September 03, 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/**
Licensing Section
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: SUMMARY MINUTES OF AUGUST 14, 2002 WORKING GROUP MEETING TO DISCUSS THE IMPROVEMENT FOR PHASE 2 FIRE PROTECTION SIGNIFICANCE DETERMINATION PROCESS (SDP) METHODOLOGY

Attached is the summary minutes of the August 14, 2002 working group meeting between NRC staff and external stakeholders which summarizes the discussion of issues affecting the Phase 2 fire protection SDP methodology, and discussion of possible approaches for addressing each issue to develop improvements for the Phase 2 fire protection SDP methodology. The handout materials distributed to the meeting participants are also included in this attachment.

Attachments: As stated

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

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FIRE PROTECTION SDP REVISION TASK

Summary Minutes of Working Group Meeting
Conference Room O10B2, One White Flint North, Rockville, Maryland
August 14, 2002

1. Meeting Objectives

   (a) To discuss the issues affecting the Phase 2 fire protection SDP methodology, and
   (b) To discuss possible approaches for addressing each issue to develop improvements for the Phase 2 fire protection SDP methodology.

2. Agenda

   S. Wong started the meeting with introductory remarks on the purpose and objectives of the meeting. The primary goals were to discuss the issues, and possible approaches for addressing each issue affecting the Phase 2 fire protection SDP tool. He was also the chair and moderator of all discussions in the meeting.

   S. Wong provided a summary of the current Phase 2 fire protection SDP methodology (IMC 0609, Appendix F), and discussed the difficulties that may be experienced by NRC inspectors in following the guidance for implementing each of the steps of the Phase 2 methodology.

   S. Nowlen, SNL provided a comprehensive summary of the issues affecting the Phase 2 fire protection SDP methodology. (See attachment 2). He led the discussions on the possible approaches for addressing each issue to develop improvements for the Phase 2 fire protection SDP methodology.

   NRC staff and the NEI representative participated actively in all discussions of the issues affecting the Phase 2 fire protection SDP tool. The meeting participants also discussed possible and alternative approaches for addressing each issue affecting the Phase 2 fire protection SDP tool.

3. Discussion of Technical Issues Affecting Phase 2 Fire Protection SDP Methodology
   (S. Nowlen, S. Wong, et al)

   S. Nowlen provided a summary of the technical issues concerning the current version of the Phase 2 fire protection SDP. (See attachment 2 for details of summary). The discussions were focused on two general issues and nine specific issues. The general issues were: (a) Phase 2 objectives and goals, and (b) the quantification approach. The specific issues were: (a) fire scenario development, (b) fire scenario frequencies, (c) degradation ratings for fixed fire detection and suppression systems, (d) manual suppression and fire brigade response evaluations, (e) fire barriers, (f) credit for compensatory measures, (g) safe shutdown findings, (h) credit of human actions, and (i) treatment of Appendix R exemptions.

The meeting participants discussed the possible approaches for proceeding with the resolution of each of the identified issues. The possible approaches for each issue are summarized below:

(A) <u>General issue 1 - Phase 2 objectives and goals</u>
The core expectations for the Phase 2 methodology are simplicity, transparency, repeatability, and reasonableness to avoid "extra conservatism" in the analysis assumptions. The working group agreed that a possible approach to meet these expectations is to develop objective criteria for clear documentation of the Phase 2 analysis steps, i.e., the description of the analysis steps could be abbreviated and extended discussions in each step can be deferred to an appendix. In addition, it was recommended that a statement of objectives (as proposed in attachment 2) should be included in the fire protection SDP guidance document.

(B) <u>General issue 2 - Quantification approach</u>
The current fire protection SDP utilizes a fire risk equation which is a summation of positive and negative terms with each term accounting for one aspect of the risk calculation. It was noted that this simplified equation appears to be obscuring the results and does not always capture the dependencies between the different aspects of the fire risk equation. The working group proposed returning to a quantification format that more closely parallels the traditional fire PRA approach. An event tree approach that explicitly treats the dependencies, was proposed to the working group for consideration.

