[7590-01-P]

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

[Docket No. PRM-51-10]

The Attorney General of Commonwealth of Massachusetts

[Docket No. PRM-51-12]

The Attorney General of California

Denial of Petitions for Rulemaking

AGENCY: Nuclear Regulatory Commission (NRC)

ACTION: Petition for rulemaking; Denial

SUMMARY: The NRC is denying two petitions for rulemaking (PRM), one filed by the Attorney General of the Commonwealth of Massachusetts (Massachusetts AG) and the other filed by the Attorney General for the State of California (California AG), presenting nearly identical issues and requests for rulemaking concerning the environmental impacts of the high-density storage of spent nuclear fuel in large water pools, known as spent fuel pools (SFPs). The Petitioners asserted that "new and significant information" shows that the NRC incorrectly characterized the environmental impacts of high-density spent fuel storage as "insignificant" in its National Environmental Policy Act (NEPA) generic environmental impact statement (EIS) for the renewal of nuclear power plant licenses. Specifically, the Petitioners asserted that spent fuel stored in high-density SFPs is more vulnerable to a zirconium fire than the NRC concluded in its NEPA analysis.

ADDRESSES: Publicly available documents related to this petition, including the petitions for rulemaking and the NRC's letters of denial to the Petitioners may be viewed electronically on

public computers in the NRC's Public Document Room (PDR), 01 F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The PDR reproduction contractor will copy documents for a fee. Publicly available documents created or received at the NRC after November 1, 1999, are also available electronically at the NRC's Electronic Reading Room at http://www.nrc.gov/reading-rm/adams.html. From this site, the public can gain entry into the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents. If you do not have access to ADAMS, or if there are problems in accessing the documents located in ADAMS, contact the PDR reference staff at (800) 387-4209, (301) 415-4737 or by e-mail to pdr@nrc.gov.

FOR FURTHER INFORMATION CONTACT: L. Mark Padovan, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, telephone (301) 415-1423, e-mail lmp@nrc.gov.

SUPPLEMENTARY INFORMATION:

I. Background.

The NRC received two PRMs requesting that Title 10 of the *Code of Federal Regulations* (10 CFR), Part 51, be amended. The Massachusetts AG filed its petition on August 25, 2006 (docketed by the NRC as PRM-51-10). The NRC published a notice of receipt and request for public comment in the *Federal Register* on November 1, 2006 (71 FR 64169). The California AG filed its petition on March 16, 2007 (docketed by the NRC as PRM-51-12). PRM-51-12 incorporates by reference the facts and legal arguments set forth in PRM-51-10. The NRC published a notice of receipt and request for public comment on PRM-51-12 in the *Federal Register* on May 14, 2007 (72 FR 27068). The California AG filed an amended petition (treated by the NRC as a supplement to PRM 51-12) on September 19, 2007, to clarify its rulemaking request. The NRC published a notice of receipt for the supplemental petition in the *Federal Register* on November 14, 2007 (72 FR 64003). Because of the similarities of PRM-51-10 and PRM-51-12, the NRC evaluated the two petitions together.

The Petitioners asserted the following in their petitions:

1. "New and significant information" shows that the NRC incorrectly characterized the environmental impacts of high-density spent fuel storage as "insignificant" in the NRC's NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear*

Plants, May 1996. Specifically, the Petitioners asserted that an accident or a malicious act, such as a terrorist attack, could result in an SFP being drained, either partially or completely, of its cooling water. The Petitioners further asserted that this drainage would then cause the stored spent fuel assemblies to heat up and then ignite, with the resulting zirconium fire releasing a substantial amount of radioactive material into the environment.

2. The bases of the "new and significant information" are the following:
   a. NUREG-1738, *Technical Study of the Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*, January 2001
   b. National Academy of Sciences Committee on the Safety and Security of Commercial Spent Nuclear Fuel Storage, *Safety and Security of Commercial Spent Nuclear Fuel Storage* (National Academies Press: 2006) (NAS Report)
   c. Gordon R. Thompson, "Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants," May 25, 2006 (Thompson Report)

3. Specifically, the Petitioners asserted that the "new and significant" information shows the following:
   a. The fuel will burn if the water level in an SFP drops to the point where the tops of the fuel assemblies are uncovered (complete or partial water loss resulting from SFP drainage being caused by either an accident or terrorist attack).
   b. The fuel will burn regardless of its age.
   c. The zirconium fire will propagate to other assemblies in the pool.
   d. The zirconium fire may be catastrophic.

e. A severe accident caused by an intentional attack on a nuclear power plant SFP is "reasonably foreseeable."

The Petitioners also asserted that new and significant information shows that the radiological risk of a zirconium fire in a high-density SFP at an operating nuclear power plant can be comparable to, or greater than, the risk of a core-degradation event of non-malicious origin (i.e., a "severe accident") at the plant's reactor. Consequently, the Petitioners asserted that SFP fires must be considered within the body of severe accident mitigation alternatives (SAMAs).

II. Petitioners' Requests.

PRM-51-10 requested that the NRC take the following actions:

1. Consider new and significant information showing that the NRC's characterization of the environmental impacts of spent fuel storage as insignificant in NUREG-1437 is incorrect.
2. Revoke the regulations which codify that incorrect conclusion and excuse consideration of spent fuel storage impacts in NEPA decision-making documents, namely, 10 CFR 51.53(c)(2), 51.95(c) and Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," of Appendix B to Subpart A of 10 CFR Part 51. Further, revoke 10 CFR 51.23(a) and (b), 51.30(b), 51.53, 51.61, and 51.80(b) to the extent that these regulations find, imply, or assume that environmental impacts of high-density pool storage are insignificant, and therefore need not be considered in any plant-specific NEPA analysis.
3. Issue a generic determination that the environmental impacts of high-density pool storage of spent fuel are significant.

