What needs to be said
9/22/99

AREAS PREVIOUSLY DISCUSSED WITH NEI

1. NEI asked for NRC to release the preliminary "Draft Technical Study of Spent Fuel Pool Accidents for Decommissioning Plants" (draft report) even though it was made clear that this was preliminary and the staff intended to subject the draft to technical review by independent reviewers. NEI was told the final report would be part of the technical basis for deciding how to provide guidance on exemption requests and reviews for decommissioning plants in the areas of emergency preparedness, safeguards, and insurance. The final report probably would provide the technical bases for rule making on this issue also. The staff stated various times that the draft report was a preliminary risk assessment (two months in preparation) that would not be used to make regulatory decisions.

2. NEI was told that the draft report was provided to them at a preliminary stage at NEI's insistence. The draft report attempted to provide a risk perspective for a full range of initiating events for decommissioning plants, unlike previous NRC analyses that were either limited in scope, highly focused, or applicable to operating reactors only.

3. NEI was told that the primary purpose of the draft report was to explore the risk associated with operation of spent fuel pools at decommissioning plants on as realistic a basis as possible. The analysis was not performed to determine the applicability of backfits. NEI was told the staff originally expected the analysis would demonstrate that exemptions could be easily justified. Such was not the case.

4. NEI was told that when the staff analyzes rules, it does not approve or endorse them on the basis of a majority of the covered plants being safe, but on the basis of all the plants being safe. We clearly would reject a rule change that left only 50% of the plants in a safe condition.

5. The staff told NEI that the risk assessment was performed in parallel with the deterministic analyses due to the short period scheduled for completion of the decommissioning analysis. The staff acknowledged that the risk assessment was performed in a rapid manner utilizing the services of several senior risk analysts at the NRC. It was assumed that the bounding deterministic evaluations would possibly show that there was no chance of significant offsite consequences (i.e., no zirconium clad fire) for all or most cases. That did not turn out to be the case. The bounding cases were chosen also to assure that they were applicable to all current and future plants as well as potential fuel configurations. The staff told NEI that plant-specific analyses might demonstrate significant margin existed compared to the staff's deterministic calculations in the draft report.

6. The staff stated that all responses to loss of cooling events at decommissioning plants had to be made by certified fuel handlers, as there were no automatic actions at current decommissioning plants.

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7. The staff directly discussed the time window between the spent fuel pool being drained to within three feet of the top of fuel and the beginning of a zirconium fire. NEI was told that it was assumed that the scenerio was unrecoverable once such a water level was reached. This was based on the anticipated radiation fields (perhaps at the 100,000 Rad per hour level at the lip of the pool) once the fuel was uncovered and the probable temperature/humidity in the spent fuel pool building at that time (probably in the 200°F/100% range.) Because of these assumptions, the staff gave no credit for mitigation of the event once it had progressed to this point. In addition the staff did not believe it would be acceptable to have firefighters or plant personnel performing very heroic measures under these conditions to attempt to prevent a zirconium fire.

8. We told NEI there are only two end states for these events: there is a zirconium fire or there is not. Without a fire, there is not enough energy to transport fission products offsite to cause a serious accident (in severe accident space). We made it clear that it would take days (with the exception of seismic and heavy load drop events) to empty the pool to three feet above the fuel. The staff stated the additional hours it would take the spent fuel pool level to drop from three feet above the fuel until the beginning of runaway clad oxidation were insignificant and would have minimal, if any, effect on human reliability analysis results. It certainly would have little effect on insights.

9. The staff repeatedly told NEI that NUREG-1353 does not apply to decommissioning plants since the NUREG examines operating plants that have a full complement of emergency diesel generators, a full complement of offsite power sources, decay heat removal systems capable of aiding the normal spent fuel pool cooling systems, seismically capable makeup systems, multiple makeup sources to the spent fuel pool, multiple makeup systems (several of which have high volume makeup capability), and 24-hour staffing by maintenance personnel. Decommissioning plants often have no emergency diesel generators, only one offsite power line, no large capacity decay heat removal system to assist the skid-mounted replacement spent fuel pool cooling system, limited low volume makeup capability, limited makeup water sources, and only day-shift (4 days a week, none on weekends) maintenance help.

10. The staff told NEI that 1E-6 per year is not our criterion for what is an acceptable frequency for a zirconium fire. No decision on any criteria in this area has been made. In addition, it is not clear to what extent the Quantitative Hhealth Objectives for the NRC Saftey Goal apply to decommissioning plants and severe accidents associated with spent fuel pools.