(C) <u>Specific issue 1 - Fire scenario development</u>
Although it appears that this issue has no significant technical challenges, the guidance for fire scenario development could be improved to help the NRC inspectors during field assessments. A possible solution is to provide a mechanistic approach for developing fire scenario(s) 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. Another possible approach involving the concept of a fire time-line, is to develop fire scenario(s) in the context of critical events laid out on a linear time-line.

(D) <u>Specific issue 2 - Fire scenario frequency</u>
This issue is centered on the use of an appropriate database of fire events for deriving reasonable estimate(s) of fire ignition frequency data. A possible solution is to use the EPRI database which includes fire events from the fire insurers' databases. Although a RES database is available, it was considered to be somewhat limited because the database contains fire events for a specific recent time period. The working group agreed that a table of fire ignition frequencies with referenced information sources should be included in the revised SDP document.

(E) Specific issue 3 - Degradation ratings for fixed fire detection and suppression systems

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. A possible solution is to clarify the criteria for the degradation ratings and develop appropriate probability values using an expert panel elicitation process. NRR/SPLB would be responsible for providing the results proposed criteria on the degradation ratings for fixed fire detection and suppression systems for subsequent expert panel elicitation.

(F) Specific issue 4 - Manual suppression and fire brigade response evaluations

Better guidance for the bases and probability values of effective manual suppression and fire brigade response are needed to reduce the subjective judgment used in characterizing the effectiveness of manual suppression and fire brigade performance in a developed fire scenario. A possible solution is to clarify the criteria for evaluating the fire brigade response and develop appropriate probability values using an expert panel elicitation process. NRR/SPLB would be responsible for providing the results of the criteria for evaluating fire brigade performance. In addition, it was proposed that explicit treatment of time factor in the fire scenario development is to be considered in the analysis of fire brigade performance.

(G) Specific issue 5 - Fire barriers

The treatment of fire barriers in the current Phase 2 fire protection SDP, both in the context of the "double room term" and in its treatment of raceway barriers, needs better guidance for NRC inspectors to properly characterize the effectiveness of fire barriers in any given fire scenario. A possible solution is to clarify the criteria for the degradation ratings and develop appropriate probability values using an expert panel elicitation process. NRR/SPLB would be responsible for providing the results of on the degradation ratings for fire barriers.

(H) Specific issue 6 - Credit for compensatory measures

The assessment of risk credit for compensatory measures has not been rigorously addressed in fire PRA practice. The challenge posed in resolution of this issue is to obtain a quantitative assessment of the net impact of the compensatory measure. A possible solution is to develop appropriate probability values for initial degradation of the fire protection defense-in-depth element and the offsetting compensatory measure using an expert panel elicitation process. In addition, the RES study on compensatory measures would be reviewed to provide insights on crediting compensatory measures in the Phase 2 fire protection SDP.

(I) Specific issue 7 - Safe shutdown findings

The current Phase 2 fire protection SDP does not evaluate licensee performance deficiencies related to post-fire safe shutdown findings. A possible solution is to provide better guidance to evaluate the significance of safe shutdown findings after a finding(s) has filtered through the Phase 1 screening process. Better guidance on plant response modeling, including the consideration of spurious actuations, are needed to enhance the fire protection SDP.

(J) Specific issue 8 - Credit for human actions
Better guidance for the treatment and bases of probability values of human actions in executing alternate shutdown and remote shutdown procedures are needed for enhancing the Phase 2 fire protection SDP. A possible solution is the development of common rules for crediting human actions based on accessibility, time factors, and fire and smoke conditions in a fire scenario. Since human reliability analysis is a complex process, the working group will explore reasonable methods for crediting human actions.

(K) Specific issue 9 - Treatment of Appendix R exemptions
The current Phase 2 fire protection SDP does not evaluate the treatment of Appendix R exemptions. A possible solution is to evaluate the risk changes due a deficiency in the approved exemption and weighing against the baseline risk of the exemption. The working group will continue to consider all possible approaches to explicitly treat exemptions in the Phase 2 SDP process.

4. Wrap-Up/ Action Items/Next Meeting (S. Wong)

The action items are:

1. Preparation of strawman for assignment of degradation ratings for fixed fire detection and suppression systems (Specific issue 3), fire brigade response (Specific issue 4), and fire barriers (Specific issue 5). Responsibility for developing the strawman and obtaining SPLB concurrence was assigned to P. Lain/SPLB.

