-20 type screening (or equivalent) and without consideration of the impact on Level 2.
QU-22	• Example truncation values used in a base PSA are given. These should be treated as examples only. The screening truncation of events or failure modes retained in the model are as follows for screened out events:	The screening truncation of events or failure modes may be as follows for screened out events: < 0.001 * CDF Base AND < 0.001 * LERF Base	The screening truncation of events or failure modes should be as follows for screened out events: < 0.0001 * CDF Base AND < 0.0001 * LERF Base	The screening truncation of events or failure modes shall be as follows (or more stringent) for screened out events: < 0.00001 * CDF Base AND < 0.00001 * LERF Base

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-23	• The truncation values used in the system fault trees and accident sequences are sufficiently low to support their use in representative applications.	The truncation of system fault trees from the model may eliminate some dependencies that are judged insignificant for CDF or LERF. This may occur in NUPRA, SETS, or RISKMAN	The truncation of system fault trees should be performed at a sufficiently low cutoff value that significant dependencies that may affect applications are not eliminated. Entire groups of sequences (e.g., ATWS, LOOP) should not be completely truncated unless thorough documentation is provided regarding the technical bases for truncation. It is noted that accident sequences may have been eliminated from the quantified model before the truncation test is applied. The elimination of certain sequences (e.g., LOCA * Failure to scram, or Breaks outside containment) should not be done using the GL 88-20 type screening (or equivalent) and without consideration of the impact on Level 2.	The truncation of system fault trees shall be performed at a sufficiently low cutoff value that significant dependencies that may affect applications are not eliminated. Entire groups of sequences (e.g., ATWS, LOOP) should not be completely truncated unless thorough documentation is provided regarding the technical bases for truncation. It is noted that accident sequences may have been eliminated from the quantified model before the truncation test is applied. The elimination of certain sequences (e.g., LOCA * Failure to scram, or Breaks outside containment) should not be done using the GL 88-20 type screening (or equivalent) and without consideration of the impact on Level 2.
QU-24	• There is evidence of convergence towards a stable result	There is limited evidence of convergence towards a stable result.	There should be evidence of convergence towards a stable result.	There shall be evidence of convergence towards a stable result.
QU-25	• If the fault tree linking approach is used, "delete" terms (cutset complements) are used to account for the successes in event sequences as appropriate to assure that the correct cut sets are generated.	---	If the fault tree linking approach is used, "delete" terms (cutset complements) shall be used to account for the successes in event sequences as appropriate to assure that the correct cut sets are generated. This includes the treatment of transfers among event trees where the "successes" may not be transferred between event trees.	If the fault tree linking approach is used, "delete" terms (cutset complements) shall be used to account for the successes in event sequences as appropriate to assure that the correct cut sets are generated. This includes the treatment of transfers among event trees where the "successes" may not be transferred between event trees.
QU-26	• The quantification process identifies and deletes mutually exclusive cutsets.	The quantification process should identify and delete mutually exclusive cutsets. The process for identifying and eliminating mutually exclusive cutsets from the model is documented in a fashion that provides only limited ability to review the process to assure its accuracy.	The quantification process shall identify and delete mutually exclusive cutsets. The process for identifying and eliminating mutually exclusive cutsets from the model should be documented.	The quantification process shall identify and delete mutually exclusive cutsets. The process for identifying and eliminating mutually exclusive cutsets from the model shall be documented.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-27	UNCERTAINTY • A search is performed for unique or unusual sources of uncertainty not present in the typical or generic plant analysis.	A search performed for unique or unusual sources of uncertainty not present in the typical or generic plant analysis is not sufficiently documented for an effective review by the Peer Review Team.	A search should be performed for unique or unusual sources of uncertainty not present in the typical or generic plant analysis. A qualitative presentation should be available for causes of uncertainty, such as: • possible optimistic or conservative success criteria, • suitability of the reliability data, • possible modeling uncertainties (asymmetry or other modeling limitations due to the method selected), • degree of completeness in the selection of initiating events, • possible spatial dependencies • etc.	A search shall be performed for unique or unusual sources of uncertainty not present in the typical or generic plant analysis. A qualitative presentation should be available for causes of uncertainty, such as: • possible optimistic or conservative success criteria, • suitability of the reliability data, • possible modeling uncertainties (asymmetry or other modeling limitations due to the method selected), • degree of completeness in the selection of initiating events, • possible spatial dependencies • etc.
QU-28	• If there are unusual sources of uncertainty, special sensitivity evaluations or quantitative uncertainty assessments are performed to support the base conclusion and future applications.	If there are unusual sources of uncertainty, special sensitivity evaluations or quantitative uncertainty assessments are not performed to support the base conclusion and future applications.	If there are unusual sources of uncertainty, special sensitivity evaluations or quantitative uncertainty assessments should be performed to support the base conclusion and future applications.	If there are unusual sources of uncertainty, special sensitivity evaluations or quantitative uncertainty assessments shall be performed to support the base conclusion and future applications.
QU-29	• The capability to perform focused sensitivities to support the PSA applications is available.	The capability to perform focused sensitivities to support the PSA applications should be available.	The capability to perform focused sensitivities to support the PSA applications shall be available.	The capability to perform focused sensitivities to support the PSA applications shall be available.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-30	• A parametric uncertainty evaluation is performed that propagates the uncertainty distribution through the model sufficient to produce a valid mean value of CDF. OR	A parametric uncertainty evaluation is all that is performed. It propagates the uncertainty distribution through the model sufficient to produce a valid mean value of CDF. OR		
	• A quantification of selected uncertainties is performed, or the impact of the selected uncertainties on the final risk measures is estimated. OR	A quantification of selected uncertainties is performed, or the impact of the selected uncertainties on the final risk measures is estimated. OR	A quantification of selected uncertainties should be performed, or the impact of the selected uncertainties on the final risk measures is estimated. OR	
	• A quantitative uncertainty evaluation is performed using selected sensitivities to establish the approximate uncertainty bands. OR	A quantitative uncertainty evaluation is performed using selected sensitivities to establish the approximate uncertainty bands.	A quantitative uncertainty evaluation should be performed using selected sensitivities to establish the approximate uncertainty bands. OR	
	• A comparison is made between the plant specific PSA and a similar generic study with "full" uncertainty evaluation. The differences in the plant, model, or data are used to identify whether there are any differences that would impact the calculated uncertainty band or obviate the ability to use the uncertainty band. OR		A comparison should be made between the plant specific PRA and a similar generic study with "full" uncertainty evaluation (e.g., NUREG-1150). The differences in the plant, model, or data are used to identify whether there are any differences that would impact the calculated uncertainty band or obviate the ability to use the uncertainty band. The implications drawn from the generic uncertainty study can then be applied to the plant specific PRA as modified by the differences in the plant, the model, or the data used.	A comparison shall be made between the plant specific PRA and a similar generic study with "full" uncertainty evaluation (e.g., NUREG-1150). The differences in the plant, model, or data are used to identify whether there are any differences that would impact the calculated uncertainty band or obviate the ability to use the uncertainty band. The implications drawn from the generic uncertainty study can then be applied to the plant specific PRA as modified by the differences in the plant, the model, or the data used. OR

