December 11, 2002

MEMORANDUM TO: Michael R. Johnson, Chief
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: See-Meng Wong /**RA/ M. Caruso for**
Licensing Section
Probabilistic Safety Assessment Branch
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY MINUTES OF NOVEMBER 6-8, 2002 PUBLIC WORKSHOP TO DISCUSS THE IMPROVEMENT FOR PHASE 1 AND PHASE 2 FIRE PROTECTION SIGNIFICANCE DETERMINATION PROCESS (SDP) METHODOLOGY

Attached is the summary minutes of the November 6-8, 2002 public workshop to discuss improvements of the Phase 1 screening process for the fire protection SDP, and to discuss possible approaches for addressing each issue affecting the Phase 2 fire protection SDP methodology. Attendees in the public workshop were NRC staff, a NRC contractor, and external stakeholders from NEI and the industry, including a media representative. The handout materials distributed to the meeting participants are also included in this attachment.

CONTACT: See Meng Wong, NRR/DSSA/SPSB
415-1125

Attachments: As stated

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Attachments: As stated

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Fire Protection SDP Improvement Initiative

Summary Minutes of Public Workshop
Ramada Inn Hotel Rockville, Rockville, Maryland
November 6-8, 2002

1. Workshop Objectives

   (a) To discuss the Phase 1 screening process for the fire protection SDP methodology, and
   (b) To discuss possible approaches for addressing each issue affecting the Phase 2 fire protection SDP methodology.

2. Agenda

M. Johnson started the meeting with introductory remarks on the purpose and objectives of the meeting. He summarized the completed activities on the fire protection SDP improvement initiative, and discussed the focus of future revision efforts. He also stressed that the primary goal of the workshop was to have both internal and external stakeholders engage in constructive discussions on the possible approaches for addressing each issue affecting the Phase 2 fire protection SDP tool, as well as discuss improvements to the Phase 1 screening process.

S. Wong was the chair and moderator of all discussions on the first day of the workshop. M. Reinhart was the chair and moderator of all discussions on the second and third day of the workshop. The final agenda and package of issue descriptions (Attachment 1) were provided to all workshop participants to focus discussions within the time allocated for each technical issue session.

The technical sessions in the workshop were presented by the following individuals as listed below:

1. Phase 1 Screening Methodology and Licensing Bases Issues - S. Wong
2. Phase 2 SDP Objectives and Goals - S. Wong
3. Quantification Approach - S. Nowlen
4. Fire Scenario Frequency and Severity Factors - JS Hyslop
5. Fire Scenario Development - P. Lain
6. Degradation Ratings for Fixed Fire Detection Systems - F. Emerson
7. Degradation Ratings for Fixed Fire Suppression Systems - F. Emerson
8. Manual Suppression and Fire Brigade Response - P. Lain
9. Fire Barriers - D. Frumkin
10. Appendix R Exemptions - P. Koltay
11. Safe Shutdown Findings and Credit for Human Actions - S. Wong
12. Compensatory Measures - F. Emerson

3. Phase 1 Screening Methodology and Licensing Bases Issues (S. Wong)

S. Wong presented a proposed screening checklist and a set of screening questions (See attachment 2) for the Phase 1 screening process for discussion between the meeting participants. S. Wong also presented proposed screening criteria for screening a finding as a Green (low risk-significant) finding. The proposed screening criteria are based on considerations of "low" fire ignition frequency and "low" degradation rating of degraded defense-in-depth (DID) elements.

The outcomes of the discussions were to include the question on meeting licensing basis requirements as an aspect of the definition of the inspection finding, and to revise the logical order of Phase 1 screening questions for low fire ignition frequency and degradation rating of degraded defense-in-depth (DID) elements. The revised logical order of the proposed set of Phase 1 screening questions would be:

1 Does the finding only affect achieving/maintaining ability to reach cold shutdown conditions? Y - screen to Green, N - continue.

2. Does the finding affect the ability to achieve/maintain hot shutdown functions? Y - go to Phase 2, N - continue.

3. Is the fire protection defense-in-depth degradation High? Y - go to Phase 2, N - continue.

4. Is the fire ignition frequency greater than Low? Y - go to Phase 2, N - screen to Green

Additionally, the question on the ability to achieve and maintain hot shutdown functions (Question #2 above) would include considerations of loss of redundancy and diversity to improve the screening process.

The workshop participants generally agreed that use of the combined criteria of low degradation rating of defense-in-depth element and low fire ignition frequency was the best possible approach for Phase 1 screening of findings to Green. However, there was no clear consensus yet on the proposed fire frequency value of less than 1E-4/year for "Low" fire ignition frequency to be considered in the Phase 1 screening process. This proposed fire ignition frequency criterion for the Phase 1 methodology will be addressed in task group meetings in the near future.

Other possible approaches for the Phase 1 process such as screening based solely on the fire ignition frequency criterion, or consideration of combustible loadings, were considered to be difficult or unacceptable alternatives for Phase 1 screening purposes.

4. Phase 2 SDP Objectives and Goals (S. Wong)

S. Wong summarized the expectations for the improved fire protection Phase 2 SDP methodology to be simplicity, transparency, repeatability, and reasonableness of assumptions to avoid "extra" conservatism (See attachment 3). The desired goal is to achieve a preliminary significance determination within one order of magnitude accuracy of the final significance determination to be consistent with other SDP applications. The workshop participants discussed the possible approaches to achieve the stated objectives and goals. There was general agreement on a combined approach of modifying the current Phase 2 SDP methodology to a simplified screening process that always yield a conservative result, and improving the assignment of credits for available safe shutdown equipment and feasible human recovery actions. This combined approach would rely on a detailed Phase 3 SDP analysis to provide a more refined estimate of the risk significance of a given finding. The workshop participants did not favor the alternative approach of keeping the current Phase 2 SDP methodology and making incremental improvements to reduce subjectivity.

5. Quantification Approach (S. Nowlen)

S. Nowlen presented a proposed quantification approach for the Phase 2 fire protection SDP methodology based on a three-factor formula used in the fire PRA framework for quantifying fire risk contributions (See attachment 4). The three-factor formula considers the fire ignition frequency, conditional probability that the fire leads to a given fire damage state, and the conditional likelihood that the operators fail to achieve safe shutdown given the fire damage state. The primary advantage of this proposed approach is the explicit treatment of dependencies between elements of a fire scenario in a more rigorous manner.

The workshop participants were generally in favor of the three-factor formula quantification approach for the Phase 2 SDP methodology. There were suggestions to keep this approach simple by providing "look-up tables" to encourage greater use by inspectors. The workshop participants considered that the alternative approach of refining the current version of the Phase 2 SDP methodology would not provide significant improvements to the fire protection SDP methodology.

