LETTER REPORT: PRA QUALITY FOR MSPI

1 Introduction

This report documents the recommendations of the MSPI PRA Quality Task Group, which, following NRC and stakeholder recommendations, was convened to resolve issues related to PRA quality prior to implementation of the MSPI. The task group charter is included as Appendix A.

In RG 1.174 [Ref. 1] and in RG 1.200 [Ref.2], the PRA quality required for an application is defined in terms of the scope of the PRA, its level of detail, and its technical adequacy. Consistent with the definition of the MSPI, the scope of PRA required for the MSPI application is a level 1 PRA at full power. A standard to support the scope of PRA required has been prepared by ASME [Ref. 3], and endorsed in RG 1.200 which has been issued for trial use. Once the trial use period is over, the MSPI application will be classified as a Phase 2 type application in the Commission's Phased Approach to PRA quality [Ref.4]. In the meantime, the task group recommends that RG 1.200 be the vehicle for demonstrating the adequacy of the PRA for MSPI.

When applying RG 1.200, it is a prerequisite that the supporting level requirements (SRs) and the associated capability category necessary to support the application be identified. Essentially it is necessary to have confidence that the structure of the PRA model is such that it is reasonably complete in addressing significant contributors, and correctly captures the various functional and inter-system dependencies to the extent required to support the accuracy necessary for the MSPI.

Even if a PRA meets the requirements of the Standard at the specified capability categories, there will still be variability in the methods used by different licensees for dealing with certain issues, e.g., the assessment of human error probabilities. Some of this will not have a significant impact on the MSPI values. However, there is a subset of issues that can have a direct and potentially significant impact on the importance of specific MSPI systems. Of particular concern are those PRA features whose treatment may vary significantly from licensee to licensee. From the NRC's perspective, the concern is with those issues that have the potential for inappropriate modeling that drives down the significance of an MSPI system, i.e., artificially lowers its FV or Birnbaum importance. In Section 2, those features of the PRA model that have an influence on the importance of the system with respect to CDF are identified.

Section 3 provides the Task Group's assessment of the ASME standard capability categories required to support the MSPI function. This assessment is based on the task group's assessment of the sensitivity of the MSPI to various aspects of PRA modeling, based on their collective experience with performing and reviewing PRAs, supplemented by the insights from Reference 5.

Section 4 discusses the group's recommendations on how a licensee should demonstrate that a PRA has sufficient technical adequacy to support its use for MSPI. The requirements of the ASME Standard that deal with those features identified in Section 2 should be given particular attention. Since the Standard is not prescriptive in many of these areas, the aim should be to demonstrate that the particular approach used by the licensee is acceptable, and that it does not unduly decrease the importance of any of the systems by increasing significantly the number of failures needed to create a change in color in the MSPI.

Section 5 discusses the issue of an expected variability in the sensitivity of the MSPI due to variations in modeling between licensees. Section 6 provides recommendations for documentation, and Section 7 on staff review. Section 8 lists the references.

2 Identification of Significant Issues

The approach taken is the following. Those significant CDF sequences in which failures of the MSPI systems appear are identified. For the purpose of this analysis the sequences are discussed at a relatively high level, corresponding to functional or systemic description. It is these sequences that directly impact the Birnbaum importance of the system/components, since it is the absolute value of the change in CDF resulting from failures of those system components that is important.

BWR MSPI Systems

The MSPI systems for BWRs are:

Emergency ac power
HPCI/HPCS/FWCI
RCIC/isolation condenser
RHR
cooling water (SW/ESW)

Emergency ac power

The system is modeled in the loss of offsite power (LOOP) event tree. Sequences initiated by LOOP, and involving failure of the ac power system, including the station blackout (SBO) sequences, are usually significant contributors to core damage. The sequences typically involve the assessment of the convolution of the progression to core damage as a result of inventory boil off and the recovery of an ac power source. The frequencies of these accident sequences are a function of the frequency of the loss of offsite power initiating event, the derivation of the various time windows for recovery of offsite power, the probability of recovery of ac power as a function of time, including credit taken for cross-tie between units and use of alternate on- or off-site sources (e.g., combustion gas turbines), and the failure probabilities and the common cause failure (CCF) probability(ies) of the diesels themselves. The CCF of the station batteries may be a significant factor in SBO frequency, but since the batteries are not included in the system boundary, they will not impact the MSPI. Partial station blackout sequences (i.e., those with one or more diesel generators operating) will involve the usual complement of makeup and heat removal sequences. The most significant issues affecting the evaluation of the MSPI for the emergency ac power system are:

- assessment of the frequency of offsite power as a function of duration
- credit taken for recovery of ac power, including:
    - recovery of offsite power
    - cross-tie with sister unit
        - typically dominated by human error

    - availability of alternate sources, e.g., combustion gas turbine, including consideration of operator action
- time windows for recovery based on factors such as;
    - battery depletion (including credit for load shedding)
    - room heat up
- CCF probabilities of diesel generators
- For the special case of BWRs with isolation condenser, the likelihood of a stuck open SRV

<u>HPCI/HPCS/FWCI</u>

HPCI: In core damage sequences of transient event trees failure of HPCI is either coupled with failure of other high pressure injection systems (RCIC, recovery of feedwater, CRD) and failure of depressurization, or failure of other high pressure injection systems and failure of low pressure injection. The importance of HPCI is affected by the credit taken for additional injection systems (over and above RCIC). For example, taking credit for firewater (as an additional low pressure system) or CRD or recovery of feedwater (as a high pressure system) can lessen the importance of HPCI.