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-30 (cont'd)	• A complete quantification of all sources of uncertainty is performed and the final estimates for risk measures is presented along with the uncertainty distribution.			A complete quantification of all sources of uncertainty shall be performed and the final estimates for risk measures is presented along with the uncertainty distribution.
QU-31	<u>RESULTS SUMMARY</u> • The PSA results summary identifies the dominant contributors.	The PSA results summary should identify the dominant contributors. The accident sequence results by sequence, sequence types, and total should be reviewed and compared to similar plants to assure reasonableness and to identify any exceptions.	The PSA results summary shall identify the dominant contributors. The accident sequence results by sequence, sequence types, and total should be reviewed and compared to similar plants to assure reasonableness and to identify any exceptions. A detailed description of the Top 10 to 100 accident cutsets (CAFTA or NUPRA) or accident sequences (RISKMAN) should be provided because they are be important in ensuring that the model results are well understood and that modeling assumption impacts are likewise well known. Similarly, the dominant accident sequence groups or functional failure groups should also be discussed. These functional failure groups should be based on a scheme similar to that identified by NEI in NEI 91-04, Appendix B.	The PSA results summary shall identify the dominant contributors. The accident sequence results by sequence, sequence types, and total shall be reviewed and compared to similar plants to assure reasonableness and to identify any exceptions. A detailed description of the Top 10 to 100 accident cutsets shall be provided because they are be important in ensuring that the model results are well understood and that modeling assumption impacts are likewise well known. Similarly, the dominant accident sequence groups or functional failure groups shall also be discussed. These functional failure groups should be based on a scheme similar to that identified by NEI in NEI 91-04, Appendix B.
QU-32	• Reflects the process used.	Documentation should provide the basis for meeting each of the criteria QU-4 through QU-30. The documentation should describe the results consistent with the process.	Documentation should provide the basis for meeting each of the criteria QU-4 through QU-30. The documentation should describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria QU-4 through QU-31. The documentation shall describe the results consistent with the process.
QU-33	• Includes an independent review for the documented results.	Independent review is performed and documented.	Independent review should be performed and documented by knowledgeable personnel.	Independent review shall be performed and documented by knowledgeable personnel.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: QUANTIFICATION AND RESULTS INTERPRETATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
QU-34	• Provides the basis and is traceable to plant specific or generic analysis.	Documentation provides the general basis for quantification process.	Documentation should provide the basis for quantification process.	Documentation shall provide the basis for quantification process.

Notes to Table QU:

(1) A model of Grade 3 Level should be capable of generating sequences (at all reliability levels) which are reasonable. That is, the sequences which are dominant and those which are of very low frequency should all be equally correct logically. It is important to view the checklist on results as integral to and a part of the process of confirming accurate sequence delineation. A review which evaluates 20 or 30 sequences and determines that they are generally logically correct would probably be sufficient to draw a conclusion that the logical depiction in the model is correct. Such a review should consider both dominant and low frequency cases. There may be thousands of sequences generated by the model. It is not necessary to evaluate even a large fraction of these many sequences as part of the peer review process. This same level of judgment is appropriate when dealing with the completeness of the consideration of systems, recovery actions, and timing.

(2) The cutset model is part of the PRSA model assessment because the cutset model may be used in future applications and its viability as a PRA tool for applications is considered to be part of the PSA Peer Review of the base PRA. The limitations of the simplified pre-generated cutsets (or equivalent) are clearly identified.

(3) It is recognized that various computer codes used in the probabilistic assessment of accident sequences may treat the success branches differently. However, in the probabilistic evaluation it is necessary for a Grade 3 and 4 to ensure that when success probabilities deviate from approximately 1.0 that this numerical effect be accounted for. Evidence of this is necessary to ensure that Grade 3 and 4 applications are appropriately evaluated and not biased.

(4) The success branches account for the calculated success states in the cutsets that result on success branches.