6. Fire Ignition Frequency and Severity Factors (JS Hyslop)

JS Hyslop presented an overview of the issues concerning the approaches for calculating fire ignition frequency estimates and fire severity factors, and discussed the implications of two fire event databases that are available for calculating fire ignition frequencies and severity factors (See attachment 5). Much of the discussions on fire ignition frequency were centered on whether the use of component-specific fire ignition frequency estimates versus the fire area ignition frequency estimates was the best possible approach for the Phase 2 SDP analyses. The consensus was to accept the use of generic fire room ignition frequency estimates as the primary basis for calculations with consideration of plant-specific partitioning factors in accordance with EPRI's FIVE methodology. The discussions on fire severity factors were focused on determining appropriate criteria for the definition of "severe fires". There was consensus on considering fire severity factors in the proposed quantification approach for the Phase 2 SDP methodology. Finally, there were much discussions on database issues such as extent of coverage, completeness, quality of data, format structure, and proprietary nature. There was general consensus to favor the use of the EPRI database because the description fields support the convenient analysis of fire severity factors, and the database is available to the industry.

J. Houghton/RES provided a short presentation of the NRC/RES database used in Accident Precursor Program (ASP) fire risk analyses. He also discussed the general structure of the database and the extent of coverage of fire events for analysis. Most of the discussions were centered on the proprietary nature of the database, and whether the database can be made available to the public to enhance transparency and public confidence in the SDP tool.

7. Fire Scenario Development (P. Lain)

P. Lain presented the possible approaches for development of fire scenarios to be considered in the Phase 2 SDP methodology. He discussed the possible approaches in terms of using qualitative screening methods and quantitative tools to estimate the time to fire damage of potential targets.

The outcome of the discussions is the need for better guidance on both qualitative and quantitative tools for fire scenario development. The workshop participants suggested the need for a toolbox and better guidance to address plant-specific factors in the fire scenario development, e.g., time-temperature considerations for IEEE-338 qualified versus non-IEEE-338 qualified cables, or Thermoset versus Thermoplastic cables.

8. Degradation Ratings for Fixed Fire Detection and Suppression Systems (F. Emerson)

F. Emerson presented a proposed set of degradation ratings for fixed fire detection and suppression systems which eliminated the “moderate” rating used in the current version of the fire protection SDP. The new set of degradation ratings were “high”, “low”, or “no” degradation. There were lots of discussions on the appropriate attributes for each degradation rating, and the linkage of each degradation rating to a quantitative probabilistic value.

The workshop participants suggested that a mini-task group of NRC and industry representatives should be established to determine the appropriate attributes and quantitative probabilistic values for each degradation rating.

9. Manual Suppression and Fire Brigade Response (P. Lain)

P. Lain discussed the issues concerning the evaluation of fire brigade performance in drills and credit for manual fire fighting and suppression in the context of identified fire scenarios. He also discussed the role of licensee self assessments for evaluating fire brigade response and credit for manual suppression in fire scenarios.

There was general agreement to use a nominal quantitative probabilistic value for fire brigade response in the significance determination of fire protection findings that are not wholly related to fire brigade performance problems. The workshop participants suggested that a separate SDP tool should be developed for evaluation of fire brigade performance problems.

10. Fire Barriers (D. Frumkin)

D. Frumkin presented the descriptive attributes for the degradation ratings of fire barriers (See attachment 6). He also discussed the issue concerning the linkage of degradation ratings for fire barriers to their rated time of effectiveness.

The outcome of the discussions was to provide better guidance to assist NRC inspectors to make the appropriate characterization of fire barrier degradation in the SDP evaluations. The workshop participants suggested that a mini-task group of NRC and industry representatives should be established to determine the appropriate attributes and quantitative probabilistic values for each degradation rating for fire barriers.

11. Appendix R Exemptions (P. Koltay)

P. Koltay presented a brief overview of the regulatory interpretation of approved exemptions from plant licensing basis.

The outcome of the discussions was to exclude the significance determination of deviations from approved Appendix R exemptions from the fire protection SDP methodology.

12. Safe Shutdown Findings and Credit for Human Actions (S. Wong)

S. Wong presented the issues concerning the treatment of safe shutdown findings and credit for manual actions outside of the Main Control Room to achieve plant safe shutdown. There were lots of discussions on crediting human actions that are outside of procedures, and the outcome was not to consider this credit in the Phase 2 SDP tool. He also presented a general approach for estimating probabilities of hot shorts leading to spurious actuations to be used in significance determination of safe shutdown findings.

The workshop participants suggested that the consideration of this issue to be deferred until after NRR/SPLB has conducted the public workshop on associated circuits analysis to be held some time in February, 2003. It was recommended that a mini-task group should be established to provide input on this area to the overall quantification approach proposed for the Phase 2 SDP methodology.

13. Compensatory Measures (F. Emerson)

F. Emerson presented the possible approaches for crediting compensatory measures in the fire protection SDP evaluations. He discussed a proposed sliding scale of the “degree of compensation” based on the nature of compensatory measures for the degraded fire protection feature. The proposed sliding scale was based on giving no credit, partial credit, or full credit of compensatory measures depending on the level of degradation of the fire protection defense-in-depth element or feature.

There was general agreement on the need to develop better guidance on crediting compensatory measures, and handing off the credit attributes for each type of compensatory measures to the corresponding mini-task groups, e.g., the fire database group needs to include the impact of a compensatory measure that reduces fire ignition frequency. Additionally, there was general agreement to include consideration of compensatory measures that may impact fire barrier effectiveness and safe shutdown analysis.

14. Wrap-Up/ Action Items (M. Reinhart, S. Wong)

M. Reinhart provided an overall summary of the issues presented in the workshop, and discussed the recommended approaches for addressing each issue affecting the Phase 2 SDP methodology.

The action items are:

(a) Establish mini-task groups to provide input on the fixes for each item listed below:

- database for fire ignition frequency
- fire scenario development
- fixed detection and suppression systems
- fire barriers
- definition of safe shutdown findings
- human reliability analysis
- hot shorts/spurious actuations

(b) S. Wong was assigned to establish the mini-task groups to include NRC and industry representatives. The skills mix for each mini-task group were specified to identify the best available expertise to be in each group. S. Nowlen was assigned to be the overall coordinator/consultant for the various mini-task groups with the primary role of ensuring the products from the task groups are consistent with the overall framework for the quantification approach.

(c) Prepare a working draft of the fire protection SDP by early January, 2003 to assist the mini-task groups to begin discussions in meetings prior to providing input to the Review Team by early February, 2003. (S. Wong, JS Hyslop and S. Nowlen).

(d) R. Fuhrmeister, Region 1 provide “Rules of Thumb” for consideration of interim implementation of fire protection SDP.

The public workshop adjourned at 12.00 noon, November 8, 2002.