2. Preparation of issues for discussion in September 4, 2002 public meeting. (S. Wong)

5. Meeting Attendees

See-Meng Wong, NRC/NRR
Jim Trapp, NRC/Region 1
Roy Fuhrmeister, NRC/Region 1
Paul Lain, NRC/NRR
J.S. Hyslop, NRC/RES
Kendra Hill, NRC/RES
Deann Raleigh, Scientech
Gareth Parry, NRC/NRR
Walt Rogers, NRC/Region 2
Ron Langstaff, NRC/Region3
D. Frumkin, NRC/NRR
Steve Nowlen, SNL
Fred Emerson, NEI

Phase 2 Fire Protection SDP Methodology
IMC 0609, APP F

Step 1, "Grouping of Fire Protection and Post-fire Safe Shutdown Findings"

State the inspection finding(s) in an identified group.

Step 2, "Define the Fire Scenario"

Develop realistic fire scenarios where the fire causes damage to the equipment in the fire area. Identify the dominant scenarios. Identify the ignition sources and associated fire ignition frequencies.

Step 3, "Qualitative Evaluation of Findings"

Qualitatively evaluate each inspection finding in terms of assigning degradation ratings of each affected defense-in-depth element.

Step 4, "Integrated Assessment of DID Findings and Fire Ignition Frequency"

$$\text{Fire Mitigation Frequency} = \log_{10}(IF) + FB + MS + AS + CC$$

Where: IF = Fire Ignition Frequency
FB = Fire Barrier
MS = Manual Suppression/Detection
AS = Automatic Suppression/Detection
CC = Dependencies/Common Cause Contribution

Step 5, "Assignment of Quantitative Values"

Assignment of quantitative value(s) of degradation ratings to complete Step 4 above, using Table 5.1.

Step 6, "Determination of Fire Ignition Frequency"

This step converts the Fire Mitigation Frequency developed in Step 4 to an approximate frequency, using Table 5.4, "Association of FMF to Approximate Frequencies for Calculation of Delta CDF."

Step 7, "Integration of Adjusted FMF with SSD"

Step 7 indicates that the evaluation should continue by utilizing the Reactor Safety Full Power Level 1 plant-specific event trees. Attachment 1 of Appendix F provides examples of using specific Reactor Safety Internal Events SDP Worksheets for evaluating the specific cases involving spurious actuations.

Step 8: Modifications Necessary To Add Impact of Spurious Actuations

This step provides guidance for considering the impact of spurious actuations.

Step 9: General Rules for Applying FPRSSM

This step provides guidance on considering the fire barrier effectiveness against fire propagation between two fire areas (double room term versus single room term) in the SDP analysis.

Fire Protection SDP Phase 2 Methodology Revision
August 14, 2002

Technical Issues

A. General issues:

- Phase II objectives and goals
- Quantification approach - what format will we use for the equation used to quantify risk?

B. Specific Issues:

- Fire scenario development - better guidance
- Fire scenario frequency - easier method, more transparent to inspectors, more intuitive
- Fixed fire detection and suppression degradation values - better guidance and revised values
- Manual fire brigade - method of analysis for degradation findings impacting the fire brigade
- Fire barriers - revision of current method for double room term, treatment for raceway barriers
- Credit for compensatory measures - potential offset to degradation in other DID elements
- Address SSD findings - expand process to encompass such findings (e.g., SSD equipment list, SSD analysis, remote shutdown, alternate shutdown, etc.)
- Human actions - improved treatment and guidance
- Exemptions - how to handle

As a set, these topics present technical challenges that range from simple to quite difficult. Certain of the topics are largely matters of clarification and simplification and can be addressed with relatively little effort (i.e., scenario development, scenario frequency, quantification approach). Others present real technical challenges, but the challenges do not appear to be fundamental in nature (i.e., fire brigade, detection/suppression, fire barriers, compensatory measures). Two issues appear to present significant technical challenges and will likely require some substantial effort to resolve (i.e., SSD findings and treatment of human actions).