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INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-1	<u>GUIDANCE</u> • Describes the process used	General description of the Level 2/LERF process is provided.	The documentation of the Level 2/LERF process should be sufficiently well described in the documented results to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for Level 2/LERF including the updating process.
L2-2	• Consistent with industry practices	General adherence to accepted industry approaches should be included.	The documentation should provide a reasonable basis for performing the quantification and should maintain consistency with proven approaches.	The guidance for Level 2/LERF analyses should be complete and detailed and should maintain consistency with proven approaches.
L2-3	• Sufficient detail provided for reproducing the evaluation	Documentation or specific guidance may be available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or specific guidance should be sufficient to provide a means to obtain equivalent results.	The guidance shall be sufficiently detailed to reproduce the results.
L2-4	<u>SUCCESS CRITERIA</u> • The success criteria are identified	Success criteria for Level 2/LERF should be documented. Examples include the following: • core cooling adequacy for in-vessel recovery • timing for in-vessel recovery • Prevention of RPV breach due to core melt progression • Hydrogen deflagration survivability • Hydrogen burn impact for steam inerted containment prior to spray initiation. • Containment boundary survivability Those parameters (e.g., containment leakage rate) to be used as the basis for assigning containment bypass or failure should be defined, and acceptable values shall be specified.	Success criteria for Level 2/LERF shall be documented. Examples include the following: • core cooling adequacy for in-vessel recovery • timing for in-vessel recovery • Prevention of RPV breach due to core melt progression • Hydrogen deflagration survivability • Hydrogen burn impact for steam inerted containment prior to spray initiation. • Containment boundary survivability Those parameters (e.g., containment leakage rate) to be used as the basis for assigning containment bypass or failure should be defined, and acceptable values shall be specified.	Success criteria for Level 2/LERF shall be documented. Examples include the following: • core cooling adequacy for in-vessel recovery • timing for in-vessel recovery • Prevention of RPV breach due to core melt progression • Hydrogen deflagration survivability • Hydrogen burn impact for steam inerted containment prior to spray initiation. • Containment boundary survivability Those parameters (e.g., containment leakage rate) to be used as the basis for assigning containment bypass or failure should be defined, and acceptable values shall be specified.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-5	• The success criteria are supported by thermal hydraulic analysis, system capability evaluations, or industry studies	Generic calculations formulated for similar plants may be used to define success criteria to prevent LERF. These calculations shall be consistent with the plant being evaluated in the PSA or adjustments shall be made to the success criteria to account for the differences.	Generic calculations formulated for similar plants may be used to define success criteria to prevent LERF. These calculations shall be consistent with the plant being evaluated in the PSA or adjustments shall be made to the success criteria to account for the differences.	Plant specific thermal hydraulic calculations using a computer code capable of assessing severe accident core melt progression should be used to define the success criteria to prevent LERF. These success criteria should be checked against similar calculations for similar plants.
L2-6	• The success criteria are judged realistic	---	The success criteria should be judged realistic	The success criteria shall be judged realistic
L2-7	<u>LEVEL 1/LEVEL 2 INTERFACE</u> • The link between the Level 1 and Level 2 is sufficient and adequately documented to provide the transfer of information from the Level 1 analysis to the Level 2 containment evaluation.	The transfer of information between Level 1 and Level 2 may use plant damage states to characterize groups of Level 1 core damage sequences with similar characteristics and impacts on severe accident melt progression. This treatment tends to have a wider uncertainty band on the results than other possible techniques. The use of multipliers (conditional probabilities) (see NUREG/CR-6595) to obtain LERF from CDF avoids the full calculation of Level 2 when the Level 1 changes. However, such multipliers shall be used carefully in developing applications that require LERF calculations because the changes to dependencies in the Level 1 model may not be reflected in the multipliers.	The transfer of information from Level 1 to Level 2 should be performed in a manner that maximizes the ability to accurately reflect dependencies due to conditions, equipment status, or operator errors in Level 1 that may adversely impact the Level 2 mitigation assessment. The use of multipliers (conditional probabilities) (see NUREG/CR-6595) to obtain LERF from CDF avoids the full calculation of Level 2 when the Level 1 changes. However, such multipliers shall be used carefully in developing applications that require LERF calculations because the changes to dependencies in the Level 1 model may not be reflected in the multipliers.	The transfer of information from Level 1 to Level 2 shall be performed in a manner that maximizes the ability to accurately reflect dependencies due to plant conditions, equipment status, or operator errors in Level 1 that may adversely impact the Level 2 mitigation assessment. The use of multipliers (conditional probabilities) (see NUREG/CR-6595) to obtain LERF from CDF avoids the full calculation of Level 2 when the Level 1 changes. However, such multipliers shall not be used in developing applications that require LERF.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-8	PHENOMENA CONSIDERED[(1),(3)] • The phenomena that may control the LERF radionuclide release characterization are included.	The phenomena that may control the LERF radionuclide release characterization should be included quantitatively. The Level 2 should address in a quantitative fashion a substantial number of issues affecting LERF that are believed potential contributors especially during PSA applications involving different plant configurations. These Level 2 issues include the following: • In-vessel Recovery • RPV vent & Containment Vent • Containment flood • Containment isolation failure • IC multiple tube rupture (if applicable) • ISLOCA • Deinerted operation • Steam explosions • Vacuum breaker failure (Internal & External) (BWRs) • Hydrodynamic loads under high pool level • Recriticality • Containment boundary multiple failures, e.g., Shell failure as a subsequent containment failure (melt through for Mark I free standing steel containment) • Vapor suppression failure • Direct Containment Heating Pressurization of the pedestal cavity following vessel failure if there is substantial water in the cavity	The phenomena that may control the LERF radionuclide release characterization shall be included quantitatively. The Level 2 shall address in a quantitative fashion a substantial number of issues affecting LERF that are believed potential contributors especially during PSA applications involving different plant configurations. These Level 2 issues include the following: • In-vessel Recovery • RPV vent & Containment Vent • Containment flood • Containment isolation failure • IC multiple tube rupture (if applicable) • ISLOCA • Deinerted operation • Steam explosions • Vacuum breaker failure (Internal & External) (BWRs) • Hydrodynamic loads under high pool level • Recriticality • Containment boundary multiple failures, e.g., Shell failure as a subsequent containment failure (melt through for Mark I free standing steel containment) • Vapor suppression failure • Direct Containment Heating Pressurization of the pedestal cavity following vessel failure if there is substantial water in the cavity	The phenomena that may control the LERF radionuclide release characterization shall be included quantitatively. The Level 2 shall address in a quantitative fashion a substantial number of issues affecting LERF that are believed potential contributors especially during PSA applications involving different plant configurations. These Level 2 issues include the following: • In-vessel Recovery • RPV vent & Containment Vent • Containment flood • Containment isolation failure • IC multiple tube rupture (if applicable) • ISLOCA • Deinerted operation • Steam explosions • Vacuum breaker failure (Internal & External) (BWRs) • Hydrodynamic loads under high pool level • Recriticality • Containment boundary multiple failures, e.g., Shell failure as a subsequent containment failure (melt through for Mark I free standing steel containment) • Vapor suppression failure • Direct Containment Heating Pressurization of the pedestal cavity following vessel failure if there is substantial water in the cavity

