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NUCLEAR ENERGY INSTITUTE

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RULEMAKINGS AND ADJUDICATIONS STAFF
SECY-02

April 12, 2000

Mr. David L. Meyer
Chief, Rules and Directives Branch
Division of Administrative Services
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

DOCKET NUMBER
PETITION RULE PRM 50-71
(65FR34599)

Project Number: 689

Dear Mr. Meyer:

On March 14, pursuant to 10 CFR 2.802(a), the Nuclear Energy Institute submitted a Petition for Rulemaking to revise 10 CFR Part 50.44, *Standards for Combustible Gas Control System in Light-Water-Cooled Nuclear Power Reactors*, and § 50.46, *Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors*. Subsequently, we decided to amend the petition in order to clarify a few points regarding the petition that were discussed during a March 30 public meeting with the NRC staff.

Please substitute the enclosed petition, in its entirety, for the one previously submitted by NEI. The motivation for the petition, to achieve regulatory process efficiencies, and net result if implemented, remains unchanged.

Sincerely,

David J. Modeen

DJM/
Enclosure

c: Dr. William D. Travers, Executive Director for Operations, U. S. Nuclear Regulatory Commission
Karen D. Cyr, Esq., General Counsel, U.S. Nuclear Regulatory Commission
Mr. Peter C. Wen, Project Manager, U.S. Nuclear Regulatory Commission
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TEMPLATE=SECY-051

SECY-02

PETITION FOR RULEMAKING
TO AMEND
10 C.F.R. §§ 50.44 AND 50.46

Submitted by the Nuclear Energy Institute

I. ISSUE

On behalf of its members, the Nuclear Energy Institute (NEI) requests the U.S. Nuclear Regulatory Commission (NRC) to revise sections 10 C.F.R. §§ 50.44(a), 50.44(b), 50.44(c)(1) and 50.46(a)(1)(i) of its regulations, which require that uranium oxide fuel pellets used in commercial reactors be contained in cladding material made of zircaloy or ZIRLO.

Subsequent to promulgation of these regulations, commercial fuel vendors have developed materials other than zircaloy or ZIRLO that have been approved by the NRC by exception to the rule for use in commercial power reactors. NEI requests NRC amend the regulations identified in the preceding paragraph to allow licensees discretion to use zirconium-based cladding materials other than zircaloy or ZIRLO, provided the cladding materials meet the fuel cladding performance requirements.

II. STATEMENT OF CURRENT REGULATION

Current NRC regulations require the use of zircaloy or ZIRLO cladding material for encasing uranium oxide fuel pellets used in light-water reactor fuel. The requirement to use either of these materials is stated in 10 CFR 50.44 and 10 CFR 50.46:

1. 10 C.F.R. §§ 50.44(a), 44(b) and 44(c)(1) (Description of applicable reactor and fuel type – boiling or pressurized light-water nuclear power reactor fuel) state:

   "(a) Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy or ZIRLO cladding, must, ..."

   "(b) Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy or ZIRLO cladding must ..."

   "(c)(1) For each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy or ZIRLO cladding, it must be shown that ..."

2. 10 C.F.R. § 50.46(a)(1)(i) (Description of applicable reactor and fuel type – boiling or pressurized light-water nuclear power reactor fuel) states:

> "Each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding must be provided with an emergency core cooling system (ECCS) that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section. ..."

III. STATEMENT OF PROPOSED AMENDMENT

The following proposed amendments would continue to allow nuclear power plant licensees the discretion to use zircaloy or ZIRLO cladding to encase the uranium dioxide fuel pellets. It would also allow nuclear power plant licensees to use other cladding materials with material properties that meet accepted fuel cladding performance requirements. Proposed additions to the regulations are identified by underlining; deletions are identified by ~~strikeout~~:

1. Amend 10 C.F.R. §§ 50.44(a), 44(b) and 44(c)(1) as follows:

(a) Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within approved cylindrical zirconium-based alloy ~~zircaloy or ZIRLO~~ cladding, must, ...

(b) Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within approved cylindrical zirconium-based alloy ~~zircaloy or ZIRLO~~ cladding must ...