In the LOOP/SBO tree a significant function of HPCI is to provide a delay to give time to recover the offsite power. Therefore, the modeling of recovery of offsite power in the short term (given that HPCI has failed), the frequency of LOOP, and the CCF probability of the diesels and the station batteries all have an impact on the importance of HPCI.

HPCI importance is therefore affected by:

- Transient frequencies
- HEP for depressurization
- Credit for alternate injection systems (e.g., fire water, SW cross-tie, CRD, recovery of feedwater)
- LOOP frequency, CCF of diesels and batteries, and the factors associated with the short time recovery of ac power given a LOOP

In addition, the MSPI pilot study found that assumptions concerning the necessity of the valves in the minimum flow bypass line to close to ensure sufficient flow may be significant. However, this is probably more of a scope issue related to what active components should be included rather than a numerical impact on the MSPI itself.

HPCS: This closely follows HPCI.

FWCI: For BWRs with an isolation condenser, the FWCI is the high pressure injection system used in case of failure of the isolation condenser. Credit for the IC will impact the MSPI.

<u>RCIC/IC</u>

RCIC: The importance of RCIC should fairly closely parallel that of HPCI. For plants with a HPCS, the credit taken for cross-tie of the Div III diesel to other buses may reduce its significance on SBO sequences.

IC: The IC will appear in sequences combined with failure of FWCI (or PCS) and failure to depressurize or failure of LPI.

RHR

The RHR pumps are also the LPCI pumps. Therefore, the importance of this system is affected by system failures and human failure events that appear with failure of LPCI in TQUV type sequences (failure of all injection), and with failure of RHR in the TW (loss of containment heat removal) sequences.

TQUV sequences: The importance of LPCI is affected by consideration of additional systems (e.g., firewater, CRD). Also, on a relative basis, these sequences may be of less significance if a conservative assessment is made of the probability of failure to depressurize the reactor following a loss of high pressure injection. However, this should not impact the MSPI, since it is only those cutsets that involve failures of the LPCI system that are relevant.

TW sequences: The importance of RHR is affected by the HEP for failure to initiate suppression pool cooling, and the credit taken for venting and continued injection, post-venting.

The issues affecting the importance of RHR are:

- credit taken for alternate injection systems (e.g., firewater, SW cross-tie, CRD)
- treatment of venting (HEP, recognizing that for MSPI, this occurs in the same cutset as equipment failure of RHR, not the failure to depressurize)
- Injection post-venting (NPSH issues, environmental survivability of systems in the reactor building (Mk II containments), sources injecting from outside the containment/RX building, e.g., SW, firewater)

Cooling water systems (SW/ESW/RHRSW)

The cooling water systems are required for cooling diesel generators and for the secondary side of the RHR heat exchangers. While room cooling may be required for some pumps, e.g., HPCI, RCIC, CS, that function is not included in the system function for MSPI. Therefore, the sequences of interest are:

LOOP sequences: while the importance of cooling water systems will be affected by the same things as the emergency ac power system, the effect will be smaller because the failure of SW to the diesels is typically a small contribution to CDF cutsets.

TW sequences: again the importance will be impacted by those things that affect the suppression pool cooling function of RHR, i.e., credit for venting and post-venting injection, and initiation of suppression pool cooling. If significant credit is taken for success of venting then this will decrease tie significance of the cooling water system in the same way as it does for RHR.

In some cases, failures of cooling water systems may be candidates for consideration as support system initiators. Inappropriately excluding their contribution or significantly underestimating the frequency of their loss will result in an underestimate of the importance of the system.

For multi-unit sites some plants have the capability to cross-tie systems between units. Depending on the credit given this can have a significant impact on the significance of a support system.

For the fault tree linking approach to PRA, the method used to cut logic loops (dependence of support systems on support systems) if done incorrectly can result in under or overestimation of the significance of the system.

Inappropriate screening of the need for room cooling will lead to underestimating the significance of the cooling systems.

The issues affecting the importance of the cooling water systems are:

- significance of the LOOP scenarios
- treatment of support system initiators
- credit for venting and post-venting injection (TW sequences)
- credit for cross-tie with a sister unit
- approach to cutting logic loops
- screening of the need for room cooling

PWR MSPI Systems

The MSPI systems for PWRs are:

emergency ac power
high pressure safety injection
auxiliary feedwater system
residual heat removal system
cooling water support (SW/CCW)

Emergency ac power system

As for BWRs, the frequency of the loss of offsite power, the derivation of the various time windows for recovery of offsite power, the probability of recovery, and the failure probabilities and CCF probabilities of the diesels will affect the significance of the emergency ac power system. However, in addition, the treatment of RCP seal LOCAs can have a significant effect on the importance of the diesel generators. The issues affecting the importance of the emergency ac power system are:

- frequency of offsite power as a function of duration
- RCP seal cooling model
- credit taken for recovery of ac power, including:
    - recovery of offsite power
    - cross-tie with sister unit
    - alternate sources, e.g., combustion gas turbine
- time windows for recovery based on factors such as;
    - battery depletion (including credit for load shedding)
    - room heat up
    - credit taken for providing alternate seal cooling
- CCF probabilities of diesel generators

High pressure safety injection

For injection, HPSI is primarily required for small and medium LOCAs, and SGTR. Its importance will be affected by LOCA frequencies, and the modeling of SGTR, in particular the HEP for failure to isolate the faulted generator. If credit is taken for depressurization to allow low head pumps to inject (core cooling recovery), the significance of the HPSI will decrease.