Meeting Attendees

Michael Johnson, NRC/NRR
Mark Reinhart, NRC/NRR
See-Meng Wong, NRC/NRR
Peter Koltay, NRC/NRR
Paul Lain, NRC/NRR
D. Frumkin, NRC/NRR
Peter Wilson, NRC/NRR
Richard Rasmussen, NRC/NRR
Donald Dube, NRC/RES
J.S. Hyslop, NRC/RES
James Houghton, NRC/RES
Steve Nowlen, Sandia National Lab
Jennifer Dixon-Herrity, NRC/OE
Roy Fuhrmeister, NRC/Region 1
Charles Payne, NRC/Region 2
Ron Langstaff, NRC/Region 3
Rebecca Nease, NRC/Region 4

Fred Emerson, NEI
David Conti, NAESCO/Seabrook Station
Roger Sims, Progress Energy/Brunswick Station
Michael Cooper, Entergy/ANO Station
Phil Barnes, FPL/St. Lucie Station
Robert Dukes, NISYS Corporation
Robert Lichtenstein, TXU
William Stillwell, STP Nuclear Station
Saeed Savar, Constellation
Edward McCann, Constellation
Cliff Sinopoli, Exelon/Peach Bottom
Micky Heatherly, TVA
Harold Barrett, Duke Power/Oconee Station
Harold Lefkowitz, Duke Power/Oconee
Robert White, NMC/Palisades
Dennis Shumaker, PSEG Nuclear
Brian Thomas, PSEG Nuclear

FIRE PROTECTION SIGNIFICANCE DETERMINATION PROCESS IMPROVEMENT INITIATIVE

PUBLIC WORKSHOP

November 6-8, 2002

NRC Headquarters

Meeting Location: Ramada Inn Hotel Rockville

Attachment 1

Fire Protection SDP Public Workshop
Ramada Inn Hotel Rockville
Rockville, Maryland.
November 6-8, 2002

FINAL AGENDA

Workshop Objectives

(1) To discuss the Phase 1 screening methodology for the fire protection SDP methodology
(2) To discuss the approaches for addressing each issue affecting the Phase 2 methodology

WEDNESDAY, November 6

1:30 - 1:45 - Welcome and Workshop Objectives — Michael Johnson

1:45 - 2:15 - Phase 1 Screening Methodology and Licensing Basis Issues — S. Wong/M. Reinhart

2:15 - 2:45 - Phase 2 Objectives and Goals — S. Wong

2:45 - 3:00 - Break

3:00 - 4:30 - Quantification Approach — J.S. Hyslop

4:30 - Adjourn

THURSDAY, November 7

8:30 - 10:00 - Fire Scenario Frequency — J.S. Hyslop

10:00 - 10:15 - Break

10:15 - 11:00 - Fire Scenario Development — Paul Lain

11:00 - 12:00 - Degradation Ratings for Fixed Fire Detection Systems — Fred Emerson

12:00 - 1:15 - Lunch

1:15 - 2:15 - Degradation Ratings for Fixed Fire Suppression Systems — Fred Emerson

2:15 - 3:00 - Manual Suppression and

Fire Brigade Response Evaluations	Paul Lain
3:00 - 3:15 - Break	
3:15 - 4:00 - Fire Barriers	Dan Frumkin
4:00 - 4:45 -Treatment of Appendix R Exemptions	Peter Koltay
4:45 - Adjourn	

FRIDAY, November 8

8:30 - 10:00 - Safe Shutdown Findings and Credit for Human Actions	S. Wong
10:00 - 10:15 - Break	
10:15 - 11:15 - Compensatory Measures	Fred Emerson
11:15 - 12:00 - Closing Plenary	Mark Reinhart
12:00 - Adjourn	

PHASE 1 SCREENING PROCESS

ISSUE 1: Fire Frequency Value for Phase 1 Screening

DESCRIPTION: Stakeholders have proposed that the Phase 1 screening process could be improved by considering simple screening criteria to filter (or screen out) an inspection finding from the Phase 2 SDP analysis. One criterion is a “Low” fire ignition frequency for the fire scenario, and another criterion is the “Low” degradation rating of the degraded defense-in-depth (DID) elements for fire protection. The issue is to determine what fire ignition frequency, when combined with a “low” degradation of the degraded DID element(s), should be used as the criterion to screen out the inspection finding (i.e., screen to Green). A fire ignition frequency value of 1E-4 has been recommended as a screening value. Is this a reasonable criterion?

POSSIBLE APPROACHES:

Approach A: Screen out findings based on combined criteria of “low” fire ignition frequency and “low” degradation rating of the affected DID element.

This approach considers an integrated view of the “low” degradation rating for the DID element and “low” fire ignition frequency. A clear definition of “low” degradation rating is needed to make a judgment on the effectiveness of the “low” degraded DID element. If the effectiveness of a “low” degraded DID element is judged to be adequate to perform its intended function, then those findings meeting this criterion could perhaps be screened out without any concern about the fire ignition frequency. This screening method would be consistent with the current fire protection SDP.

Coupling the low degradation of a DID element with a fire frequency criterion may provide additional assurance that an important finding is not screened out, but there is no strong technical basis for choosing a specific fire frequency value as a criterion.

Approach B: Screen out findings based on the fire ignition frequency criterion alone.

In the Phase 1 screening process, no fire scenarios are defined yet. Therefore, any fire ignition frequency criterion considered should refer to the derived fire ignition frequency for the affected compartment room, or fire area. In particular, the fire frequency used should not depend on the development of fire scenarios.

Since a delta CDF of less than 1E-6/year is the criterion used to screen out a finding (i.e., screen to Green), any screening criterion for fire ignition frequency greater than 1E-6/year for a room or fire area needs to account for the margins of credit for: (a) plant-specific mitigation capability from remaining systems capable of maintaining hot shutdown, (b) duration of exposure time for the finding, and (c) remaining fire protection features. The margin from the criterion of delta CDF less than 1E-6/year depends on other factors such as the unavailability of protected redundant trains for safe shutdown, fire brigade response and capability for effective manual suppression, and fast fire growth. The dependencies between some of these factors make this approach of using the fire ignition frequency alone for screening out a finding somewhat difficult.

Moreover, the choice of a room fire frequency of 1E-4/year as a criterion may not screen out many findings. Fire area, or room fire ignition frequencies of less than 1E-4/year generally do not exist. It has been generally observed that the lowest fire ignition frequency, e.g., for transient combustibles, may be greater than 1E-4/year if the frequency estimate is equally partitioned into the affected fire compartments. Therefore, a criterion of fire ignition frequency of 1E-4/year may not screen out many findings.

Approach C: An alternative approach is to consider the loading of combustibles in a fire compartment or a fire area, and physical configuration (e.g., large or small room). The finding could be screened out if the combustible loading is "low". A clear definition of "low" combustible loading needs to be developed as a screening criterion.

Approach D: Modify the approach discussed in Approach B.

This approach could consider the room fire frequency, the exposure time of the finding, and the conditional core damage probability (CCDP) for the room or fire area, and evaluate the three variables together as a screening method. However, this would involve resources and knowledge of the plant conditions beyond the information typically available in the screening phase. This approach is complex and may be beyond the Phase 1 screening method.