4. Require that any NRC licensing decision that approves high-density pool storage of spent fuel at a nuclear power plant, or any other facility, must be accompanied by a plant-specific EIS that addresses the environmental impacts of high-density pool storage of spent fuel at that nuclear plant and a reasonable array of alternatives for avoiding or mitigating those impacts.
5. Amend its regulations to require that SAMAs that must be discussed in utility company environmental reports (ERs) and NRC supplemental EISs for individual plants under 10 CFR 51.53(c)(3)(ii)(L) and Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 ("Postulated Accidents: Severe Accidents") must include alternatives to avoid, or mitigate, the impacts of high-density pool zirconium fires.

PRM-51-12 incorporates by reference PRM-51-10. PRM-51-12 requested that the NRC take the following actions:

1. Rescind all NRC regulations found in 10 CFR Part 51 that imply, find, or determine that the potential environmental effects of high-density pool storage of spent nuclear fuel are not significant for purposes of NEPA and NEPA analysis.
2. Adopt, and issue, a generic determination that approval of such storage at a nuclear power plant, or any other facility, does constitute a major federal action that may have a significant effect on the human environment.
3. Require that no NRC licensing decision that approves high-density pool storage of spent nuclear fuel at a nuclear power plant, or other storage facility, may issue without the prior adoption and certification of an EIS that complies with NEPA in all respects, including full identification, analysis, and disclosure of the potential environmental effects of such storage, including the potential for accidental or deliberately caused release of

radioactive products to the environment, whether by accident or through acts of terrorism, as well as full and adequate discussion of potential mitigation for such effects, and full discussion of an adequate array of alternatives to the proposed storage project.

III. Public Comments.

The NRC's notice of receipt and request for public comment invited interested persons to submit comments. The comment period for PRM 51-10 originally closed on January 16, 2007, but was extended through March 19, 2007. The public comment period for PRM 51-12 closed on July 30, 2007. Accordingly, the NRC considered comments received on both petitions through the end of July 2007. The NRC received 1,676 public comments, with 1,602 of these being nearly identical form e-mail comments supporting the petitions. Sixty-nine other comments also support the petitions. These comments were submitted by States, private organizations, and members of the U.S. Congress. Two letters from the Nuclear Energy Institute (NEI) oppose the petitions, and three nuclear industry comments endorse NEI's comments.

In general, the comments supporting the petitions focused on the following main elements of the petitions:

- NRC should evaluate the environmental impacts (large radioactive releases and contamination of vast areas) of severe accidents and intentional attacks on high-density SFP storage in its licensing decisions (NEPA analysis).
- The 2006 decision of the United States Court of Appeals for the Ninth Circuit, *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016 (9th Cir. 2006), *cert. denied* 127 S. Ct.

1124 (2007), concluded that the NRC must evaluate the environmental impacts of a terrorist attack on SFP storage in its licensing decisions.

- NRC's claim that the likelihood of a SFP zirconium fire is remote is incorrect. Partial loss of water in an SFP could lead to a zirconium fire and release radioactivity to the environment.
- NRC's characterization of the environmental impacts of high-density SFP storage as "insignificant" in NUREG-1437 is incorrect, and the NRC should revoke the regulations which codify this.
- Any licensing decision approving high-density spent fuel storage should have an EIS.

Comments opposing the petitions centered on the following:

- Petitioners failed to show that regulatory relief is needed to address "new and significant" information concerning the potential for spent fuel zirconium fires in connection with high-density SFP storage. None of the documents that the Petitioners cited or referenced satisfy the NRC's standard for new and significant information.
- Petitioners failed to show that the Commission should rescind its Waste Confidence decision codified at 10 CFR 51.23, or change its determination that the environmental impacts of high-density spent fuel storage are insignificant.
- The Commission has recently affirmed its longstanding view that NEPA demands no terrorism inquiry, and that the NRC therefore need not consider the environmental consequences of hypothetical terrorist attacks on NRC-licensed facilities.
- The Commission's rejection of the Ninth Circuit Court's view is consistent with the U. S. Supreme Court's position that NEPA should not be read to force agencies to consider environmental impacts for which they cannot reasonably be held responsible. Moreover,

the NRC has, in fact, examined terrorism under NEPA and found the impacts similar to the impacts of already-analyzed, severe reactor accidents.

The NRC reviewed and considered the comments in its decision to deny both petitions, as discussed in the following sections:

IV. NEPA and NUREG-1437.

The NRC's environmental protection regulations in 10 CFR Part 51 identify renewal of a nuclear power plant operating license as a major federal action significantly affecting the quality of the human environment. As such, an EIS is required for a plant license renewal review in accordance with the NEPA. The Petitioners challenge NUREG-1437, which generically assesses the significance of various environmental impacts associated with the renewal of nuclear power plant licenses. NUREG-1437 summarizes the findings of a systematic inquiry into the potential environmental consequences of operating individual nuclear power plants for an additional 20 years. The findings of NUREG-1437 are codified in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51.

The NUREG-1437 analysis identifies the attributes of the nuclear power plants, such as major features and plant systems, and the ways in which the plants can affect the environment. The analysis also identifies the possible refurbishment activities and modifications to maintenance and operating procedures that might be undertaken given the requirements of the safety review as provided for in the NRC's nuclear power plant license renewal regulations at 10 CFR Part 54.

NUREG-1437 assigns one of three impact levels (small, moderate, or large) to a given environmental resource (*e.g.*, air, water, or soil). A small impact means that the environmental effects are not detectable, or are so minor that they will neither destabilize, nor noticeably alter, any important attribute of the resource. A moderate impact means that the environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource. A large impact means that the environmental effects are clearly noticeable, and are sufficient to destabilize important attributes of the resource.

In addition to determining the significance of environmental impacts associated with license renewal, the NRC determined whether the analysis in NUREG-1437 for a given resource can be applied to all plants. Under the NUREG-1437 analysis, impacts will be considered Category 1 or Category 2. A Category 1 determination means that the environmental impacts associated with that resource are generic (*i.e.*, the same) for all plants. A Category 2 determination means that the environmental impacts associated with that resource cannot be generically assessed, and must be assessed on a plant-specific basis.