11. The staff told NEI that we are not contemplating backfits at this time, but are evaluating the technical basis for potential future exemption requests regarding emergency preparedness, insurance, and safeguards at decommissioning plants. Circumstances under which the staff would grant an exemption request do not trigger backfit requirements.

12. On page 39 of the NEI report, it is stated that it appears that the tornado evaluation appears to be bounding for all nuclear sites in the U.S. We explained to NEI that when we perform an evaluation that is to encompass all commercial nuclear power plants in the United States that the analysis normally is performed so that it actually applies to all

of the plants. We attempted to do this for the threat from tornadoes. We explained to NEI that detailed analysis for each plant may differ from our generic analysis.

13. On page 41, NEI states that the 50.59 evaluation process is in place to assist in managing the potential risks associated with new or unusual alignments during decommissioning. During several public meetings we attempted to explain to NEI why 50.59 did not really control spent fuel pool cooling during decommissioning. Under 10CFR50.59, an unreviewed safety question (USQ) exists only if the probability of occurrence or consequences of an accident **previously** analyzed in the safety analysis report may be increased; or if the possibility of a different type of accident than **any** previously analyzed in the safety analysis report may be created; or if the margin of safety defined in the basis for any technical specification is reduced. The event analyzed in safety analysis reports for determination of the adequacy of the spent fuel pool system design is the bundle drop event, not the shipping cask drop, so changing the frequency or consequences of a cask drop does not "trip" the 50.59 USQ process. ***[CONFIRM THIS WITH SPLB]***In addition, since a drop event was analyzed previously, a different type of accident than previously analyzed would not be created. Finally, most of the equipment associated with spent fuel pool cooling and makeup is neither in nor controlled by the technical specifications.

14 On page 54, NEI states that BNL estimates 7 to 17 months as the critical period during which a zirconium fire could occur. We have explained to NEI that the BNL code has some significant non-conservatisms and the fuel configurations analyzed by BNL are not applicable to plants today.

15. On page 34, NEI states that the draft report's evaluation of heavy load drops does not credit resolution of Generic Issue A-36. We explained to NEI and documented in the draft report (pg 32) that the staff's estimates of load drops leading to loss of spent fuel pool inventory gave credit for plants following NUREG-0612 guidelines.

AREAS WHERE WE AGREE WITH NEI

Regardless of the disagreement the staff may have over some statements in the NEI report, there is almost universal approval of the practical risk insights called forth in Section 5.2 of the NEI report. The staff heartily endorses the benefit of these insights and believe that the application of these insights most likely will be adequate to reduce or eliminate the risk from most if not all potential events at decommissioning spent fuel pools so as to render moot the need for significant improvements beyond what is suggested in Section 5.2.

1. The typical plant configurations for BWRs and PWRs were modeled in the draft report essentially the same as described in "A Review of Draft NRC Staff Report: `DRAFT Technical Study of Spent Fuel Pool Accidents for Decommissioning Plants'" (NEI report)

2. The differences between operating plants and decommissioning plants can prove to be important because of the substantially different configuration of the plant and the SFP or because of the reduced complement of electrical power sources in a decommissioning plant.

3. The draft report is unique in identifying the majority of accident types as worthy of additional consideration (NEI characterized them as "risk significant.") We found that previous analyses were not applicable to the configurations found at today's decommissioning plants. The draft report was the first to model actual decommissioning plant configurations. We also found other limitations in earlier analyses that tend to reduce the value of their conclusions on the risk associated with different initiators at decommissioning plants.

4. We agree that the staff has not developed safety goals or other "benchmarks" applicable to operation of spent fuel pools at decommissioning plants. We agree that it is very difficult to try and compare operating reactor safety goals to spent fuel pool accidents (there are several technical reasons for this.)

5. We agree that the endstates for operating reactor accidents are different than for decommissioning plants. Operating reactor endstates, which apply to the operating reactor and not to the spent fuel pool, are differentiated because there are multiple automatic and diverse mitigation systems, there is a containment around the reactor, and there are emergency preparedness procedures in place at the plant and at the state and local levels to evacuate the population in the event of a severe reactor accident. Decommissioning plants do not have any automatic equipment action; all actions must e taken by the certified fuel handlers. Decommissioned plants have limited systems (compared to spent fuel pools at operating reactors as well as to the operating reactor itself) available to provide cooling and makeup to the spent fuel pools. Spent fuel pools do not have containments around them. We are considering the removal of emergency preparedness by exemption for decommissioning plants.