PHASE 2 SDP ISSUES

ISSUE 1: Phase 2 SDP Objectives and Goals (S. Wong)

DESCRIPTION: Earlier feedback from NRC and industry stakeholders indicate that the current version of the fire protection SDP was complex and difficult to use. Therefore, some suggested expectations for the improved fire protection Phase 2 SDP methodology are simplicity, transparency, repeatability, and reasonableness of assumptions to avoid 'extra' conservatism. A desired goal for the fire protection Phase 2 SDP methodology is to achieve a preliminary significance determination within one order of magnitude accuracy of the final significance determination to be consistent with other SDP applications. However, this desired goal may not be readily achievable due to sources of substantial uncertainty affecting other aspects or parameters (e.g., fire growth and damage, fire detection, and fire suppression) of the fire risk significance analysis. These uncertainty influences can result in greater than one-order of magnitude away from the final risk significance color of the identified inspection finding, either as a false positive or false negative outcome.

POSSIBLE APPROACHES:

Approach A: Modify the existing Phase 2 SDP methodology to a simplified screening approach that always yield a conservative result. Rely on a detailed Phase 3 SDP analysis to provide a more refined estimate of the risk significance of a given finding. This approach would lead to false-positive outcomes, but would minimize false-negatives. The Phase 3 SDP analysis would often produce a lower significance color than the Phase 2 result.

Approach B: Keep the existing Phase 2 SDP methodology, but make incremental improvements in the various steps of the Phase 2 methodology to reduce subjectivity where applicable.

Approach C: Assign appropriate credits for available safe shutdown equipment and feasible human recovery actions in the current Phase 2 SDP methodology. This approach may achieve an order-of-magnitude accuracy. This approach would involve development of reasonable bases for the assigned credits to reduce uncertainty influences affecting these factors.

ISSUE 2: Quantification Approach (J.S. Hyslop)

DESCRIPTION: Stakeholders have suggested that a new approach to the quantitative assessment of the significance of fire protection findings is needed. The primary complaint associated with the current approach appears to be its lack of transparency. The current approach also does not treat dependencies between elements of a fire scenario in a rigorous manner. The overall quantification approach is a key element of the fire protection SDP process and needs to be outlined as early in the revision process as possible. This is because other elements of the fire protection SDP methodology must be compatible with the chosen quantification approach. For example, significance of degradation finding(s) must be quantitatively evaluated in a manner consistent with the overall quantification approach.

POSSIBLE APPROACHES:

Approach A: Utilize the fire PRA quantification framework. Current fire PRAs utilize a quantification framework that was initially developed in the early 1980's. Since that time, the framework has changed little, and has 'stood the test of time.' The primary advantage of the PRA approach is the explicit treatment of dependencies. The fire PRA framework also builds explicitly on the competitive processes of fire growth and fire suppression (i.e., the time to fire suppression is viewed in the context of fire growth and ultimately the estimated time to component damage). Use of a PRA-style quantification framework would allow for the direct utilization of various aspects of current fire PRA methods and data, and would ease the transition between Phase 2 and Phase 3 SDP analyses.

In fire PRAs, the fire risk contributions are quantified using three-terms; namely, the fire ignition frequency, the conditional probability that the fire leads to a given fire damage state, and the conditional likelihood that operators fail to achieve safe shutdown given the fire damage. For an improved fire protection SDP, a streamlined version of the existing fire PRA approach is recommended. In particular, while a fire PRA may analyze many fire scenarios in a given room, for SDP purposes, the approach could be based on defining a limited set of (up to 3) discrete fire damage state scenarios. One fire damage state scenario can likely be used to cover most findings, whereas other findings may require the analysis of up to three discrete damage states.

This approach had been discussed in previous working group meetings, and it is recommended for improving the fire protection SDP. Additional details on the proposed approach is attached.

Approach B: Refine the existing approach. The existing approach is based on an additive process. This process considers various factors that contribute either positively or negatively to the development of a fire scenario. There are two challenges associated with the refinement of the existing approach. The first challenge involves increasing the transparency of the process so that it is more scrutable. Secondly, the treatment of dependencies between those positive and negative factors considered in the process needs to be improved. For example, it may be possible to group factors in such a way as to preserve these dependencies. However, the bigger challenge would be to provide better treatment of the time competition between fire growth and fire suppression. This approach would then likely appear to be similar to Approach A in that the SDP methodology would likely be utilizing a fire risk equation like the three-term PRA expression.

A. Additional Discussion on Approach A

It is proposed that the fire SDP quantification process consider fire scenarios in the context of three discrete fire damage states:

- fires leading to localized damage to unprotected components/cables,
- fires leading to widespread damage including damage to cables protected by degraded raceway fire barrier systems, and
- fires leading to multi-room fire damage.

Most inspection findings should require the examination of fire scenarios representing just one of the three fire damage states. However, some findings might require the analysis of fire scenarios representing two, or all three, fire damage states.

The quantification of a damage state scenario will be based on a three-term equation. The three terms will be:

- the fire scenario frequency,
- the likelihood that the fire damage state is actually reached, and
- the likelihood that operators fail to achieve safe shutdown given the damage state.

Fire damage state scenarios will be analyzed based primarily on event timing. This is especially important for the second term, the likelihood that damage state is reached given ignition of a fire. This term depends on quantification of the competing processes of fire growth and fire suppression, both time-oriented processes.

As a result, the primary approach to quantifying degradation findings will be through timing information. Depending on the finding, this would either involve a reduction in the performance time of a passive protective feature, or delays in activation times for an active protective feature. Examples include the following:

- Findings related to degradation of a fire barrier should be quantified as an estimate of the actual fire endurance time for the barrier - e.g., a one-hour fire barrier might be assumed to last 10 minutes in a highly degraded condition, and 30 minutes in a moderately degraded condition.

- Findings related to a fire detection system should be expressed as a delay in the actuation time of the system - e.g., one might assign a 10 minute delay in fire detection if a fixed detection system is moderately degraded, and a 30 minute delay if it is highly degraded.

- Most findings related to fire suppression systems should also be expressed as a delay in suppression system actuation time (similar to detection time cited above).

It is recognized that this sort of time delay / performance time information may not be appropriate for all cases. Some findings may be better reflected as a reduction in system reliability and/or effectiveness. This might be applicable, for example, to findings that relate to failure to comply with maintenance schedules. An example is as follows:

- If a finding is made that fire pump inspection and maintenance work has not been performed per requirements, then this might lead to a failure of the system on demand. In this case, sprinkler head reaction time would not be impacted, but the system may fail on demand with a higher likelihood. Hence, in this case the degradation finding could be quantified based on a reduced system reliability.

For some cases, both a reduction in reliability/effectiveness and time delay may be appropriate. An example includes the following:

- A finding involves badly mis-placed sprinkler heads. As a result, it is expected that the sprinkler system actuation will be delayed, and the system may not be effective against a specific fire threat. In this case both a time delay and an overall reduction in reliability/effectiveness might be assessed.

Additional Discussion on Quantification Process:

The proposed SDP quantification process will follow the common practices of fire PRA which use a three-term quantification equation. That is, risk is quantified as the product of the following three terms:

- the likelihood that a fire occurs during a reactor operating year - the fire frequency,
- the likelihood that the fire damages a particular set of plant components/cables - the conditional fire damage probability, and
- the likelihood that the fire damage leads to core damage - the conditional core damage probability.