The NRC regulations at 10 CFR Part 51, Subpart A , Appendix B, Table B-1 and NUREG-1437 set forth three criteria for an issue to be classified as Category 1. The first criterion is that the environmental impacts associated with that resource have been determined to apply to all plants. The second criterion is that a single significance level (*i.e.*, small, moderate, or large) has been assigned to the impacts.[1] The third criterion is that the mitigation of any adverse impacts associated with the resource has been considered in NUREG-1437 and further, it has been determined that additional plant-specific mitigation measures are not likely to be sufficiently

1 A note to Table B-1 states that significance levels have not been assigned "for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal." 10 CFR Part 51, Subpart A, App. B, Table B-1, n. 2.

beneficial to warrant implementation. For Category 1 issues, the generic analysis may be adopted in each plant-specific license renewal review.

A Category 2 classification means that the NUREG-1437 analysis does not meet the criteria of Category 1. Thus, on that particular environmental issue, additional plant-specific review is required and must be analyzed by the license renewal applicant in its ER.

For each license renewal application, the NRC will prepare a draft supplemental EIS (SEIS) to analyze those plant-specific (Category 2) issues. Neither the SEIS nor the ER is required to cover Category 1 issues. However, both are required to consider any new and significant information for Category 1 or unidentified issues. The draft SEIS is made available for public comment. After considering public comments, the NRC will prepare and issue the final SEIS in accordance with 10 CFR 51.91 and 51.93. The final SEIS and NUREG-1437, together, serve as the requisite NEPA analysis for any given license renewal application.

The NUREG-1437 analysis, as shown in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, found that the environmental impact of the storage of spent nuclear fuel, including high-density storage, in SFPs, during any plant refurbishment or plant operation through the license renewal term, are of a small significance level and meet all Category 1 criteria. It is this finding that the Petitioners challenge. After reviewing the petitions and the public comments received, the NRC has determined that its findings in NUREG-1437 and in Table B-1 remain valid, both for SFP accidents and for potential terrorist attacks that could result in an SFP zirconium fire.

V. Reasons for Denial ─ General.

A. *Spent Fuel Pools.*

Spent nuclear fuel offloaded from a reactor is stored in a SFP. The SFPs at all nuclear plants in the United States are massive, extremely-robust structures designed to safely contain the spent fuel discharged from a nuclear reactor under a variety of normal, off-normal, and hypothetical accident conditions (*e.g.*, loss of electrical power, floods, earthquakes, or tornadoes). SFPs are made of thick, reinforced, concrete walls and floors lined with welded, stainless-steel plates to form a leak-tight barrier. Racks fitted in the SFPs store the fuel assemblies in a controlled configuration (*i.e.*, so that the fuel is both sub-critical and in a coolable geometry). Redundant monitoring, cooling, and makeup-water systems are provided. The spent fuel assemblies are positioned in racks at the bottom of the pool, and are typically covered by at least 25 feet of water. SFPs are essentially passive systems.

The water in the SFPs provides radiation shielding and spent fuel assembly cooling. It also captures radionuclides in case of fuel rod leaks. The water in the pool is circulated through heat exchangers for cooling. Filters capture any radionuclides and other contaminants that get into the water. Makeup water can also be added to the pool to replace water loss.

SFPs are located at reactor sites, typically within the fuel-handling (pressurized-water reactor) or reactor building (boiling-water reactor). From a structural point of view, nuclear power plants are designed to protect against external events such as tornadoes, hurricanes, fires, and floods. These structural features, complemented by the deployment of effective and visible physical security protection measures, are also deterrents to terrorist activities. Additionally, the

emergency procedures and SAMA guidelines developed for reactor accidents provide a means for mitigating the potential consequences of terrorist attacks.

B. *Physical Security.*

The Petitioners raise the possibility of a successful terrorist attack as increasing the probability of an SFP zirconium fire. As the NAS Report found, the probability of terrorist attacks on SFPs cannot be reliably assessed, quantitatively or comparatively. The NRC has determined, however, that security and mitigation measures the NRC has imposed upon its licensees since September 11, 2001, and national anti-terrorist measures to prevent, for example, aircraft hijackings, coupled with the robust nature of SFPs, make the probability of a *successful* terrorist attack, though numerically indeterminable, very low.

The NRC's regulations and security orders require licensees to develop security and training plans for NRC review and approval, implement procedures for these plans, and to periodically demonstrate proficiency through tests and exercises.[2] In addition, reactor physical security systems use a defense-in-depth concept, involving the following:

- vehicle (external) barriers
- fences
- intrusion detection, alarm, and assessment systems
- internal barriers

2 For additional related information, please see the NRC fact sheet "NRC Review of Paper on Reducing Hazards From Stored Spent Nuclear Fuel," which is available on the NRC's public website at: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/reducing-hazards-spent-fuel.html.

- armed responders
- redundant alarm stations with command, control, and communications systems
- local law enforcement authority's response to a site and augmentation of the on-site armed response force
- security and emergency-preparedness procedure development and planning efforts with local officials
- Security personnel training and qualification

The NRC's regulatory approach for maintaining the safety and security of power reactors, and thus SFPs, is based upon robust designs that are coupled with a strategic triad of preventive/protective systems, mitigative systems, and emergency-preparedness and response. Furthermore, each licensee's security functions are integrated and coordinated with reactor operations and emergency response functions. Licensees develop protective strategies in order to meet the NRC design-basis threat (DBT).[3] In addition, other Federal agencies such as the Federal Aviation Administration, the Federal Bureau of Investigation, and the Department of Homeland Security have taken aggressive steps to prevent terrorist attacks in the United States. Taken as a whole, these systems, personnel, and procedures provide reasonable assurance that public health and safety, the environment, and the common defense and security will be adequately protected.

3 The DBT represents the largest threat against which a private sector facility can be reasonably expected to defend with high assurance. The NRC's DBT rule was published in the *Federal Register* on March 19, 2007 (72 FR 12705).

