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Last Revised: July 14, 2000 (2:01PM)

Appendix 8 Public Concerns Raised During the Public Comment Period

On Feb. 15, 2000, the Nuclear regulatory Commission (NRC) released the "Draft Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Plants," for public comment. The NRC encouraged members of the public and stakeholders to review the draft report and to formally submit comments for review. Several public groups commented during this period that the NRC solicited comments from the public, when it had no intention of addressing the public's comments. In order to ensure that adequate consideration had been given to stakeholders comments, the staff reviewed stakeholder comments which had been received prior to February 15, 2000, as well as stakeholders comments received as a result of their review of the draft final report. Reviewed comments, which were received prior to February 15, were identified by reviewing transcripts of meetings with the public, letters from the public, and other available documentation related to the staff's efforts in completing the draft final report.

This appendix provides the NRC's responses to the comments and concerns received as described above. In most cases, responses are provided in this appendix. However, in other cases, the comments or concerns are identified in this appendix and a reference is provided to other parts of the report where the identified issues are addressed.

CRITICALITY

Pulled from SRXB Public Comment Responses (Tony Ulses-Received 7/7/00)

Public Comments #1, 3, and 4: A public commenter raised several concerns related to SFP criticality. First, they stated that the NRC should consider criticality events due to chemical stripping of primary piping. **We don't seem to directly address this question - question seems to me to be is this possible, if not we should say so.** Second, they expressed concern that the potential exists for contaminated solution to go overboard into public waters or be flushed back into the SFPP. Finally, during primary system decontamination at decommissioning reactors, is it possible to misalign the valves and send corrosive chemicals into the SFP? Could these chemicals precipitate boron from the SFP water? Is there a potential for criticality? Is there a potential for fuel damage?

Response:
Without knowing which specific chemicals are used at a given plant, there may be the potential for a chemical to precipitate boron out of solution if it got into the SFP water; however, there would be no increase in criticality risk because boron in SFP water is not credited to maintain spent fuel pool subcriticality (k-eff < 1.0). Consideration of such things as chemical intrusion into the spent fuel pool or offsite discharge pathways will be considered when the staff reviews the plant specific decommissioning plans.
Does DLPM agree?

Q/206

Public Comment #6: The NRC should identify the scenario where a steam explosion is possible because of a severe criticality event and the basis upon which the probability was determined to be "highly unlikely."

Response:
The discussion in the draft final report paper was intended to mean that a steam explosion from a severe critically event is highly unlikely not because of the low probability of the scenario, but because of the fact that inherent negative feedback **(reactivity??? What is feedback? Does the public know?)** in the fuel would prevent a severe criticality event in all load drop scenarios which are themselves of a low probability. **(Are we saying that you could never get this situation?)** The report will be clarified to better illustrate this point. **Was this done?**

Not done

Public Comment #7: The NRC should identify all radioactivity in the SFP and that capable of being dispersed in an accident (beyond that on p A3-11 to A3-13).

Response:
The information supplied in pages A.3-11 to A.3-13 do not relate to the generation of the source term. These nuclides were selected because they contribute to the reactivity of the spent fuel. The nuclides listed there represent well over 90 percent of the reactivity contribution in spent fuel. Therefore, it is not necessary to expand the list because such an expansion will not significantly alter the predicted reactivity of the spent fuel in the storage racks. The source term is addressed in detail in Appendix 4.

Public Comment #8: The criticality accident analysis does not consider the risk of a criticality accident that arises from placement of low-burnup fuel assemblies in a pool where the licensee relies on burnup credit to prevent criticality.

Response:
The double contingency principle discussed in ANS 8.1, which has been endorsed by the staff, requires that only the worst highly unlikely single failure or event needs to considered in a criticality evaluation. The staff considers fuel misloading events to be highly unlikely and has demonstrated via analysis (affidavit of A. Ulses in hearing before the Atomic Safety and Licensing Board, ASLBP No. 99-762-02-LA, January 4, 2000.) that the worst possible misloading scenario will not lead to a criticality event. Therefore, further consideration is not needed.

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Appendix 8 Public Concerns Raised During the Public Comment Period

On Feb. 15, 2000, the Nuclear regulatory Commission (NRC) released the "Draft Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Plants," for public comment. The NRC encouraged members of the public and stakeholders to review the draft report and to formally submit comments for review. Several public groups commented during this period that the NRC solicited comments from the public, when it had no intention of addressing the public's comments. In order to ensure that adequate consideration had been given to stakeholders comments, the staff reviewed stakeholder comments which had been received prior to February 15, 2000, as well as stakeholders comments received as a result of their review of the draft final report. Reviewed comments, which were received prior to February 15, were identified by reviewing transcripts of meetings with the public, letters from the public, and other available documentation related to the staff's efforts in completing the draft final report.

This appendix provides the NRC's responses to the comments and concerns received as described above. In most cases, responses are provided in this appendix. However, in other cases, the comments or concerns are identified in this appendix and a reference is provided to other parts of the report where the identified issues are addressed.

CRITICALITY

Pulled from SRXB Public Comment Responses (Tony Ulses-Received 7/7/00)

Public Comments #1, 3, and 4: A public commenter raised several concerns related to SFP criticality. First, they stated that the NRC should consider criticality events due to chemical stripping of primary piping. **We don't seem to directly address this question - question seems to me to be is this possible, if not we should say so.** Second, they expressed concern that the potential exists for contaminated solution to go overboard into public waters or be flushed back into the SFPP. Finally, during primary system decontamination at decommissioning reactors, is it possible to misalign the valves and send corrosive chemicals into the SFP? Could these chemicals precipitate boron from the SFP water? Is there a potential for criticality? Is there a potential for fuel damage?

Response:
Without knowing which specific chemicals are used at a given plant, there may be the potential for a chemical to precipitate boron out of solution if it got into the SFP water; however, there would be no increase in criticality risk because boron in SFP water is not credited to maintain spent fuel pool subcriticality (k-eff < 1.0). Consideration of such things as chemical intrusion into the spent fuel pool or offsite discharge pathways will be considered when the staff reviews the plant specific decommissioning plans.
Does DLPM agree?

Public Comment #6: The NRC should identify the scenario where a steam explosion is possible because of a severe criticality event and the basis upon which the probability was determined to be "highly unlikely."

Response:
The discussion in the draft final report paper was intended to mean that a steam explosion from a severe critically event is highly unlikely not because of the low probability of the scenario, but because of the fact that inherent negative feedback **(reactivity??? What is feedback? Does the public know?)** in the fuel would prevent a severe criticality event in all load drop scenarios which are themselves of a low probability. **(Are we saying that you could never get this situation?)** The report will be clarified to better illustrate this point. **Was this done?**

Public Comment #7: The NRC should identify all radioactivity in the SFP and that capable of being dispersed in an accident (beyond that on p A3-11 to A3-13).

Response:
The information supplied in pages A.3-11 to A.3-13 do not relate to the generation of the source term. These nuclides were selected because they contribute to the reactivity of the spent fuel. The nuclides listed there represent well over 90 percent of the reactivity contribution in spent fuel. Therefore, it is not necessary to expand the list because such an expansion will not significantly alter the predicted reactivity of the spent fuel in the storage racks. The source term is addressed in detail in Appendix 4.

Public Comment #8: The criticality accident analysis does not consider the risk of a criticality accident that arises from placement of low-burnup fuel assemblies in a pool where the licensee relies on burnup credit to prevent criticality.

Response:
The double contingency principle discussed in ANS 8.1, which has been endorsed by the staff, requires that only the worst highly unlikely single failure or event needs to considered in a criticality evaluation. The staff considers fuel misloading events to be highly unlikely and has demonstrated via analysis (affidavit of A. Ulses in hearing before the Atomic Safety and Licensing Board, ASLBP No. 99-762-02-LA, January 4, 2000.) that the worst possible misloading scenario will not lead to a criticality event. Therefore, further consideration is not needed.

SRXB (Contact: J. Wermiel - J. Staud.)