For those plants for which feed and bleed is an option, the importance of HPSI will be affected by the unavailability of the AFW system, and any credit taken for recovery of main feedwater. The issues affecting the importance of the HPSI are:

- small and medium LOCA frequencies (including stuck open PORVs)
- credit for core cooling recovery (rapid depressurization)
- SGTR frequency and HEP for failure to isolate the faulted generator
- Modeling of AFW system
- Recovery of main feedwater
- Transient frequencies

Auxiliary feedwater system

AFW importance can be affected by the credit taken for recovery of main feedwater, and, for those plants for which it is an option, probably more so by the credit taken for feed and bleed, which is a function of the HEP and the assumptions on the success criteria (1 PORV vs 2). In all cases, sequences involving loss of the AFW will need to address containment heat removal. This is typically achieved by establishing RHR following cooldown and depressurization, or by sump recirculation.

A loss of DC bus has the potential to initiate a transient / loss of offsite power (e.g. circuit breakers don't operate), cause loss of normal heat removal (no main feedwater), defeat an entire division of emergency safeguards (HPSI, AFW, pressurizer PORV), often resulting in only one motor-driven AFW pump available to mitigate the transient absent recovery of DC power. The CDF from this initiator is highly dependent on the frequency and modeling of recovery of DC power.

The issues affecting the importance of the AFW system are:

- Credit taken for Feed and Bleed (if applicable)
  - the HEP for failure to initiate feed and bleed
  - the assumed success criterion, (1 vs. 2 PORVs)
- Credit for recovery of main feedwater
- probabilities of failure to establish containment heat removal, particularly the HEPs for either establishing RHR (including cooldown and depressurization), or establishing sump recirculation
- Transient frequencies
- Treatment of loss of DC power initiator

Residual heat removal system

All sequences that include failure of AFW and PCS will contribute to the importance of the RHR system. For those plants that require the low pressure pumps for high head recirculation (piggy-back mode), the sequences that end in sump recirculation will contribute to the importance of the RHR system. For plants where the RHR pumps are also the low pressure injection pumps, the importance of the system is affected by the assumptions made for the large and medium LOCAs. For some plants (Beaver Valley, Surry and North Anna) the RHR function is performed by the inside and outside containment spray recirculation system. While, in a relative sense, the importance of the RHR system will be less than that for the other plants, the same issues will affect its significance on an absolute basis. The issues that can affect the significance of the RHR system are:

- LOCA frequencies (all categories) (for all plants there are LOCA sequences that include failure of residual heat removal, either from failure of RHR or failure of sump recirculation)
- Credit for recovery of main feedwater

Cooling water systems

These are typically required for diesel generator cooling, for RCP seal cooling (CCW and SW), for pump cooling and RHR in the recirculation mode, and other decay heat removal functions, such as room cooling. They may or may not be needed for pump cooling for injection from the RWST following a LOCA, but since ultimately all F&B and LOCA sequences transfer to the requirement for decay heat removal they all require cooling water. Failures of cooling systems may be identified as support system initiators. Inappropriately excluding their contribution or significantly underestimating the frequency of their loss will result in an underestimate of the importance of the system.

Some cooling systems, e.g., service water, may be more prone to problems arising from the environment, e.g., raw water as opposed to chemically controlled water. This could have an impact on valve reliability to change state.

The issues that can influence the importance of the cooling water systems are:

- treatment of support system initiators
- the assessment of LOOP and recovery of ac power
- LOCA treatment
- credit for inter-unit cross-ties
- Internal (to system) environmental conditions

3 Identification of Capability Category for SRs Required for MSPI

This section presents the task group's assessment of what capability category is needed for the supporting level requirements (SRs) of the ASME PRA Standard [Ref. 3] that are necessary to ensure that the PRA is of sufficient technical adequacy to support the MSPI function. The calculation of the MSPI is based upon importance measures (Fussell-Vesely, and/or Birnbaum), and the importance measure of any one event in the PRA model is affected to some extent by everything else in the PRA model. Therefore it is important that the overall PRA model is such that it is reasonably complete in addressing significant contributors, and correctly captures the various functional and inter-system dependencies to the extent required to support the accuracy necessary for the MSPI. This indicates that the majority of the SRs in the ASME Standard should be met. The question is whether they should be met at capability category I or II.

