Executive Summary

This report documents an evaluation of spent fuel pool accident risks at decommissioning plants. It was done to provide an interim, risk-informed technical basis for reviewing exemption requests, and to provide a regulatory framework for integrated rulemaking. The application of this report is intended to eliminate to the extent practical, unnecessary regulatory burden, thereby improving efficiency and effectiveness of the regulatory process. By establishing a consistent, predictable process fully open to public observation and comment, the agency intends to enhance public confidence in the regulatory process for decommissioning reactors. The report was initiated by the Commission when they asked the staff to consider whether the risk from decommissioning plants was low enough to justify generic regulatory relief in the areas of emergency planning, indemnification and safeguards.

The current body of NRC regulations pertaining to light-water reactors (10 CFR 50) [Ref. 1] is primarily directed towards the safety of operating units. It is generally understood that this body of regulations is conservative when a plant transitions from an operating to a decommissioned status. In the past, decommissioning plants have requested exemptions to certain regulations as a result of their permanently defueled condition. When evaluating the acceptability of exemption requests from regulations for permanently shutdown plants, the staff has assessed the susceptibility of the spent fuel to a zirconium fire accident. To date, exemptions have been granted on a plant-specific basis, resulting in different analyses and criteria being used for the basis of the exemptions. In some cases, we have requested heat up evaluations of the spent fuel cooled only by air. This criterion was used because of national laboratory studies that had identified the potential concern for a significant offsite radiological release from a zirconium fire which could occur when all water is lost from the spent fuel pool. A clad temperature of 565 °C, based on the onset of clad swelling, was used as a conservative limit to ensure no radiological release.

In March, 1999, the staff formed a technical working group to evaluate spent fuel pool accident risks at decommissioning plants. A two month effort was launched to review the available technical information and methods and identify areas in need of further work. A substantial effort was made to involve public and industry representatives throughout the entire effort. A series of public meetings was held with stakeholders during and following the generation of a preliminary draft study that was published in June at the request of the Nuclear Energy Institute (NEI). The partially completed DRAFT report was released to facilitate a stakeholder/NRC two day workshop that was held in July, 1999. Information gained at the workshop and through other stakeholder interactions was constructive in completing the report.

Estimates of the risk from heavy load handling accidents were revised and criticality concerns were addressed in response to stakeholder feedback. A checklist was developed to establish seismic capability of SFPs, and industry commitments were documented to address the vulnerabilities that had been identified by the June, 1999 draft report. Independent technical quality reviews of controversial aspects of the report were initiated to bring in outside expert opinion on the details of the report. These experts evaluated several areas of the report, including the human reliability analysis, seismic considerations, thermal-hydraulic calculations, and PRA assumptions and treatment. The PRA results were requantified to take into account the industry commitments to reduce risk vulnerabilities.

This report contains the results of our effort. It includes four main outputs. The first is a discussion in Chapter 2 on how risk-informed decision making is being applied to

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decommissioning plants. The second is a summary in Chapter 3 of the risk assessment of SFPs at decommissioning plants. The third in Chapter 4 provides the implications of SFP risks on regulatory requirements, including recognition that the assumptions employed in the risk analysis will need to be monitored as part of routine regulatory oversight. The fourth in Chapter 5 provides findings and conclusions and explains where industry initiatives may be useful in improving the generic study.

As described in Chapter 2, a spent fuel pool performance guideline (PPG) for frequency of zirconium fires has been developed and proposed based upon the numerical guidelines incorporating large release frequency (LERF) as described in Regulatory Guide (RG) 1.174 [Ref. 2]. In a letter dated November 12, 1999 [Ref. 3], the ACRS suggested that the end state of uncovery of top of fuel was an appropriate PRA surrogate for zirconium fire frequency, and that comparison with LERF would be acceptable for risk-informed decision making, even though the correlation is not perfect.

The engineering calculations supporting the risk estimates demonstrate that a zirconium fire can occur during an extended period after shutdown (up to five years), depending on spent fuel burn up and spent fuel pool rack configurations, if fuel uncovery were to occur. The consequences of such an event would be severe. However, as presented in Chapter 3, the requantified PRA demonstrates that if operation of a decommissioned plant is carried out in accordance with the commitments proposed by the industry and the other constraints assumed in the risk study are followed, such as the seismic check list, then the proposed PPG large release frequency of less than 1×10^{-5} per year can be met.

Chapter 4 points out that the low numerical risk results in combination with satisfaction of other safety principles as described in RG 1.174, such as defense in depth, maintaining safety margins, and performance monitoring, demonstrate that there is a low level of public risk from SFP accidents at decommissioning plants. In that chapter, the staff has concluded that after one year following final shutdown, the low likelihood that a zirconium fire will occur, in combination with the long time frames available for offsite protective actions, provides an adequate basis such that emergency planning requirements can be relaxed to a minimum baseline level. Chapter 4 discusses continued indemnification requirements while the threat of a zirconium fire exists, and points out that no definitive criteria exist that would allow relaxation on the basis of low likelihood. Chapter 4 includes a discussion on how the risk insights contained in this report could be considered to assess the vulnerabilities to sabotage, and concludes that any reduction in security provisions would be constrained by the target threat, such that some level of security is required as long as the fuel in the SFP is exposed to a sabotage threat.

Chapter 5 points out that any future reduction of the generic one year post-shutdown time delay before relaxing emergency planning requirements would be contingent on an industry initiative to improve the state of the art. It also identifies the possibility that an industry initiative to improve the thermal-hydraulic calculational methodology could result in shortening the generic 5 year window of vulnerability to zirconium fire for purposes of reducing indemnification requirements.

In summary, this report provides an authoritative and definitive treatment of SFP risks at decommissioning plants as it relates to emergency planning, insurance, and security requirements. It systematically examines the differences between an operating reactor spent fuel pool configuration, and the typical SFP configuration in place at one year post-shutdown for

a decommissioning plant. It provides the technical basis for determining the regulatory requirements for decommissioning plants using risk-informed decision making. It recognizes that some aspects of the regulations such as 10 CFR 20 [Ref. 3] are not amenable to this kind of analysis. And it points out other areas of consideration for bringing coherency to future rulemaking.