1. Page 256, Criticality due to chemical stripping of primary piping [Ref. 1] (Tony Ulses)
2. Page 451, Barrett: worst case draining of the SFP. [Ref. 1] (Joe Staud.)
3. Page 60, Ray Shadis: Concern about primary system chemical decon. and the potential for contaminated solution to go overboard into public waters or be flushed back into the SFP. [Ref. 2]
4. Page 14, Shadis statement: During primary system decontamination at decomm. reactors, is it possible to misalign the valves and send corrosive chemicals into the SFP? Could these chemicals precipitate boron from the SFP water? Is there a potential for criticality? Is there a potential for fuel damage? **EMCB assist if needed** [Ref. 2]
5. Page 15, Shadis statement: In a half-empty SFP, if a SFP liner presses racks together, or, if fuel racks or assemblies or boral plates fail, are localized heat and criticality issues to be considered? [Ref. 2]
6. Page 4, Atherton comment: NRC should identify the scenario where a steam explosion is possible because of a severe criticality event and the basis upon which the probability was determined to be "highly unlikely." [Ref. 7]
7. Page 4, Atherton comment: The NRC should identify all radioactivity in the SFP and that capable of being dispersed in an accident (beyond that on p A3-11 to A3-13). [Ref. 7] **RES assist if needed**
8. Orange County (OC) comment: Criticality accident analysis does not consider risk of a criticality accident that arises from placement of low-burnup fuel assemblies in a pool where the licensee relies on burnup credit to prevent criticality. [Ref. 8] (Tony Ulses)
9. OC comment: Study is deficient in that it ignores phenomenon associated with partial draindown of SFP that will suppress convective heat transfer by presence of residual water at the base of fuel assemblies. [Ref. 8]
10. OC comment: Study is deficient in that partial draindown will lead to a steam-zirc reaction producing hydrogen gas which could reach explosive concentrations in the atmosphere of the spent fuel building, potentially leading to a breach of that building. [Ref. 8]
11. Mats Sjöberg/ Ferenc Müller on report: [Ref. 9] Page A1-7 in the report says:

> "When zirconium reaches temperatures where air oxidation is significant, the heat source is dominated by oxidation. The energy of the reaction is 262 kcal per mole of zirconium. In air, the oxidation rate and the energy of the reaction is higher than zirconium-steam oxidation."
>
> We can transfer 262 kcal to other units:
> 262 kcal pel mol Zr = 1.1 MJ per mol Zr (1 mol Zr = 91.2 kg Zr) = 1.1E+06/91.2 = 1.2E+04 J/kg Zr. We can conclude that the air oxidaton energi according to the report is = 1.2E+04 J per kg Zr
>
> The corresponding values for Zr-steam reaktion in the Melcor manual = 6.43E+06 J/kg Zr (Ref. Bottom Head Package, Reference Manual, Table 3.6. Heats of reaction at 1,700 K) The Maap code uses 6.18E+08 J per mol Zr = 6.78E+06 J/kg Zr, for
> Zr-steam reaktion i.e. near the same as Melcor.

• Need to address that public comments are addressed in this appendix or referenced to where in report they are addressed.
• Also need to discuss how we handled previous public comments. App 7

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Appendix 8 Public Concerns Raised During the Public Comment Period

On Feb. 15th, 2000, the "Draft Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Plants," was released for public comment. The NRC staff encouraged members of the public and stakeholders to review the draft report and to formally submit comments for staff review. Several public groups commented during this period that the NRC staff solicited comments from the public, when it had no intention of addressing the public's comments. Therefore, to ensure that we have addressed all stakeholder comments in the final report, we compiled a list of all public comments which came from transcripts of meetings with the public, letters from the public, and emails received, from April 1999 until the close of the public comment period on April 7, 2000. Is this true?

The intent of this appendix is to address those concerns raised by stakeholders which were submitted during the public comment period. In the following, the staff identified and addressed the stakeholder public comments in various technical areas.

CRITICALITY

Pulled from SRXB Public Comment Responses (Tony Ulses-Received 7/7/00)

Public Comments #1, 3, and 4: A public commenter raised several concerns related to SFP criticality. First, they stated that the NRC should consider criticality events due to chemical stripping of primary piping. Second, they expressed concern that the potential exists for contaminated solution to go overboard into public waters or be flushed back into the SFPP. Finally, during primary system decontamination at decommissioning reactors, is it possible to misalign the valves and send corrosive chemicals into the SFP? Could these chemicals precipitate boron from the SFP water? Is there a potential for criticality? Is there a potential for fuel damage? Will this cause criticality?

Response:
Should chemicals precipitate boron out of solution, there is no increase in criticality risk because the boron is not credited to maintain spent fuel pool subcriticality (k-eff < 1.0). Consideration of such things as chemical intrusion into the spent fuel pool or offsite discharge pathways will be considered when the staff reviews the plant specific decommissioning plans.

Public Comment #6: The NRC should identify the scenario where a steam explosion is possible because of a severe criticality event and the basis upon which the probability was determined to be "highly unlikely."

Don't use a new term

Response:
The discussion in the paper was intended to mean that a steam explosion from a super-prompt critical event is highly unlikely not because of the low probability of the scenario, but because of the fact that inherent negative feedback in the fuel would prevent a super-prompt critical event in all load drop scenarios which are themselves of a low probability. The report will be clarified

Was this done?

to better illustrate this point.

Public Comment #7: The NRC should identify all radioactivity in the SFP and that capable of being dispersed in an accident (beyond that on p A3-11 to A3-13).

Is this SRXB or NRR?

Response:
The information supplied in pages A.3-11 to A.3-13 do not relate to the generation of the source term. These nuclides were selected because they contribute to the reactivity of the spent fuel. The nuclides listed there represent well over 90 percent of the reactivity contribution in spent fuel. Therefore, it is not necessary to expand the list because such an expansion will not significantly alter the predicted reactivity of the spent fuel in the storage racks. The source term is addressed in detail in Appendix 4.

Public Comment #8: The criticality accident analysis does not consider the risk of a criticality accident that arises from placement of low-burnup fuel assemblies in a pool where the licensee relies on burnup credit to prevent criticality.

Response:
The double contingency principle discussed in ANS 8.1 Title, which has been endorsed by the staff, requires that only the worst highly unlikely single failure or event needs to considered in a criticality evaluation. The staff considers fuel misloading events to be highly unlikely and has demonstrated via analysis (affidavit of A. Ulses in hearing before the Atomic Safety and Licensing Board, ASLBP No. 99-762-02-LA, January 4, 2000.) that the worst possible misloading scenario will not lead to a criticality event. Therefore, further consideration is not needed.

(including the scenario of concern)?
or
(which bounds the scenario of concern)?

INSURANCE

Public Comment #1:

The obligation for decommissioning plants to participate in the secondary financial protection should be reviewed in light of the low public risk posed for SFP's for decommissioned plants. Industry does not believe that the risk justifies requiring participation. (The majority of the 3 in 1 million risk of significant offsite consequences comes from an upper bound determination of the risk posed by seismic events, not on a best estimate of the seismic risk).

If it is determined that participation will be required during the short time that decommissioning plants pose a non-zero risk, then the level of participation should be in proportion to a best estimate of the risk posed relative to the risk posed by operating plants. If any participation is required, it should be only for the short period that clad surface temperatures greater than 570° C can occur in a loss of water configuration. The calculation of this temperature should be by an approved methodology. The capacity required for primary financial protection should be eliminated for consideration of any potential for accidents with significant offsite consequences.

This stakeholder also proposed that for other events with offsite consequences, onsite coverage be reduced to $25M for the period when spent fuel remains in the pool and offsite coverage be reduced to $5-10M. When fuel has been removed offsite or placed in an offsite ISFSI, we recommend onsite coverage be reduced to $25M while the site still contains significant sources of radioactive material. Onsite coverage could be reduced to zero when there are no sources exceeding 1000 gallons of fluid. Offsite coverage should be reduced to $5-10M for plants with fuel offsite or in an onsite ISFSI.

Response:

The staff has previously stated that while it is correct that the risk of a zirconium fire is not significant, the property and liability insurance requirements of our regulations are meant to ensure that the public is protected in the event of a low probability, high consequence event. The underlying purpose of Section 50.54(w) is to provide sufficient property damage insurance coverage to ensure funding for onsite post-accident recovery stabilization and decontamination costs in the unlikely event of a nuclear accident. Section 140.11 also serves to provide sufficient liability insurance to ensure funding for claims resulting from a nuclear incident or precautionary evacuation.

In SECY-93-127, the Commission established that the amount of insurance coverage necessary for reactor licensees should be determined by the worst "reasonably conceivable" accident possible. Reasonably conceivable accidents may exceed design basis accidents but are less severe than remotely possible hypothetical accidents that are often termed "incredible." The TWG risk study concluded that the probability of a zirconium fire at a permanently shutdown plant is low but did not conclude that its probability is low enough to be considered "incredible." Thus, adequate insurance coverage is necessary for such an event.

The zirconium fire scenario would be possible for up to several years following shutdown. Since the consequences of such a fire are severe in terms of property damage and land

* Is this the same as SECY 4 proposed rulemaking plan - Yes GFH

contamination, the staff position is that full offsite liability coverage must be retained for five years or until analysis has indicated that a zirconium fire is no longer possible. At that point, primary coverage would be reduced from $200 million to $100 million and participation in the secondary retrospective pool would no longer be required. When all fuel was moved offsite or to an onsite dry cask storage system, the primary insurance coverage would be reduced to $25 million.

PROBABILITY AND HUMAN RELIABILITY ASSESSMENT

Public comment #1 : Experience at nuclear power plants demonstrates that safety problems are not caused by workers making mistakes or by not following procedures. Problems are caused by bad management.

Response: The staff agrees that utility safety culture and utility oversight/expectations in the day-to-day operations of a facility are important contributors to either a well run plant or a poorly run one. The staff is proposing that utilities with decommissioning sites develop a process that will help insure that proper attention is paid to spent fuel pool status, procedures are developed that guide fuel handlers in the event of a spent fuel pool accident, communications are established between onsite and offsite organizations, and cask drop analyses are performed or a single failure proof crane is used for handling very heavy loads. These prescriptions and commitments are discussed in Sections 3.2, 3.3.1, 3.3.6, 4.2.1, 4.2.4, and Appendix 6 of the Draft Final Technical Study.