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-8 (cont'd)		• High drywell temperatures leading to degradation of penetrations into the wetwell (BWRs) • The use of sprays • Hydrogen deflagration and detonation • TISGTR - Thermally Induced Steam Generator Tube Rupture • Many of the phenomena are sufficient in and of themselves to fail containment. Therefore, the combination of the phenomena with other severe accident conditions are not necessary. This applies to phenomena such as: - ISLOCA - Steam explosions - Hydrodynamic loads - Recriticality (BWRs) - Multiple containment boundary failures - Vapor suppression failure - DCH - TISGTR - Hydrogen detonation • Other phenomena or failure modes affect the core melt progression and can be modeled using typical severe accident computer codes such as MAAP. These include: - In-vessel recovery - RPV vent and containment vent - Containment flooding	• High drywell temperatures leading to degradation of penetrations into the wetwell (BWRs) • The use of sprays • Hydrogen deflagration and detonation • TISGTR - Thermally Induced Steam Generator Tube Rupture • Many of the phenomena are sufficient in and of themselves to fail containment. Therefore, the combination of the phenomena with other severe accident conditions are not necessary. This applies to phenomena such as: - ISLOCA - Steam explosions - Hydrodynamic loads - Recriticality (BWRs) - Multiple containment boundary failures - Vapor suppression failure - DCH - TISGTR - Hydrogen detonation • Other phenomena or failure modes affect the core melt progression and can be modeled using typical severe accident computer codes such as MAAP. These include: - In-vessel recovery - RPV vent and containment vent - Containment flooding	• High drywell temperatures leading to degradation of penetrations into the wetwell (BWRs) • The use of sprays • Hydrogen deflagration and detonation • TISGTR - Thermally Induced Steam Generator Tube Rupture • Many of the phenomena are sufficient in and of themselves to fail containment. Therefore, the combination of the phenomena with other severe accident conditions are not necessary. This applies to phenomena such as: - ISLOCA - Steam explosions - Hydrodynamic loads - Recriticality (BWRs) - Multiple containment boundary failures - Vapor suppression failure - DCH - TISGTR - Hydrogen detonation • Other phenomena or failure modes affect the core melt progression and can be modeled using typical severe accident computer codes such as MAAP. These include: - In-vessel recovery - RPV vent and containment vent - Containment flooding

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-8 (cont'd)		- Containment isolation failure - IC multiple tube rupture - Vacuum breaker failure • Combinations of phenomena with other severe accident conditions should be performed in certain cases. The method of combination shall be justified by the PSA documentation. Specific phenomena in this group include: - Hydrogen deflagration - Transient pressurization due to debris quenching	- Containment isolation failure - IC multiple tube rupture - Vacuum breaker failure • Combinations of phenomena with other severe accident conditions should be performed in certain cases. The method of combination shall be justified by the PSA documentation. Specific phenomena in this group include: - Hydrogen deflagration - Transient pressurization due to debris quenching	- Containment isolation failure - IC multiple tube rupture - Vacuum breaker failure • Combinations of phenomena with other severe accident conditions should be performed in certain cases. The method of combination shall be justified by the PSA documentation. Specific phenomena in this group include: - Hydrogen deflagration - Transient pressurization due to debris quenching
L2-9[4]	• (BWRs): The phenomena that may affect accident management actions and planning are included. <u>OR</u> • (PWRs): If plant specific features are not consistent with those assumed in Owners Group SAMG analyses, the L2 model addresses any plant-specific phenomena that may affect accident management actions and planning.	The phenomena that may affect accident management actions and planning should be included.	The phenomena that may affect accident management actions and planning should be included.	The phenomena that may affect accident management actions and planning shall be included.
L2-10	• The phenomena that may influence applications are included.	See L2-8	See L2-8	See L2-8

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-11	<u>HEPs AND SYSTEM PERFORMANCE</u> • System performance has been evaluated to account for the adverse conditions that may be present during the core melt progression response.	System performance shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize system performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the system operability (real or procedural). Level 2 system performance should be explicitly broken out as separate evaluations recognizing the environmental conditions. However, some conservatisms in the system performance evaluation may exist due to the lack of detailed information regarding environmental conditions and equipment survivability. System models and their documentation should be consistent with SY, DA and DE (Tables 5-4, 5-5 and 5-10).	System performance shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize system performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the system operability (real or procedural). Level 2 system performance should be explicitly broken out as separate evaluations recognizing the environmental conditions. However, the best estimate evaluation may have large uncertainties due to uncertainties regarding the environmental conditions and the equipment survivability. System models and their documentation shall be consistent with SY, DA, and DE (Tables 5-4, 5-5 and 5-10).	System performance shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize system performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the system operability (real or procedural). Level 2 system performance shall be explicitly broken out as separate evaluations recognizing the environmental conditions. Detailed calculations of the environmental conditions and a detailed survey of the equipment survivability (not EQ) shall be performed to support the system performance during severe accident melt progression and provide a realistic estimate of the systems performance. System models and their documentation shall be consistent with SY, DA, and DE (Tables 5-4, 5-5 and 5-10).