C. *Very Low Risk.*

Risk is defined as the probability of the occurrence of a given event multiplied by the consequences of that event.[4] Studies conducted over the last three decades have consistently shown that the probability of an accident causing a zirconium fire in an SFP to be lower than that for severe reactor accidents. The risk of beyond design-basis accidents (DBAs) in SFPs was first examined as part of the landmark *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants* (WASH-1400, NUREG-75/014, 1975), and was found to be several orders of magnitude below those involving the reactor core. The risk of an SFP accident was re-examined in the 1980's as Generic Issue 82, *Beyond Design Basis Accidents in Spent Fuel Pools*, in light of increased use of high-density storage racks and laboratory studies that indicated the possibility of zirconium fire propagation between assemblies in an air-cooled environment. The risk assessment and cost-benefit analyses developed through this effort, NUREG-1353, *Regulatory Analysis for the Resolution of Generic Issue 82, Beyond Design Basis Accidents in Spent Fuel Pools*, Section 6.2, April 1989, concluded that the risk of a severe accident in the SFP was low and "appear[s] to meet" the objectives of the Commission's "Safety Goals for the Operations of Nuclear Power Plants; Policy Statement," (August 4, 1986; 51 FR 28044), as amended (August 21, 1986; 51 FR 30028), and that no new regulatory requirements were warranted.[5]

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4 The American Society of Mechanical Engineers (ASME) "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," ASME RA-S-2002, defines risk as the probability and consequences of an event, as expressed by the risk "triplet" that is the answer to the following three questions: (1) What can go wrong? (2) How likely is it? and (3) What are the consequences if it occurs?

5 The Commission's Safety Goals identified two quantitative objectives concerning mortality risks: 1) The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents in which members of the U.S. population are generally exposed; and 2) The risk to the population in the

SFP accident risk was re-assessed in the late 1990s to support a risk-informed rulemaking for permanently shutdown, or decommissioned, nuclear power plants. The study, NUREG-1738, *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants*, January 2001, conservatively assumed that if the water level in the SFP dropped below the top of the spent fuel, an SFP zirconium fire involving all of the spent fuel would occur, and thereby bounded those conditions associated with air cooling of the fuel (including partial-draindown scenarios) and fire propagation. Even when all events leading to the spent fuel assemblies becoming partially or completely uncovered were assumed to result in an SFP zirconium fire, the study found the risk of an SFP fire to be low and well within the Commission's Safety Goals.

Furthermore, significant additional analyses have been performed since September 11, 2001, that support the view that the risk of a successful terrorist attack (*i.e.*, one that results in an SFP zirconium fire) is very low. These analyses were conducted by the Sandia National Laboratories and are collectively referred to herein as the "Sandia studies."[6] The Sandia studies are sensitive security related information and are not available to the public. The Sandia studies considered spent fuel loading patterns and other aspects of a pressurized-water reactor SFP and a boiling-water reactor SFP, including the role that the circulation of air plays in the cooling of spent fuel. The Sandia studies indicated that there may be a significant amount of time between the initiating event (*i.e.*, the event that causes the SFP water level to drop) and the

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area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

6 Sandia National Laboratories, "Mitigation of Spent Fuel Pool Loss-of-Coolant Inventory Accidents and Extension of Reference Plant Analyses to Other Spent Fuel Pools," Sandia Letter Report, Revision 2 (November 2006) incorporates and summarizes the Sandia Studies. This document is designated "Official Use Only—Security Related Information." A version of the Sandia Studies, with substantial redactions, was made public as a response to a Freedom of Information Act request. It is available on the NRC's Agencywide Document Access and Management System (ADAMS). The redacted version can be found under ADAMS Accession No. ML062290362. For access to ADAMS, contact the NRC Public Document Room Reference staff at 1-800-397-4209, 301-415-4737, or by e-mail to pdr@nrc.gov. For additional related information, please see the NRC fact sheet "NRC Review of Paper on Reducing Hazards From Stored Spent Nuclear Fuel," which is available on the NRC's public website at: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/reducing-hazards-spent-fuel.html.

spent fuel assemblies becoming partially or completely uncovered. In addition, the Sandia studies indicated that for those hypothetical conditions where air cooling may not be effective in preventing a zirconium fire (*i.e.*, the partial drain down scenario cited by the Petitioners), there is a significant amount of time between the spent fuel becoming uncovered and the possible onset of such a zirconium fire, thereby providing a substantial opportunity for both operator and system event mitigation.

The Sandia studies, which more fully account for relevant heat transfer and fluid flow mechanisms, also indicated that air-cooling of spent fuel would be sufficient to prevent SFP zirconium fires at a point much earlier following fuel offload from the reactor than previously considered (*e.g.*, in NUREG-1738). Thus, the fuel is more easily cooled, and the likelihood of an SFP fire is therefore reduced.

Additional mitigation strategies implemented subsequent to September 11, 2001, enhance spent fuel coolability and the potential to recover SFP water level and cooling prior to a potential SFP zirconium fire. The Sandia studies also confirmed the effectiveness of additional mitigation strategies to maintain spent fuel cooling in the event the pool is drained and its initial water inventory is reduced or lost entirely. Based on this more recent information, and the implementation of additional strategies following September 11, 2001, the probability, and accordingly, the risk, of a SFP zirconium fire initiation is expected to be less than reported in NUREG-1738 and previous studies.

Given the physical robustness of SFPs, the physical security measures, and SFP mitigation measures, and based upon NRC site evaluations of every SFP in the United States, the NRC has determined that the risk of an SFP zirconium fire, whether caused by an accident or a

terrorist attack, is very low. As such, the NRC's generic findings in NUREG-1437, as further reflected in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, remain valid.

VI. Reasons for Denial ─ NRC Responses to Petitioners Assertions.

A. New and Significant Information.

The Petitioners asserted that new and significant information shows that the NRC incorrectly characterized the environmental impacts of spent fuel storage as "insignificant." The information relied upon by the Petitioners, however, is neither "new" nor "significant," within the NRC's definition of those terms. The NRC defines these terms in its Supplement 1 to NRC Regulatory Guide 4.2, *Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses*, Chapter 5 (September 2000) (RG 4.2S1). "New and significant" information, which would require supplementing NUREG-1437, is defined as follows:

> (1) Information that identifies a significant environmental issue that was not considered in NUREG-1437 and, consequently, not codified in Appendix B to Subpart A of 10 CFR Part 51, or
>
> (2) Information that was not considered in the analyses summarized in NUREG-1437 and that leads to an impact finding different from that codified in 10 CFR Part 51.