In Table 3-1, for those SRs for which there is a distinction between capability categories, the suggested category is identified, accompanied by a brief explanation. The table specifically includes remarks pertaining to the issues identified in Section 2 that directly impact the MSPI. The task group paid particular attention to those SRs that relate to the issues identified in Section 2, since they are particularly important for the MSPI applications. The suggestions were informed the task group's experience with performing and reviewing PRAs, and by Reference 5.

4 Demonstration of Technical Adequacy

Table 3-1 indicates the task group's recommendations on which capability categories are needed to support the MSPI application. The majority of the SRs in the Standard make no distinction between capability categories. For many of the remaining SRs, a capability category I is judged to be sufficient.

All but one of the licensee PRAs were peer reviewed using the NEI-00-02 peer review process [Ref. 6] (the one exception was SONGS, for which the ASME Standard with Addenda A was used as the basis for the review). This peer review process was developed, and for many plants applied, before the ASME standard was completed. To address differences between the criteria used to review the PRA using the NEI-00-02 process, and those implied by the SRs in the standard, NEI has developed a self-assessment process [Ref. 7], with which a licensee can close the gap, and provide an assessment of whether the PRA meets the ASME standard. The staff position on the self-assessment process is documented in Appendix B of RG 1.200. The self-assessment guidance does have a limitation in that it has only been developed for a Capability Category II PRA. While it may be desirable for other applications to have a PRA with CC II for all SRs, it is not practical in the short term, nor is it necessary for the MSPI application. Therefore, a more pragmatic approach is necessary.

In developing the recommended approach, the following factors were considered:

From the technical perspective:

- the results of the PRA that are to be used for the MSPI are not required to be exact, but rather it is only required to be accurate within a factor of 2 or 3, and, as demonstrated in the pilot plant verification report [Ref.5], the effectiveness of the indicator is not particularly sensitive to variability in the PRA treatment of many of the PRA elements.
- experience has shown that the identification and grouping of initiating events (with the exception of support system initiating events) and the development of event trees and fault trees are generally performed in a consistent manner across the industry.
- **Need some additional input regarding the findings of the industry peer reviews with respect to what aspects of the PRA most of the F&Os relate to.**

From the process perspective:

- the MSPI is complemented by the performance of the SDP on single failures.
- the MSPI is supplemented by a backstop, based on the expected number of failures of the components, which imposes a color change for systems for which the MSPI is an insensitive indicator based on an observed number of failures lower than that which would change the color using the MSPI.
- the staff will perform focused reviews or audits; MSPI results that differ significantly from the norm are likely to be triggers for review.

Taking these factors into consideration, the task group considers that, for the majority of SRs, there is reason to believe that, if the facts and observation (F&Os) generated by the peer review are addressed, they will have been met to the degree needed for the MSPI. However, it is necessary to demonstrate with high confidence that those specific issues identified in Section 2 have been addressed appropriately. This can be done by performing a self-assessment in accordance with Appendix B of RG 1.200 against the SRs as identified in Table 4-1.

5 Variability between Licensee PRAs

The way in which requirements that address the issues identified in Section 2 are addressed is in all likelihood different for different PRAs. For example, concerning the credit taken for alternate injection systems (BWR), there is no SR that dictates to what extent this should be done; it is a decision for the individual licensee to make. Therefore, two licensees can produce different MSPI values for equivalent systems at similar plants, that, even though they are both derived using PRAs of an appropriate quality, will require different numbers of failures to trip a color.

As another example, the HEPs for failure to depressurize taken from the licensees' PRAs vary over almost two orders of magnitude. It is quite conceivable that the analyses might be done in a manner that is equivalent to a CC II, but it is the differences in the assessments from the HRA method that drive this variability. Therefore, in this case also, the licensees would have different thresholds for color change for HPCI.

These two cases are somewhat different however. In the first case, the difference is caused by a choice as to the level of detail in the model. Therefore, as long as the credit for alternate systems is addressed properly, there is no reason to question the use of the PRA for the derivation of the MSPI. This should be addressed by appropriate attention to the corresponding requirements. The second case is a type of model uncertainty (related to the choice of HRA model), and the choice and acceptability of specific models is to some extent subjective.

Absent an increased level of prescription on the use a PRA for the MSPI, variability will occur. The staff's major concern here is that a particular choice of model or level of detail may lead to desensitizing the MSPI inappropriately. Therefore, when the Birnbaum of a particular system at any given plant is significantly different from those of the same system at similar plants, a licensee should be prepared to justify the values used. This places some requirements on the documentation as discussed in Section 6. However, it has to be remembered that excessive variability would be compensated for by the backstop correction.

6 Recommendations on Documentation of Assurance of Technical Adequacy for MSPI

The recommendation of the task group is that, to demonstrate that the PRA is technically adequate to support the MSPI application, the licensees should document the following in their basis documents:

- a summary description of the resolution of the significant F&Os identified by the peer review team, or, for those F&Os not resolved, a justification why not resolving them has no impact on the efficacy of the MSPI.
- the results of, and resolution of any findings from, the self-assessment performed for the SRs identified in Table 4-1, taking into consideration Appendix B of RG 1.200, with particular attention to the notes in Table 4-1.
- a summary description of the methods and data used to address the issues identified in Section 2.

In addition, the licensee should ensure that the base PRA documentation is available for audit or review by the NRC staff.

