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UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

February 10, 1999

MEMORANDUM TO: Samuel J. Collins, Director
Office of Nuclear Reactor Regulation

FROM: David B. Matthews, Director *DBM*
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

SUBJECT: NRR STAFF RESPONSE TO BACKFIT REVIEW PANEL FINDINGS

On October 28, 1998, the backfit review panel (the Panel) appointed to review a Maine Yankee backfit appeal issued its report. The report concluded that the NRC did not impose a backfit on the Maine Yankee licensee. However, the Panel's report discussed several additional issues regarding the process and criteria being used by the NRC staff in its evaluation of emergency planning (EP) exemption requests submitted by licensees of permanently shutdown reactors. The Panel's findings formed the basis for the Director's Decision you issued to Maine Yankee on November 6, 1998, regarding their backfit appeal. Subsequent to issuance of the Director's Decision, you requested the NRR staff to assess the findings of the backfit review panel. The staff reviewed the Panel's conclusions and identified the following three areas for comment: (1) the level of detail of the review conducted by the staff, (2) the timeliness of the review, and (3) the applicability of certain technical conclusions relied upon by the Panel. The staff also noted that the panel agreed with Maine Yankee's claim that the application of the backfit rule should not depend on whether a change comes from an NRC initiative or a licensee application. This position contradicts OGC's current view on this issue.

1. Level of detail of review conducted by the staff

The Panel concluded that "the staff sought to develop an absolute safety finding rather than a risk-informed reasonable assurance finding" in granting an exemption from certain requirements of offsite EP to Maine Yankee. In addition, based on the amount of time that Maine Yankee had been shut down, the panel stated that "complex analyses of heat-up rates and extensive reviews of computer codes as the staff initially requested in this case are not required" and concluded that "the staff had ample opportunity to establish reasonable assurance that public health and safety was protected without going into such technical depth."

The staff's practices regarding EP exemptions at permanently shutdown reactors evolved from SECY 93-127, "Financial Protection Required of Licensees of Large Nuclear Power Plants During Decommissioning," dated May 10, 1993, and its associated Staff Requirements Memorandum (SRM), issued on July 13, 1993. In the SRM, the Commission directed the staff to "allow, after a requisite minimum spent fuel pool cooling period has elapsed, a reduction in the amount of financial protection required" at permanently shutdown facilities. In addition, the

CONTACT: Michael K. Webb, DRPM/NRR
415-1347 701

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Commission directed the staff to proceed with rulemaking "to determine more precisely the appropriate spent fuel cooling period after plant shut down" beyond which offsite liability insurance coverage could be reduced. In SECY 93-127, the staff identified that the zirconium fuel cladding fire was possible for "the first two to three years after shut down for spent fuel stored in certain high density configurations." Although this accident scenario is a beyond-design-basis event, in SECY 93-127, it was determined to be the most "significant accident sequence" for a permanently shutdown reactor and was found to be "reasonably conceivable" for the purposes of evaluating the need for offsite liability insurance. The need for offsite emergency preparedness is based on a spectrum of severe accidents which is not limited to design basis events. The mean probability of the spent fuel pool draindown scenario is 2×10^{-6} per reactor year and its consequences, if a zirconium fire results, would be extensive. Thus, since the issuance of the SECY 93-127 SRM, the staff's review of decommissioning EP exemptions for permanently shutdown reactors has considered the complete loss of spent fuel pool water and subsequent heatup of the fuel as one of the accidents that must be evaluated to show that the facility does not pose any undue risk to the public. Licensees have performed calculations to determine the plant-specific spent fuel pool cooling periods necessary to preclude a zirconium cladding fire. The staff reviewed these submittals to confirm that a zirconium fire was not possible before approving the exemption requests.