The Petitioners' "new and significant" information does not meet the RG 4.2S1 criteria. NUREG-1437 (Sections 6.4.6.1. to 6.4.6.3.), and the analyses cited therein, including the NRC's "Waste Confidence Rule" (December 6, 1999; 55 FR 38474, 38480-81), extensively considered the risk of SFP accidents. Moreover, to the extent any information submitted by the Petitioners was not considered in NUREG-1437, none of the information is "significant," because, as

explained further in this document, it would not lead to “an impact finding different from that codified in 10 CFR Part 51,” or as set forth in NUREG-1437.

B. Spent Fuel Assemblies Will Burn If Uncovered.

The Petitioners asserted that new and significant information, consisting primarily of the Thompson Report, NUREG-1738, and a government-sponsored study, the NAS Report, show that spent fuel will burn if the water level in an SFP drops to the point where the tops of the fuel assemblies are uncovered. Specifically, the Petitioners asserted that the NRC fails to recognize the danger of a partial loss of water in an SFP, which in the Petitioners’ view, is more likely to cause an SFP zirconium fire than a complete loss of water, because the remaining water will block the circulating air that would otherwise act to cool the spent fuel assemblies.

The NRC does not agree with the Petitioners’ assertions. The NRC has determined that a zirconium cladding fire does not occur when only the tops of the fuel assemblies are uncovered. In reality, a zirconium fire cannot occur unless fuel uncovering is more substantial. Even then, the occurrence of a zirconium fire requires a number of conditions which are extremely unlikely to occur together. The Sandia studies provide a more realistic assessment of the coolability of spent fuel under a range of conditions and a better understanding of the actual safety margins than was indicated in NUREG-1738. The Sandia studies have consistently and conclusively shown that the safety margins are much larger than indicated by previous studies such as NUREG-1738.

1. Heat Transfer Mechanisms.

Past NRC studies of spent fuel heatup and zirconium fire initiation conservatively did not consider certain natural heat-transfer mechanisms which would serve to limit heatup of the spent fuel assemblies and prevent a zirconium fire. In particular, these studies, including NUREG-1738, did not consider heat transfer from higher-decay-power assemblies to older, lower-decay-power fuel assemblies in the SFP. This heat transfer would substantially increase the effectiveness of air cooling in the event the SFP is drained, far beyond the effectiveness of air cooling cited in past studies. Both the Sandia studies and the NAS Report confirm the NRC conclusion that such heat transfer mechanisms allow rapid heat transfer away from the higher-powered assemblies. The NAS Report also noted that such heat transfer could air-cool the assemblies to prevent a zirconium fire within a relatively short time after the discharge of assemblies from the reactor to the SFP.[7] Thus, air cooling is an effective, passive mechanism for cooling spent fuel assemblies in the pool.

2. Partial Drain-Down.

Air cooling is less effective under the special, limited condition where the water level in the SFP drops to a point where water and steam cooling is not sufficient to prevent the fuel from overheating and initiating a zirconium fire, but the water level is high enough to block the full natural circulation of air flow through the assemblies. This condition has been commonly referred to as a partial draindown, and is cited in the Thompson Report. Under those conditions, however, it is important to realistically model the heat transfer between high- and low-powered

7 NAS Report at 53.

fuel assemblies. The heat transfer from hot fuel assemblies to cooler assemblies will delay the heat-up of assemblies, and allow plant operators time to take additional measures to restore effective cooling to the assemblies. Further, for very low-powered assemblies, the downward flow of air into the assemblies can also serve to cool the assembly even though the full-circulation flow path is blocked. Also, as discussed further in this document, all nuclear plant SFPs have been assessed to identify additional, existing cooling capability and to provide new supplemental cooling capability which could be used during such rare events. This supplemental cooling capability specifically addresses the cooling needs during partial draindown events, and would reduce the probability of a zirconium fire even during those extreme events.

3. License Amendments.

In January 2006, the nuclear industry proposed a combination of internal and external strategies to enhance the spent fuel heat removal capability systems at every operating nuclear power plant. The internal strategy implements a diverse SFP makeup system that can supply the required amount of makeup water and SFP spray to remove decay heat. The external strategy involves using an independently-powered, portable, SFP coolant makeup and spray capability system that enhances spray and rapid coolant makeup to mitigate a wide range of possible scenarios that could reduce SFP water levels. In addition, in cases where SFP water levels can not be maintained, leakage control strategies would be considered along with guidance to maximize spray flows to the SFP. Time lines have been developed that include both dispersed and non-dispersed spent fuel storage. The NRC has approved license amendments and issued safety evaluations to incorporate these strategies into the plant licensing bases of all operating nuclear power plants in the United States.

C. Fuel Will Burn Regardless of its Age.

The NRC disagrees with the Petitioners' assertion that fuel will burn regardless of age. Older fuel (fuel which has been discharged from the reactor for a longer time) is more easily cooled and is less likely to ignite because of its lower decay power. A study relied upon by the Petitioners, NUREG-1738, did conservatively assume that spent fuel stored in an SFP, regardless of age, may be potentially vulnerable to a partial drain down event, and that the possibility of a zirconium fire could not be ruled out on a generic basis. This conclusion, however, was in no sense a statement of certainty and was made in order to reach a conclusion on a generic basis, without relying on any plant-specific analyses.

Furthermore, the SFP zirconium fire frequency in NUREG-1738 was predicated on a bounding, conservative assumption that an SFP fire involving all of the spent fuel would occur if the water level in the SFP dropped below the top of the spent fuel. The NUREG-1738 analysis did not attempt to specifically address a number of issues and actions that would substantially reduce the likelihood of a zirconium fire, potentially rendering the frequency estimate to be remote and speculative. For example, NUREG-1738 did not account for the additional time available following the spent fuel being partially or completely uncovered, but prior to the onset of a zirconium fire, that would allow for plant operator actions, makeup of SFP water levels, and other mitigation measures. In addition, NUREG-1738 did not consider the impact of plant and procedure changes implemented as a result of the events of the September 11, 2001, terrorist attacks. NUREG-1738 did clarify that the likelihood of a zirconium fire under such conditions could be reduced by accident management measures, but it was not the purpose of NUREG-1738 to evaluate such accident management measures.