6. The staff agrees that the duration over which there is a risk of zirconium fires at decommissioning plants is plant-specific and should be five years or less.

7. We agree that because substantial offsite resources can be brought to bear in most cases with almost certainty (our risk assessment estimated the failure to mitigate events due to operator inaction, management lack of attention, or failure of offsite resource inaction/failure to be on the order of 1 $x10^{-4}$ per year or less) to mitigate an event.

8. We agree that offsite resources for makeup will not be adequate to mitigate large loss of inventory events at spent fuel pools as is listed in Table 3.2-0).

9. We agree that it would be helpful to have better data and analysis of loss of offsite power initiating event frequency for decommissioning plants.

10. We agree that if the industry pledges to have no cask operations during the window (2to 3 years?) when severe consequences associated with a zirconium cladding fire are possible, then the risk from heavy load drops is negligible.

11. We agree with NEI that different frequencies of fuel uncovery from tornadoes appeared in various places in the draft report. The staff has improved the tornado analysis and will check to assure that the final report uses frequency of fuel uncovery values consistently.

12. We agree that fuel is generally not allowed administratively to be moved in a cask until it has decayed for 5 years. This is because no casks have been approved yet for fuel that has decayed less time than that. However, NRC regulations actually would allow movement of fuel in a cask after one year of decay, if such a cask could be licensed.

AREAS WHERE WE DO NOT AGREE WITH NEI'S ASSESSMENT

1. The staff does not agree that NUREG-1353 applies to decommissioning plants. We do believe that it provides a reasonable representation of the risk associated with most initiating events for spent fuel pools at operating plants.

2. The staff does not agree that its draft report called for backfits at decommissioning plants.

3. The NEI report incorrectly states that the draft report does not consider mitigation on-site and does not consider the time between initial fuel uncovery and complete uncovery.

4. The NEI report appears to misunderstand the difference between the 800°C and 1600°C temperatures regarding when a zirconium fire will occur. The 800 degree C value is the temperature at which runaway oxidation will occur. In a short period (perhaps 20 minutes), the exothermic reaction will have heated the cladding to 1600 degrees C, the temperature at which ignition of the zirconium cladding in air is expected. The 800°C is not an NRC criteria, but is a useful benchmark for when the cladding has reached a temperature (it would have taken hours to get to this temperature) whereby within a very short period a zirconium fire would be expected.

5. The NEI report mischaracterizes the staff's position on the meaning of the deterministic results. The staff found that because the deterministic analyses could not rule out the possibility of a zirconium fire, then it was prudent to perform a risk assessment of the likelihood and consequences of such events.

6. On page 31 and in Table 3.2-0 of the NEI report, it is stated that some plants do not move shipping casks over spent fuel pools, but rather restrict movement to the fuel transfer pit area. NEI then claims this would eliminate heavy load risks. While such restrictions certainly would significantly reduce the risk, drops that could affect fuel transfer tubes, lines penetrating the pool, pool supports, or possibly other plant features would still potentially represent a risk. It may be possible to evaluate these areas during the walkdown and checklist review to be performed to find seismic vulnerabilities. In addition, the risk assessment has to assume that unintended and unplanned events happen. In general, procedural and administrative requirements do not eliminate risk.

7. The staff disagrees that the NRC has established a standard method to perform risk assessments or that NRC has set specific precedents in how a PRA must be performed for a particular area or decision-making arena. The modeling and assumptions used in previous NUREGs that evaluated spent fuel pool risk were tailored for the particular purpose to which they served (e.g., generic issue resolution, backfit evaluation.) The state-of-the-art continues to progress, and the staff is not bound to limit itself to codes and methods that have been superseded by improved versions.

8. On pg 21 of the NEI report, NEI stated that in the NRC SER on AP-600 that he staff recognized that accidents that progress for multiple days without fuel uncovery can be considered not to be a credible event. The key here is that the NRC did look at and evaluate the likelihood of such an event and found for AP-600's situation that the frequency was so low that it need not be evaluated further. Such a case cannot be made at this time for the decommissioning risk assessment results.

9. The staff disagrees that it used bounding deterministic evaluations or conservative assumptions to try and "demonstrate the 'importance' of an issue." If a bounding deterministic evaluations were made, it was in an attempt to provide a useful basis for inclusion of all future decommissioning plant situations. Conservative risk assessment assumptions were made in those instances where there was limited information available or uncertainties were very high.