Attachment 2

General Issue #1: Phase II Process Expectations and Objectives

A point of particular discussion on July 9 meeting is related to the stakeholders expectations regarding the overall fire SDP process, including documentation. These expectations also lead to a very fundamental question - what should the fire SDP Phase II analysis objectives be? This particular question needs to be answered before proceeding with reworking specific sections/aspects of the fire SDP.

The core expectations that can and should be met:

- Simplicity - must be applied in the field by non-fire-experts within a short time period (e.g., hours not days).
- Transparency - include solid technical bases that users can understand and that are amenable to review and verification.
- Clear process documentation - abbreviated description of analysis steps with extended discussions deferred to an appendix.
- Streamlined - a more linear step-to-step flow (e.g., the discussion of the three fire protection options/schemes each having a different set of flow charts).
- Repeatability - two analysts should ultimately reach the same conclusion.
- No false negatives - any substantial chance of a false negatives is undesirable.
- Avoid ‘extra’ conservatism - where possible, work towards the most reasonable and representative answer we can achieve.

However, some unrealistic expectations have been expressed. The most important case is the following:

- The Phase II fire SDP answer should be within one order of magnitude of the final answer (e.g., the Phase III answer) consistent with other SDP applications.

For fire SDP, an order of magnitude accuracy may not be achieved in Phase II while still achieving the simplicity goal stated above. There are three identifiable sources of substantial uncertainty that cannot be avoided in a simple approach (i.e., field application by non-experts) while still assuring a very low incidence of false negatives:

- With fire risk analysis, achieving a simplicity goal (as stated above) means that some physical aspects of the fire scenario will not be treated in detail. Examples are fire growth and damage, fire detection, and fire suppression. This aspect alone could lead to an order of magnitude uncertainty in a screening tool like SDP Phase II. Given the desire to avoid false-negatives, there should be caution not to over-credit certain factors when the call is being made by a non-expert.

- The simplicity goal also implies reliance on readily available plant documentation for the Phase II analysis. However, to achieve an order of magnitude accuracy, there should be credit for systems and components that are not credited in the fire safe shutdown (SSD) analysis. The most pervasive example is off-site power. The fire SSD equipment list represents a minimal set of plant equipment. Most licensees only trace those cables needed to ensure the proper operation, or which might cause mal-operation, of the fire SSD components. The location of cables for non-credited systems may not be known. There are exceptions.

Newer plants generally have better information. Those plants with high-quality full-scope fire PRAs also would have done substantial cable tracing beyond the SSD list. However, one cannot typically determine whether the non-SSD systems would survive a given fire without substantial effort (e.g., cable tracing). To assume that these systems survive could easily lead to false-negative findings. To assume complete failure could easily lead to 1-2 orders of magnitude conservatism.

- Simple implies that human performance must be treated in a limited way. Human recovery actions are critical to many fire scenarios. A screening tool like the Phase II SDP must credit human actions at some level, but also must not take excessive credit for human actions to minimize the chances of false negatives. Hence, additional analysis could lead to more optimistic results. In some cases this might also be an order of magnitude issue.

These issues present a fundamental dilemma - in avoiding false negatives, we must live with potential conservatism in the Phase II answers. That conservatism may well exceed one order of magnitude. Two or even three orders of magnitude conservatism are not an unreasonable screening level expectation in the case of fire. For the fire SDP, the Phase III analyses will remain an integral and critical part of the process. This appears unavoidable.

<u>Recommendation on Phase II analysis objective:</u>

The following is recommended as a statement of objectives for inclusion in the fire SDP documentation:

> "The objective of the Phase II fire SDP analysis is to calculate a realistic but bounding estimate of the risk importance of inspection findings impacting the fire protection program. The Phase II fire SDP is a simplified screening approach that can identify, with confidence, inspection findings of low risk significance. The analysis process is designed to minimize the potential for false-negative findings. As a result, the Phase II fire SDP analysis may yield a conservative result leading to false-positive findings. It is recognized and accepted that the more detailed Phase III analysis process could lead to substantial reductions in the estimated risk significance of a given finding."