D. SFP Zirconium Fire Will Propagate.

Although it is possible that once a spent fuel assembly ignites, the zirconium fire can propagate to other assemblies in the SFP, the NRC has determined (as explained previously) that the risk of an SFP zirconium fire initiation is very low.

E. SFP Zirconium Fire May Be Catastrophic.

1. Not New and Significant Information; Very Low Probability.

The Massachusetts AG states that "while such a catastrophic accident is unlikely, its probability falls within the range that NRC considers reasonably foreseeable." Thus, the Petitioners asserted that an SFP zirconium fire qualifies as a DBA and, that the impacts of an SFP fire must be discussed in the ER submitted by the licensee and the NRC's EIS, as well as designed against under NRC safety regulations.

The facts that a SFP contains a potentially large inventory of radionuclides and that a release of that material could have adverse effects are not new. These facts are well known, and were considered in the risk evaluation of spent fuel storage contained in NUREG-1738. Even with the numerous conservatisms in the NUREG-1738 study, as described previously, the NRC was able to conclude that the risk from spent fuel storage is low, and is substantially lower than reactor risk.

A study relied upon by the Petitioners, the Thompson Report, claimed that the probability (frequency) of an SFP zirconium fire would be 2E-5 per year[8] for events excluding acts of malice (*e.g.*, terrorism) and 1E-4 per year[9] for acts of malice. With respect to random events (*i.e.*, excluding acts of malice), the NRC concludes that the Thompson report estimate is overly conservative. A more complete and mechanistic assessment of the event, as described in section VI.E.2. of this Notice, and associated mitigation measures, leads to considerably lower values. With respect to events initiated by a terrorist attack, the NRC concludes that such probability (frequency) estimates are entirely speculative. The NRC also concludes that the additional mitigation measures for SFP events implemented since September 11, 2001, together with the more realistic assessment of spent fuel cooling, indicates that the likelihood of a zirconium fire, though numerically indeterminable, is very low

The 2E-5 per year estimate for events excluding acts of malice is based on an unsubstantiated assumption that 50 percent of all severe reactor accidents that result in an early release of substantial amounts of radioactive material will also lead to a consequential SFP zirconium fire. The Thompson Report does not identify the necessary sequence of events by which such scenarios might lead to SFP zirconium fires, or discuss the probability of their occurrence. The NRC analysis in the Shearon Harris ASLBP proceeding (described in section VI.E.2. of this Notice) showed that a more complete and mechanistic assessment of the event and associated mitigation measures leads to considerably lower values. This assessment includes the following:

8 Two occurrences in 100,000 reactor years.
9 One occurrence in 10,000 reactor years.

- Frequency and characteristics of the releases from the containment for each release location;
- Transport of gases and fission products within the reactor building;
- Resulting thermal and radiation environments in the reactor building, with emphasis on areas in which SFP cooling and makeup equipment is located, and areas in which operator access may be needed to implement response actions;
- Availability/survivability of SFP cooling and makeup equipment in the sequences of concern; and
- Ability and likelihood of successful operator actions to maintain or restore pool cooling or makeup (including consideration of security enhancements and other mitigation measures implemented in response to the terrorist attacks of September 11, 2001).

2. Shearon Harris Atomic Safety and Licensing Board Panel (ASLBP) Proceeding.

In the proceeding regarding the expansion of the SFP at the Shearon Harris nuclear power plant, located near Raleigh, North Carolina, the Shearon Harris intervenor described a scenario similar to that raised by the Petitioners, namely, that a severe accident at the adjacent reactor would result in a SFP zirconium fire.[10] The Shearon Harris proceeding considered the probability of a sequence of the following seven events:

1) a degraded core accident
2) containment failure or bypass
3) loss of SFP cooling

10 *Carolina Power Light Co.*, LBP-01-9, 53 NRC 239, 244-245 (2001).

4) extreme radiation levels precluding personnel access

5) inability to restart cooling or makeup systems due to extreme radiation doses

6) loss of most or all pool water through evaporation

7) initiation of a zirconium fire in the SFP

Based on a detailed probabilistic risk assessment, the licensee calculated the probability of a severe reactor accident that causes an SFP zirconium fire to be 2.78E-8 per year. The NRC staff calculated the probability to be 2.0E-7 per year. The intervenor calculated the probability to be 1.6E-5 per year. The ASLBP concluded that the probability of the postulated sequence of events resulting in an SFP zirconium fire was "conservatively in the range described by the Staff: 2.0E-7 per year (two occurrences in 10 million reactor years) or less."[11] Accordingly, the ASLBP found that the occurrence of a severe reactor accident causing an SFP zirconium fire "falls within the category of remote and speculative matters."[12] The Commission affirmed the ASLBP's decision, and the United States Court of Appeals, District of Columbia Circuit, upheld the Commission decision.[13]

In the Shearon Harris proceeding, the intervenor assumed that, given an early containment failure or bypass, a spent fuel zirconium fire would occur (*i.e.*, a conditional probability of 1.0). In order for a reactor accident to lead to a SFP zirconium fire a number of additional conditions must occur. The reactor accident and containment failure must somehow lead to a loss of SFP cooling and must lead to a condition where extreme radiation levels preclude personnel access to take corrective action. There must be then an inability to restart cooling or makeup systems.

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11 *Id.*, 53 NRC at 267.
12 *Id.*, 53 NRC at 268.
13 *Carolina Power Light Co.*, Commission Law Issuance (CLI)-01-11, 53 NRC 370 (2001), *pet. for review denied, sub nom, Orange County, NC v. NRC*, 47 Fed. Appx. 1, 2002 WL 31098379 (D.C. Cir. 2002).