7 Recommendations for Staff Review

The use of RG 1.200 is intended to reduce the need for staff review of the base PRA. However, the staff may choose to audit the licensee's PRA on a sampling basis. The focus would be on those issues identified in Section 2. An audit may be expected to be carried out if the Birnbaum importance measures used for MSPI are significantly different from the typical range found for similar plants so that the index is relatively insensitive, requiring that a larger number of failures is needed to change color than at other plants.

QUESTION: HOW ARE OUTLIERS IDENTIFIED? Once full scale implementation is initiated, the cross comparison at the level of the Birnbaum importance measures will become feasible. Sample information should be available currently based on the results of the pilot plant evaluations. What is the role of the SPAR models here?

An alternate approach would be to focus on the methods used to address the issues in Section 2 and, for example, in the case of parameter values, define a range within which most licensee's parameters would lie. For any licensee with a parameter outside of this range the reviewer would determine if there were a valid reason for being outside the range (e.g., a different definition of the parameter), or request the licensee to demonstrate through a sensitivity study that the MSPI is not particularly sensitive to the value of the parameter.

Another reason for differences in sensitivity of the MSPI could be the method used for truncation. The contributions to the MSPI derive from the accident sequence cutsets that include failures of the components of the system as defined in the MSPI guidance. one concern is that such cutsets are not truncated or otherwise screened out of the model. Therefore, reviewers should pay careful attention to the approach used for truncation.

8 References

1. USNRC, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis”, Regulatory Guide 1.174, Revision 1, November 2002.

2. USNRC, “An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities”, Regulatory Guide 1.200 for trial use, February 2004.

3. American Society of Mechanical Engineers (ASME), “Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications”, ASME RA-S-2002, April 5, 2002, and “Addenda to ASME RA-S-2002", ASME RA Sa-2003, December 5, 2003.

4. USNRC, “Plan for the Implementation of the Commission’s Phase Approach to Probabilistic Risk Assessment Quality”, SECY-04-0118, July 13, 2004.

5. USNRC, “Report on the Independent Verification of the Mitigating Systems Performance Index (MSPI) Results for the Pilot Plants”, NUREG-xxxx, December 2004(?).

6. Nuclear Energy Institute (NEI), “Probabilistic Risk Assessment Peer Review Process Guidance”, NEI-00-02, Revision A3, March 20, 2000.

7. Letter from NEI, Anthony Pietrangelo, Director of Risk and Performance Based Regulation Nuclear Generation, to the USNRC, Ashok Thadani, Director of the Office of Nuclear Regulatory Research, December 18, 2001.

Table 3-1 Capability Categories for MSPI

Supporting Requirement	Comments
IE-A1	Category I = Category II = Category III
IE-A2	Category I = Category II = Category III
IE-A3	Category I = Category II = Category III
IE-A4	Category II Attention to plant specific initiators and special initiators, especially loss of DC bus, Loss of AC bus, or Loss of room cooling type initiators
IE-A5	Category I = Category II = Category III
IE-A6	Category I The principal concerns for MSPI are support system initiators and LOSP. It is unlikely these will have been overlooked if IE-4 is met.
IE-A7	Category I in general. However, precursors to losses of cooling water systems in particular, e.g., from fouling of intake structures, may indicate potential failure mechanisms to be taken into account in the system analysis (IE-C6, 7, 8, 9)
IE-A8	Category I. However, system alignments should be taken into account when modeling support system initiators (IE-C6, 7, 8, 9).
IE-A9	Category II for plants that choose FTs to model support systems. Watch for IE frequencies that are substantially (e.g., more than 3 times) below generic values.
IE-A10	Category I = Category II = Category III
IE-B1	Category I = Category II = Category III
IE-B2	Category I = Category II = Category III
IE-B3	Category I = Category II
IE-B4	Category I = Category II = Category III
IE-C1	Category I = Category II = Category III Attention to LOOP frequency as a function of duration
IE-C2	Category II especially for LOOP and medium and small LOCA frequencies including stuck open PORVs
IE-C3	Category I = Category II = Category III

Supporting Requirement	Comments
IE-C4	Category I = Category II = Category III
IE-C5	no requirement (Category I/II)
IE-C6	Category I = Category II = Category III For plants that choose FTs for support systems, attention to loss of cooling systems initiators.
IE-C7	Category I = Category II = Category III
IE-C8	Category I = Category II = Category III (this appears to relate to IE-A8)
IE-C9	Category II for plants that choose FTs for support systems. Watch for IE frequencies that are substantially (i.e., more than 3 times) below generic values
IE-C10	Category I = Category II = Category III
IE-C11	Category I = Category II
IE-C12	Category I = Category II
IE-D1	Category I = Category II = Category III
IE-D2	Category I = Category II = Category III
IE-D3	Category I = Category II = Category III
AS-A1	Category I = Category II = Category III
AS-A2	Category I = Category II = Category III
AS-A3	Category I = Category II = Category III Attention to credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A4	Category I = Category II = Category III Attention to credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A5	Category I = Category II = Category III Attention to credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A6	Category I = Category II = Category III
AS-A7	Category I = Category II
AS-A8	Category I = Category II = Category III