The first term is captured by the fire frequency task. The second term, the conditional fire damage probability, must capture fire growth and damage behavior as well as the competing processes of fire detection and suppression. The final term, conditional core damage probability, derives from the plant model provided in the SDP notebooks.

(One interface point that will need to be clarified is the treatment of fire severity factors/concepts. Fire severity factors can be applied in the calculation of fire frequency - i.e., estimate the frequency of a challenging fire. The same concepts can also be treated in the context of the likelihood of fire damage - i.e., fire damage can only occur if the fire is large enough to threaten nearby components and/or to involve secondary combustibles allowing fire spread. Either approach can be made to work, and this is largely a process question.)

The product of these three terms represents the risk contribution from a given fire scenario. Normally a fire PRA will quantify a large number of fire scenarios, each of which represents a unique combination of fire source, component damage, and plant response. For SDP this process of scenario analysis will be substantially simplified.

Fire damage will be considered based on a limited set of discrete fire “damage states.” Four nominal states of fire damage have been identified as follows:

- Damage State 0 (DS0) - A fire has been ignited and the component associated with the ignition is damaged. This damage state is represented by the quantification of fire frequency. This damage state does not contribute uniquely to risk and will not be explicitly quantified for a risk contribution in an of itself.

- Damage State 1 (DS1) - The fire causes localized damage to unprotected raceways and components. This damage state represents a fire that has grown to the point where overhead raceways and adjacent components might be damaged. This case would also encompass explosive equipment faults that lead to localized damage from the effects of the explosion. However, protected raceways and components/cables spatially separated from the fire source will be assumed to survive (unless damaged by an explosion).

- Damage State 2 (DS2) - The fire causes widespread damage to components/cables in the room including damage to protected raceways where the raceway fire barrier is degraded. In this stage it is assumed that fire damage may be observed despite spatial separation. Further, degraded raceway barrier systems will be assumed to fail. This does not necessarily mean full room involvement if there is no basis for such assumptions (e.g., a very large compartment).

- Damage State 3 (DS3) - The fire spreads through primary inter-compartment fire barriers (i.e., walls and ceiling/floor structures) resulting in a threat to components/cables in an adjacent space. In this case, the spread may, or may not, be associated with a degradation of an inter-compartment fire barrier element (e.g., a penetration seal). For this damage state it will be appropriate to develop additional guidance on damage for the second compartment. That is, it may not be appropriate to assume that the second compartment is lost in total, but rather, additional damage state scenarios for the second compartment may be desirable, e.g.:
  - DS3a - damage in second compartment is limited to unprotected raceways near point of fire penetration;
  - DS3b - widespread damage in second compartment.

Note that DS2 and DS3 are not necessarily sequential. That is, DS3 is not predicated on first achieving DS2. A degraded fire barrier might allow fire spread to an adjacent space even given only DS1 fire development if the fire happens to occur adjacent to the degraded penetration. It might also be possible to postulate fires that would bypass DS1 entirely - e.g., a large explosion.

Fire protection inspection findings will be binned and a process will be developed to identify which fire damage state scenarios must be analyzed for a given finding. A given finding may require the analysis of fire scenarios involving one, two, or all three damage states. Nominal examples would include the following cases:

- A finding of degradation to a raceway fire barrier would only require the analysis of DS2 fire scenarios. In this case, there would be no risk change associated with either DS1 or DS3 fire scenarios as a result of the observed degradation.

- A finding of degradation to a penetration seal would require only the analysis of DS3 fires. Again, there would be no anticipated change to either DS1 or DS2 fire scenarios due to degradation of an inter-compartment fire barrier.

- A finding related to a fixed fire suppression system might require analysis of DS1, DS2 and DS3 fire scenarios. Degradation of fixed suppression would make longer duration fires more likely which would impact the likelihood that each of the three damage stages might be observed. The total risk impact would be the sum of the contribution from each fire scenario.

An analysis of fires for each damage state would follow a similar quantification approach. Fire frequencies would be essentially identical for each damage state if the same fire source is assumed. However, one might postulate one specific fire source as leading to critical damage for DS1 whereas a different fire source might be postulated for a DS2 or DS3 fire in the same compartment. Different fire sources may be chosen to best represent each damage state. For example:

- Consider a switchgear room with two rows or banks of switchgear, Bank A and Bank B, separated by a 4-foot walkway. Above Bank A is a set of unprotected raceways. Above Bank B is a set of fire barrier clad raceways:
    - DS1 fire scenarios might be best represented by fires in Bank A that damage the unprotected raceways directly overhead. The unprotected raceways will be most vulnerable to fire damage, so postulating a fire directly below these raceways would be most representative of what might occur in an actual fire.
    - DS2 fires might be best represented by fires in Bank B that are of sufficient intensity to damage both the protected raceways directly overhead and the unprotected raceways above Bank A. The protected raceways will require a more direct fire exposure before damage will be observed. Hence, the fire directly below the protected raceways would be most likely to actually damage those raceways. Given such a fire, the unprotected raceways above Bank A might also be damaged.

<u>Interface to Degradation Findings:</u>

Fire damage state scenarios will be quantified in the context of two types of quantification factors. The first will be split fractions reflecting such things as a fire severity factors and general reliability estimates for protective features. The second factor will be event timing. In particular, event timing reflects the competition between fire growth and damage, and fire detection and suppression. Through consideration of event timing, conditional probability values will be estimated - e.g., what is the likelihood that a fire progresses to DS2 before it is suppressed.

As a result, the quantitative impact of degradation findings will typically need to be couched in the context of either timing information and/or degradations in overall reliability/effectiveness. Examples include the following:

- A degraded fire barrier should be cited as having a reduced protection time against challenging fire threats. For example, a one hour raceway fire barrier might be assumed to provide 10 minutes protection if it is found to be highly degraded. The same barrier might provide 30 minutes of protection in a moderately degraded state. This would then be combined with separate estimates of fire suppression timing to estimate the likelihood that this damage actually occurs. (One question that must be resolved in this regard is the extent to which one might wish to tailor degradation ratings and quantification to the fire threat. For example, is a large oil fire more threatening to the barrier than an electrical panel fire?)

- Fire detection system degradations might lead to a delay in fire detection, and/or may render the system less reliable overall. That is, some degradations might be judged to render a system unreliable - it simply might not detect the fire within any reasonable time. In this case a degradation might be quantified in the context of overall system reliability. In other cases, misplacement of fire detectors might lead to a delay in actuation while not impacting general system reliability - the system will detect the fire, but detection might be delayed. For this case degradation might be quantified based on the delayed detection time.

- We generally assign very high reliability to fixed suppression systems to actuate on demand (e.g., 95-98%). A degradation might reduce this reliability, and/or impact the anticipated actuation time. For example, a pendant mounted fire sprinkler head might not impact reliability but might lead to a delay in actuation (e.g., while the hot layer builds up to the depth of the pendant). A failure to maintain system valves, pumps, etc. might be reflected as a general reduction in overall reliability.