There must be a loss of significant pool water inventory through evaporation (which can take substantial time). Finally, the event must also lead to a zirconium fire. In contrast to the intervenor's estimate, the licensee and the NRC staff estimated a conditional probability of about one percent that a severe reactor accident with containment failure would lead to a SFP accident. The NRC staff expects that the conditional probability of a SFP zirconium fire, given a severe reactor accident, would be similar to that established in the Shearon Harris proceeding. As such, the probability of a SFP zirconium fire due to a severe reactor accident and subsequent containment failure would be well below the Petitioners' 2E-5 per year estimate.

The 1E-4 per year estimate in the Thompson Report for events involving acts of malice assumes that there would be one attack on the population of U.S. nuclear power plants per century, and that this attack will be 100 percent successful in producing a SFP zirconium fire (thus, fire frequency = 0.01 attack/year x 1.0 fire/attack x 1/104 total reactors = 1E-4/year). The security-related measures and other mitigation measures implemented since September 11, 2001, however, have significantly reduced the likelihood of a successful terrorist attack on a nuclear power plant and its associated SFP. Such measures include actions that would improve the likelihood of the following:

a. Identifying/thwarting the attack before it is initiated.
b. Mitigating the attack before it results in damage to the plant.
c. Mitigating the impact of the plant damage such that an SFP zirconium fire is avoided.

Given the implementation of additional security enhancements and mitigation strategies, as well as further consideration of the factors identified above, the NRC staff concludes that the

frequency of SFP zirconium fires due to acts of malice is substantially lower than assumed by the Petitioners.

3. SFP Zirconium Fire Does Not Qualify As a DBA.

Regarding the Petitioners' assertion that a SFP zirconium fire qualifies as a design-basis accident (DBA), the NRC staff has concluded that a realistic probability estimate would be very low, such that these events need not be considered as DBAs or discussed in ERs and EISs. Moreover, the set of accidents that must be addressed as part of the design basis has historically evolved from deterministic rather than probabilistic considerations. These considerations, which include defense-in-depth, redundancy, and diversity, are characterized by the use of the single-failure criterion.[14] The single-failure criterion, as a key design and analysis tool, has the direct objective of promoting reliability through the enforced provision of redundancy in those systems which must perform a safety-related function. The single failure criterion is codified in Appendix A and Appendix K to 10 CFR 50 and other portions of the regulations. The SFP and related systems have been designed and approved in accordance with this deterministic approach.

F. Intentional Attack on a SFP is "Reasonably Foreseeable".

The Petitioners asserted that an intentional attack targeting a plant's SFP is "reasonably foreseeable." Specifically, the Petitioners raised both the NAS study and the decision by the United States Court of Appeals for the Ninth Circuit, *San Luis Obispo Mothers for Peace v. NRC*,

14 "A single failure means an occurrence which results in the loss of capability of a component to perform its intended safety functions . . . Fluid and electric systems are considered to be designed against an assumed single failure if neither 1) a single failure of any active component . . . nor 2) a single failure of a passive component . . . results in a loss of the capability of the system to perform its safety functions." 10 CFR Part 50, App. A.

449 F.3d 1016 (9th Cir. 2006), *cert. denied* 127 S. Ct. 1124 (2007), to support the assertion that the NRC's NEPA analysis of a license renewal action for a given facility must include analysis of the environmental impacts associated with a terrorist attack on that facility. The NRC has considered both the NAS Report and the Ninth Circuit decision, and remains of the view that an analysis of the environmental impacts of a hypothetical terrorist attack on an NRC-licensed facility is not required under NEPA.[15] But, if an analysis of a hypothetical terrorist attack were required under NEPA, the NRC has determined that the environmental impacts of such a terrorist attack would not be significant, because the probability of a *successful* terrorist attack (*i.e.*, one that causes an SFP zirconium fire, which results in the release of a large amount of radioactive material into the environment) is very low and therefore, within the category of remote and speculative matters.

1. NAS Report.

The Petitioners rely, in part, upon the NAS Report, the public version of which was published in 2006 and is available from NAS.[16] In response to a direction in the Conference Committee's Report accompanying the NRC's FY 2004 appropriation,[17] the NRC contracted with NAS for a study on the safety and security of commercial spent nuclear fuel. The NAS made a number of findings and recommendations, including:

- SFPs are necessary at all operating nuclear power plants to store recently discharged fuel;
- Successful terrorist attacks on SFPs, though difficult, are possible;

15 The NRC will, of course, comply with the Ninth Circuit decision for those NRC licensed facilities located within the states subject to the jurisdiction of the Ninth Circuit.
16 The NRC response to the NAS Report is available at ADAMS Accession No. ML0502804280.
17 Conference Committee's Report (H. Rept. 108-357) accompanying the *Energy and Water Development Act, 2004* (Pub. L. 108-137, December 3, 2003).

- The probability of terrorist attacks on spent fuel storage cannot be assessed quantitatively or comparatively;
- If a successful terrorist attack leads to a propagating zirconium cladding fire, it could result in the release of large amounts of radioactive material; and
- Dry cask storage has inherent security advantages over spent fuel storage, but it can only be used to store older spent fuel.

The NAS Report found, and the NRC agrees, that pool storage is required at all operating commercial nuclear power plants to cool newly discharged spent fuel. Freshly discharged spent fuel generates too much decay heat to be placed in a dry storage cask.

The NRC agrees with the NAS finding that the probability of terrorist attacks on spent fuel storage cannot be assessed quantitatively or comparatively. However, the NRC concludes that the additional mitigation measures for SFP events implemented since September 11, 2001, together with a more realistic assessment of spent fuel cooling, as shown by the Sandia studies, indicates that the likelihood of a zirconium fire, though numerically indeterminate, is very low.