Supporting Requirement	Comments
AS-A9	Category II for MSPI systems and components and for systems such as CRD, fire water, SW cross-tie, recovery of FW
AS-A10	Category II in particular for alternate systems where the operator actions may be significantly different, e.g., more complex, more time limited.
AS-A11	Category I = Category II = Category III
AS-B1	Category I = Category II = Category III
AS-B2	Category I = Category II = Category III
AS-B3	Category I = Category II = Category III Attention to credit for injection post-venting (NPSH issues, environmental survivability, etc.)
AS-B4	Category I = Category II = Category III
AS-B5	Category I = Category II = Category III
AS-B6	Category I = Category II = Category III Attention to (a) time phasing in LOOP/SBO sequences, including battery depletion, and ©) adequacy of CRD as an adequate injection source.
AS-C1	Category I = Category II = Category III
AS-C2	Category I = Category II = Category III
AS-C3	Category I = Category II = Category III
AS-C4	Category I = Category II = Category III
SC-A1	Category I = Category II = Category III
SC-A2	Category I = Category II = Category III
SC-A3	Category I = Category II = Category III
SC-A4	Category I = Category II = Category III Attention to modeling of shared systems and cross-ties in multi-unit sites
SC-A5	Category I = Category II = Category III
SC-A6	Category I = Category II = Category III

Supporting Requirement	Comments
SC-B1	Category II Attention to proper application of the MAAP code for T/H calculations, especially for LOCA, IORV, SORV, and F&B scenarios.
SC-B2	Category I
SC-B3	Category I = Category II = Category III
SC-B4	Category I = Category II = Category III
SC-B5	Category I = Category II = Category III
SC-C1	Category II
SC-C2	Category I = Category II = Category III
SC-C3	Category I = Category II = Category III
SC-C4	Category I = Category II = Category III
SY-A1	Category I = Category II = Category III
SY-A2	Category I = Category II = Category III
SY-A3	Category I = Category II = Category III
SY-A4	Category II for MSPI systems and components
SY-A5	Category I = Category II = Category III
SY-A6	Category I = Category II = Category III
SY-A7	Category I = Category II = Category III
SY-A8	Category I = Category II = Category III
SY-A9	Category I = Category II = Category III
SY-A10	Category I = Category II = Category III
SY-A11	Category I = Category II = Category III Attention to (d) modeling of shared systems
SY-A12	Category I = Category II = Category III
SY-A13	Category I = Category II = Category III
SY-A14	Category I = Category II = Category III
SY-A15	Category I = Category II

Supporting Requirement	Comments
SY-A16	Category I = Category II = Category III
SY-A17	Category I = Category II = Category III
SY-A18	Category I = Category II = Category III
SY-A19	Category I = Category II
SY-A20	Category I = Category II = Category III Attention to credit for alternate injection systems, alternate seal cooling
SY-A21	Category I = Category II = Category III
SY-A22	Category I = Category II = Category III
SY-B1	Category I Should include EDG, AFW, HPI, RHR CCFs
SY-B2	no requirements
SY-B3	Category I = Category II = Category III
SY-B4	Category I = Category II = Category III
SY-B5	Category I = Category II = Category III Attention to dependencies of support systems (especially cooling water systems) to the initiating events
SY-B6	Category I = Category II = Category III Attention to room cooling requirements, especially in LOOP events
SY-B7	Category I A conservative approach tends to make the MSPI for cooling water systems more important.
SY-B8	Category I = Category II = Category III
SY-B9	Category I = Category II = Category III Attention to credit for injection post-venting (NPSH issues, environmental survivability, etc.)
SY-B10	Category I = Category II = Category III
SY-B11	Category I
SY-B12	Category I = Category II = Category III
SY-B13	Category I = Category II = Category III
SY-B14	Category I = Category II = Category III

Supporting Requirement	Comments
SY-B15	Category I = Category II = Category III Attention to credit for injection post-venting (NPSH issues, environmental survivability, etc.)
SY-B16	Category I = Category II = Category III
SY-C1	Category I = Category II = Category III
SY-C2	Category I = Category II = Category III
SY-C3	Category I = Category II = Category III
HR-A1	Category I = Category II = Category III
HR-A2	Category I = Category II = Category III
HR-A3	Category I = Category II = Category III
HR-B1	Category I For the level of accuracy required for MSPI, contributions from failures to restore following maintenance or test are unlikely to make a significant difference.
HR-B2	Category I = Category II = Category III
HR-C1	Category I = Category II = Category III
HR-C2	Category I For the level of accuracy required for MSPI, contributions from failures to restore following maintenance or test are unlikely to make a significant difference.
HR-C3	Category I = Category II = Category III
HR-D1	Category I = Category II = Category III
HR-D2	Category I For the level of accuracy required for MSPI, the use of screening values for pre-initiator HEPs unlikely to make a significant difference.
HR-D3	Category I As above (HR-D2).