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-12	• Success of human actions has been evaluated to account for the adverse conditions that may be present during the core melt progression response.	Success of human actions shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize operator performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the operator HEP. Level 2 operator actions should be explicitly broken out as separate evaluations recognizing the environmental conditions and the adverse effects of the actions. However, some conservatisms in the human performance evaluation may exist due to the lack of detailed information regarding environmental conditions. Operator actions, the human error probabilities derived for the PSA, and their documentation should be consistent with the subelement criteria cited in Table 5-6.	Success of human actions shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize operator performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the operator HEP. Level 2 operator actions should be explicitly broken out as separate evaluations recognizing the environmental conditions and the adverse effects of the actions. However, the best estimate evaluation may have large uncertainties due to uncertainties regarding the environmental. Operator actions, the human error probabilities derived for the PSA, and their documentation should be consistent with the subelement criteria cited in Table 5-6.	Success of human actions shall be evaluated to account for the adverse conditions that may be present during the core melt progression response. The ability to adequately characterize operator performance using solely a Level 1 model may be difficult because of the substantial impacts core melt progression effects may have on the operator HEP. Level 2 operator actions shall be explicitly broken out as separate evaluations recognizing the environmental conditions and the adverse effects of the actions. Detailed calculations of the environmental conditions shall be performed to support the human performance during severe accident melt progression. Operator actions, the human error probabilities derived for the PSA, and their documentation should be consistent with the subelement criteria cited in Table 5-6.
L2-13	<u>CONTAINMENT CAPABILITY ASSESSMENT</u> • Containment and system functional failures are conservatively treated <u>OR</u> • Containment and system functional failures are treated realistically for dominant contributors	Containment and system functional failures may be conservatively treated.	Containment and system functional failures should be treated realistically for dominant contributors.	Containment and system functional failures should be treated realistically for dominant contributors.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-14	• Containment capability is analyzed under severe accident conditions for its survivability	Containment should be analyzed under severe accident conditions for its survivability.	Containment shall be analyzed under severe accident conditions for its survivability.	Containment shall be analyzed under severe accident conditions for its survivability.
L2-15	• Both static and dynamic effects are included[(2),(3)]	Both static and dynamic effects should be included. Quasi static containment capability evaluations alone are not adequate to address all severe accident phenomena.	Both static and dynamic effects shall be included. Quasi static containment capability evaluations alone are not adequate to address all severe accident phenomena.	Both static and dynamic effects shall be included. Quasi static containment capability evaluations alone are not adequate to address all severe accident phenomena.
L2-16	• All postulated failure modes identified by IDCOR or NRC Staff in NUREG-1150 are considered[(2),(3)]	---	All postulated containment failure modes identified by IDCOR or NRC Staff in NUREG-1150 shall be considered. The containment isolation failure assessment should be retained in the model. Applications involving ranking the isolation system or considering configurations that have altered reliability for containment isolations would be adversely impacted by the non-inclusion of containment isolation.	All postulated containment failure modes identified by IDCOR or NRC Staff in NUREG-1150 shall be considered. The containment isolation failure assessment shall be retained in the model. Applications involving ranking the isolation system or considering configurations that have altered reliability for containment isolations would be adversely impacted by the non-inclusion of containment isolation.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-17	• For Ice Condenser and BWR Mark III containments only: Geometric details impacting the hydrogen related phenomena (i.e., heat sink distribution, circulation paths, ignition sources, water availability, and gravity drain paths) should be documented in a readily comprehensible form, together with representative combustible transients.	For Ice Condenser and BWR Mark III containments only: Geometric details impacting the hydrogen related phenomena (i.e., heat sink distribution, circulation paths, ignition sources, water availability, and gravity drain paths) should be documented in a readily comprehensible form, together with representative combustible transients. A deflagration-to-detonation transition may be a means of creating a hydrogen detonation. The configuration of the ice condenser (a vertically oriented enclosed compartment with obstacles in the flow path) can promote flame acceleration and initiate a detonation in upper portions of the ice bed or the upper plenum. Specific features that promote deflagration-to-detonation transition should be considered in containment analysis: • Small, enclosed spaces with a hydrogen source • Lack of transverse vents along the length of tubular enclosures • Obstacles in the flow paths of tubular enclosures • Presence of solid floors to promote localized hydrogen accumulation • Unvented compartments	For Ice Condenser and BWR Mark III containments only: Geometric details impacting the hydrogen related phenomena (i.e., heat sink distribution, circulation paths, ignition sources, water availability, and gravity drain paths) should be documented in a readily comprehensible form, together with representative combustible transients. A deflagration-to-detonation transition may be a means of creating a hydrogen detonation. The configuration of the ice condenser (a vertically oriented enclosed compartment with obstacles in the flow path) can promote flame acceleration and initiate a detonation in upper portions of the ice bed or the upper plenum. Specific features that promote deflagration-to-detonation transition should be considered in containment analysis: • Small, enclosed spaces with a hydrogen source • Lack of transverse vents along the length of tubular enclosures • Obstacles in the flow paths of tubular enclosures • Presence of solid floors to promote localized hydrogen accumulation • Unvented compartments	For Ice Condenser and BWR Mark III containments only: Geometric details impacting the hydrogen related phenomena (i.e., heat sink distribution, circulation paths, ignition sources, water availability, and gravity drain paths) shall be documented in a readily comprehensible form, together with representative combustible transients. A deflagration-to-detonation transition may be a means of creating a hydrogen detonation. The configuration of the ice condenser (a vertically oriented enclosed compartment with obstacles in the flow path) can promote flame acceleration and initiate a detonation in upper portions of the ice bed or the upper plenum. Specific features that promote deflagration-to-detonation transition shall be considered in containment analysis: • Small, enclosed spaces with a hydrogen source • Lack of transverse vents along the length of tubular enclosures • Obstacles in the flow paths of tubular enclosures • Presence of solid floors to promote localized hydrogen accumulation • Unvented compartments

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-18	• Both leakage and large failures are included in the analysis	Containment failure sizes of leak and rupture may be conservatively treated. The degree of conservatism may be difficult to ascertain because of competing effects related to the containment pressurization.	A best estimate representation of the containment failure sizes should be included in the model. This best estimate evaluation should be based on a plant specific structural analysis or a generic evaluation that has been adjusted to account for plant specific features.	A realistic representation of the containment failure sizes shall be in included in the model based on a plant specific structural evaluation. If the results differ significantly from similar plant evaluations, the technical basis for the differences shall be clearly identified.
L2-19	• Containment failure modes are treated realistically in the analysis	A conservative assessment of possible containment failure modes may be included in the PRA.	Containment failure modes should be treated on a best estimate basis in the analysis.	Containment failure modes shall be treated realistically in the analysis.
L2-20	• The containment analysis is: - Conservative <u>OR</u> - Realistic	The containment analysis may be conservative, e.g., NUREG/CR-6595 generic analysis	The containment analysis should be a best estimate and account for plant specific features.	The containment analysis shall be realistic and plant specific.
L2-21	<u>ENDSTATE DEFINITION</u> • The Level 2 end states support the applications currently envisioned.	The Level 2 end states should support the applications currently envisioned. The release categories may be assigned to the end states of the Level 2 analysis using insights from previous PRA work and judgements regarding the effectiveness of various release pathway mitigation measures.	The Level 2 end states shall support the applications currently envisioned. The Level 2 release categories should have a deterministic code calculation to support the subtle differences in the sequence that can influence release.	The Level 2 end states shall support the applications currently envisioned. The Level 2 release categories shall have a deterministic code calculation to support the subtle differences in the sequence that can influence release.
L2-22	<u>LERF DEFINITION</u> • The LERF definition is consistent with the following guidance, and is documented: - Regulatory Guide 1.174 <u>OR</u> - PSA Applications Guide or other Owners Group-specific definitions(5)	• The LERF definition should be consistent with the following guidance, and is documented: - Regulatory Guide 1.174 <u>OR</u> - PSA Applications Guide or other Owners Group-specific definitions (5)	• The LERF definition shall be consistent with the following guidance, and is documented: - Regulatory Guide 1.174 <u>OR</u> - PSA Applications Guide or other Owners Group-specific definitions (5)	• The LERF definition shall be consistent with the following guidance, and is documented: - Regulatory Guide 1.174 <u>OR</u> - PSA Applications Guide or other Owners Group-specific definitions (5)