Public comment #2 : Experience at nuclear power plants shows that multiple shifts can make the same error and not recognize it for a long time. With watching the pool being their major responsibility, a fuel handler's life would be very tedious and boredom would set in. This should result in a poorer response by the fuel handler in the event of an accident.

Response: The staff agrees that multiple shifts can make the same error although this is very unlikely. Our modeling and quantification of spent fuel pool risk includes consideration of multiple shift turnovers and the chance that shift after shift makes the same mistake. However, for almost all postulated SFP accidents there is a very long time available to the fuel handlers to discover and recover from the existence of a problem in the spent fuel pool or its support systems. The staff believes that the commitments made by the industry and the NRC's staff decommissioning assumptions provide a basis for reducing the chances of multiple shift errors to the point where they do not contribute significantly to the overall risk of spent fuel pool operation (See Sections 3.2, 3.3.1, 3.3.6, 4.2.1, 4.2.4, and Appendix 6 of the Draft Final Technical Study). The rest of the accidents (i.e., seismic and heavy load drop), which progress rapidly, proceed independent of operator intervention once the accident has occurred because the SFP is drained so rapidly.

Public comment #3 Over time, tedious tasks will cause workers to make mistakes. The NRC needs to address this in a conservative manner.

Response: The staff agrees that tedious tasks can increase the chances of a fuel handler making a careless mistake. We do not agree that fuel handler errors need be handled in a conservative manner when performing a probabilistic risk assessment. It is the NRC's policy to make its risk assessments as realistic as possible, which the staff did in the report.

Public comment #4: How is common mode failure accounted for in the staff's risk analysis? How confident are you of your ability to model and quantify common mode failures?

Response: The staff's risk analysis accounts for dependencies among the initiating events, the equipment needed to mitigate the events, and also the operator actions needed for accident mitigation. Initiating events that have the potential of simultaneously degrading mitigating equipment or impeding operator actions are modeled in the construction of the event trees and in the estimation of equipment failure rates and human failure probabilities. For example, for an event where a fire is not extinguished within 20 minutes, it was assumed that the SFP cooling system and the electric-driven firewater pumps are failed (either due to fire damage or due to loss of the electrical supply to the plant). Therefore, no credit is taken for this equipment. In addition, the estimation of the human error probability (for starting backup diesel pumps or for offsite recovery) took into account a high level of operator stress, which increases the failure probability.

Equipment hardware failure dependencies, usually referred to as common cause failures, have also been modeled in the risk analysis. Since these failures have the potential for disabling multiple trains of equipment at the same time, they can be big contributors to the risk. In the staff's analysis, the only multiple train system modeled is the spent fuel pool cooling system. In the fault tree model for this system, common cause failures are modeled for the cooling pumps, the heat exchangers, and the discharge check valves. The modeling of dependent failures, including common-cause hardware failures, in the staff's risk analysis is consistent with NRC and industry guidelines.

Public comment # 5: NRC should set guidelines on how often fuel handlers make their rounds at decommissioning facilities. This would help assure operator attentiveness.

Response: The staff agrees that if fuel handlers make the rounds of the SFP and its equipment on a frequent basis, the probability of the handlers detecting problems early is greatly enhanced. To this end staff decommissioning assumption (SDA) #1 states in part that walk-downs of the SFP systems will be performed at least once per shift by the fuel handlers. This is documented in Section 3.3.1 of the report. The staff expects that these assumptions will be translated into requirements or industry guidance during the rulemaking process.

Public comment # 6: NRC should assure that the probability of failure of systems required to mitigate the consequences of design bases and beyond design bases spent fuel pool events are minimized.

Response: The need to have highly reliable systems to prevent or mitigate an accident is partly a function of how rapid the accident progresses and how serious its consequences are. If an accident would result in serious consequences unless a rapid response were achieved, then highly reliable systems and components are needed to prevent and/or mitigate the event. If the accident were very slow in progressing or has benign consequences, the equipment designed to prevent or mitigate it need not be as reliable. The large volume of water above the spent fuel provides an inherent delay time before fuel could be uncovered. This delay time (measured in days) allows for repair or replacement of equipment. If it were impossible to repair or replace the equipment, inventory could be added to the pool to match the boil-off rate. The industry has committed in industry decommissioning commitment (IDC) #4 (Section 3.2) to implement an off-site resource plan to include access to portable pumps and emergency power. IDC #7 and IDC #9 commit the industry to implement procedures or administrative controls to reduce the

likelihood of rapid drain down events. The staff decommissioning assumption (SDA) #1 (Section 3.3.1) calls for procedures to be developed that will provide guidance on the availability of on-site and off-site inventory make-up sources and time available to initiate these sources. In addition, the industry has committed in IDC #10 to perform routine testing of the alternative fuel pool make-up system components and to have procedural controls on equipment out of service to increase confidence that components will be available. The two accidents that could lead to very rapid draining of the SFP are extremely large seismic events and heavy load drops. IDC #1 and SDA #2 (Section 3.3.6) address heavy load drop concerns. SDA #3 (Section 4.2.1) calls for each decommissioning plant to successfully complete the seismic checklist provided in Appendix 5 to this report. Implementation of these commitments and assumptions will help assure the frequency of a zirconium fire remains below the pool performance guideline of $1X10^{-5}$ per year.

Public comment #7: Why is station blackout at a decommissioning site acceptable to the staff?

Response: The staff does not find having station blackouts to be an acceptable practice. At the same time, as with an operating reactor, the staff recognizes that there is some small annual probability that a station blackout will occur at a decommissioning site. Unlike an operating reactor, decommissioning spent fuel pools (at one year or greater after the last fuel was irradiated in the reactor) can go without electrical power for almost a week and not suffer serious consequences. This is due to the inherent margin provided by the large volume of water sitting above the spent fuel in the pool. It takes a long time to heat this water up to boiling and then to continue to boil it off until fuel is uncovered. IDC #2 commits the industry to develop procedures and train personnel to ensure that on-site and off-site resources can be brought to bear during an event. IDC #3 calls for communication systems to be set up between the SFP site and off-site resources that can survive severe weather and seismic events, which can cause a station blackout. See Section 3.2.

Public comment #8: The risk assessment should take into account changes in local aircraft traffic when evaluating the probability and consequences from aircraft crashing into SFPs.

Response: The risk from aircraft crashes is small, and even large increases in traffic should not make aircraft crashes a dominant contributor to risk. A decommissioning plant will continue to be governed by 10 CFR Part 50 for the evaluation of hazards as discussed in Standard Review Plan 2.2.3, "Evaluation of Potential Accidents," including accidents involving nearby industrial, military, and transportation facilities. Changes in local aircraft traffic would continue to be assessed on a deterministic basis at a decommissioning plant and a reassessment of risk would be performed, as needed.

The frequency of an aircraft crash leading to an accident in a spent fuel pool was estimated in the report to be in the range of $9.6x10^{-12}$ to $4.3x10^{-8}$ per year where damage to the pool was significant enough that it resulted in a rapid loss of water from the pool (See Section 3.4.2 and Appendix 2b). The mean value was estimated to be $2.9x10^{-9}$ per year. These values are a small fraction of the overall risk of uncovering the spent fuel in the pool at a decommissioned plant, which was estimated to be less than $5.0x10^{-6}$ per year. An aircraft crash could also result in damage to a spent fuel pool support system. The estimated range of striking a support system was estimated to be in the range of $1.0x10^{-9}$ to $1.0x10^{-5}$ per year, with a mean value of

4.5

7.0×10^{-7} per year, without consideration of recovery actions. These values are also a small fraction of the estimated frequencies for the loss of cooling initiator (3.0×10^{-3} per year), the internal fire initiator (3.0×10^{-3} per year), or the loss of inventory initiator (1.0×10^{-3} per year).

Aircraft traffic and accident data were reviewed by the staff (Ref: "Data Development Technical Support Document for the Aircraft Crash Risk Analysis Methodology (ACRAM) Standard," C.Y. Kimura, et al., UCRL-ID-124837, Lawrence Livermore National Laboratory, August 1, 1996). The number of U.S. Air Carrier operations increased from about 5.5 million departures per year in the 1970s to about 8.7 million departures per year in the mid-1990s. The average miles traveled per departure increased from about 500 to 650. For the period from 1986 to 1993 general aviation operations remained relatively constant, with a decrease in activities reported in 1992 and 1993. Military aircraft data, which are a small fraction of the total risk (see Table A2d-1, "Generic Aircraft Data"), was not reviewed.

While it is very unlikely that changes to aircraft traffic near a decommissioning plant will significantly increase the estimated risk of uncovering the spent fuel in the pool, changes in aircraft traffic would continue to be assessed at a decommissioning plant.

Public comment #9: What is the generic frequency of events leading to zirconium fires at decommissioning plants before the implementation of industry commitments and staff assumptions?

