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UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

March 3, 2000

MEMORANDUM TO: ACRS Members

Noel Dudley

FROM: Noel Dudley, Senior Staff Engineer

SUBJECT: SUPPLEMENTAL USER NEED REQUEST FOR AGE RELATED DEGRADATION OF REACTOR VESSLE INTERNAL COMPONENTS

Attached is a supplemental user need request, which requests the Office of Nuclear Regulatory Research to assist in resolving age related degradation of reactor vessel internals for the following:

1. Irradiation-assisted stress-corrosion cracking (IASCC),

2. Void swelling in austenitic stainless steel,

3. Neutron embrittlement (e.g. loss of fracture toughness), and

4. Synergistic embrittlement of cast austenitic stainless stress (CASS) from concurrent exposure to high temperature and neutron irradiation.

cc via e-mail w/o att.:
J. Larkin
H. Larson
S. Duraiswamy
ACRS Fellows and Staff

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 11, 2000

MEMORANDUM TO: Ashok Thadani, Director
Office of Nuclear Regulatory Research

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

SUBJECT: SUPPLEMENTAL USER NEED REQUEST FOR AGE RELATED DEGRADATION OF REACTOR VESSEL INTERNAL COMPONENTS

By memorandum dated August 30, 1999, the Office of Nuclear Reactor Regulation (NRR) requested that the Office of Nuclear Regulatory Research (RES) develop additional information to assist in NRR's assessment of industry's actions to solve the problem of the cracking of both boiling water reactor (BWR) and pressurized water reactor (PWR) internal components; assess the potential consequences and risks of the failure of BWR internals components caused by intergranular stress corrosion cracking, and provide verification and validation of low-alloy steel (LAS) crack growth models, weldability at various fluence levels, and underwater welding technology.

In your memorandum dated November 2, 1999, you informed me that RES intended to reassess the overall research program in this area, including interacting with NRR, and provide a revised program plan. This is an appropriate approach for incorporating our research needs in the RES program.

In addition to the activities described in our August 30, 1999, memorandum which mainly apply to BWRs, our review of license renewal applications submitted by Baltimore Gas and Electric and Duke Power has resulted in the identification of several additional issues specifically related to degradation of PWR vessel internal components. Currently these issues are being addressed for license renewal on a plant-specific basis, typically through commitments to participate in ongoing industry research programs, as appropriate, and implement the results of these programs. It is expected that results of the industry programs will become available in four to five years, at which time we will need to assess the results of the industry research and the acceptability of associated aging management programs that are proposed. We request RES assistance in resolving these issues. The specific issues related to PWR vessel internal components to be addressed are (in order of priority):

CONTACT: Allen L. Hiser, Jr., NRR
415-1034

1. Evaluation of the causes and mechanisms for IASCC in PWR internals, with consideration of current understanding of mechanisms for BWR internals and environmental differences between PWR and BWR internals. The work in this area should provide information to assist in the review of industry proposed models for cracking propensity (initiation of cracking) and crack growth rate.

2. Void swelling in austenitic stainless steel (SS). The specific issues to be addressed include quantifying dimensional change as a function of fluence and assessing the potential impact of these changes on core flow and function of reactor internals.

3. Neutron irradiation embrittlement (e.g., loss of fracture toughness) of wrought austenitic SS. The purposes of this work will be to provide data on the level of embrittlement associated with the fluence levels anticipated for PWR internals and to assess the potential impact of the embrittlement on the integrity of RPV internals, e.g., potential for fracture in terms of critical flaw sizes and the ability to accommodate strain at localized stress risers.

4. Synergistic embrittlement of cast austenitic stainless steel (CASS) from concurrent exposure to high temperature and neutron irradiation. The purpose of this work is similar to that of Item 3, except in this case the CASS materials are subject to loss of fracture toughness from thermal embrittlement as well as neutron irradiation embrittlement. Procedures currently exist to assess the effects of thermal embrittlement on the fracture toughness of CASS materials, but not the synergistic combination of thermal and neutron irradiation embrittlement.

We request that reports on this PWR work cover the extent of degradation to be expected for license renewal conditions, such that we can assure in our review of industry programs that the data and analyses used in the industry programs are reasonable. As indicated previously, the staff is currently assessing these issues via plant-specific commitments for license renewal. However, we expect that results from the industry programs should begin to be available as early as the FY 2005 time frame and that the industry will then propose generic aging management programs. Therefore, we anticipate a need for the results of the work in this request beginning in FY 2005.

In addition, we request that work pertaining to the impact of the LWR environment on the fatigue life of components continue. Specifically, we request that tests to establish the saturation strain rate for low alloy steels be completed, the effects of the reactor coolant environment on sensitized stainless steels be evaluated, and the impact of loading sequence on fatigue life be evaluated. The staff needs the additional research effort in order to establish a final staff position regarding the industry criteria to be used in evaluating the effects of reactor water environment on the fatigue life of metal components. The specific application of these results will be to assure that environmental effects on fatigue life have been appropriately accounted for in license renewal evaluations. We expect this work to be completed by the end of FY 2002.

All of these issues, including the new efforts on PWR vessel internal components, have been included in the staff-level interactions between NRR and RES in prioritizing and coordinating RES activities within the environmental-assisted cracking (EAC) area, and hence should be covered in the revised program plan described in the memorandum from you.

The NRR staff contact for this new work related to PWR vessel internal components is Allen L. Hiser, Jr., of the Division of Engineering. He can be reached at 415-1034.

The data and other RES support requested by this memorandum will aid the NRR staff in establishing a position on the most effective aging management program(s) to be implemented by licensees with licenses renewed in accordance with Part 54. This staff position will provide for a high level of efficiency and effectiveness in the aging management programs through the use of appropriate tools (e.g., analysis, inspection, etc.) as warrented, while ensuring adequate levels of safety without undue regulatory burden on licensees.

Your continued support in these areas is appreciated. Please keep the NRR staff informed of your progress.