PDR

Docket No. 50-255

January 4, 1994

MEMORANDUM FOR: Edward G. Greenman, Director
Division of Reactor Projects, Region III

FROM: John A. Zwolinski, Assistant Director
for Region III Reactors
Division of Reactor Projects - III/IV/V, NRR

SUBJECT: RESPONSE TO REQUEST FOR TECHNICAL ASSISTANCE (TASK INTERFACE AGREEMENT) REGARDING PALISADES SPENT FUEL DRY CASK STORAGE (AIT NO. 93-0586) (TAC NO. M88109)

In response to your request for technical assistance dated October 21, 1993, regarding the Palisades spent fuel dry cask storage, NRR has obtained assistance from NMSS in reviewing the design and analyses for the dry casks used at Palisades Plant against the regulations set forth in Subpart K of 10 CFR Part 72; specifically, to address the issues of the consequence from a potential liquefaction of the sand dune where the dry cask storage pad is located, thus blocking the dry cask vents, and the effect of the lake water on the cask and the canister that contain the spent fuel assemblies.

The enclosed discussion addresses the above issues that were raised in your memorandum dated October 21, 1993. The staff does not believe that a complete blockage of the VSC-24 dry cask vents, especially one that goes unnoticed by the surveillance program, is credible. In case of a hypothetical complete blockage of the dry cask vents, the staff agrees with the vendor's evaluation that, with no action from the licensee, the peak fuel clad temperature could be reached in about 7 days and the peak concrete temperature could be reached in 30 hours. If you need any clarification or additional information regarding this response, please contact the Palisades Project Manager, Tony Hsia on (301) 504-3028.

Original signed by

John A. Zwolinski, Assistant Director
for Region III Reactors
Division of Reactor Projects, NRR

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ENCLOSURE

TASK INTERFACE AGREEMENT RESPONSE

REGARDING PALISADES SPENT FUEL DRY CASK STORAGE

EFFECTS OF COMPLETE VENT BLOCKAGE

The cask and canister being buried completely in sand was not specifically identified as an accident condition in the VSC-24 cask safety analysis report (SAR) or safety evaluation report (SER). However, the vendor, Pacific Sierra Nuclear Associates (PSNA), investigated the case where the cask vents were completely blocked followed by an adiabatic heatup.[1] This evaluation indicated that with design basis fuel (24 assemblies all at 1 Kw), the peak fuel clad temperature criterion of 1058°F would be reached in about 7 days (162 hours) and the concrete would reach the accident maximum temperature criterion of 350°F in 30 hours. The 1058°F criterion was based on Reference 4 of the NRC safety evaluation dated April 28, 1993, while the 350°F criterion was based on the requirements from American Concrete Institute (ACI) 349-80. For fuel assemblies that are cooled much longer than 5 years out of the reactor and with much less than the maximum 1 Kw, the heat-up rate would be much slower and therefore the time period to recover would also be longer.

Unless the licensee can demonstrate that the cask and canister being buried completely in sand does not constitute an equivalent to the full vent block event, one appropriate time limit that the cask and canister can be buried completely in sand would be 30 hours. In order not to damage the concrete (i.e., to reduce the concrete strength) and be able to continue using the cask without further evaluation, the vent should be reopened and the cask recovered within this 30-hour time period. However, if the licensee can demonstrate that, due to a lower heat load, the accident maximum concrete temperature criteria would not be reached as quickly, or that the concrete strength would have no significant reduction in the design margin due to elevated temperatures over a given time period, then the time period for recovery could be extended accordingly.

An alternative recovery period could be based on the time for the peak fuel clad temperature to reach the accident temperature criteria of 1058°F. According to vendor calculations, that recovery period is approximately 7 days (162 hours). Again, based on lower heat loads and other ambient conditions, this recovery time period could also be extended with proper justification.

The staff does not believe that complete blockage, especially one that goes unnoticed by the surveillance program is credible. However, the effects of complete blockage of all the inlet or all the outlet vents have been studied and there are two potential consequences: high temperatures in the ventilated concrete cask (VCC) and high temperatures in the multi-assembly sealed basket (MSB).

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[1]The Adiabatic Heatup Analysis, PSN Calculation No. WEP 109.003.9, February 15, 1990.

High Temperatures in the VSC

In the highly unlikely hypothetical case of a completely buried cask and canister in the sand, assuming that all inlet and outlet vents are blocked, the final steady state temperatures depend upon highly variable conditions such as the ambient temperatures, the age of fuel, and the heat load within the cask. Under worst-case conditions (adiabatic heat-up and all fuel assemblies at the maximum allowable heat load of 1 kW), the maximum allowable short-term accident temperature criterion of 350°F for the concrete cask could potentially be exceeded in about 30 hours.

This temperature criterion is important because it limits the uncertain effects higher temperatures may have upon the strength and durability of the concrete that makes up the VCC. However, conservative analysis showed that the short-term accident concrete temperature criterion of 350°F could be reached in about 30 hours. A study commissioned by the NRC[2] recommended that long-term concrete temperatures be held to less than 450°F. Good engineering judgment says: the effects of high temperatures over short time periods would not be detrimental to overall VCC strength.