Supporting Requirement	Comments
HR-D4	Category I = Category II = Category III
HR-D5	Category I = Category II = Category III
HR-D6	Category I = Category II = Category III
HR-D7	Category I = Category II = Category III
HR-E1	Category I = Category II = Category III Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-E2	Category I = Category II = Category III Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-E3	Category I The HFEs that directly impact the MSPI are well-recognized as contributors. If they are defined in a non-standard manner that leads to a significantly different HEP from the norm, this would most likely have been identified during the peer review or should be addressed in the self-assessment.
HR-E4	Category I As above (HR-E3).
HR-F1	Category I = Category II = Category III
HR-F2	Category I The intent is that HEPs that are significantly different from the norm (to be defined) will be subject to a sensitivity study to determine the sensitivity of the MSPI to the value.
HR-G1	Category II , though Category I for the critical HEPs would produce a more sensitive MSPI (i.e., fewer failures to change a color)
HR-G2	Category I = Category II = Category III Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-G3	Category I See note on HR-G1. Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-G4	Category I See note on HR-G1.

Supporting Requirement	Comments
HR-G5	Category II See note on HR-G1.
HR-G6	Category I = Category II = Category III
HR-G7	Category I = Category II = Category III
HR-G8	Category I = Category II = Category III
HR-G9	Category I = Category II = Category III
HR-H1	Category I = Category II
HR-H2	Category I = Category II = Category III Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-H3	Category I = Category II = Category III
HR-I1	Category I = Category II = Category III
DA-A1	Category I = Category II = Category III
DA-A2	Category I = Category II = Category III
DA-A3	Category I = Category II = Category III
DA-B1	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity. However, attention to service condition (clean vs untreated water) for SW systems
DA-B2	Category I = Category II
DA-C1	Category I = Category II = Category III Attention to LOOP recovery
DA-C2	Category I = Category II = Category III
DA-C3	Category I = Category II = Category III
DA-C4	Category I = Category II = Category III
DA-C5	Category I = Category II = Category III

Supporting Requirement	Comments
DA-C6	Category I = Category II = Category III
DA-C7	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity.
DA-C8	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity.
DA-C9	Category I = Category II
DA-C10	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity.
DA-C11	Category I = Category II = Category III
DA-C12	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity.
DA-C13	Category I = Category II = Category III
DA-C14	Category I = Category II = Category III
DA-C15	Category I = Category II = Category III Attention to recovery from LOSP and loss of SW events
DA-D1	Category I For BWRs with isolation condenser, attention to the likelihood of a stuck open SRV
DA-D2	Category I = Category II = Category III
DA-D3	Category I The uncertainty characterization does not play a role in the MSPI.
DA-D4	Category II/III. If a Bayesian approach is used its validity should be examined. (This requirement will probably be significantly changes in Addendum B of the ASME Standard)
DA-D5	Category I Given that there is a fall back position on the incorporation of CCF in the MSPI, it does not seem reasonable to require a higher category.
DA-D6	Category I Given that there is a fall back position on the incorporation of CCF in the MSPI, it does not seem reasonable to require a higher category.

Supporting Requirement	Comments
DA-D7	Category I The MSPI pilot program did not find that parameter values were a significant source of concern for MSPI sensitivity.
DA-E1	Category I = Category II = Category III
QU-A1	Category I = Category II = Category III
QU-A2	Category I It is judged that performing a point estimate calculation, rather than using a formal propagation of uncertainty, will not have much of an impact on the accident sequences and cutsets involving the MSPI systems.
QU-A3	Category I = Category II = Category III
QU-A4	Category I = Category II = Category III
QU-B1	Category I = Category II = Category III
QU-B2	Category I = Category II = Category III Attention to truncation limits that are appropriate for F-V calculations. The truncation limits are typically 5 to 6 orders of magnitude smaller than the base CDF.
QU-B3	Category I = Category II = Category III This is an MSPI implementation concern and should be addressed in the guidance document. Attention to truncation limits that are appropriate for F-V calculations. The truncation limits are typically 5 to 6 orders of magnitude smaller than the base CDF.
QU-B4	Category I = Category II = Category III
QU-B5	Category I = Category II = Category III Attention to cutting logic loops for ESW systems
QU-B6	Category I = Category II = Category III
QU-B7	Category I = Category II = Category III
QU-B8	Category I = Category II = Category III
QU-B9	Category I = Category II = Category III
QU-C1	Category I = Category II = Category III

Supporting Requirement	Comments
QU-C2	Category I = Category II = Category III
QU-C3	Category I = Category II = Category III
QU-D1	Category I = Category II = Category III
QU-D2	Category I = Category II = Category III
QU-D3	Category II This is a natural thing for peer reviewers to do.
QU-D4	Category I = Category II = Category III
QU-D5	Category II for those who have used fault tree models to address support system initiators.
QU-E1	Category I = Category II = Category III
QU-E2	Category I = Category II = Category III
QU-E3	Category I Uncertainty characterization does not play a role in MSPI.
QU-E4	Category II for the issues that directly affect the MSPI
QU-F1	Category I = Category II = Category III
QU-F2	Category I Category II/III is not necessary for MSPI.
QU-F3	Category I = Category II = Category III
QU-F4	Category I = Category II = Category III
QU-F5	Category I = Category II = Category III
QU-F6	Category I = Category II = Category III