The Commission, in the SRM on SECY 93-127, directed the staff to proceed with rulemaking to determine the appropriate spent fuel cooling period after shutdown to preclude a zirconium fire. The staff initiated a rulemaking effort with the Office of Nuclear Regulatory Research that included technical support from Brookhaven National Laboratory (BNL). BNL was tasked to identify existing codes that could perform these calculations or to develop a code that the staff and licensees could use to determine appropriate plant-specific spent fuel cooling periods. BNL concluded that existing codes were not sufficient and that a new code must be developed for this specific use. The staff planned to use the new code to perform sensitivity analyses to establish "generic" spent fuel cooling periods for use in an emergency planning rulemaking which would eliminate the need for EP exemptions at permanently shutdown plants.

While code development was ongoing at BNL, the staff went ahead with rulemaking efforts and on June 16, 1997, forwarded SECY 97-120, "Rulemaking Plan for Emergency Planning Requirements for Permanently Shutdown Nuclear Power Plant Site 10 CFR 50.54(q) and (t); 10 CFR 50.47; and Appendix E to 10 CFR Part 50" to the Commission for review. Option 2 of the Rulemaking Plan proposed that the reduction in offsite EP would occur when "the spent fuel in the spent fuel pool is no longer susceptible to a zirconium cladding fire . . . in the event the spent fuel pool is drained." The Commission directed the staff to proceed with this option in its SRM of July 10, 1997. Thus, in approving the rulemaking plan, the Commission also endorsed the criteria that the staff had been using since July 1993 for EP exemptions.

In August 1997, in response to an allegation related to the Haddam Neck facility (NRR-97-A-0048) regarding the safety of spent fuel storage after permanent reactor shutdown, the NRC staff replied to a member of the public stating that "the staff will require the licensee to submit analysis of the worst case radiological event and determine the level of emergency preparedness required at the site to handle this worst case scenario. The safety analyses will ensure that spent fuel pool water loss scenarios for shutdown power plants will be analyzed in establishing the worst case radiological event." This letter was shared by the allegor with other active members of the public in the vicinity of the Maine Yankee plant. Several of those individuals then contacted the NRC and requested that the staff ensure the same level of

protection for the Maine Yankee residents as was afforded to persons living near Haddam Neck. The discussion of this topic with stakeholders in the public domain underscored the need for the staff to maintain a reasonably consistent position on this issue in all exemptions and safety evaluations issued for emergency planning at shutdown plants.

Also, in August 1997, the staff published contractor report NUREG/CR-6451, "A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants," which provided an assessment of risk at permanently shutdown plants and recommendations for an appropriate level of regulatory requirements and potential reduction of those requirements over time following shutdown. This report was based on the new code developed by Brookhaven and was part of the effort to calculate spent fuel cooling time periods beyond which the spent fuel would lack sufficient decay heat to cause cladding oxidation. The Brookhaven analysis suggested that the critical decay time was 17 months for the "representative" PWR and 7 months for the "representative" BWR¹, but cautioned that the "representative" geometries analyzed did not necessarily include the most limiting configurations.

On November 6, 1997, Maine Yankee submitted a request seeking exemption from certain offsite emergency preparedness requirements. In its request, Maine Yankee indicated that it had undertaken a plant-specific analysis of the susceptibility of its spent fuel to an accidental radiological release in the event that the spent fuel pool is drained. On January 20, 1998, Maine Yankee submitted a request seeking exemption from the insurance requirements of 10 CFR 50.54(w) (onsite liability) and 10 CFR 140.11 (offsite liability). The submittal stated an analysis of the Maine Yankee spent fuel indicated that after January 16, 1998 (approximately 13 months after final reactor shutdown), natural circulation of air was sufficient to keep the cladding temperature below 565°C. This temperature (565°C) represents the onset of early clad failure and was the point at which significant reductions in insurance coverage were to be granted by the proposed rule on insurance requirements for permanently shutdown reactors approved by the Commission and published in Federal Register on October 30, 1997 (62FR58690). Staff review of the licensee's analysis identified non-conservative modeling errors and inconsistencies that could significantly increase the actual cladding temperature. The staff asked the licensee to address these issues in two requests for additional information (RAI). Maine Yankee never provided a response to the second RAI, issued on July 6, 1998. To this date, the accuracy of their heatup analysis remains an unresolved issue.