The Certificate of Compliance for Dry Spent Fuel Storage Casks (C of C) issued on May 3, 1993, requires that if the concrete accident temperature criterion has been exceeded for more than 24 hours, the licensee must take action. At worst, they would be required to remove the VCC from service. However, if the licensee can demonstrate that the concrete temperature criterion has not actually been exceeded, such an extreme measure might not be necessary. Even if the analysis determines that the 350°F criterion had been exceeded, the licensee still has alternatives. The ACI code allows testing of the concrete to determine its characteristics. The C of C Specification 1.3.4 permits the licensee to sample and test the VCC concrete in accordance with the ACI code. With acceptable results, the VCC could still be used. However, if the licensee determines it must remove the VCC from service, this action does not pose any health and safety risk to the general public because the VCC is not part of the confinement boundary. During this entire hypothetical event, the MSB remains intact with the spent fuel assemblies safely confined. The MSB could simply be returned to the fuel handling building and loaded into a new VCC.

High Temperatures in the MSB

The second effect of a complete vent blockage would be higher temperatures in the MSB. This in turn could cause the peak fuel clad temperature to exceed the allowable long-term steady-state fuel clad temperature criterion of

[2]Durability of Concrete at High Temperatures, Science Applications International Corporation, WJE No. 871767, August,1988

712°F[3]. However, complete vent blockage is an accident condition and therefore, the short-term fuel clad temperature criterion of 1058°F applies. Under the worst-case conditions (adiabatic heat-up and all fuel assemblies at the maximum allowable heat load of 1 kW), this criterion could potentially be exceeded in approximately 7 days.

High temperatures over short time periods (weeks) would have little or no effect on the fuel integrity. Exceeding the short-term fuel clad temperature criterion of 1058°F could have a damaging effect only if the fuel clad temperature exceeds 1800°F. At that temperature, the fuel pins might start to rupture. This is a serious event, and the surveillance program is designed specifically to identify conditions that could lead to such an occurrence. However, if such a condition were to occur, there would be no public health and safety consequences. Should all the fuel pins rupture, there is never a danger of the resulting pressure increase rupturing the MSB. The total pressure within an MSB during normal operations are negligible. The hypothetical rupture of all fuel pins would only result in an increase in the internal pressures to 49.4 psia. This is well within the allowed pressure levels by designing and fabricating the MSB to the ASME boiler and pressure vessel (B&PV) code, Section III. Therefore, the fuel would remain safely confined within the MSB.

EFFECTS OF LAKE WATER ON THE DRY CASK

In the unlikely hypothetical event that the dry cask is either partially or completely immersed in lake water, the effects of the lake water on the dry cask were considered for its thermal effects and structural effects.

The lake water would provide more efficient heat removal capability to the dry cask than would the surrounding air. The effects that lake water has on the VSC-24 cask should be bounded by the accident condition of flooding evaluated in the VSC-24 SAR (Para. 11.2.5.1) and in the staff's March 29, 1991, SER (Section 3.3.4.1.3, pg. 3-28; Section 3.3.4.2.3, pg. 3-46). Two different flood conditions were considered in the SAR and SER. The effects of flooding were also addressed in the Final Rule that approved the VSC-24 Cask (58 FR 17948).

The first is a fully immersing flood, which could cause a tip over or movement of the cask. The stream velocity required to overturn the cask is 25.2 ft/sec when the flood height is 213 inches. The actual maximum permissible external pressure (to prevent buckling) acting on the MSB as a result of a flood was determined to be 142 psi. This corresponds to a maximum flood height of 328 feet to achieve this pressure, a height which is well above the design criteria.

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[3]The difference between long- and short-term storage criteria is further explained in SER Section 5.0 on preventing diffusion controlled cavity growth (DCCG) and Creep.

The second flood condition is a small flood which only blocks the air inlet ducts and results in increased temperatures for a short period of time. This accident is evaluated in SAR Section 11.2.9, and bounded by the adiabatic heatup analysis discussed above and evaluated in Section 4 of the SER.

The effects of flooding considered below were extracted from the response to public comments in the Final Rule that approved the VSC-24 Cask (58 FR 17948).

15. Comment. The SER states that there is no credible chain of events that could spread contamination from the MSB. Only air-coolant loss due to blockage was considered. Comments indicated that the SER should also consider the effect of flooding of the hot cask and steam explosion. A concern was also expressed regarding the structural integrity of the pads which may, in the case of Palisades, be built on a sand dune area that shifts.

Response. The SER for the VSC-24 cask did consider the effects of flooding as well as air-coolant loss due to blockage of the vents. The analysis showed the release of contamination from the exterior surface of the MSB due to flooding is possible but the resultant contamination would not be significant. Steam explosions involving water contacting molten metal are not credible under dry spent fuel storage conditions. In addition, explosions due to steam forming under flooding conditions are not considered credible due to the fact that if steam were to be formed, it would be released non-violently through the vents. With respect to the comment on structural integrity of the pads, the certificate of compliance requires, per 10 CFR 72.212(b), that written evaluations be performed by the licensee prior to cask use to establish that cask storage pads and areas have been designed to adequately support the static load of the stored casks. Consequently, the structural integrity of the pads would have to be evaluated and verified before the licensee could use the VSC-24 at the Palisades site or at any site.