General Issue #2: Quantification Approach - The Risk Equation

Stakeholders have expressed interest in revising the fire SDP risk quantification expression. Currently, the fire SDP sums a series of positive and negative terms each accounting for one aspect of the risk calculation. The factors correspond to exponents of 10, so the addition is equivalent to multiplication of frequency/probability values. This approach appears to be obscuring the ultimate goal unnecessarily. Another potential problem is the treatment of each factor as being fully independent. The factors are not always independent, and the simplified SDP approach does not always capture dependencies.

An alternate approach proposed was to follow a format similar to that taken in NEI 00-01. This approach is not feasible for one fundamental reason. The NEI 00-01 approach assumes some number of cascading and fully independent values that can be multiplied to achieve a final answer. Again, in the context of the fire SDP the factors considered are not all independent.

It may be prudent to return to a quantification format that more closely parallels traditional fire PRA. The traditional fire PRA approach can be framed in a format that will be easy for a non-PRA expert to understand and calculate. Traditional fire PRA practice considers three terms in quantifying CDF:

- the occurrence frequency of a challenging fire in a given location,
- the likelihood that given a particular fire, damage to some set of safety equipment will occur, and
- the likelihood that given fire-induced damage, the plant will fail to achieve safe shutdown.

The product of these three terms represents the risk contribution of a given scenario. Summing the contribution for each scenario, and each alternate path within each scenario yields the plant-wide fire CDF.

The primary advantage of this formulation is the ability to explicitly treat term dependencies. The approach would also more clearly support the development of fire scenarios based on a fire time line, and the consideration of alternate time lines. For example, if suppression fails and a fire barrier is threatened, the component damage state may change leading to a new risk scenario. This formulation would allow for a more clear-cut summing of risk contributions from alternate time lines involving the same basic fire scenario. Finally, the approach would more closely parallel what one might expect of a Phase III analysis.

Specific Issue #1: Fire scenario development

In the case of fire scenario development, there appear to be no fundamental technical challenges. Rather, the issue is with guidance and practice - better guidance for non-fire-experts so they can have confidence in their field assessments. While there are no technical hurdles to overcome, some substantial effort may be required to actually develop improved guidance.

It seems that one element that could be brought out more fully in the development of fire scenarios is the time factor. Fire scenarios involve a competition in time between fire growth and damage and fire mitigation (detection, suppression, and recovery). This might be brought out more explicitly in the SDP process.

One possibility would be to implement a mechanistic fire scenario development approach. The mechanistic approach views the fire scenario in the context of several events or phases. Typical formulations include the following phases:

- Ignition - an electrical or chemical energy source contacts a combustible fuel in the presence of oxygen
- Initial phase fire - burning of the initial source materials
- Fire spread phase - spread of fire to nearby secondary combustibles
- Fully developed fire phase - spread of fire to room involvement
- Room-to-room fire phase - spread of fire to adjacent space
- Fire suppression phase - control and eventual extinguishment of the fire

This mechanistic view is an intuitive approach, and as such, is easy for a non-expert to grasp. Each phase might be associated with certain likelihoods and physical damage states. Guidance could be given specific to various classes of fires - e.g., pump fires, electrical fires, explosive electrical fires, gas leaks, transients. One simple approach might be to develop a fire event tree that would lead the inspector through the process of each fire stage.

Another tool that might be applied would be the concept of a fire time line. That is, the inspector could develop fire scenarios in the context of critical events laid out on a linear time line. The time line could reflect both uncertainty and changes associated with either an alternate scenario path or a fire protection feature degradation or enhancement. One might even extend this concept to involve two time lines - one associated with fire growth and damage, and one associated with fire mitigation (detection, suppression, and recovery).

Specific Issue #2: Fire scenario frequency

The goal with regard to fire scenario frequency estimation appears to be to establish an easier method that is more transparent to inspectors. This implies a method that is more intuitive and more clearly documented. In this case there appear to be no fundamental technical hurdles to overcome. Hence, this should be a relatively easy topical area to address from a technical standpoint. However, revision of the guidance may require some substantial time. In particular, we will have to generate a new set of guidance tables to support the assessment - perhaps in electronic format rather than in the form of paper look-up tables.