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-23	• The LERF definitions use Emergency Action Levels (EAL) bases if required; and the EAL bases are documented.	The LERF definitions should use Emergency Action Levels (EAL) bases if required; and the EAL bases are documented.	The LERF definitions shall use Emergency Action Levels (EAL) bases if required; and the EAL bases are documented.	The LERF definitions shall use Emergency Action Levels (EAL) bases if required; and the EAL bases are documented.
L2-24	<u>CONTAINMENT EVENT TREES (CETs)</u> • The CETs: - Include all the functional events required to meet a safe stable condition - Include the phenomena cited under phenomena	The methodology should provide a logical framework to probabilistically assess the accident sequences that can lead to LERF end states. The CETs: • Should include all the functional events required to meet a safe stable condition or a non-LERF state • Should include the phenomena cited under phenomena	The methodology shall provide a logical framework to probabilistically assess the accident sequences that can lead to LERF end states. The methodology should provide a best estimate LERF assessment. The CETs: • Shall include all the functional events required to meet a safe stable condition or a non-LERF state • Shall include the phenomena cited under phenomena	The methodology shall provide a logical framework to probabilistically assess the accident sequences that can lead to LERF end states. The methodology should provide a best estimate LERF assessment. The CETs: • Shall include all the functional events required to meet a safe stable condition or a non-LERF state • Shall include the phenomena cited under phenomena
L2-25	• The CETs: - Include the systems and HEPs necessary - Are consistent with the EOPs - Include reasonable recovery actions	---	Truncation of Level 1 sequences to avoid transfer to Level 2 shall not be performed unless they meet the truncation limits in QU. The CETs shall: • Include the systems and HEPs necessary • Are consistent with the EOPs • Include reasonable recovery actions	Truncation of Level 1 sequences to avoid transfer to Level 2 shall not be performed unless they meet the truncation limits in QU. The CETs shall: • Include the systems and HEPs necessary • Are consistent with the EOPs • Include reasonable recovery actions

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-25 (cont'd)		---	While "conservative" modeling is typically judged sufficient for IPEs, the neglect of the in-vessel recovery is not realistic, and is not appropriate for accident management applications. That is, by assuming the vessel serves no purpose in altering the accident sequence trajectory, opportunities for risk reduction measures are lost. If the damaged core is retained in-vessel, questions of direct containment heating, core-concrete interaction, debris quench on the drywell floor, etc., become moot. Use of the vessel to partition the risk reduces the importance of modeling highly uncertain containment damage processes, reducing the overall analysis uncertainty as well. Recognizing that saving the core in the vessel (e.g., by use of AC power recovery, fire suppression water, etc.), results in risk reduction for certain accident management actions and provides a better estimate of the risk associated with severe accidents.	While "conservative" modeling is typically judged sufficient for IPEs, the neglect of the in-vessel recovery is not realistic, and is not appropriate for accident management applications. That is, by assuming the vessel serves no purpose in altering the accident sequence trajectory, opportunities for risk reduction measures are lost. If the damaged core is retained in-vessel, questions of direct containment heating, core-concrete interaction, debris quench on the drywell floor, etc., become moot. Use of the vessel to partition the risk reduces the importance of modeling highly uncertain containment damage processes, reducing the overall analysis uncertainty as well. Recognizing that saving the core in the vessel (e.g., by use of AC power recovery, fire suppression water, etc.), results in risk reduction for certain accident management actions and provides a better estimate of the risk associated with severe accidents.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-26	DOCUMENTATION • Documentation reflects the process used	Documentation should provide the basis for meeting each of the criteria L2-4 through L2-25. The documentation should describe the results consistent with the process.	Documentation should provide the basis for meeting each of the criteria L2-4 through L2-25. The LERF quantification and the dominant contributors should be described. Unusual features of the LERF results or missing accident contributors to LERF when compared with similar plants should be explained. A summary of the dominant contributors to LERF should be provided including: - containment failure mode - Level 1 accident sequence type Significant influences on the LERF determination should be discussed. These may include: - operator actions - adverse environmental conditions - assumptions - unique plant characteristics The documentation should describe the results consistent with the process.	Documentation shall provide the basis for meeting each of the criteria L2-4 through L2-25. The LERF quantification and the dominant contributors shall be described. Unusual features of the LERF results or missing accident contributors to LERF when compared with similar plants shall be explained. A summary of the dominant contributors to LERF shall be provided including: - containment failure mode - Level 1 accident sequence type Significant influences on the LERF determination shall be discussed. These shall include: - operator actions - adverse environmental conditions - assumptions - unique plant characteristics The documentation shall describe the results consistent with the process.
L2-27	• Includes an independent review for the documented results	Independent review may be performed and documented by knowledgeable personnel.	Independent review should be performed and documented by knowledgeable personnel.	Independent review shall be performed and documented by knowledgeable personnel.

Table 5-10

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: LEVEL 2 / LERF EVALUATION

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
L2-28	• Provides the basis of the containment performance analysis and the analysis is traceable to plant specific or generic analysis.	Documentation may provide the basis for quantification process.	Documentation should provide the basis for quantification process.	Documentation shall provide the basis for quantification process.

Notes to Table L2:

(1) The consideration of the severe accident phenomena that may influence core melt progression or containment integrity should be quantified as part of the Level 2 evaluation. This quantification should also recognize the uncertainty in the phenomena. For PWRs, accident management actions need only be considered for grades 3 and 4.

(2) The assessment of containment failure modes should be included quantitatively in the PSA. It may be possible to treat certain failure modes in a conservative fashion for some applications.

(3) Position papers that justify eliminating phenomena or modes should be used with care. Quantification is the preferred method of evaluation in the PSA process. Assignment of higher grades would in general be based on a quantified model of LERF that recognizes phenomena uncertainties.

(4) BWR EOPs have strategies to prevent containment failure, whereas PWR EOPs stop at the onset of core damage and no instruction / guidance is available to model in the Level 2 PSA. Thus, accident management has traditionally been modeled in BWR PSA Level 2 studies, while for PWRs, the level 2 analyses generally assume little or no response to the severe accident by control room operators. Thus, PWR PSAs do not generally model phenomena that impact accident management, and to do so would require a major upgrade to most PWR PSA Level 2 studies. Consideration of applications suggested for PSA Grades 3 and 4 implies a need to start considering severe accident management guidance (SAMG). Thus, the criteria for phenomena that imply or require accident management are only applicable to PSA Grades 3 and 4. The L2-9 criterion for PWRs are considered to be met (grades 3 or 4) if the plant features are consistent with those modeled in the Owners Group SAMG analyses, or if the level 2 analysis addresses accident management actions related to plant-specific phenomena not covered by the SAMG analyses.

(5) For example, the WOG has adopted its own definition of LERF.

