From: Richard Emch
To: George Hubbard
Date: Friday, July 07, 2000 02:03 PM
Subject: Respose to Public Comments

Attached is Glenn's input to response to comments. I have reviewed and approved his input.

CC: Glenn Kelly, Mark Rubin

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Version post-Joe
Response2.wpd
Version 2   7/06/00 2:00pm

July 6, 2000

NOTE TO: Rich Emch

FROM: Glenn Kelly

SUBJECT: NEED TO PROVIDE RESPONSE TO PUBLIC COMMENTS BY 7/7/2000

Enclosed is a copy of the proposed response to public comments on the draft final report on SFP risk at decommissioning plants. Mike Cheok has looked at this already. When you are satisfied with it, I will email it to George Hubbard (if you complete your review today), otherwise I will send you an email copy you can markup and send to George, as I will be on CWS tomorrow.

SPSB RESPONSE TO PUBLIC COMMENTS ON THE "DRAFT FINAL TECHNICAL STUDY OF SPENT FUEL POOL ACCIDENT RISK AT DECOMMISSIONING PLANTS"

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 shutdown 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 continued 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 $7.0x10^{-7}$ per year, without consideration of recovery actions. These values are also a small fraction of the estimated frequencies for the loss of cooling initiator ($3.0x10^{-3}$ per year), the internal fire initiator ($3.0x10^{-3}$ per year), or the loss of inventory initiator ($1.0x10^{-3}$ 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.

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.)

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.

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.

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 discussion of conservatisms associated with the design bases earthquake should be moved to a separate section in Appendix 2b. Furthermore, the~~

~~deterministic method used by the staff should be contrasted with the probabilistic method.~~

~~Response: **[this is an editorial comment and should be dropped]**~~

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.

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 commentator 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.