Table 4-1 SRs for self-assessment

Supporting Requirement	Comments
IE-A4	Focus on plant specific initiators and special initiators, especially loss of DC bus, Loss of AC bus, or Loss of room cooling type initiators
IE-A7	Category I in general. However, precursors to losses of cooling water systems in particular, e.g., from fouling of intake structures, may indicate potential failure mechanisms to be taken into account in the system analysis (IE-C6, 7, 8, 9)
IE-A9	Category II for plants that choose FTs to model support systems. Watch for IE frequencies that are substantially (e.g., more than 3 times) below generic values.
IE-C1	Focus on LOOP frequency as a function of duration
IE-C2	Focus on LOOP and medium and small LOCA frequencies including stuck open PORVs
IE-C6	For plants that choose FTs for support systems, attention to loss of cooling systems initiators.
IE-C9	Category II for plants that choose FTs for support systems. Watch for IE frequencies that are substantially (i.e., more than 3 times) below generic values
AS-A3	Focus on credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A4	Focus on credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A5	Focus on credit for alternate sources, e.g., gas turbines, CRD, fire water, SW cross-tie, recovery of FW
AS-A9	Category II for MSPI systems and components and for systems such as CRD, fire water, SW cross-tie, recovery of FW
AS-A10	Category II in particular for alternate systems where the operator actions may be significantly different, e.g., more complex, more time limited.
AS-B3	Focus on credit for injection post-venting (NPSH issues, environmental survivability, etc.)
AS-B6	Focus on (a) time phasing in LOOP/SBO sequences, including battery depletion, and ©) adequacy of CRD as an adequate injection source.
SC-A4	Focus on modeling of shared systems and cross-ties in multi-unit sites

Supporting Requirement	Comments
SC-B1	Focus on proper application of the MAAP code for T/H calculations, especially for LOCA, IORV, SORV, and F&B scenarios.
SC-C1	Category II
SY-A4	Category II for MSPI systems and components
SY-A11	Focus on (d) modeling of shared systems
SY-A20	Focus on credit for alternate injection systems, alternate seal cooling
SY-B1	Should include EDG, AFW, HPI, RHR CCFs
SY-B5	Focus on dependencies of support systems (especially cooling water systems) to the initiating events
SY-B9	Focus on credit for injection post-venting (NPSH issues, environmental survivability, etc.)
SY-B15	Focus on credit for injection post-venting (NPSH issues, environmental survivability, etc.)
HR-E1	Focus on credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-E2	Focus on credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-G1	Category II , though Category I for the critical HEPs would produce a more sensitive MSPI (i.e., fewer failures to change a color)
HR-G2	Focus on credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-G3	Category I See note on HR-G1. Attention to credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
HR-G5	Category II See note on HR-G1.
HR-H2	Focus on credit for cross ties, depressurization, use of alternate sources, venting, core cooling recovery, initiation of F&B
DA-B1	Focus on service condition (clean vs untreated water) for SW systems
DA-C1	Focus on LOOP recovery
DA-C15	Focus on recovery from LOSP and loss of SW events
DA-D1	For BWRs with isolation condenser, focus on the likelihood of a stuck open SRV

Supporting Requirement	Comments
QU-B2	Focus on truncation limits that are appropriate for F-V calculations. The truncation limits are typically 5 to 6 orders of magnitude smaller than the base CDF.
QU-B3	This is an MSPI implementation concern and should be addressed in the guidance document. Attention to truncation limits that are appropriate for F-V calculations. The truncation limits are typically 5 to 6 orders of magnitude smaller than the base CDF.
QU-D3	This is a natural thing for peer reviewers to do.
QU-D5	Category II for those who have used fault tree models to address support system initiators.
QU-E4	Category II for the issues that directly affect the MSPI

Appendix A

Mitigating Systems Performance Index (MSPI) PRA Quality Task Group Charter

As a result of NRC and stakeholder recommendations, the MSPI PRA Quality Task Group has been convened to resolve issues related to the quality required of a PRA for implementation of the MSPI.

In RG 1.174 and in RG 1.200, the PRA quality required for an application is defined in terms of the scope of the PRA, its level of detail, and its technical adequacy. Consistent with the scope of the MSPI, the scope of PRA required for the MSPI application is a level 1 PRA at full power. Since a Standard to support the scope of PRA required has been endorsed in RG 1.200, the MSPI application can be classified as a Phase 2 type application in the Commission's Phased Approach to PRA quality.

The objectives of the Task Group are to:

- Provide guidance on the level of detail and the characteristics of the base PRA needed to support the MSPI implementation, using, as a basis, the supporting level requirements and capability categories of the ASME PRA Standard.

- Provide guidance on licensee and staff activities needed to demonstrate that the base PRA is technically adequate to support its use to support the MSPI application, addressing the use of RG 1.200, the roles of peer review and self-assessment, and guidance for determining the need for, and scope of, staff audit of the base PRA model.

- Provide recommendations on an approach to dealing with those PRA uncertainties, assumptions, and methodological issues that are known to affect MSPI significance levels.

- Review and revise recommendations based on experience with initial implementation.

- Provide resolution of those emergent PRA methodological issues that are discovered during the lead plant implementation of the MSPI.

The Task Group recommendations will be provided in a letter report.