Table 5-11

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: PRA MAINTENANCE AND UPDATE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
MU-1	GUIDANCE • Describes the process used	General description of the PRA maintenance and update process is provided in the PRA Guidance Documents.	The maintenance and update process should be sufficiently well described to act as guidance for future updates and revisions.	A specific guidance document should be available that specifies the process for PRA maintenance and the updating process.
MU-2	• Consistent with industry practices	General adherence to accepted industry approaches is included	The documentation or separate specific guidance should provide a reasonable basis for performing the maintenance and update process, and should maintain consistency with proven approaches.	The guidance for performing the PRA maintenance and the updating process should be complete and detailed and should maintain consistency with proven approaches.
MU-3	• Sufficient detail provided for reproducing the evaluation	Documentation or separate specific guidance is available to describe general approaches used. The general description is sufficient to convince the reviewers that the process could be repeated with similar results.	The documentation or separate specific guidance should be sufficient to provide a means to ensure the PRA can be maintained in an updated configuration consistent with the as-built, as-operated plant and consistent with the current state of PRA technology.	The guidance shall be sufficiently detailed to ensure the PRA can be maintained in an updated configuration consistent with the as-built, as-operated plant and consistent with the current state of PRA technology.

Table 5-11

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: PRA MAINTENANCE AND UPDATE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
MU-4	<u>INPUT -- MONITORING AND COLLECTING NEW INFORMATION</u> (2) • Each of the following information sources is part of the PSA update process for monitoring new information associated with the following: - Operational Experience - Plant Design - New Maintenance Policies - Operator Training Program - Technical Specification - Revised Engineering Calculations - Emergency and Abnormal Operating Procedures - Operating Procedures - Emergency Plan - Accident Management Programs - Industry Studies	The identified information should be reviewed in general to ensure that no major issues affecting the PRA are present. A general statement that these inputs are reviewed is sufficient.	The identified information should be reviewed in general to ensure that no major issues affecting the PRA are present. Documented evidence of the review of each input should be provided as part of the update. Corrections to improve the process should be tracked and integrated into the process.	Each of the information sources should be reviewed as part of the update and a documented disposition of the results of the review provided. Corrections to improve the process should be tracked and integrated into the process.

Table 5-11

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: PRA MAINTENANCE AND UPDATE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
MU-5	• Plant specific data is included for quantitative reevaluation.	---	Plant specific data should be incorporated in the PRA update for at least initiating events and system train or component unavailability.	Plant specific data shall be incorporated in the PRA update of initiating events and major components reliability and unavailability (e.g., diesels).
MU-6	<u>MODEL CONTROL</u> • The computer models of the PRA are stored in a controlled manner. This also applies to sensitivity cases that may be performed to support a specific application.	A secure offsite storage facility for computer codes, inputs, outputs and models should be used.	A secure offsite storage facility for computer codes, inputs, outputs and models should be used.	A secure offsite storage facility for computer codes, inputs, outputs and models shall be used. Should use CD-Rom or equivalent to prevent corruption of the files. Should limit access to read-only for server version of the computer model. Model changes should be recorded in a protected location or data base.
MU-7	<u>COMPUTER CODE CONTROL</u> • Computer code controls are formalized to ensure that the effect on the PRA of changes to these codes are understood and addressed if appropriate	A process is used to control both the computer codes, their inputs, models, and outputs.	A formal process should be in force to control the PRA computer codes, their inputs, outputs, and the models.	A formal process shall be in force to control the PRA computer codes, their inputs, outputs, and the models.

Table 5-11

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: PRA MAINTENANCE AND UPDATE

Designator	CRITERIA	SUBTIER CRITERIA Grade 2	Grade 3	Grade 4
MU-8	PRA UPDATE • A process is in place to maintain the PRA. The PRA update model process consists of the elements identified and the steps in the process. The model update process consists of the following: - Identification of Affected Model Elements - Modification of PRA Models - Requantification of PRA Models - Evaluation of Results - Re-Evaluation of Past PRA Applications -	The PRA update process should include all of the steps identified for a PRA update. Evidence that the process has been implemented should be available.	The PRA update process should include all of the steps identified for a PRA update. Evidence that the process has been implemented should be available.	The PRA update process shall include all of the steps identified for a PRA update. Evidence that the process has been implemented should be available.
MU-9	• The plant has defined a fixed update schedule or a reasonable criteria upon which to base the need for an update.	A fixed update schedule of not more than every other refueling or a criteria that examines the impact of possible changes should be defined.	A fixed update schedule of not more than every other refueling or a criteria that examines the impact of possible changes should be defined.	A fixed update schedule of not more than every other refueling shall be defined.

Table 5-11

INDUSTRY PRA PEER REVIEW SUBTIER CRITERIA: PRA MAINTENANCE AND UPDATE

Designator	CRITERIA	SUBTIER CRITERIA		
		Grade 2	Grade 3	Grade 4
MU-10	EVALUATION OF RESULTS • The PRA results are evaluated by knowledgeable personnel before the results are used.	The PRA results should be evaluated by the PRA experts for accuracy and reasonableness and by an expert panel before the results are used.	The PRA results should be evaluated by the PRA experts for accuracy and reasonableness and by an expert panel before the results are used.	The PRA results shall be evaluated by the PRA experts for accuracy and reasonableness and by an expert panel before the results are used.
MU-11	RE-EVALUATION OF PAST PRA APPLICATIONS [(3)] • Past PRA Applications are evaluated qualitatively to assure that the conclusions remain valid.	Past PRA applications should be reviewed and evaluated qualitatively to determine whether the conclusions are valid.	Past PRA applications should be reviewed and evaluated qualitatively to determine whether the conclusions are valid.	Past PRA applications shall be reviewed and evaluated qualitatively to determine whether the conclusions are valid.
MU-12	• Past PRA Applications that may be affected by the latest information and update are re-performed.	Quantitative recalculations should be performed if the applications could be modified as a result of the PRA changes.	Quantitative recalculations should be performed if the applications could be modified as a result of the PRA changes.	Quantitative recalculations shall be performed if the applications could be modified as a result of the PRA changes.
MU-13	DOCUMENTATION • Documentation reflects the process used	Documentation of the update process provides the Peer Review Team reasonable confidence that the process can succeed in maintaining a PRA for use in applications.	Documentation should provide a traceable path connecting the maintenance and update process with the PRA updates that have been performed.	Documentation shall provide a traceable path connecting the maintenance and update process with the PRA updates that have been performed.
MU-14	• Includes an independent review for the documented results	An independent review should be performed.	Independent review should be performed and documented by knowledgeable personnel.	Independent review shall be performed and documented by knowledgeable personnel.
MU-15	• Provides the basis of the update process and the results are traceable to specific changes in design, procedures, training, or operating experience.	The documentation as implemented provides reasonable confidence to the Peer Review Team that the inputs to the PRA reflecting changes have been adequately considered.	Documentation should provide a traceable path connecting the maintenance and update process with the PRA updates that have been performed. The documentation of the PRA should support the technical basis of the PRA.	Documentation shall provide a traceable path connecting the maintenance and update process with the PRA updates that have been performed. The documentation of the PRA shall support the technical basis of the PRA.