There are two general approaches to fire frequency estimation. Both have potential advantages. In early PRA practice the most common approach was to estimate fire frequencies for a generic room, or even building, based on fire event data. The fire frequency was then assigned to the specific location of interest through some sort of weighting factor. For example, the frequency of a cable spreading room fire would be estimated first for the room overall. If the fire PRA determined that only certain locations within the room were important, then the fire frequency would be adjusted to reflect the likelihood that the fire would occur at that specific location. This was often based on an area ratio, for example, the critical area of the fire damage footprint as a fraction of the total room area.

More recent efforts are exploring component level fire frequency. The ideal would be to estimate the fire frequency of a given component, for example, a large motor. One could then go into a room, count the number of large motors, and estimate the motor fire frequency accordingly. This ideal has not yet been reached. Obstacles that have not been overcome involve the lack of complete data on plant by plant component populations and a lack of sufficiently detailed fire reporting to assess component level fire frequencies. One must also ask whether or not a lower number of, for example, electrical panels at one plant versus another necessarily implies a lower plant-wide frequency of electrical panel fires.

The most common approach today involves a hybrid of these two methods. A plant-wide frequency is estimated for a given fire source based on the generic data. This value is then assigned (partitioned) to specific fire areas based on the relative number of such fire sources located in that area. For example, the plant-wide frequency of large motor fires is estimated from the event data for such fires. A fraction of the plant-wide frequency is then assigned (partitioned) to any given room based on the number of large motors in that room versus the total number of large motors in the plant. This approach still requires knowledge of the component populations for the plant being analyzed, and this is often not available. Nonetheless, this appears to be the most fruitful avenue to pursue for the fire SDP.

One complicating factor is that most fire areas have a combination of fire sources present. Hence, the correct fire frequency for the room is a roll-up of all the fire sources. We are, however, typically interested in only a subset of the fires - those that can cause damage to critical targets. This may be limited to an easily identified set of components, but may also involve combinations of scenarios (for example a panel fire, a transient fire, and/or a self-ignited cable fire). The fire frequency used in SDP should reflect this.

Specific Issue #3: Fixed fire detection and suppression degradation values

The need expressed with regard to the analysis of fixed detection and suppression was for better guidance and revised values. This area does present some significant technical challenges, especially given a target audience that is not expert in fire protection system performance. In particular, the assignment of degradation values is a rather subjective exercise. Some code violations, for example, would be of a technical nature only and would have little impact on performance. Others might appear minor but substantially impact system performance or reliability.

Likely, the Phase II SDP will need to continue to rely on a limited and somewhat subject set of degradation evaluation criteria. Additional evaluation and a more detailed performance assessment may ultimately be needed, but this should likely be deferred to a Phase III analysis. Hence, in this area it is recommended that we take a similar approach to that currently documented, but work to improve and clarify the criteria and guidance. A further review of the numerical values would also be appropriate.

Specific Issue #4: Manual fire brigade

A method of analysis in needed to assess degradation findings impacting the fire brigade. The most difficult aspect is that manual fire brigade findings potentially impact every fire area in the plant. Hence, the impact is a cumulative impact from several fire scenarios rather than a single fire scenario. A method is needed that captures this properly.

One approach would be to focus on the risk contribution from a chosen subset of the plant fire areas/zones. Typically fire risk is dominated by a small number of zones. Furthermore, manual fire fighting is typically found to be an important quantification factor only for a limited number of these significant fire zones. The analysis could consider the plant specific risk findings, and estimate risk impact by examining a small number of fire zones. This might, for example, include fire zones that lack fixed suppression capability. In some manner, we would need to develop a set of rules that would allow for identification of an appropriate set of analysis zones upon which to base a plant-wide fire brigade degradation risk impact.

A second complication is the fact that degradation in fire fighting basically translates to less confidence that a fire will be suppressed within a given time - again the time factor is critical. Hence, more explicit treatment of time as a factor in the fire scenario development might support a more reasoned approach to fire brigade analysis.

Specific Issue #5: Fire barriers

There has been considerable desire expressed to rework the current treatment of fire barriers, both in the context of the 'double room term,' and in its treatment for raceway barriers. This is an areas where technical challenges do exist that are not likely to be overcome in the near term. In particular, we have only rough estimates of the likelihood that a fire barrier will fail when challenged. We also lack a method for correlating a fire barrier degradation to a performance degradation in the context of any given fire. The challenge here will be to develop an approach that will stand up to scrutiny given a poor knowledge base.