On February 17, 1998, Maine Yankee filed its backfit claim. On March 24, 1998, the staff briefed the NRR Office Director on the process it was using to evaluate the three active EP exemption requests (Haddam Neck, Maine Yankee, and Big Rock Point).

The staff continued to review the Maine Yankee EP exemption in accordance with the approved Option 2 of SECY 97-120; i.e., that the reduction in EP could occur when "the spent fuel in the spent fuel pools is no longer susceptible to a zirconium cladding fire . . . in the event the spent fuel pool is drained." The review plan was consistent with criteria and objectives previously outlined to the Commission, NRR management, and the public. Since the licensee became unresponsive to staff questions intended to verify the accuracy of the Maine Yankee heatup analysis, NRR managers and staff met to develop an approach to complete the evaluation without licensee input. As part of the effort, the staff performed its own simplified heatup

¹The NRC staff has recently identified some modeling and code errors in the Brookhaven report. Preliminary assessment indicates that the critical decay times may increase significantly.

analysis of the Maine Yankee spent fuel pool in order to expedite the approval process. Once the staff's own heatup analysis was completed, the staff moved quickly to finalize the review and develop a rationale for accepting the exemption, which was issued on September 3, 1998. The exemption could not have been issued before the staff completed its analysis because neither the NRC staff nor the licensee could provide a technical basis (either plant-specific or generic) to show that the zirconium fire scenario was not still a reasonably conceivable event. Thus, the staff believes it used an approval process with the appropriate depth of review regarding this issue.

2. Timeliness of the staff review

The Panel concluded that "the most compelling observation was the lack of staff sensitivity to elapsed time and schedules confronting decommissioning power plants."

The staff performed a review of all decommissioning licensing actions performed for plants that entered the decommissioning process during the last 5 years: Haddam Neck, Big Rock Point, Maine Yankee, and Zion Units 1 and 2. The staff determined that 31 of 36 completed or open licensing actions (86 percent) are less than 1 year old, 36 of 36 total licensing actions (100 percent) are less than 2 years old, and no licensing action is more than 2 years old. These data compare with the Fiscal Year (FY) 1998 - 1999 NRR timeliness goals of 80 percent of actions less than or equal to 1 year old, 95 percent of actions less than or equal to 2 years old, and all licensing actions less than or equal to 3 years old. It is also important to note that 4 of the 5 actions that exceeded 1 year of age were for the Haddam Neck facility. The completion of these actions was delayed in order to address offsite release of radioactive material issues that arose at Haddam Neck and caused the staff to respond by diverting substantial project management resources that otherwise would have been used to process licensing actions. In the specific case of Maine Yankee's EP exemption, the elapsed time from the date of their request to issuance of the exemption was slightly less than 10 months. To ease the burden for future licensees and reduce the amount of time required for a review, the staff is attempting to establish criteria during the current decommissioning rulemaking that would not require a licensee to submit an analysis to demonstrate that the zircaloy fire was no longer a reasonably credible event.

3. Applicability of certain technical conclusions relied upon by the Panel

A number of characterizations in the Panel's report did not reflect all of the information available to the staff regarding spent fuel pool heatup scenarios. Discussions of specific examples are provided below.

The panel's review relied upon the following information from NUREG-1353: "[f]or a zirconium clad fire to occur, the fuel must be recently discharged (between 30 and 180 days in a cylindrical BWR configuration, and between 30 and 250 days in a cylindrical PWR configuration)." However, this conclusion is applicable only to cylindrical (low-density) PWR spent fuel storage configurations. Most facilities, including Maine Yankee, utilize high density storage racks. The staff is unaware of any power reactor facilities that continue to store all their fuel in a cylindrical configuration. (Note that NUREG-1353 was published in 1989 before many plants completed re-racking their spent fuel pools.) For the Maine Yankee high density spent fuel pool configuration, Table 4.5.1 of NUREG-1353 lists the critical spent fuel cooling time to preclude a zirconium fire as 360 to 700 days (roughly 1 to 2 years). Thus, the data contained in

NUREG-1353 does not support a conclusion that a zirconium fire was not "reasonably credible"² at Maine Yankee which had been shut down only 11 months at the time the EP exemption request was submitted to the NRC. The staff's approval of the Maine Yankee exemption on September 3, 1998, about 21 months after plant shutdown, could not have been granted by using available generic data; the plant-specific heat up analysis required by the staff was judged to be essential to provide reasonable assurance of public health and safety.