Response: The staff visited four decommissioning sites as part of the preparation for developing the risk assessment of decommissioning spent fuel pools. The insights from those visits include that the facilities appeared to have been staffed by well trained, knowledgeable individuals with significant nuclear power plant experience. Procedures were in place for dealing with routine losses of inventory. Fuel handlers appeared to know whom to call off-site if difficulties arose with the SFP. The staff recognized that these attributes were not required by any NRC regulations nor suggested in any NRC guidance for decommissioning sites. The industry's IDCs and the staff's SDAs are an attempt to increase the assurance that fuel handlers will continue to be knowledgeable of offsite resources and have good procedures available to them. The staff believes that the initiating event frequencies at the visited decommissioning sites are very similar to those estimated in the staff's decommissioning SFP risk assessment. The response of the fuel handlers at the visited sites would probably be as good as estimated in the report. If somehow it were possible for a zirconium fire to begin at one of these pools, the staff believes that the frequency of this fire would be on the same order of magnitude as that estimated in the report. Do we need to be more specific

Public comment #10: What will the NRC staff do to protect plant workers and the public from spent fuel pool risks at permanently closed plants and operating plants before the industry commitments and staff assumptions are implemented?

Response: Regarding protection of the public, for plants that are currently in a decommissioning status, the staff has no reason to believe that these sites have characteristics significantly worse than those discovered by the staff during its visits to four decommissioning sites. The as-found conditions at these sites were the basis for the modeling of the spent fuel pool cooling system and operator actions in the report. In addition, most decommissioning sites

have even lower decay heat levels than assumed in the report, and the likelihood of a zirconium cladding fire should be even lower at these sites than estimated in the report since these sites have longer periods within which to recover spent fuel pool cooling or inventory. **The staff intends to review the heavy load operations at current decommissioning sites to assure that there are no vulnerabilities.** Future decommissioning plants will either implement the industry commitments and staff assumptions or will have to continue with full emergency preparedness, security, and insurance. Operating reactors are fully staffed, have multiple backup systems, and have full emergency preparedness, security, and insurance. The staff believes that the risks from operating reactor spent fuel pools are less than those of decommissioning plants and are within the NRC's Safety Goals.

The dominant health concern for decommissioning site workers caused by beyond design bases accidents is the potential for very high exposures should the spent fuel become uncovered (the field at the edge of the pool would be in the range of tens of thousands of rem per hour.) However, since the expected frequency of spent fuel uncovery is so low and workers already are aware that uncovering the fuel could subject them to high doses, the staff believes that no additional warnings to the fuel handlers are deemed necessary at this time regarding the potential dose rates at the edge of the spent fuel pool associated with fuel uncovery. Decommissioning plant workers continue to have radiation dose limits set by the NRC and their utility, just as workers do at operating nuclear power plants.

Public comment #11: There are several places in the draft report where the staff refers to "uncovering the core" rather than "uncovering the fuel."

Response: References to "uncovering the core" have been replaced with ones discussing "uncovering the fuel."

Pubic comment #12: Recalculating the frequencies for event trees produced numerical results for some sequences that were off by one or two orders of magnitude.

Response: In the staff's risk analysis, the accident scenario frequencies in the event trees were calculated such that dependencies among the failure events (in the event tree branches) were taken into account. Therefore, if an event resulted in functional failure in more than one branch in the event tree, this dependency was taken into account, and the resultant scenario frequency is therefore larger (in some cases, by as much as two orders of magnitude) than if the events were assumed to be independent.

Public comment #13: The initiating frequencies, human error rates, and equipment failure rates should more accurately take into account the occurrence of actual events such as Chernobyl and Three Mile Island.

Response: The decommissioning SFP risk assessment takes into account actual events that are applicable to spent fuel pools and their support systems. The staff used initiating event frequencies from staff studies from actual events at spent fuel pools, from actual crane lift data, from site-specific seismic hazard curves, from studies on aircraft crashes and tornadoes, and

from large databases developed to provide estimates for initiating events and equipment failure rates. Human error rates were developed by the staff in conjunction with experts at Idaho National Engineering and Environmental Laboratory. The staff believes that the values used in the report provide a reasonable picture of the risks associated with operation of decommissioning spent fuel pools under the assumptions and commitments documented in the study.

Public comment #14: The NRC should determine which failure rates used in the report are reliable and which are not and the results should be included in the study.

Response: The staff uses the most reliable information on failure rates that it has at its disposal. Because of the long time it takes for water above the spent fuel to heat up and boil off, the failure rates of specific equipment that support a spent fuel pool are not important contributors to spent fuel pool risk for long term sequences (i.e., the results are not particularly sensitive to the assumed failure rate of equipment.) Very large seismic events or heavy load drops could rapidly drain the spent fuel pool. For seismic events, the robustness of the spent fuel pool is assured by implementation of a seismic check list (See Appendix 5). For heavy load drops, industry decommissioning commitment (IDC) #1 calls for performance of cask drop analyses or use of a single-failure-proof crane when moving heavy loads over or near the spent fuel pool (See Section 3.2), which should help assure that the risk from heavy load drops is extremely low.

Public comment #15: Mitigating systems at decommissioning spent fuel pools are not automatic. The NRC should assure that fuel handlers are available in the event of an accident.

Response: The staff is developing regulations that will address staffing at future decommissioning sites. Staffing at present day decommissioning sites is controlled by Technical Specifications on a plant-specific basis. In addition, staff decommissioning assumption (SDA) #1 calls for walkdowns of the spent fuel pool area by fuel handlers every shift (See Section 3.2.)

Does DRP agree?

Public comment #16: What measures are taken by the NRC to assure that fuel handlers remain attentive?

Response: The staff has sought to help assure fuel handler attentiveness in a number of ways. First, staff decommissioning assumption (SDA) #1 calls for walkdowns of the spent fuel pool area by fuel handlers every shift. Second, industry decommissioning commitment (IDC) #4 states that SFP instrumentation will be in place providing readouts and alarms in the control room or where the fuel handlers are stationed. Discussions with the industry indicate that it is a general practice for sites to log instrument readings in the decommissioning spent fuel pools at least once per shift. Such practices help maintain fuel handler alertness and keep them abreast of the status of the pool and its support systems. See Sections 3.2 and 3.3.1.

Public comment #17: What measures have been taken to help minimize fuel handler error in postulated SFP accident scenarios?

Response: Having procedures in place helps reduce that chance of human errors, especially under stressful conditions such as during a severe accident. The industry has committed to providing procedures or administrative controls to reduce the likelihood of rapid drain down events. Procedures and training of personnel are to be in place to ensure that on-site and off-site resources can be brought to bear during an accident. Procedures will be in place to establish communication between on-site and off-site organizations during severe weather and seismic events. An off-site resource plan will be developed that will include access to portable pumps and emergency power. In addition, fuel handlers will have available to them spent fuel pool instrumentation that monitors spent fuel pool temperature, water level, and area radiation levels. See Section 3.2.

Public comment #18: The NRC should review the need to place a containment around spent fuel pools.

Response: The staff has evaluated the risk from spent fuel pool operation and from zirconium fires at operating plants in Generic Issue 82, "Beyond Design Basis Accidents in Spent Fuel Pools." NUREG-1353 determined that the risks of spent fuel pool operation and the cost of alterations did not justify performing any generic backfits at operating plants, including installation of improved containment structures. Risk estimates from the decommissioning spent fuel pool risk assessment are similar to risk numbers (same order of magnitude) found in NUREG-1353, and decommissioning sites have a shorter period of vulnerability to zirconium fires than do operating reactors. The staff believes that an additional containment structure is not warranted for decommissioning spent fuel pools.

Public comment #19: To the extent possible, experimental validation of risk-informed results should be addressed.

Response: The staff does not plan on performing any proto-typical tests of SFP configurations. However, the predictive models used for estimating the risk from spent fuel pools are based on a wealth of experimentation. Many experiments have been performed in the areas of human reliability analysis, seismic fragility of equipment, fires, and thermal hydraulics (where billions of dollars have been spent to better understand the phenomenology of reactor accidents.) The results of the decommissioning spent fuel pool risk assessment come from a systematic analytical modeling of the spent fuel pool and its support systems at a "typical" decommissioning site. The model of the spent fuel pool and its support systems was based on plant-specific visits made by the staff. The staff used failure rates of support system equipment based on existing large databases of equipment failure rates. Human error rates were developed by the staff with help from experts at Idaho National Engineering and Environmental Laboratory. Heavy load drops were based on modeling performed for NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants, Resolution of Generic Technical Activity A-36" with additional sources of data from U.S. Navy crane experiences, Waste Isolation Plant Trudock Crane System experience, and data supplied by NEI (See Appendix 2c). The effects of aircraft crashes were analyzed using Department of Energy models (See Appendix 2d) and generic aircraft crash data. Therefore, the staff does not believe that work in the experimental validation of risk-informed results is warranted.