ISSUE 3: Fire Scenario Frequency and Severity Factors (J.S. Hyslop)

DESCRIPTION: The method for calculating fire ignition frequencies has been widely accepted by the PRA community. Generally, the accepted practice has involved assigning an average fire ignition frequency to the unit and distributing that frequency among the components within the unit. Incremental improvements in methods associated with calculating fire ignition frequencies, e.g. moving closer to a component based approach (versus relying upon an average room frequency to develop component frequencies) may need to be made for the estimation of fire ignition frequencies.

Fire ignition frequencies have generally been adjusted for severity by reviewing the database of "severe" fires (meeting a specific criteria), and applying a factor based upon the ratio of severe fires to all fires. In some cases, the database has been culled for only those severe fires and the derived fire ignition frequency is used alone.

The derived fire scenario frequency used in the proposed quantification approach (presented in Issue 2) relies upon extracting and analyzing data for fire frequencies, and for severity factors (if they are used in this phase 2 approach). As a result, the calculation of fire frequencies relies upon the choice of database.

Unfortunately, for the databases available, much of the data are proprietary, and will not be available to the public. Also, there may exist legal issues regarding the utilization of one of the databases. The current version of the fire protection SDP directs the user to reference the IPEEE for fire component frequencies (typically, from implementation of FIVE via Ignition Source Data Sheet), and does not use severity factors.

<u>POSSIBLE APPROACHES TO FIRE FREQUENCY</u>

Approach A: Calculate fire ignition frequencies based on the assumption that each unit has the same fire frequency. For the EPRI database, the average unit fire frequency determines the frequencies for plant wide components (with a given weighting factor), and other components such as pumps and electrical cabinets (e.g. for a cable spreading room, the electrical cabinet frequency is based upon the number of cabinets in the room). In this manner, a unit with many components have the same fire frequency as a unit with fewer components.

Approach B: Calculate fire ignition frequencies for each specific plant component. This component-based approach would distinguish the fire ignition frequencies among units with different numbers of components. However, time would need to be spent developing a population component database of all units. All units would not need to be surveyed; however, a representative sample would need to be developed. Statistical techniques would need to support the lack of all units in the survey. The result of this technique would be a frequency per component, and the frequency of a unit would not be constrained to the average. However, this approach would require research, and may not be amenable to a short timetable.

Note: For both approaches A and B, fire ignition frequencies would be calculated based upon the choice of representative scenarios from the fire scenario development task. One of the issues in performing the calculation would be binning the events that describe the representative fire scenario such that the scenario frequency is accurately represented. A lookup table for fire ignition frequency needs to be provided.

POSSIBLE APPROACHES TO SEVERITY FACTORS

Approach A: Quantify fire severity factors and incorporate fire severity in the quantification approach as described in Issue 2, Approach A. The consideration of fire severity factors identifies the challenging fires which extend beyond the source of origin, and potentially become risk significant. As such, the fire ignition frequency based on all fires is adjusted to reflect consideration of challenging fires becoming severe fires.

Approach B: Continue to use all fires as the population of events to determine ignition frequency, and ignore severity. This approach can be accommodated by the proposed quantification approach, but appears inconsistent with the goal of enhanced realism in the Phase 2 analysis process.

POSSIBLE APPROACHES TO DATABASE

Approach A: Use NRC/RES database. The latest released NRC/RES database contains fire events from approximately 1986-99. Data from 2000-01 is being reviewed. (A separate NRC database exists that contain older data from 1968-85). Currently, fire frequencies have been developed for rooms or fire areas, but not for components. As a result, calculations to determine component fire frequency and severity factor would need to be done. The NRC/RES database is available to NRC users for fire frequency calculations in Phase 3 SDP analyses. Note that the NRC database contains proprietary data, and will not be available to the public as long as data sources are required to remain proprietary.

Approach B: Use the EPRI database. This is the database that is provided to EPRI members. The latest EPRI database covers the period from 1968 - 2000. The EPRI database has been used to develop fire frequencies and severity factors. Proprietary questions exist with regards to the use of the EPRI database, and results from the database. An older version of the EPRI database has been used to support the FIVE methodology for deriving fire ignition frequencies.

Additional Notes:

The quantification approach for the fire protection SDP relies upon extracting and analyzing data for fire duration and suppression reliability, as well as fire frequencies and severity factors (if they are used in this phase 2 approach). Fire duration and suppression must be extracted consistently with fire frequency and severity to ensure dependencies are treated accurately. As a result, the issue of database is much broader than fire frequency and severity.

ISSUE 4: Fire Scenario Development (P. Lain)

DESCRIPTION: Although there are no significant technical challenges to determining credible fire scenario(s), the guidance for fire scenario development could be improved to help NRC inspectors during field assessments. Fire scenarios involve a competition in time between fire growth and damage, and fire mitigation (suppression and recovery). Therefore, better guidance is needed to assist NRC inspectors to obtain the necessary information to develop a credible fire scenario. The necessary information includes the identification of all likely ignition sources, combustible materials and potential targets of fire damage. An important aspect of credible fire scenario development is the methods or tools used to estimate the time to fire damage of the potential targets (electrical cables, or equipment) which affect safe shutdown capability in the event of a fire. One of these tools developed by NRC staff (SPLB) is the Fire Dynamics Spreadsheet. Is this tool sufficient for screening purposes?

POSSIBLE APPROACHES:

Approach A: Use a mechanistic approach for fire scenario development. This approach views the fire scenario development in the context of several events or phases: initial ignition, fire growth and spread, fully developed fire, propagation to adjacent equipment or rooms, and fire suppression. Each phase may be associated with certain likelihoods, and guidance will be needed on how to assign these likelihoods. This approach will require quantitative techniques to determine the fire size and severity, and deterministic analyses to determine incident heat fluxes or hot gas layer temperatures.

Approach B: Use the concept of a fire time-line to develop fire scenarios in the context of critical events laid out on a linear time line. The time-line for fire growth and damage can be estimated by the Fire Dynamics Spreadsheet tool developed by NRC staff. Other methods such as manual suppression “time curves” could be used to determine the time-line for fire mitigation (suppression and recovery).

ISSUE 5: Degradation Ratings for Fixed Detection and Suppression Capability (F. Emerson)

DESCRIPTION: Better guidance for the bases and revised values of the degradation ratings for fixed fire detection and suppression systems are needed to reduce the subjective judgment used in characterizing the effectiveness of fixed fire protection systems. The measurement of degradation of the detection and suppression defense-in-depth elements should be realistic. The values of the degradation ratings for the fixed fire protection systems in the current Phase 2 SDP methodology may not realistically reflect industry operating experience.

POSSIBLE APPROACHES:

Approach A: Enhance the assignments of degradation as shown in Manual Chapter 0609F Attachment 2

Degradation ratings for fixed suppression systems are categorized at three levels of degradation such as high, moderate, or normal operating state. Each level of degradation has an assigned quantitative value as shown on Table 5.1, IMC 0609F. Provide additional guidance to define the bases for the levels of degradation so that this does not become an area of contention during Phase 2 SDP analyses.