Notes to Table MU:

1. PRA maintenance encompasses the identification and evaluation of new information, and the incorporation of this information into the PRA on an as-needed basis. PRA maintenance typically refers to minor model modifications and effort. More extensive maintenance may be performed if a specific application requires refinement of certain parts of the model. The on-going maintenance of the PRA can be performed on a resource-available basis when not driven by specific application needs. PRA maintenance should serve to keep the PRA reasonably current between PRA updates.

   A PRA update is a comprehensive revision to the PRA models and associated documentation. PRA updates are scheduled to be performed periodically. In addition, they may also be performed on an as needed basis as determined by the PRA Group leader. It is recommended that the update frequency should be no greater than once per year and no less than once per every three years (or every other fuel cycle).

   The need for an update prior to a specific application is dependent upon the needs of the specific application (e.g., greater detail in specified areas) and the effect of new information on the assessment of the fidelity of the model to the current plant and procedures.

2. The purpose of the monitoring and data collection process is to identify information which could impact the PRA models. Monitoring implies a vigilant attitude towards industry and plant experiences, information, and data with the purpose of identifying inputs pertinent to the PRA. Collection refers to the process of logging the information and collecting explanatory information to evaluate its importance to the PRA.

3. The update of the PRA may result in a dramatically changed risk profile. Changes to the risk profile can in turn affect the results of past PRA applications. Possible examples are the safety significance determination in the Maintenance Rule, the in-service test interval for IST evaluations, or the on-line safety matrix to support on-line maintenance safety evaluations. PRA Application re-evaluations can be performed in a rigid fashion that involves a complete re-analysis. However, in general, a qualitative review of the applications would appear to be sufficient for many applications. A complete reanalysis may be needed only on a selected basis.

REFERENCES

[1] BWROG PRA Peer Review Certification Implementation Guidelines, BWROG, January 1997.

[2] NEI PRA Certification Workshop, , Renaissance Harborplace, Baltimore, Maryland, April 7-8, 1998.

[3] Gregory A. Krueger, Edward T. Burns, Richard A. Hill, Results of Applying the BWROG PRA Peer Review Certification Guidelines, PRA 99, Washington D.C., August 22-26, 1999.

[4] Transmittal of BWR Owners' Group Document, "PRA Peer Review Certification Implementation Guidelines," Letter from Kevin P. Donovan, Chairman BWR Owner's Group, to U.S. Nuclear Regulatory Commission Document Control Desk, J.H. Wilson, dated January 31, 1997.

[5] PRA Peer Review Guidelines, NEI 00-02(DRAFT), April 2000.

[6] PRA Applications Guide, EPRI-TR105396, August 1995.

ACRONYMS AND INITIALS

ACRS	Advisory Committee on Reactor Safety
ASLB	Atomic Safety and Licensing Board
BWR	Boiling Water Reactor
CCDP	Conditional Core Damage Probability
CCF	Common Cause Failure
CCW	Component Cooling Water
CDF	Core Damage Frequency
CS	Containment SPSAy
CST	Condensate Storage Tank
DCH	Direct Containment Heating
DFP	Diesel Fire Pump
DOE	U.S. Department of Energy
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EOPs/AOPs	Emergency Operating Procedures/Abnormal Operating Procedures
EPRI	Electric Power Research Institute
ESW	Emergency Service Water
FHB	Fuel Handling Building
F&O	Facts and Observations
GIP	Generic Implementation Procedure
HCLPF	High Confidence of Low Probability of Failure
HPCI	High Pressure Coolant Injection
HVAC	Heating, Ventilation, And Air Conditioning
IC	Isolation Condenser
I&C	Instrumentation and Control
IE	Initiating Event
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events

ACRONYMS AND INITIALS (Cont'd)

ISLOCA	Interfacing Systems Loss Of Coolant Accident
JPMs	Job Performance Measures
LERF	Large Early Release Frequency
LOCA	Loss Of Coolant Accident
LOSP/LOOP	Loss Of Offsite Power
LPCI	Low Pressure Coolant Injection
MAAP	Modular Accident Analysis Program
MMI	Modified Mercalli Intensity
MOV	Motor Operated Valve
NEI	Nuclear Energy Institute
NRC	United States Nuclear Regulatory Commission
NSW	Normal Service Water
OBE	Operating Basis Earthquake
OSC	Operations Support Center
PCS	Power Conversion System
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
PMWS	Primary Makeup Water System
POS	Plant Operating States
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSHA	Probabilistic Seismic Hazard Analysis
PWR	Pressurized Water Reactor
QA	Quality Assurance
RAB	Reactor Auxiliary Building
RCIC	Reactor Core Isolation Cooling
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System

ACRONYMS AND INITIALS (Cont'd)

RHR	Residual Heat Removal
RLE	Review Level Earthquake
RPV	Reactor Pressure Vessel
RWST	Refueling Water Storage Tank
SAR	Safety Analysis Report
SEL	Seismic Equipment List
SFP-AET	Spent Fuel Pool Assessment Event Tree
SFPCCS	Spent Fuel Pool Cooling and Cleanup System
SFPs	Spent Fuel Pools
SGTR	Steam Generator Tube Rupture
SMA	Seismic Margin Assessment
SPLD	Success Path Logic Diagram
SPSA	Seismic Probabilistic Safety Assessment
SRO	Senior Reactor Operator
SSC	Structure, System, or Component
SSE	Safe Shutdown Earthquake
SSEL	Safe Shutdown Equipment List
SSHAC	Senior Seismic Hazard Analysis Committee
SSI	Soil Structure Interaction
SSW	Standby Service Water
SW	Service Water
THERP	Technique For Human Error Rate Prediction (see NUREG/CR-1278)
TISGTR	Temperature Induced SGTR
TS	Technical Specifications
TSC	Technical Support Center
UHS	Uniform Hazard Response Spectrum
ZR	Zircaloy