Public comment #20: An earthquake large enough to cause severe damage to a spent fuel pool

would wreak havoc upon the local infrastructure. How has NRC considered the availability of local resources as identified by IDC #2, #3, and #4?

Response: The response by local, state, or national authorities needed at the spent fuel pool site will depend on the actual or potential damage to the spent fuel pool. For earthquakes below at least three times the peak ground acceleration of the design bases earthquake, the spent fuel pool should be robust enough to prevent any rapid drain down. The most likely damage would be to the support systems that provide cooling to the pool. The large inventory of water above the spent fuel should provide adequate time (it would take about a week without pool cooling before boiling would occur) for repairing or bringing in replacement pumps and heat exchangers. Seismic events with accelerations greater than three times the design bases earthquake would result in catastrophic damage to the surrounding area. At such acceleration levels, the spent fuel pool would likely begin to suffer catastrophic damage and mitigation of the draining of the pool is not possible. Evacuation would be the only mitigating action that could be taken.

Public comment # 21: The ruthenium inventory in spent fuel is substantial. Ruthenium has a biological effectiveness equivalent to that of Iodine-131 and has a relatively long half-life. If there were significant releases of ruthenium in a zirconium fire, the Regulatory Guide 1.174 large early release frequency (LERF) value may not be an appropriate surrogate for the prompt fatality quantitative health objective. The controlling consequence may become latent cancer deaths.

Response: Our conclusion in the draft final report was that, even though there are some differences in source term and timing, scenarios involving a spent fuel pool zirconium fire would result in population doses that are generally comparable to those expected from accident scenarios at operating reactors. Since a zirconium fire in the SFP would involve a direct release to the environment, the LERF guideline was applied. The staff reassessed these conclusions following the performance of additional consequence calculations that took into account the possibility of significant Ruthenium release fractions.

The staff's reassessment showed that, when the Ruthenium release fraction was increased to 100% from the originally assumed fraction of $2x10^{-5}$, the number of early fatalities increased by approximately two orders of magnitude. However, the resulting early fatality consequences are still relatively low when compared to those predicted for operating reactor accidents. For example, for the various source terms considered in the NUREG-1150 assessment of Surry, the conditional number of early fatalities varied from essentially zero to approximately 11. The reassessment for SFP zirconium fire consequences (assuming 100% Ruthenium release fraction, and a population distribution like Surry) indicated conditional prompt fatalities of 0.13 for the scenarios where evacuation was initiated before onset of a zirconium fire.

When considering latent cancer fatalities, the staff analysis also provided a sensitivity study for total latent cancer deaths up to 500 miles away, with and without the increased Ruthenium release fraction. For the situation where evacuation is initiated prior to zirconium fire, latent cancer fatalities increased by approximately 17%, indicating that latent effects were only slightly sensitive to the Ruthenium release fraction. It should also be acknowledged that these long term health impacts are sensitive to public policy decisions such as land interdiction criteria for returning populations.

Public comment #22: The seismic risk was treated in a conservative manner. Risk-informed decision making regarding spent fuel pool zirconium fire issues should use realistic analysis, including uncertainty assessment.

Response: The assessments of the frequency of fuel uncovery from seismic events were performed using the Lawrence Livermore National Laboratory (LLNL) seismic hazard curves. The LLNL hazard curves are generally conservative with respect to those generated by EPRI. This is a result of different expert judgements. An assumed HCLPF (high confidence of low probability of failure) value of 0.5g was used in the seismic analysis. The HCLPF value was chosen on the basis that it was the value that was felt to be attainable by a plant that met the seismic checklist (see Appendix 5.) It was recognized by the staff that the HCLPF value at a plant could be greater than 0.5g (i.e., the plant might actually have a higher capacity than the minimum predicted if the checklist were met.) However, in the absence of plant-specific assessments of fuel pool capacities, this is a good approximation, which is bounding. The draft report also states that the approach used to evaluate the frequency gives a slightly conservative estimate of the mean value that would be calculated from a convolution of the hazard curve and the fragility curve. Since the treatment of uncertainties is an inherent part of the development of the hazard curves and the fragility curves, this mean value does indeed address uncertainties. While it can be concluded that the frequency of fuel uncovery from seismic events is potentially conservative, it is not considered by the staff that this will impact the quality of the decisions that will be made on a generic basis using this information.

Public comment #23: Because the accident analysis is dominated by sequences involving human errors and seismic events that involve large uncertainties, the absence of an uncertainty analysis of frequencies of accidents is unacceptable. Absent knowledge of the uncertainties, the decision making process is flawed.

Response: The staff intends to use the decommissioning spent fuel pool risk assessment results and insights in decision making based on the guidance used in Regulatory Guide (RG) 1.174. In this approach, when acceptance (in this case performance) guideline(s) are established, it is understood that the appropriate measure with which to make the comparison is the mean value of a distribution characterizing the quantified uncertainty. Uncertainties that cannot be incorporated into this quantification and that are usually associated with modeling issues or the adoption of specific assumptions are to be addressed in the decision making process by demonstrating that the adoption of alternate, plausible modeling assumptions would not lead to a change in the conclusion that the guidelines have (or have not) been met.

Seismic analysis and the assessment of the human performance in response to losses of heat removal and fuel pool inventory were pointed out as having large uncertainties. With respect to the accident sequences developed using a detailed logic model for losses of heat removal and pool inventory, the frequencies generated for those sequences are point estimates, based on the use of point estimates for the input parameters. The input parameter values were taken from a variety of sources, and in many cases were presented as point estimates with no characterization of uncertainty. In some cases, such as the initiating event frequencies derived from NUREG/CR 5496 and the human error probabilities (HEPs) derived from THERP (Technique for Human Error Rate Prediction), an uncertainty characterization was given, and

the point estimates chosen corresponded to the mean values of the distributions characterizing uncertainty. For all other parameters, it was assumed that the values would be the mean values of distributions characterizing the uncertainty on the parameter value. In the case of the Simplified Plant Risk (SPAR) HEPs, the authors of the SPAR human reliability analysis approach consider their estimates to be mean values since the numbers were established on the basis of considering several different sources, most of which specified mean values. Consequently, the results of this analysis are interpreted as being mean values.

A propagation of parameter uncertainty through the model was not performed, nor was it considered necessary. With the exception of the spent fuel pool cooling system itself, the systems relied on are single train systems. The dominant failure contributions for the spent fuel pool cooling system are assumed to be common cause failures. Thus there are no dominant cutsets in the solutions that involve multiple repetitions of the same parameter, and under these conditions, use of mean values as input parameters produces a very close approximation to mean values of sequence frequencies. Since typical uncertainty characterization for the input parameters is a lognormal distribution with error factors of 3 or 10, the 95th percentile of the output distribution will be no more than a factor of three higher than the mean value. This is not significant enough to change the conclusion of the analysis.

The numerical results are a function of the assumptions made and, in particular, the models used to evaluate the human error probabilities. The staff believes the models used are appropriate for the purpose of this analysis and, in particular, are capable of incorporating the relevant performance shaping factors to demonstrate that low levels of risk are achievable, given an appropriate level of attention to managing the facility with a view to ensuring the health and safety of the public. Alternate HRA models could result in frequencies that are different. However, given the time scales involved and the simplicity of the systems, we believe that the conclusions of this study (namely the risks are low and the industry decommissioning commitments play an important role in determining that low level) are robust.

Certain assumptions may be identified as having the potential for significantly influencing the results. For example, the calculated time windows associated with the loss of inventory event tree are sensitive to the assumptions about the leak rate. The SPAR HRA method is, however, not highly sensitive to the time windows within the ranges determined to be plausible for the scenarios modeled. Consequently, the assumption of the large leak rate as 60 gpm to represent those leaks that require isolation is not critical. For the loss of inventory event tree, the assumption that the leak is self-limiting after a drop in level of 15 feet may be a more significant assumption that, on a site-specific basis, may be non-conservative and requires validation. The assumption that the preparation time of several days is adequate to bring off-site sources to bear may be questioned in the case of extreme conditions. However, the very conservative assumption that offsite recovery is guaranteed to fail would increase the corresponding event sequences by about an order of magnitude, which would still be a very low risk contributor. In conclusion, the staff considers that, by determining that the estimates for the sequence frequencies are equivalent to mean values, and in identifying those assumptions that could affect the numerical results, and in understanding the effects of these assumptions on the numerical results, the uncertainty analysis performed is sufficient to support the decision making process.

Public comment #24: For all central and eastern U.S. nuclear power plant sites and for some

western U.S. nuclear power plant sites, all that is necessary to have an adequately safe spent fuel pool with respect to seismic-induced risk is for the pool to meet the requirements of the seismic checklist. Several western U.S. sites may need to demonstrate a high confidence with low probability of failure (HCLPF) of 2 X SSE.

Response: The staff agrees that for most sites throughout the U.S. meeting the enhanced seismic check list (Appendix A5) is sufficient to demonstrate acceptable seismic risk for decommissioning spent fuel pools. However, four sites east and two sites west of the Rocky Mountains are beyond the scope of a simple screening evaluation; these sites must perform a plant-specific seismic risk evaluation of their spent fuel pools if relaxation of EP, indemnification, or safeguards is desired.