(c)(1) For each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within approved cylindrical zirconium-based alloy ~~zircaloy or ZIRLO~~ cladding, it must be shown that ...

2. Amend 10 C.F.R. § 50.46(a)(1)(i) as follows:

Each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within approved cylindrical zirconium-based alloy ~~zircaloy or ZIRLO~~ cladding must be provided with an emergency core cooling system (ECCS) that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section. ...

3. Add new §50.46(e) to define *approved cylindrical zirconium-based alloy:*

Approved cylindrical zirconium-based alloys are those whose performance has been evaluated and determined by the NRC to conform to the acceptance criteria of paragraphs §50.46(b)(1) and (b)(2).

IV. INTEREST OF PETITIONER IN AMENDMENT

NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

Safe and reliable operation of nuclear power plants, including fuel performance, is very important to our members, as well as to our country and the international community. NEI's members are regulated by the NRC with respect to the use of radioactive materials; NRC allows licensees who are license holders for nuclear power plants to use a variety of cladding material once it is demonstrated to have the material charactoristics deemed necessary.

The use of cladding materials other than zircaloy or ZIRLO has been a practice permitted in the past nine years by NRC, subject to NRC approval of a formal exemption request. During that timeframe, there have been at least eight exemptions requested. The cost of each exemption is in excess of $ 50,000. We are unable to estimate the impact on NRC staff resources.

These exemption requests have become increasingly frequent, cause significant administrative confusion, and potentially have adverse impact on efficient and effective use of NRC, licensee and vendor resources.

V. JUSTIFICATION FOR AMENDMENT

A. The Current Regulation Given the Diversity of Commercially Available Fuel Cladding Materials is too Narrow and Restrictive

The beneficial use of zirconium (Zr) has been recognized for many years. It has a very low neutron cross-section when separated from hafnium with which it is typically found in nature. It also has excellent corrosion resistance to oxidizing environments, such as steam and water. Certain impurities were found to decrease this corrosion resistance and early

programs were established to develop alloys that produced more consistent corrosion resistance.

Primary additives were tin, as used initially in a variety of zirconium-based alloys commonly referred to as zircaloy, and niobium (Nb) favored in Canada and Russia.

Beginning in approximately the mid-1980's, nuclear fuel vendors began developing new alloy variations to improve cladding corrosion resistance in support of higher burnup fuel management strategies. The new alloy variants were initially within the ASTM specifications for existing zirconium-based cladding. As fuel cycle burnups were projected to increase further, additional alloys were developed, some of which involved formulations outside the ASTM specifications for existing cladding material.

The tin (Sn) based alloys were generally favored in the US and were successfully developed in both BWR and PWR reactors. Early Zr-Sn alloys tended to use relatively high tin concentrations until long term corrosion tests showed that there was an increase in the corrosion rate as a function of time. Subsequent developments of the alloy, currently defined as Zircaloy-2 and Zircaloy-4, limited tin concentration to between 1.2 and 1.7 percent. Most of the early zircaloy compositions were at a nominal 1.5 percent Sn. Subsequent testing of the alloy in high rated PWR plants has shown that the lower tin concentrations provide even better performance. Current zircaloy compositions tend to focus on a mean Sn composition of about 1.3 percent. That value has been established by producers to minimize the risk of manufacturing a product below the ASTM specified range. However, there is significant data to show that lower Sn compositions would provide even better corrosion resistance.

Excellent corrosion performance has also been achieved with the niobium-based alloys; however, these appear to be more sensitive to the coolant composition. For example, the corrosion resistance is superior to the tin-based alloy under PWR environments but tends to suffer from nodular-type oxidation under BWR conditions. The alloy is much less temperature sensitive and the oxide thickness is generally less than that of the corresponding corrosion layer on zircaloy irradiated under identical conditions. The optimum niobium content is probably about one percent, or such as is found in M5 or ZIRLO cladding alloys.

The major variant on the Zr-Sn and Zr-Nb systems is the Zr-Sn-Nb system developed in the US as ZIRLO and in Russia as E635.