10. In Table 3.2-0, NEI seems to indicate that it believes that the staff did not use convective or radiative heat transfer in its thermal-hydraulic calculations. This is not so. The staff's calculations used adiabatic heat transfer to conservatively find the limiting time for the fuel to heat up to the runaway oxidation temperature. See discussion of the details of the heat transfer calculations in the staff's "Draft Technical Study of Spent Fuel Pool Accidents for Decommissioning Plants."

11. On page 36, NEI proposes several distributions that could be used to model the endpoints derived from the Navy data for heavy load drops. The reality is that regardless of the distribution used (and none are justified mathematically), the results are close enough to 1E-6 per year to warrant attention by the staff.

12. On page 49, NEI stated that the draft report treated drain down optimistically in that the potential for effective operator mitigative action given a rapid pool drain down is limited if such a drain down will rapidly lower the water level below the bottom of the fuel. In addition NEI noted that there currently is no prohabition against placement of piping or systems with siphon potential below or even near the top of the fuel. The staff modeled large and small drain down events in the draft report. In small drain down events, the normal makeup was assumed to be capable of keeping up with the leak. For large drain down events, fire pumps were deemed necessary for makeup due to their high capacities. While there is no regulation that prohibits lines from penetrating the spent fuel pool below the level of the fuel, nor is there a prohibition against placing lines into the spent fuel pool that potentially could cause a siphon effect, the staff did issue a generic letter on these issues (GL **XXXXX**) that surveyed all plants to search for potential vulnerabilities. Based on the survey, the staff inspected several sites. At this time we believe that there are few to no pipes or lines that could cause rapid siphoning or draining of spent fuel pools down to the level of the top of the spent fuel pool. However, it was correctly pointed out that there is no prohibition to such a design or operational change.

13. On page 52, NEI states that it believes that the risk of a zirconium cladding fire is so low that "substantial plant or procedural modification would appear imprudent after this time" [i.e., 2 to 3 years after the last fuel is unloaded from the reactor.] The staff wishes to note that it has not recommended any plant or procedural changes in its draft report or other documents sent on to the Commission.

14. On pg 61, NEI states that when a point estimate is established, it must also be accompanied by uncertainty bounds on the assessment. In principle, if the information were available or time were adequate to perform such an evaluation, the staff would have performed a full uncertainty analysis. However, the data is so limited in many cases and we have no distributions for the data that it is not practical to provide a mathematically rigorous set of uncertainty bounds.

15. On pgs. 27 and 28 of the NEI report, it is claimed that NEI's reanalysis of the 10 industry events noted in NUREG-1275, Vol. 12 results in zero events being judged applicable to a decommissioning plant. We note that four of the events were eliminated on the basis of implementation of the insights in Section 5.2 of the NEI report. The staff agrees that such implementation would significantly decrease the potential risk from spent fuel pools at decommissioning plants. However, the industry has not committed to implement these concepts and the staff's analysis is a baseline of what exists at decommissioning plants today. We also note that an INEL-96/0334 report listed 30 such events. We are in the process of reviewing this data, and believe that some events may not be applicable to decommissioning plants.

AREAS WHERE NEI NEEDS TO PROVIDE A BASIS FOR ITS CLAIMS OR PROVIDE AN ENHANCED EXPLANATION OF ITS POSITION

1. On pgs. 18 and 21 of the NEI report, it is stated that, "Over 48 hours, the HEPs can be assumed to be negligible and the offsite recovery actions would also be considered feasible." What is the technical basis for assigning negligible values to the HEPs? What methodology did NEI use? In addition, once boiling starts and as time passes the environment in the spent fuel pool area will degrade (high radiation field near the pool, high temperature and humidity, poor visibility), making entry and mitigation efforts extremely difficult. How does NEI's analysis factor the environment in the spent fuel pool area into the HEPs?

2. On pg. 18 of the NEI report it is proposed that 1E-5 per year be the acceptable frequency for the occurrence of a zirconium fire. (A) What is the basis for this proposal? (B) What are the offsite consequences of such a fire? What is the risk? How many early fatalities would there be?

3. On pg. 19 of the NEI report, it states that, "this risk measure [i.e., frequency of fuel uncovery] is potentially extremely conservative for all cases analyzed..." This statement is made without any systematic analysis by NEI that proposes and justifies failure rates or provides relevant references to show that the measure is extremely conservative.