Public comment #25: The staff's report is misleading when it states that there is about a factor-of-two reduction in prompt fatalities if the accident occurs after one year instead of thirty days. The real insight should be that compared to operating plants, the absolute value of prompt fatalities from zirconium fires at SFPs is a couple of orders of magnitude lower. In fact, the report does not justify a one-year delay in eliminating off-site emergency preparedness. Prompt fatalities are sufficiently reduced one month after reactor shutdown to support eliminating off-site emergency preparedness.

Did we answer this?

Response: The report does not focus on comparing the results of an accident at 30 days versus 1 year. The staff evaluated the risk to the public from spent fuel pool operation at decommissioning plants at one year and longer after final reactor shutdown. The basis for our recommendations on delaying reduction or elimination of off-site emergency preparedness is based on a number of factors, two of which are the estimated frequency of spent fuel pool zirconium cladding fires and the estimated consequences of such a fire.

Public comment #26: The use of Lawrence Livermore National Laboratory (LLNL) hazard curves at high ground motion values may not be credible. Even EPRI results are likely to be overly conservative at high ground motions. The requirement that some plants with higher SSE values perform detailed HCLPF assessments of their SFPs is not warranted. In conclusion, there should be no SFP screening level distinctions based on plant SSEs for the central and eastern U.S. All that is needed is that the sites pass the screening criteria (Appendix 5). For a few western sites, it is reasonable to require that the plants demonstrate a HCLPF of 2 X SSE.

Response: While it is possible that there is some conservatism in the EPRI and LLNL hazard curves at higher ground motions, the staff finds this prudent since the geologic record east of the Rocky Mountains is sparse and does not provide many examples of very large ground motions. The ERPI and LLNL hazard curves were made by different experts who gave their best judgement as to how to reflect the risks from seismic events at various nuclear power plant sites. They provided expert advice for high and low ground motions. Should we discuss revised criteria?

Public comment #27: The value of three times the SSE for the SFP HCLPF should not be a hard and fast acceptance criteria, since this is only a screening criteria.

Response: The staff agrees that this value is only a screening criterion. In Appendix 5g the staff discusses potential mitigation measures that can be taken by a plant that does not pass

the seismic checklist. Options offered include delay in requesting an exemption, correction of the identified areas on non-compliance with the checklist, or performance of a plant-specific seismic risk analysis to demonstrate that the risk associated with a catastrophic failure of the pool is at an acceptable level.

Public comment #28: The human error probabilities (HEPs) used for the operator action "Operator Recovery Using Off-Site Sources" are too conservative.

Response: The HEPs for recovery using off-site sources were quantified with the assumption that the fuel handlers/plant operators will initially attempt to mitigate the upset condition using in-house resources, and having failed this, attempt recovery using off-site sources. This was based on input obtained from licensees during public meetings on this subject, and on the assumption that fuel handlers will initially avoid using raw water (i.e., water not chemically controlled) when possible. It was however assumed that licensee procedures and training are in place to ensure that off-site resources can be brought to bear (IDC # 2 and 4) and that these procedures explicitly state that if the water level drops below a certain level (e.g., 15 ft below normal level), the fuel handler must initiate recovery using off-site sources. The probability of this event was quantified under the assumption that there is a low dependence with preceding fuel handler failures. Given that the event is always coupled with other fuel handler failures, it would, in the staff's opinion, be inappropriate to argue for zero dependence. When looked at in the context of the complete cutsets, it can be seen that the likelihood of failure to respond to any of the initiating events (excluding seismic and heavy load drops) where meaningful responses are possible is indeed very low as is evident from the very low sequence frequencies.

Public comment #29: Is it realistic to assume "good communication" with off-site emergency organizations once the plant is shutdown and "forgotten"?

Response: The staff assumes the need for off-site emergency response during seismic or severe weather events will only last for about five years. As the time after shutdown increases, the decay heat loads decrease and the longer the time it would take the pool to heat up and boil off if heat removal were lost. After one year, the decay heat levels are such that there is at least a week of delay between loss of cooling and spent fuel uncovery. Even following a seismic or severe weather event, the staff expects that a utility will be aware of the resources that are available in the area to provide pool cooling or inventory make up and that the utility will have assured the availability of the resources. In addition, the utility should have a plan for communicating with suppliers and government officials during such emergencies by means that would not be disrupted by such events (e.g., by portable radio). Industry commitments (IDC #2 and #3) provide assurance that good communication will be maintained.

Public comment #30: Will commitments lead to practices better than current? If not, use historic data.

Response: It is the staff's expectation that the commitments will in general provide guidance that assures that the good practices found at decommissioning sites visited by the staff will be implemented at future decommissioning sites. Some industry commitments and staff assumptions, such as IDC #1 (See Section 3.2) and SDA #2 (See Section 3.3) and SDA #3 (See Section 4.2.1), may be enhancements of capabilities currently practiced by existing

decommissioning plants. Where possible (e.g., for some initiating event frequencies), the staff has used actual data from spent fuel pool events. The commitments provide a basis for the staff to conclude that the low human error probabilities associated with the loss of SFP cooling and loss of inventory events are justified. In addition, the commitments provide a bound on the risk associated with the two events that could rapidly drain the spent fuel pool (i.e., seismic and heavy load drop events.)

Public comment #31: The staff noted a recent event (January 2000) that occurred during shutdown, when SFP monitoring should have been a priority. This event should have raised the initiating event frequencies, not lowered them.

Response: Including the two recent loss-of-cooling events mentioned in Section 3.3.1 of the draft report would increase the initiating event frequency for loss of cooling accidents. However, since the fuel uncovery frequency from this event is very low (approximately 10^{-8} per year), the conclusion in the report that the loss of cooling events are not a major risk contributors is not affected. However, these recent events illustrate the importance of industry commitments, particularly IDC #5 that requires temperature instrumentation and alarms in the control room.

Public comment #32: The discussion in Section 3.3.2 states that many of the events listed in NUREG-1275, Volume 12 do not apply to a decommissioning facility. Therefore, adherence to IDCs #2, 5, 8, and 10 are not really important to establishing a low frequency of fuel uncovery.

Response: The commenter correctly noted that many of the initiating events from operating reactor spent fuel pool incidents that are discussed in NUREG-1275 do not apply to decommissioning facilities. The staff likewise did not include these events when estimating the frequency of events at decommissioning plants. To help assure that the frequency of these events does not end up being much higher than assumed by the staff in its risk assessment, the industry committed to various actions regarding procedures and planning for contingencies to limit, prevent, or mitigate loss of inventory and loss of cooling events.

Public comment #33: How did the staff come up with the factor of 100 reduction in the failure rate for heavy load drops for single-failure-proof systems?

Response: For a non-single-failure-proof handling system, the mean probability of a loss-of-inventory event was estimated based on NUREG-0612. In NUREG-0612, an alternate fault tree (Figure B-2, page B-16) was used to estimate the probability of exceeding the release guidelines (loss-of-inventory) for a non-single failure proof system. The mean value was estimated to be about 2.1×10^{-5} per year when corrected for the new Navy data and 100 lifts per year. A comparison of this mean value to the 2.0×10^{-7} per year mean value for the single-failure-proof crane shows a factor of 100 reduction.

SEISMIC

DE Public Comments # 1-3: Already addressed in the draft report. (Please indicate where they were addressed in the draft report).

DE Public Comment #4: Is addressed in the seismic check list as an item to be evaluated by a decommissioning applicant. (Where)

DE Public Comment #5:
The NRC should perform rigorous engineering analysis of the effects of aging*[1] upon the spent fuel pool and its associated structures and equipment. Most SFPs were never designed to be quasi-permanent fuel storage facilities. Because there is as-yet no permanent place to store used fuel, SFPs have had to accept more fuel than they were originally designed to hold. To allow SFPS to continue to store spent fuel for as yet an undetermined period of time requires, I suggest, a comprehensive look at aging.

Response:
Spent fuel pools at currently operating nuclear power plants are constructed with reinforced concrete walls and lined with liner plates. Through the use of the proposed seismic check list, any degradation such as spalling of concrete or cracks and indications of rust, stain, etc. will be detected and appropriate corrective actions will be taken. Since concrete gains compressive strength with age and strength of reinforcing bars does not change with age, provided that rebars are not degraded by corrosion, there should be no change in structural strength. There is no operating experience of degradation of spent fuel pool structures; consequently, it is not meaningful to perform engineering analysis using unsubstantiated assumptions.

SPSB Public Comment #20: **(Goutam responsed to this and so did Glenn)...Maybe combine their responses or only address in SPSB's section**

Comments on Seismic Designs:
A significant seismic event which damages and drains the SFP is also likely to wreak havoc upon the local infrastructure. How has NRC considered the availability of local resources as identified by IDC #2, #3, and #4? Should the local infrastructure be destroyed?