Provide guidance on degradation ratings for fixed detection systems.

Approach B: Refine existing degradation ratings. As shown on the attachment (NEI recommendations from October 18, 2001) to this issue, the attributes for the level of degradation for fixed detectors and suppression systems should be defined as follows:

1. *Detectors*: Assignment of “High” degradation should be reserved for the system (in a room or area) being inoperable. An insufficient number of detectors, or the mis-placement of 25% of the detectors, constitute conditions far less severe than the system being inoperable, and should be assigned a “Moderate” or “Low” degradation (see Enclosure 2 Comment 6). Further, the criterion “insufficient number” should be assigned a numerical threshold – it is far too subjective. This also is true for the degree of misplacement.

The criterion for “Moderate” degradation (10 % of detectors misplaced) is more appropriate for “Low” degradation.

2. *Automatic sprinkler system water curtains, automatic sprinkler systems, and automatic spray systems*: As with detectors, “High” degradation should be reserved for system inoperability. The criterion for “Moderate” degradation should be “The system is functional but outside the design basis,” or “The system is in an unanalyzed condition.” “Low” degradation could include a number of the items currently assigned to the “High” or “Moderate” categories, such as slight obstructions of the sprinkler heads, or minor gaps between the draft stop and ceiling. Use of these criteria considerably simplifies the inspector's task without adversely impacting safety.

3. *Automatic Halon systems and automatic CO_2 systems*: "High" degradation should be reserved for system inoperability, and "Moderate" degradation should be the same as for the sprinkler and spray systems. "Low" degradation should include such minor deficiencies as a slight obstruction to the discharge nozzle or minimal degradations to the enclosure's ability to maintain gas concentration.

4. *Fire pumps and water supply system, manual suppression systems and equipment*: "High" degradation should be reserved for system inoperability, and "Moderate" degradation should be the same as for the sprinkler and spray systems. "Low" degradation should reflect minor deficiencies in water supply or minor deviations from the code-of-record.

ISSUE 6: Degradation Ratings for Manual Suppression and Fire Brigade Response Capability (P. Lain)

DESCRIPTION: Degradation basically translates to reduced confidence that a fire will be manually suppressed within a given time. Triennial fire protection inspections usually do not require inspectors to witness fire brigade drills. Therefore, resident inspector insight is relied upon to evaluate fire brigade performance. The measurement of degradation of the manual suppression and fire brigade response capability should be realistic. Degradation can be based on a variety of factors such as personnel availability and training, equipment, fire severity and growth, smoke production, access to the fire, detection and response time, fixed suppression, and response procedures.

Manual suppression capability can be credited even when highly degraded, unlike other DID elements. This is based upon the potential for early detection and suppression of fires by personnel using hand-held fire extinguishers or extinguishment after the fixed suppression system controls the spread of a fire. Quantitatively, the credit provided for the Control Room fire is partially based on operators detecting fires rapidly, and suppressing them when they are small. On the other end of the spectrum, minimal credit can be given for a highly degraded brigade, detecting a fire in an uninhabited area, and suppressing a fast growing fire without fixed suppression. Credit for manual suppression can depend heavily on the fire scenarios developed.

Therefore, a method of analysis is needed to assess degradation findings impacting manual suppression/fire brigade performance that integrates the degradation with other fire protection issues.

POSSIBLE APPROACHES:

Approach A: Enhance degradation ratings as shown in Manual Chapter 0609F, Attachment 2.

Degradation ratings for manual fire fighting effectiveness is split into two categories; fires inside and outside control rooms, and then quantified by level of degradation: high, moderate, or normal (Table 5.1). Provide additional guidance to define the bases for the levels of degradation so that this does not become an area of contention during Phase 2 SDP analyses.

Approach B: Refine existing degradation ratings.

Fire brigade performance should not be judged on the basis of a single observed drill per year. This allows no credit for remediation of observed deficiencies. “High” degradation should include either a missed drill, or consistent performance with two or more of the findings listed below:

– Brigade response time excessive (10 minutes beyond nominal timeline criteria – see below)
– Fire brigade did not perform satisfactorily as a team
– Weaknesses associated with the proper use of personal protective equipment
– Suppression equipment (foam carts, hose reels, etc.) not in working order or available for use (per the pre-fire plans)
– Fire brigade did not use proper fire-fighting techniques or agents
– Fire brigade did not use full protective equipment
– Pre-fire plans and their goals not fully implemented
– Communications ineffective

"Moderate" degradation should be any one of the above deficiencies on a consistent basis. "Low" degradation should include minor deficiencies in any of the above areas.

Timeline criteria for assessing drill performance should not be based on the arbitrary values indicated in 0609F, Attachment 2. Criteria should reflect plant status; brigade members' other duties on that particular day, and the drill location onsite. Drill controllers are in the best position to determine whether the elements of drill performance are timely, and the inspector should make increased use of drill controller evaluations in assessing timeliness.

Approach C: Develop separate SDP for fire brigade performance (SNL/BNL).

Develop scenario dependence curves to reflect increase fire size or damage with delayed suppression activities. Divide degradation into levels corresponding to time delays. Focus the SDP on risk dominate areas (e.g., cable spreading room, control room, and switch gear rooms.) Damage estimates could show additional impact to safety related systems or reduce credit taken for fire brigade performance. SNL has experience in developing scenario/time dependent damage curves. BNL has experience inspecting fire brigades at nuclear facilities.

Option 1: Keep it simple, assign a single value to brigade success assuming a severe fire, as done in most Phase 3 SDP.

Option 2: Develop a separate multiple degradation level approach.

Option 3: Develop severity/response time/damage curves.

Option 4: Develop performance measures including readiness and self assessments.

Option 5: Develop a set of rules to identify analysis zones to base degradation risk impact.

ISSUE 7: Degradation Ratings for Fire Barriers (D. Frumkin)

DESCRIPTION: In general, there are three types of fire barriers used in nuclear power plants for fire protection purposes. One type is the 1-hour raceway fire barriers, typically with detection and suppression systems installed. The second type is a 3-hour raceway fire barriers, typically with no suppression installed (detection may or may not be installed). Barriers between fire areas, often 3-hour rated walls, are also installed.

Fire barriers are typically tested to the same standard. Therefore, fully functional barriers of the same rating will generally be expected to perform similarly. However, the barrier materials have different properties, and if there is degradation, the performance of the barrier may vary widely.

Determining a factor for fire barrier degradation is highly dependent on other factors. If the detection and suppression systems work effectively, then even a highly degraded barrier may be satisfactory. If there is no detection, the fire may burn for a long period unnoticed and increases degradation of a barrier with a relatively high hourly rating. Therefore, it may be difficult to determine whether the same degradation rating may be used for the 1 and 3 hour raceway fire barriers and for fire barrier walls between areas.