Consider first the question of raceway fire barrier systems. These barriers provide protection for critical cables or components within a room and are treated in the context of the single room scenario. The current approach assigns a degradation value based on qualitative assessments of the level of barrier degradation. This appears to be a viable approach and there seem to be no clear alternatives. Hence, it is recommended that we focus on a rework of this current approach and development of enhanced guidance. We should also consider the role of such fire barriers in the overall context of the reworked phase II analysis, e.g., in the context of new guidance on fire scenario development, fire frequency analysis, any credits taken for fire severity, etc.

For those fire barriers that separate fire zones and areas, the problem is more complex. The current double room term approach is quite confusing to the inspectors. Again, it would be appropriate to consider the treatment of such barriers as being an integral part of the overall fire scenario development - that phase of the fire where spread to an adjacent room is possible. In fire PRA we consider the likelihood that a fire sufficient to challenge the barrier will occur, the likelihood that given a challenge the barrier will fail, and the likelihood that fire spread to an adjacent compartment might damage an expanded set of components and systems. An approach that more closely follows PRA practice in this regard seems appropriate.

Specific Issue #6: Compensatory Measures

The incorporation of compensatory measures (CMs) presents a non-trivial technical challenge. There is currently little technical basis for assessing a risk credit for CMs. This topic, for example, has not be rigorously addressed in fire PRA practice. This represents new territory for fire PRA. Our first step should be to acquire an understanding of CMs. We can then proceed to the second step, namely, develop a process for assessing risk impact.

We can gain substantive insights from a RES-sponsored review of compensatory measures completed about two years ago.[1] The LER data base representing a five-year window of operation (1995-1999) was searched for any references to compensatory measures. A total of 78 LERs (from an initial set of over 6000) were identified that documented 93 instances of fire-related CMs. Compensatory measures were classified according to the nature of the measure taken, the reason for having taken the measure, and the duration of the measure. They were also assessed for that aspect of the fire protection program that was degraded, and therefore being compensated for, and that aspect of the fire protection program enhanced as a result of the CM.

One observation of the review was that degradation in one element of the fire protection program is often addressed through a CM that enhances an alternate element of fire protection. For example, a fire suppression system degradation may be compensated for by video surveillance of the impacted fire area - a degradation in suppression is compensate for by an enhancement in fire detection.

The primary challenge will be to quantify the net impact of the CM. That is, we must reflect a degradation in the normal fire protection program simultaneous with a risk benefit gained by implementation of the CM. It would likely prove most fruitful to approach the problem in exactly this way - ask what is the net risk impact. To do this one would simultaneously evaluate the fire protection program degradation that led to a need for a CM and the CM itself. The risk increase associated with degradation of the normal fire protection program would be offset to some degree (perhaps even fully offset) by implementation of the CM. Guidance would be needed to lead the inspector through this process. Perhaps the greatest challenge will be the assignment of numerical values to both the initial degradation and offsetting CM.

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[1]The review was done as a part of a larger task and has not been published. A Letter Report was drafted but has not been completed. We will need to consider how this study should be documented to support the SDP efforts.

Specific Issue #7: SSD-Related Findings

There are a range of potential fire protection program deficiencies related to the post-fire safe shutdown that are currently excluded from the fire SDP Phase II analysis. Such findings may involve deficiencies, for example, in the SSD equipment list, in the SSD analysis, involving remote shutdown, or involving alternate shutdown. Currently, such findings would screen out of the SDP and would not be reviewed. To incorporate such findings in the Phase II fire SDP represents a substantial challenge, particularly because of the 'simplicity objective.' That is, it will be a challenge to address such findings and yet achieve a simple method amenable to application by non-fire, non-PRA experts.

Findings related to SSD come into play in the plant response modeling. That is, these findings could impact the availability or reliability of the post-fire SSD efforts. The current fire SDP currently focuses on the more traditional aspects of fire protection; namely, fire prevention, fire detection, fire confinement (e.g., fire barriers), and fire suppression. The plant response portions of the analysis are currently covered by the SDP plant notebooks - basically a systems response 'cookbook' tailored to the plant. To address the SSD-related findings, we will need to open the 'cookbook' a bit wider and 'change the ingredients.'