Response
Seismic capacity of spent fuel structures against catastrophic failures, such that a very rapid loss of water can be assumed, is very high - substantially above their safe shutdown earthquake levels. Consequently, high ground motion levels are necessary to initiate failures. At those large earthquake levels emergency evacuation cannot be assumed to be effective. However, such large earthquakes are extremely rare events, so the risk is less than the safety goal.

Glenn's is better

[1] * Aging could include degradation, failure, etc. of structures & equipment.

DE Public Comment #6:
To my knowledge, not every spent fuel pool was designed to the seismic criteria in use today. The use of works like "robust" does not necessarily address seismic qualifications. The NRC should identify all spent fuel pools that were not initially designed to seismic criteria and explain their level of qualification, including the SF racks.

Response:
All spent fuel pools have undergone seismic and structural revaluation, at least once, during licensing review of requests for expanding the spent fuel storage capacity. Spent fuel pool structures, as well as the spent fuel racks undergo detailed analysis and staff review and approval process. Since all currently operating nuclear power plants have expanded their spent fuel storage capacity, they all meet their safe shut down earthquake criteria. Therefore, identification of all spent fuel pools that were not initially designed to seismic criteria is not necessary

DE Public Comment #7:
Not all PWR building housing spent fuel are seismically qualified. The NRC should perform a worst case analysis of the result of a seismic event which collapses the spent fuel pool building, and/or drains the pool and/or damages the spent fuel. Both criticality and zirc fires are of concerns. The nine initiating events listed at p. 11 which could occur concurrent with the earthquake should also be considered if the events contribute to the worst case scenario.

can tie we to T/H analysis?

Response:
The staff identified the following nine initiating event categories to investigate as part of the quantitative risk assessment on SFP risk:
Loss of Off-site Power from plant centered and grid related events
Loss of Off-site Power from events initiated by severe weather
Internal Fire
Loss of Pool Cooling
Loss of Coolant Inventory
Seismic Event
Cask Drop
Aircraft Impact
Tornado Missile

The initiating events indicated above are independent and the event sequences that emanate from each event are carefully modeled in the event tree. This means that a seismic event tree would include the consideration of off-site and on-site power loss. In a PRA assessment no risk insight can be gained by considering worst case combination of truly random and independent events such as a seismic event and a tornado missile. However, the frequency of a combined seismic and tornado missile would be much less than 10^{-8}. Also, with respect to other structures such as crane girders and super-structures, they are covered in the seismic check list for the spent fuel pool structure.

DE Public comment #8:
The NEI seismic checklist requires a seismic engineer to review drawings in addition to conducting a walkdown of the SFP. It has been my experience that many electrical drawings of NAP's do not reflect the existing plant electrical installation. How is the seismic engineer going to verify drawings to the existing SFP building and pool if much of the pool is inaccessible? For

instance, how does he verify concrete degradation under the steel liner? The NRC should require that specific areas be inspected and that these areas be accessible. If these areas are not accessible, then the checklist is not complete and susceptibility to sumac activity remains a concern.

Seismic ?

Response:
The staff considers the review of construction drawings to be very important. Minimum reinforcing areas are dictated by the code and thick walls and slabs forming spent fuel pool structure are in many cases governed by minimum reinforcing requirements. Should there be any additional shear or flexural steel requirements, engineering calculations would indicate where they are needed and how much is needed. Therefore, a review of drawings and design calculations would present a more complete picture. With respect to accessibility, cracks, spalling of concrete and stains and efflorescence are indications of a degradation in progress in inaccessible areas. In order to determine the root cause of the external signs, it is necessary to use more invasive procedures, such as chipping and breaking concrete etc. This is not unique to spent fuel pool structures and there are several examples of this type of inspection in the operating experience of several plants.

Is this acceptable

DE Public Comment #9:

The NRC should specify why it is not cost effective to perform a plant-specific seismic evaluation for each spent fuel pool and what impact this has on safety. Because there are so many differently designed spent fuel pools, it is difficult to perceive how a generic approach could be acceptable without assembling a list of similar &/or identical designs and performing a seismic evaluation of the various groups which are assembled. Specific seismic evaluations for each plant or groups of similar/identical plants should be considered.

Response:
A significant body of work exists characterizing the strength and capacity of shear walls based on tests and analyses. The use of a generic parameter, with the underpinning of data, that is to be used solely for the purpose of screening is very appropriate and reliable. Provided that all the conditions in the check list are met, only then a structure could be screened in. At sites where the prescribed seismic demand is greater than the 0.5g peak ground acceleration value or the 1.2g spectral acceleration value, a plant specific evaluation is to be conducted. The use of a screening parameter is a reliable way to determine the need for further evaluation. This concept was developed without any consideration of cost.

SECURITY/EP/RESIN FIRE/WORKER SAFETY (FROM IOLB)

IOLB Public Comment #1: Section 4.3.2, "Security" of the draft report casks a shadow on the entire 10 CFR 73.51 rulemaking and needs to clarify the scope of the safety issues. The last paragraph in Section 4.3.2 should be clear and completely identify the scope and basis of the ISFSI safety concerns from the radiological sabotage and theft identified in 10 CFR 73.1. Finally, the last paragraph appears to contradict the May 15, 1998, NRC rulemaking on Physical Protection for Spent Nuclear Fuel and High-Level Radioactive Waste, Federal Register Vol. 63, No. 94 Pages 26955 - 26963.

Response:
The NRC staff agrees that Section 4.3.2, Security, as written, appears to be inconsistent with the changes to Part 73 as described in FRN 26955 dated May 15,1998. The description of risk associated with potential criticality and fuel heat up is for spent nuclear fuel (SNF) recently discharged from the reactor vessel and not SNF stored at an ISFSI. The staff acknowledges that this section needs to be rewritten to properly described the staff's understanding of these two risks. Therefore, this section has been revised.

Right justified

The staff believes that as written 10 CFR 73.51, provides proper physical protection for the storage of all spent nuclear fuel (wet or dry storage) at an ISFSI. The design basis threat for radiological sabotage of power reactors under 10 CFR 73.1 is not considered appropriate for the types of facilities subject to 73.51 and therefore, a separate protection goal is defined for these facilities. The protection goal states that "The physical protection system must be designed to protect against loss of control of the facility that could be sufficient to cause radiation exposure exceeding the dose as described in 10 CFR 72.106 and referenced by 73.51(b)(3)".

Is this part of the review?

With regard to protection against malevolent use of land-based vehicle, NRC continues to believe there is no compelling justification for requiring a vehicle barrier as perimeter protection at this time. The staff will however, continue to review the requirements to ensure that proper level of security is provided for new cask designs and other changing technologies.

IOLB Public comment 2: With new personnel and decommissioning personnel, what methods are available to instill or ensure the same "safety culture" as during operation?

Response:
There are several methods of instilling/ensuring "safety culture" in new ~~personnel~~ employees at both operating and decommissioning facilities. Methods include management policies and procedures, training, and qualification. OSHA requires employers to provide employees with safety training and education. 29 CFR 1926.21(b)(2) requires training in the recognition and avoidance of unsafe conditions, 29 CFR 1926.21(b)(3) requires training in the safe handling and use of poisons, caustics, and other harmful substances, 29 CFR 1926.21(b)(5) requires training in the safe handling and use of flammable liquids, gases, or toxic materials, and 29 CFR 1926.21(b)(6) requires confined or enclosed space training. In addition, 10 CFR 50.120 requires training and qualification of nine categories of personnel involved with spent fuel pool maintenance and support. The training programs for the nine categories of personnel should include occupational safety and radiation protection training. While NRC and OSHA require training, it is incumbent upon the licensee to provide the training and instill/ensure upon the workers the proper "safety culture."

Can we use this in part of criticality effects?

IOLB Public comment #3: The report concludes that there is no methodology currently available to access probabilities of terrorist activity or behaviors which might culminate in attempted sabotage of spent fuel. We disagree. For instance, Sandia National Laboratories, a key contractor employed by the NRC on security matters, has applied a probabilistic approach to security in decommissioning on the Maine Yankee docket. We encourage the staff to review this report.

Response:
The staff disagrees with this comment and again states there is no methodology available to access the probability of terrorist activity. The report in question, its identity verified through NEI, is ~~the~~ "A Vulnerability Analysis of a Proposed Security Plan for the Maine Yankee Power Plant," dated January 9, 1998. The purpose of this report was twofold, first it is to present the results of an analysis of the effectiveness of the proposed physical security system in preventing or mitigating an attempt by the design basis threat adversaries attempting radiological sabotage and secondly to present the results of a study to determine the need for a vehicle barrier systems. This report does not predict the probability of terrorist activities or behaviors. The staff has read this report, and conducted an on site inspection (June 8, 1999) of its technical finding and found them to be deficient. It is recommended that NEI read this report.

entitled

Why NEI?

IOLB Public comment #4: The decommissioning rule should specify that the licensee is excused from 10 CFR 50.47 offsite EP requirements after the short lived nuclides important to dose have undergone substantial decay resulting in offsite dose consequences due to license basis accidents of less than 1 rem (the EPA protective action guideline).