The Panel stated a conclusion derived from NUREG-1353 that 1 year after shutdown, the population dose resulting from a spent fuel pool draindown scenario decreases from 2,600,000 person-rem to 4 person-rem. However, this statement compares a zirconium fire release 30 days after shutdown to a gap release of 50 percent of the fuel with no fire at 1 year after shutdown. While the Panel's conclusion might be appropriate for the cylindrical PWR storage configuration after 1 year, it is not applicable to the high density racks at Maine Yankee as discussed in the previous paragraph. Because it is still possible to have a zirconium fire beyond 1 year after shutdown when spent fuel is stored in high density racks, actual dose consequences of such a draindown at Maine Yankee would be much higher than the 4 person-rem value cited by the Panel.

The Panel cited a conclusion from NUREG-1353 that "for spent fuel pool accidents, there are no 'early fatalities' and the risk of early injury is negligible." The Panel is correct that NUREG-1353 makes this statement. However, there is no reference data in NUREG-1353 that supports the assertion. Another analysis was completed in 1997 by Brookhaven National Laboratory and documented in NUREG/CR-6451. When BNL analyzed the consequences of a spent fuel pool fire, it found that early injury could occur and calculated prompt fatalities ranging from 0.2 to 101 deaths within a 500-mile radius (NUREG/CR-6451; Tables 4.1 and 4.2). For perspective, BNL then compared these consequences with previously published consequences of core melt accidents. For a major core melt accident with prompt evacuation, 88 prompt fatalities were calculated within a 500-mile radius (NUREG/CR-6451; Table 4.3). Thus, the consequences of a spent fuel pool fire could be significant.

While the Panel's report did not specifically address what offsite dose criteria should be used for determining whether a reasonably conceivable event has consequences that require offsite emergency planning, the Panel's discussion of early fatalities and risk of early injury might imply that emergency planning is not needed unless early injury is expected. In reviewing the Maine Yankee exemption, the staff used the EPA Protective Action Guidelines (1 rem whole body, 5 rem thyroid) as the threshold for determining the need for offsite EP. These EPA guidelines have been used since 1978 by the NRC when evaluating emergency plans to determine when offsite protective actions are needed.

The Panel stated that the mean probability of a seismic event leading to a complete draindown (and assumed zirconium clad fire) is 2×10^{-6} per reactor year. Although accurate as the mean value, this single number does not account for the range of uncertainty in the probabilistic data. These uncertainties should be considered when using probabilistic data to make risk-informed judgements. In this case, Table S.1 of NUREG/CR-4982 specifies the range of uncertainty which is from 2.6×10^{-4} to 1.6×10^{-10} for PWRs and 6.5×10^{-5} to 4×10^{-11} for BWRs. These very large uncertainties associated with the estimated frequency of seismic-induced spent fuel pool failure led the staff to conclude that the risk of a spent fuel pool fire was significant enough to ask the licensee to perform an analysis.

²In its report, the panel used the term "reasonably credible" event. For the purposes of this paper, the staff has interpreted "reasonably credible" to be synonymous with "reasonably conceivable" as used in SECY 93-127.

The Panel's report noted that the Trojan licensee justified that its pool was designed to seismic criteria that essentially precluded a credible seismic event that would lead to a loss of water inventory. The report implies that the NRC staff should have concluded that the Maine Yankee spent fuel pool had similar margins. However, to demonstrate the robust seismic design of the Trojan spent fuel pool, its licensee submitted a seismic margins assessment that quantitatively demonstrated that it could withstand a seismic event eight times greater than the design basis seismic event. The NRC staff could not have made a similar finding on Maine Yankee without a seismic margins assessment of the pool. No such analyses were performed or submitted by Maine Yankee.