4. On pages 22 and 23, NEI states that the draft report does not provide a probabilistic assessment of information needed to perform a probabilistic risk assessment. (A) NEI should identify exactly where it finds the NRC's assessment to be lacking. (B) In addition, NEI should provide the basis, including database, models, and assumptions, for its claim that security personnel should be modeled in the risk assessment as resources available for mitigation. We are not aware of any nuclear power plant risk assessments that model potential mitigation provided by security.

5. On page 25 of the NEI report, it indicates that NEI believes that there will be no cask movements within five years of shutting the plant down. This conflicts with the NRC's understanding that a number of operating reactors actually are moving casks today while they are operating at full power. Casks cannot be loaded with fuel, at this time, that has been in the pool less than five years. This does not mean that no casks can be loaded for five years after a plant begins decommissioning. Older fuel can be moved by cask at any time, unless NEI is proposing to implement a ban on such movements. NEI needs to clarify what it means by this entry to Table 3.2-0.

6. On page 25 of the NEI report, it appears that NEI believes and took credit for decommissioning plants having their originally installed spent fuel pool cooling system, including all support systems such as the service water system, component cooling water system, and residual heat removal system. The staff's visit to four decommissioning plants in April 1999 seemed to show that decommissioning plants remove such "unnecessary" equipment from service as quickly as possible following shutdown. (A) Does NEI want to declare that the full spent fuel pool cooling system and its support systems as a whole are necessary? (B) What exactly did NEI credit the decommissioning plant as having during the five years it is potentially vulnerable to zirconium cladding fires?

7. On page 25 of the NEI report, "Nominal Estimates" are listed for inputs to the NEI risk assessment such as decay heat load, burnup, zirconium ignition temperature. The draft report released by the staff documented its assumptions and where they came from. For example, per NUREG-1353, decay heat from 20 years of accumulated discharged fuel is estimated to be 3.5 MBTU/hr for a typical spent fuel pool in addition to newly discharged fuel. The heat load from a full core discharge after one year is estimated in the NUREG to be 2.4 MBTU/hr. In the NEI report, the 'Nominal Estimate' value is 2 MBTU/hr. It is unclear what is the basis for NEI's nominal estimates as no references are provided.

8. On page 26 of the NEI report, it appears that NEI believes the frequency of heavy load drops is 3×10^{-8} per year. What is the basis for this number?

9. NEI appears to not like the "data" being used to represent heavy load drops. The NRC welcomes any improved data that NEI can supply in this area.

10. On page 35, NEI states that the "one-in-ten events" assumption for how many load drops results in significant damage is too conservative. NEI should provide any evaluations it has that can provide a better estimate or should provide a basis for whatever conditional probability it proposes.

11. On page 36, NEI states with respect to heavy load drops that "the assessment of human interface improvement associated with this implementation [NUREG-0612, of which only one of two parts was ever implemented] is judged to be on the order of 2 to 3 orders of magnitude." Who has made this judgement and what is the technical basis and where is the data for this estimate?

12. On page 37, NEI states that the assumption for probability of successful equipment repair, which is truncated at 1E-4 per year, is too conservative. NEI needs to explain who has determined that this assumption is too conservative and on what basis? Data

should be provided or a published methodology should be referenced to backup the statement. What value does NEI propose, and what is the basis for the value.

13. On page 40, NEI states that the use of HCLPF methodology is by definition an upper bound analysis and not a best estimate analysis. The staff has no plant-specific information on the seismic capacities of spent fuel pools at any plants. The staff would like NEI to provide plant-specific capacities of spent fuel pools at all plants that will eventually become decommissioning plants so that the staff can perform a best estimate seismic evaluation for each plant.

14. On page 54, NEI criticizes the data used for estimating the temperature at which runaway oxidation and fire begin for zirconium. In particular NEI states that data on air oxidation rate of zirconium tubing that has a corrosion film is lacking. If NEI has data, the staff would appreciate an opportunity to review its applicability to the question at hand. In fact, if NEI has any data that it believes is better than the data the staff has used, we would like to see it or be given a reference for it.

15. In Table 5-1 on page 71, NEI provided its "revised frequency estimates" for various accident initiators and compared them to the staff's estimates. The staff's draft report provided event trees, fault trees, basic event probabilities, and assumptions. No bases were provided for the NEI estimates.