Response:
The staff has considered the decay time of short lived nuclides and the offsite dose consequences along with the risks of both design basis accidents and beyond design basis events in efforts to determine an appropriate point at which requirements for offsite EP could be relaxed. The staff also considered the effects of the substantial decay heat and longer lived nuclides available in stored spent fuel which would could result in offsite dose consequences. In consideration of these effects and the associated risks the staff has proposed the one year decay time before considering relaxation of offsite emergency planning requirements.

IOLB Public comment #5: What does "reducing unnecessary regulatory burden" mean in practice when it comes to emergency planning? What kind of reductions are foreseen for the following: manpower onsite/offsite, emergency equipment, communication means, alarm means, notification of personnel/public, EP, plans, KI, EPZ radius?

Did we answer.

Response:
The specific reductions in the areas mentioned is a subject that is beyond the intent of this study. Generally speaking it is anticipated that onsite manpower could be reduced early in the decommissioning process provided adequate personnel are available to provide emergency response duties. Offsite manpower needs, equipment, communication, alarms, notifications, plans, and planning areas, would be relaxed consistent with the relaxation of requirements for offsite emergency planning. The consideration of the use of KI would not be necessary when iodine releases are no longer a concern.

IOLB Public comment #6: It's conspicuously absent form your review of risk in this overall subject, that we (the staff) haven't looked at the issue of sabotage and terrorism. (comment from a member of the public)

Response:
The commenter is correct that security is identified but not highlighted in the report. The report was a technical study to quantify the risks as it relates to the draining of a decommissioned spent fuel pool and the issue of a zirconium fire. Its was not intended to address security in any detail. The integrated rulemaking, which is an out growth of the technical study, addresses safeguards as one of the major components of the decommissioning integrated rulemaking. An entire section is devoted to security with none of the requirements less than those currently required in 10CFR 73.51. A rulemaking package is before the Commission which details the schedule for the rulemaking. As with any rulemaking there will be opportunities for the public to comment on the security requirements the staff is recommending.

IOLB Public comment #7: A commenter requested that the consequences of an offsite radiological release from an onsite fire involving radioactive material from a resin container fire; fire in a waste storage building; and fire in a container vehicle with waste stored in it that could trigger emergency response mechanisms, be re-evaluated.

Response:
This evaluation is beyond the scope of this study which is focused on spent fuel pool accident risk.
Check with DLPM

IOLB Public comment #8: Discuss protection of plant workers, particularly for less severe accidents such as pool uncovery without a zirc fire.

Response:
Existing regulatory requirements address the need for emergency plans to consider protective actions and a means for controlling exposures in an emergency for emergency workers as well as the public. see #2 can we expand.

IOLB Public comment #9: Asked about calculations for radiation dose experienced by members of the fire brigade responding to resin fires.

Response:
Comments #8 and #9 are very similar in nature, the comments ask about the protection of emergency responders onsite. In accordance with existing emergency planning requirements each site has established procedures for the protection of works responding to emergency situations. General these procedures include the consideration of radiological conditions when responding to events. 10CFR DLPM.

SPLB Public Comment Responses (Not sure what specific technical area these responses fall under - may need to be separated into the other technical areas).

SPLB Public Comment #1: Heavy objects, such as crane rail or masonry wall, falling into the SFP or taking out electricity during decommissioning activities.

Response:
The loss of electricity and the control of heavy loads were considered in the study. The loss of electricity would result in a loss of the spent fuel pool cooling system. Industry Decommissioning Commitment (IDC) # 1 and Staff Decommissioning Assumption (SDA) # 2 both deal with controlling heavy loads over the spent fuel pool. With regards to a masonry wall, any design feature specific to an individual plant would be dealt with on a case-by-case basis.

SPLB Public Comment #2: Is SBO [station black out] of the SFP area acceptable?

Repeat Question add this comment to SPSB #7

~~With regards to spent fuel accidents, if a decommissioning plant lost off-site and on-site power (station black out), the spent fuel pool cooling system would not function. As shown in the study, the loss of the pool cooling system is a slow event. The study looked at the loss of cooling to the spent fuel after one year following final shut down and the loss of cooling would not be a safety concern for several days to weeks. In this time, the licensee could restore power or find alterative means for cooling. Several industry decommissioning commitments are directed at assisting on-site personnel to identify and maintain adequate water in the spent fuel pool and to ensure resources are available for personnel to address the loss of the cooling system.~~

SPLB Public Comment #3: Could foreign materials with lower ignition temperatures enter a drained SFP and catch fire, thus raising the temperature of SF to the point of rapid zirconium oxidation?

Response:
Licensee have programs to keep any objects from unintentionally entering the spent fuel pool (called foreign objects). Retrievable foreign objects that fall into the pool are moved to designated storage areas within the pool. The staff does not have any evidence to show that the current foreign object exclusion program are unacceptable. The staff determined that additional analysis is not merited at this time.

SPLB Public Comment #4: Since the National Severe Storm Center is predicting more frequent and more intense severe weather phenomena, shouldn't the size and velocity of wind-driven missiles and maximum height of storm surges be reassessed?

Response:
The agency can not change regulations based solely on predictions. If a licensee requests to change its licensing basis dealing with storms or storm-generated missiles, then they would look at more recent data since the licensing of the plant.

SPLB Public Comment #5: How can there be no SFP degradation issues if type 304 stainless steel employed in fuel racks and assemblies is known to exhibit stress-corrosion cracking in oxygenated or stagnant borated water?

Response:
Type 304 stainless steel material is susceptible to stress corrosion cracking in oxygenated water environment at relatively high temperature conditions. At the temperature levels that exist in the spent fuel pools, stress corrosion cracking of the spent fuel racks made of stainless steel is not a concern and there has been no report of any actual incidence of stress corrosion cracking of spent fuel racks. Stagnant, borated condition of the spent fuel pool water is not a significant factor in inducing stress corrosion cracking of the racks. Most spent fuel assemblies are clad with zirconium and are not known to be susceptible to stress corrosion cracking.

SPLB Public Comment #6: The draft report should be revised to include credible hazards to plant workers at permanently closed plants.

Response:
While the staff is concerned about the worker safety at decommissioning plants, this study focused on spent fuel pool accidents. There are many topics related to spent fuel accidents, all aspects or other types of accidents were not included in the study. OSHA and NRC regulations require safety training and education, including safe handling and use of poisons, caustics, flammable liquids, gases and toxic materials; radiation protection; and occupational safety. Worker safety will be looked at under the consolidated rulemaking for decommisssioning plants. This study will be considered when worker safety is addressed.

SPLB Public Comment #7: All pools leak, dry storage is the only way for long term safety.

SPLB Public Comment #8: The NRC should identify all SFP's that leak. Degradation of the lines and concrete should be investigated. The leaks should be sealed.

Response to #7 & #8:
All pools do not leak. Further, the statement that all pools leak implies leakage to the environment. Most pools have a leak detection system between the steel liner and the concrete wall to identify and quantify if leakage from the liner occurs. This is not leakage to the environment. This water is collected by the system in the plant. This system allows licensees to monitor a situation and evaluate if there is a safety concern.

Dry storage casks are a viable option for spent fuel storage for licensees. Dry storage casks are currently approved for fuel that have been removed from the reactor for at least five years.

SPLB Public Comment #9: The NRC should determine the qualifications and degradation of spent fuel racks.

Response:
Spent fuel rack designs are reviewed and approved by the NRC. The staff technical reviewers are provided guidelines in NUREG-0800, Standard Review Plan (SRP). The SRP incorporates the regulations specified in the Code of Federal Regulations, Appendix A, General Design Criteria which requires safe handling and storage under normal and accident conditions.

SPLB Public Comment #10: The NRC should determine the proper methods of extinguishing a possible zirconium fire.

Response:
At the present time, the state-of-art for zirconium fire experiments has not advanced to researching the various methods for extinguishing. Additional research would need to be performed to investigate acceptable methods, required quantities, conditions of use, and guidelines. Due to the low probability of the event, this research is not recommended at this time.

SPLB Public Comment #11: What happened to the commitment verbally agreed up on through Mr. Meisner of Maine Yankee to install a single failure proof crane system using safety grade electrical equipment.

Response:
NEI verbally committed decommissioning plants to implement Phase II of NUREG-0612 (Control of Heavy Loads), which prescribed the use of single failure proof cranes or to implement a load drop analysis. NEI provided this commitment in writing on November 12, 1999. The commitment was included in the analysis and documented in the report as Industry Decommissioning Commitment #1.

SPLB Public Comment #12: The draft report omitted acts of sabotage and vandalism. Emergency evacuation plans should be prepared with this consideration of terrorism.

Response:

SPLB Public Comment #13: ~~Atherton comment: It is suggested that NRC "err on the side of safety" since terrorist acts can not be specifically addressed. [Ref. 7]~~ **~~SPLB coordinate with Safeguards~~**

Repeat question - add this comment to IOLB comment #6

~~While acts of sabotage and vandalism were not directly addressed in the report, insights for necessary safeguards, in addition to the design basis safeguards events, will be taken from the results of the study.~~