Furthermore, the NAS Report states that "[i]t is important to recognize, however, that an attack that damages a power plant or its spent fuel storage facilities would not necessarily result in the release of *any* radioactivity to the environment. There are potential steps that can be taken to lower the potential consequences of such attacks."[18] The NAS Report observed that a number of security improvements at nuclear power plants have been instituted since September 11, 2001, although the NAS did not evaluate the effectiveness and adequacy of

18 NAS Report at 6 (emphasis in the original).

these improvements and has called for an independent review of such measures. Nevertheless, the NAS Report states that "the facilities used to store spent fuel at nuclear power plants are very robust. Thus, only attacks that involve the application of large energy impulses or that allow terrorists to gain interior access have any chance of releasing substantial quantities of radioactive material."[19]

As discussed previously, following the terrorist attacks of September 11, 2001, the NRC has required that nuclear power plant licensees implement additional security measures and enhancements the Commission believes have made the likelihood of a successful terrorist attack on an SFP remote.

2. Ninth Circuit Decision.

The Petitioners asserted that the NRC should follow the decision of the United States Court of Appeals for the Ninth Circuit, *San Luis Obispo Mothers for Peace v. NRC*, 449 F.3d 1016 (9th Cir. 2006), *cert. denied* 127 S. Ct. 1124 (2007), by considering the environmental impacts of intentional attacks on nuclear power plant fuel storage pools in all licensing decisions. The Ninth Circuit held that the NRC could not, under NEPA, categorically refuse to consider the consequences of a terrorist attack against a spent fuel storage facility on the Diablo Canyon reactor site.

The NRC's longstanding view is that NEPA does not require the NRC to consider the environmental consequences of hypothetical terrorist attacks on NRC-licensed facilities. NEPA

19 NAS Report at 30.

requires that there be a "reasonably close causal relationship" between the federal agency action and the environmental consequences.[20] The NRC renewal of a nuclear power plant license would not cause a terrorist attack; a terrorist attack would be caused by the terrorists themselves. Thus, the renewal of a nuclear power plant license would not be the "proximate cause" of a terrorist attack on the facility.

If NEPA required the NRC to consider the impacts of a terrorist attack, however, the NRC findings would remain unchanged. As previously described, the NRC has required, and nuclear power plant licensees have implemented, various security and mitigation measures that, along with the robust nature of SFPs, make the probability of a *successful* terrorist attack (*i.e.,* one that causes an SFP zirconium fire, which results in the release of a large amount of radioactive material into the environment) very low. As such, a successful terrorist attack is within the category of remote and speculative matters for NEPA considerations; it is not "reasonably foreseeable." Thus, on this basis, the NRC finds that the environmental impacts of renewing a nuclear power plant license, in regard to a terrorist attack on an SFP, are not significant.

The NRC has determined that its findings related to the storage of spent nuclear fuel in pools, as set forth in NUREG-1437 and in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, remain valid. Thus, the NRC has met and continues to meet its obligations under NEPA.

G. SFP Zirconium Fire Should be Considered within the Analysis of SAMAs.

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20 *Department of Transportation v. Public Citizen*, 541 U.S. 752, 767 (2004) *citing Metropolitan Edison v. People Against Nuclear Energy*, 460 U.S. 766, 774 (1983).

The Petitioners asserted that SFP fires should be considered within the analysis of severe accident mitigation alternatives (SAMAs). While a large radiological release is still possible, and was assessed as part of Generic Issue 82, *Beyond Design Basis Accidents in Spent Fuel Pools*, and later, in NUREG-1738, the NRC considers the likelihood of such an event to be lower than that estimated in Generic Issue 82 and NUREG-1738. Based on the Sandia studies, and on the implementation of additional strategies implemented following September 11, 2001, the probability of a SFP zirconium fire is expected to be less than that reported in NUREG-1738 and previous studies. Thus, the very low probability of an SFP zirconium fire would result in an SFP risk level less than that for a reactor accident.

For example, in NUREG-1738, the SFP fire frequencies were conservatively estimated to be in the range of 5.8E-7 per year to 2.4E-6 per year. NUREG-1738 conservatively assumed that if the water level in the SFP dropped below the top of the spent fuel, an SFP zirconium fire involving all of the spent fuel would occur, and thereby bounded those conditions associated with air cooling of the fuel (including partial-drain down scenarios) and zirconium fire propagation. It did not mechanistically analyze the time between the spent fuel assemblies becoming partially or completely uncovered and the onset of a SFP zirconium fire, and the potential to recover SFP cooling and to restore the SFP water level within this time. NUREG-1738 also did not consider the possibility that air-cooling of the spent fuel alone could be sufficient to prevent SFP zirconium fires.

Furthermore, the Sandia studies indicated that air cooling would be much more effective in cooling the spent fuel assemblies. In those cases where air cooling is not effective, the time before fuel heatup and radiological release would be substantially delayed, thus providing a substantial opportunity for successful event mitigation. The Sandia studies, which more fully

account for relevant heat transfer and fluid flow mechanisms, also indicated that air-cooling of spent fuel would be sufficient to prevent SFP zirconium fires much earlier following fuel offload than previously considered (*e.g.*, in NUREG-1738), thereby further reducing the likelihood of an SFP zirconium fire. Additional mitigation strategies implemented subsequent to September 11, 2001, will serve to further enhance spent fuel coolability, and the potential to recover SFP cooling or to restore the SFP water level prior to the initiation of an SFP zirconium fire.

Given that the SFP risk level is less than that for a reactor accident, a SAMA that addresses SFP accidents would not be expected to have a significant impact on total risk for the site. Despite the low level of risk from fuel stored in SFPs, additional SFP mitigative measures have been implemented by licensees since September 11, 2001. These mitigative measures further reduce the risk from SFP zirconium fires, and make it even more unlikely that additional SFP safety enhancements could substantially reduce risk or be cost-beneficial.

VII. Denial of Petitions.

Based upon its review of the petitions, the NRC has determined that the studies upon which the Petitioners rely do not constitute new and significant information. The NRC has further determined that its findings related to the storage of spent nuclear fuel in pools, as set forth in NUREG-1437 and in Table B-1, of Appendix B to Subpart A of 10 CFR Part 51, remain

valid. Thus, the NRC has met and continues to meet its obligations under NEPA. For the reasons discussed previously, the Commission denies PRM-51-10 and PRM- 51-12.

Dated at Rockville, Maryland, this _____ day of _____, 2008.

For the Nuclear Regulatory Commission.

Annette Vietti-Cook,
Secretary of the Commission.