The current SDP plant notebooks should be amenable to adaptation for this need. However, we will likely need to exercise some example cases in order to verify this. It is possible that some expansion or modification of the notebooks would be needed, in which case the work load could increase substantially. Hence, this is something we should assess as soon as possible. There will also be a need for substantial new guidance.

This will be non-trivial task and will require input from plant systems modeling experts. We should likely look to the SRAs for input here. In terms of target audience, we should also anticipate a need for substantial SRA involvement in the evaluation of SSD-related findings. It will likely take SRA level expertise to make this work at all.

Specific Issue #8: Human actions

Human actions is a significant challenge area, perhaps the most challenging of the identified needs. Stakeholders have expressed a need for improved treatment and guidance. However, the quantitative analysis of human action is a very complex science. In the case of the fire SDP we should keep our expectations modest.

However, human actions can also be a critical aspect of the fire response procedures under a range of circumstances. Alternate shutdown and remote shutdown are the most obvious examples. Hence, we must provide for some reasonable treatment of human actions.

One aspect of a fire scenario analysis the need to identify what human actions are actually being credited. In general, identified actions are credited with a nominal reliability unless the fire itself might impact their success or failure.

Common rules applied in fire PRA include the following:

- No credit is taken for human actions that would require entry into, or passage through, a fire area.
- If the normal access route is blocked, but an alternate route exists that would allow the action while bypassing the fire area, then a degraded reliability might be assigned.
- If an action is not directly impacted by the fire but takes place outside the control room, then some degradation in the success likelihood is generally assumed due to the heightened stress level associated with a fire event.
- Actions that take place within the control room are assumed to not be impacted by fires outside the control room.

For the fire SDP we should likely focus on development of a set of rules such as those cited above. Guidance on the identification of credited human actions is needed. We should then attempt to assign numerical values corresponding to each rule that would quantify the failure likelihood under the cited conditions. Beyond the application of simple rules, HRA analysis can become quite complex and would be beyond the capacity of a non-expert.

Specific Issue #9: Exemptions

The question of exemptions has also been raised. That is, how does one treat exemptions in the SDP process? This particular issue seems more one of policy than fundamental methodological issues. The main issue would seem to be establishing the baseline risk condition in assessing the impact of an inspection finding. This also gets to the issue of risk contribution versus risk change due to a deficiency.

From a regulatory perspective, approved exemptions are part of the licensing basis. Hence, it would seem appropriate to assume that an approved exemption represents the baseline state. Risk changes due to a deficiency would then be weighed against that baseline. It would seem that exemptions might become inspection issues in one of three ways:

- Provisions called for in the exemption as an alternative to the nominal requirements are found to be degraded. Example: spatial separation is not maintained free of combustible fuels.

- An inspection finding is contrary to the basis of the granted exemption. Example: an exemption might be granted in part based on low combustible fuel loadings and a lack of ignition sources and a later inspection might find that some particular ignition source or substantial combustible loading was introduced through a subsequent plant change.

- A degradation is noted in a fire protection feature or system that provides defense in depth protection impacting a granted exemption. Example: a fire detection system is found to be degraded in an area granted an exemption from an automatic fire suppression system in lieu of a manually actuated fire suppression system.

Fire Protection SDP Phase 2 Improvement Working Group Meeting
One White Flint North
Wednesday, August 14, 2002

Room O10B2

AGENDA TOPICS

9:00 a.m.	Welcome, Meeting Purpose and Objectives	S. Wong
9:05 a.m.	Fire Protection SDP Phase 2 Methodology	S. Wong
9:30 a.m.	Issues Affecting Fire Protection SDP Phase 2 Methodology and Suggested Priorities	NRC staff, NEI and others
10:45 a.m.	Break	
11:00 a.m.	Continue Discussion on Issues and Suggested Priorities	NRC staff, NEI and others
12:00 p.m.	Lunch	
1:00 p.m.	Proposed Approaches for Addressing Each Issue	All
2:30 p.m.	Break	
2:45 p.m.	Discussion of Proposed Approaches to Resolve Issues	All
4:30 p.m.	Adjourn	

Attachment 3