As a result of these development programs, cladding materials now available include zircaloy, ZIRLO, Alloy A, M5, and Duplex. All of these alloys are zirconium-based. Since zircaloy and ZIRLO are currently the only cladding materials provided for in the regulations, utilities must obtain an exemption from the applicable regulatory requirements to use these other cladding materials. Exemption requests will become more frequent as use of new cladding materials becomes more prevalent. Once a specific cladding material is approved for use by NRC, the subsequent exemption requests do not increase safety or confidence in the performance of the cladding. They are strictly an administrative process necessitated by the restrictive language of the current regulations.

The rule should be modified to address the currently available alloys as well as those that may be developed in the future.

B. A More General Description Of Cladding Material Facilitates Technical Improvements

Currently, a licensee desiring to use fuel with cladding materials other than zircaloy or ZIRLO must obtain NRC approval through an exemption request. The time delay in obtaining approval as well as expenses incurred in preparing exemption requests might cause some licensees to defer adopting new cladding materials despite performance advantages to be gained. The proposed amendments would permit use of improved cladding materials without expending NRC, licensee, and vendor resources to develop, review, and approve exemption requests for cladding materials that fully meet NRC performance requirements.

Since the current industry interest focuses on cladding materials for which the performance criteria in § 50.46(b) remain applicable, a new section, § 50.46(e) is proposed that provides a clear tie between the approved cladding material alloy mentioned in §§ 50.44 and 50.46 with the criteria noted in § 50.46(b).

Similarly, to facilitate technical innovation, the NRC staff often encourages licensees and vendors to conduct Lead Test Assembly (LTA) Programs to demonstrate the performance of the new fuel assembly materials. It has been the past practice of the NRC not to require licensees to obtain approval of the LTA Program before placing the LTAs in the reactor. It is not the intent of industry to change that practice by making reference to approved cylindrical zirconium-based alloys in §§50.44 and 50.46.

C. The Regulation as Applied to Nuclear Power Plant Fuel Loading Incurs Unwarranted Implementation Costs

The implication of the current rule language that only the use of zircaloy or ZIRLO clad fuel is appropriate requires utilities to request, and NRC to approve, exemptions to use other cladding materials. Each exemption request is estimated to cost approximately $50,000, exclusive of NRC's cost. It is also estimated that the proposed change to the regulations could avoid at least thirty exemption requests over the next eight to nine years.

D. The Proposed Amendment Allows the Use of Alternative Materials That Meet the Cladding Performance Requirements

The existing regulations address only zircaloy and ZIRLO cladding materials. The regulation needs to be generalized to avoid unnecessary burdens on the developers of new cladding alloys and utilities who will use those alloys. The language of this proposed amendment will encompass all zirconium-based cladding material for which the ECCS performance criteria of 10 CFR 50.46(b) are applicable.

The proposed wording does not eliminate current NRC practices regarding review and approval of new cladding materials brought forward by fuel vendors. It does permit the NRC regulation to be more efficiently applied to those cladding materials demonstrated to meet the acceptance criteria of §50.46(b)(1) and (b)(2).

Experience has shown that qualification of an acceptable material can only be achieved by testing. An applicant must perform high-temperature oxidation and quenching tests of the cladding material to demonstrate that the 2200-degrees F peak cladding temperature and 17 percent oxidation limits protect the cladding against embrittlement and prevent the oxidation from becoming autocatalytic. This is demonstrated by heating the cladding to various high temperatures for a variety of time periods and quickly quenching the cladding in a cold water bath.

These tests must demonstrate that failure did not occur until beyond the temperature limits and that no autocatalytic oxidation was observed. As long as the tests confirm that the 2200-degrees F and 17 percent oxidation are conservative for the cladding material, then the material design is acceptable for LOCA licensing analyses up to currently approved burn up limits.

Providing a new, more general description of the fuel cladding is consistent with the NRC movement toward a performance-based, rather than prescriptive, regulatory philosophy.

VI. CONCLUSION

For the foregoing reasons, NRC should amend 10 C.F.R. §§ 50.44 and 50.46 as stated above to allow the use of zirconium-based alloys in addition to those specified in the current regulation.

The stated goal of those existing NRC regulations is to ensure adequate coolability for reactor fuel in case of a design basis accident. The proposed amendment does not degrade the ability to meet that goal. Rather, it removes an unwarranted licensing burden without increasing risk to public health and safety.