POSSIBLE APPROACHES:

Approach A: Enhance the assignments of degradation ratings for fire barriers as shown in Manual Chapter 0609F Attachment 2

Degradation ratings for fire barriers are categorized at three levels of degradation such as high, moderate, or normal operating state. Each level of degradation has an assigned quantitative value as shown on Table 5.1, IMC 0609F. Provide additional guidance to define the bases for the levels of degradation so that this does not become an area of contention during Phase 2 SDP analyses.

Approach B: Refine existing degradation ratings. The attributes for the level of degradation for fire barriers should be defined as discussed below.

For “High” degradation, openings in fire barriers (including inoperable dampers) should have an associated size threshold. Blocked-open fire doors should also be without a fire watch to be classified as “High” degradation. Fire barrier ratings that are indeterminate or designs that are mis-applied have some protective capability; therefore they should be classified as “Moderate” degradation. Also, for fire dampers the “Moderate” category should reflect the term “fails to close” instead of “is not qualified to close.” Fire dampers not installed with the required thermal expansion clearances should be considered “Low” degradation along with improper fusible link setpoint or installation. The fire door deficiencies should have the phrase "with meaningful fire load" added; a door deficiency without a meaningful fire load constitutes no threat.

ISSUE 8: Compensatory Measures (F. Emerson)

ISSUE DESCRIPTION: The SDP should provide guidance on the extent to which compensatory measures provide equivalent protection for deficiencies in defective or out-of-service detection systems, suppression systems, fire protection equipment, or fire barriers.

POSSIBLE APPROACHES:

Approach A: Consider compensatory measures to provide no compensation for defective or out-of service equipment. Compensatory measures are required for any level of degradation of any defense-in-depth element.

Approach B: Consider compensatory measures to provide full compensation for defective or out-of-service equipment (equipment not considered defective or out of service). Compensatory measures are required only for high level of degradation of any defense-in-depth element.

Approach C: Sliding scale of "degree of compensation" based on nature of compensatory measures. No compensatory measure should be considered to fully compensate for defective equipment; this could discourage repair or return to service. The best compensatory measure (such as a continuous fire watch) should reduce the level of degradation for the specific defect to "Low". Compensatory measures are required only for medium and high degradation levels of any defense-in-depth element.

ISSUE 9: Treatment of Safe Shutdown Findings and Credit for Human Actions (S. Wong)

DESCRIPTION: Fire protection program deficiencies related to post-fire safe shutdown are currently excluded from the fire protection Phase 2 SDP methodology. Post-fire safe shutdown findings range from (a) taking credit for manual actions outside of Main Control Room, to (b) the potential of spurious actuations due to cable hot-short conditions. The appropriate treatment of safe shutdown findings and the ground rules for crediting feasible human actions in achieving post-fire safe shutdown needs to carefully addressed in the Phase 2 methodology.

POSSIBLE APPROACHES:

Approach A: Use the relevant accident sequences (e.g., Transient) in the full-power Phase 2 SDP notebooks to evaluate and credit the plant system response and human recovery actions in fire scenarios affecting post-fire safe shutdown capability. Utilize the credits described in the Phase 2 SDP notebooks for plant-specific mitigation capability and human actions.

Approach B: Develop new ground rules for crediting manual actions in fire scenarios affecting post-fire safe shutdown capability. Examples include no credit given for human actions that require entry into a fire area, or higher human error probabilities (HEPs) for human actions in fire and smoke conditions.

ISSUE 10: Treatment of Appendix R Exemptions (P. Koltay)

DESCRIPTION: The current fire protection Phase 2 SDP does not evaluate the treatment of Appendix R exemptions. From a regulatory perspective, approved exemptions are part of the plant's licensing basis. However, there may be a plant design change (e.g., increased combustible loading) subsequent to the approved exemption that results in a deviation of the baseline risk conditions that were enveloped under the approved exemption. The appropriate treatment of Appendix R exemptions needs to be considered in the fire protection Phase 2 SDP methodology.

POSSIBLE APPROACHES:

Approach A: Exclude the evaluation of significance of deviations from approved Appendix R exemptions.

Approach B: Develop guidance to assess the significance of risk change due to deviation(s) from a granted exemption.

PHASE 1 SCREENING METHODOLOGY

A. Phase 1 Screening Checklist

1. The finding has a described performance deficiency.

2. The finding is considered "more than minor" based on IMC 0612 criteria.

3. Are the licensing basis requirements met? Yes - do not proceed with the SDP analysis. No, continue.

B. Phase 1 Screening Questions

1. Does the finding affect only achieving/maintaining the ability to get to cold shutdown? Yes - screen to Green. No, continue.

2. Does the finding affect the ability to achieve/maintain hot shutdown functions? Yes - go to Phase 2. No, continue.

3. Is the (fire area, or room) fire ignition frequency greater than Low? Yes - go to Phase 2. No, continue.

4. Is the fire protection defense-in-depth degradation High?
   Yes - go to Phase 2. No, screen to Green.

ISSUE 1: Fire Frequency Value for Phase 1 Screening

- Screening Criteria
  - "Low" fire ignition frequency
  - "Low" degradation rating of fire protection features

- Fire frequency value of 1E-4 for screening

APPROACHES

(A) Use combined criteria of "low" fire ignition frequency and "low" degradation rating of defense-in-depth element.

(B) Use fire ignition frequency criterion alone.

(C) Use "low" combustible loading and room size.

(D) Evaluate room fire frequency, exposure time, and conditional core damage probability for room or fire area together.

PHASE 2 SDP ISSUES

ISSUE 1: Phase 2 SDP Objectives and Goals

- Expectations for Improved Phase 2 SDP
  - Simplicity
  - Transparency
  - Repeatability
  - Reasonableness of Assumptions

- Desire Goal
  - Preliminary Significance Determination Within An Order-of-Magnitude Accuracy

<u>APPROACHES</u>

(A) Modify existing Phase 2 SDP to a simplified screening method to yield conservative result. Rely on Phase 3 analysis to provide a more refined estimate of risk significance color.

(B) Keep the existing Phase 2 SDP, but make incremental improvements in the various steps of Phase 2 to reduce subjectivity.

(C) Develop appropriate credits for available safe shutdown equipment and feasible human recovery actions in the current Phase 2 SDP.

ISSUE 9: Treatment of Safe Shutdown Findings and Credit for Human Actions

- Post-fire Safe Shutdown Findings
  - Credit for Manual Actions Outside of Main Control Room
  - Potential for Spurious Actuations due to Cable Hot-Short Conditions
- Appropriate Treatment of Safe Shutdown Findings
- Ground Rules for Crediting Feasible Human Actions in Post-fire Safe Shutdown Activities

<u>APPROACHES</u>

(A) Use relevant accident sequences in full-power Phase 2 SDP notebooks to evaluate the plant system response and human recovery actions. Use the credits described in the Phase 2 SDP notebooks for plant-specific mitigation capability and human actions.

(B) Develop new ground rules for crediting manual actions in fire scenarios.