July 23, 2002

MEMORANDUM TO: Chairman Meserve
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan

FROM: William D. Travers **/RA/**
Executive Director for Operations

SUBJECT: RESEARCH INFORMATION LETTER 0202 ISSUED ON JUNE 20, 2002, TO SUPPORT CHANGES IN 10 CFR 50.46 AND APPENDIX K, UPDATE

The staff is currently engaged in activities leading to potential risk-informed changes to 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-water Nuclear Power Reactors." These activities fall in three areas: (1) modifications to the embrittlement criteria in 50.46 and in related evaluation models in Appendix K, (2) revisions to General Design Criterion 35 and 10 CFR 50.46 that change emergency core cooling system (ECCS) reliability requirements, and (3) changes in the spectrum of pipe break sizes that need to be considered for ECCS performance evaluation. The research information letter that is the subject of this memorandum addresses the first of these areas, which deals with embrittlement criteria and evaluation models.

In SECY-01-0133, the staff recommended changes to the technical requirements of 10 CFR 50.46 and its related Appendix K on acceptance criteria and evaluation models, which are used to assess the performance of emergency core cooling systems during postulated loss-of-coolant accidents (LOCAs). Changes have been sought by the industry because (a) the acceptance criteria currently apply only to Zircaloy and ZIRLO cladding and not to the recently approved M5 cladding or other cladding alloys that are under development, and (b) obvious improvements have been made in the areas of two of the evaluation models, namely, oxidation kinetics and decay heat. On June 20, 2002, the Office of Nuclear Regulatory Research (RES) issued Research Information Letter 0202 to provide technical bases for making appropriate changes to the rule. That letter is attached to this memorandum and is being provided to the Commissioners for their information.

Acceptance Criteria - The acceptance criteria of interest are a 2200 °F peak cladding temperature limit and a 17 percent cladding oxidation limit. These limits have been in the regulation since 1973 and were based on ductility tests made on rings cut from Zircaloy tubing that had been oxidized under simulated LOCA conditions. Because these numerical values cannot be assumed to apply for all future cladding alloys, it is suggested in the research information letter that the underlying ductility test could be specified in the rule rather than the

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numerical results for Zircaloy since the test has generic applicability. Such a rule would thus provide performance-based criteria that could be used as an option to the current prescriptive requirements.

According to this suggestion, numerical values different from 2200 °F and 17 percent might be derived for various cladding alloys, and in fact the acceptable peak cladding temperature might increase above 2200 °F. The research information letter points out that, in the original rulemaking, there was an independent concern about peak cladding temperature with regard to runaway temperature escalation due to rapid oxidation. Work performed by RES has improved our understanding of oxidation kinetics such that the peak cladding temperature could now be increased to 2300 °F without reducing the margin that was perceived in the original rule. Therefore, an upper bound of 2300 °F for the derived temperature limit is suggested for the modified rule.

Evaluation Models - Several models have been suggested for change by the industry, and prominent among them are the 1971 American Nuclear Society (ANS) standard for radionuclide decay heat and the Baker-Just correlation for cladding oxidation kinetics. In both cases, more recent models that are now widely accepted predict significantly lower decay heat and oxidation rates, and these models in turn would result in a significant reduction in predicted peak cladding temperature. The research information letter describes the basis for replacing the 1971 ANS standard for decay heat with the 1994 ANS standard, and for replacing the older Baker-Just correlation for oxidation kinetics with the newer Cathcart-Pawel correlation.

The staff also discussed a number of other phenomena that are now known to contribute non-conservatism to the result inasmuch as their effect tends toward an underprediction of peak cladding temperature. These non-conservative phenomena, which are either omitted or inadequately modeled, include: (a) boiling in the downcomer annulus during reflood, (b) downcomer entrainment and inventory reduction that are due to steam bypass, and (c) fuel relocation following cladding swelling during the temperature transient. The staff concluded that, if changes are made in decay-heat and oxidation-kinetics models, then changes will also have to be made in other models to ensure that an appropriate level of overall conservatism is retained in the evaluation model package.

Recent Activities - Contents of the research information letter were discussed with the Advisory Committee on Reactor Safeguards on May 31, 2002. The letter was issued on June 20, 2002, and was publicly accessible in ADAMS (ML021720744). A public meeting was held with stakeholders on June 28, 2002, to obtain further comments.

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