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PDR

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

JAN 28 1988

MEMORANDUM FOR: William Kerr, Chairman, ACRS

FROM: Victor Stello, Jr., EDO

SUBJECT: ACRS COMMENTS ON THE EMBRITTLEMENT OF STRUCTURAL STEEL IN REACTOR SUPPORT STRUCTURES

This memorandum is in reply to your December 8, 1987 letter concerning the embrittlement of structural steel in reactor support structures. In summary, we have restudied the 1983 NRC analysis of this issue as well as the more recent ORNL data that emerged from the HFIR analysis, and, as discussed in more detail below, our judgment is that this issue does not constitute an immediate threat to the safety of nuclear power plants that the NRC has licensed.

With regard to the two questions posed in your letter on the current and future status of the NDTT of the reactor support structures, our responses are:

(1) We have not studied enough plant specific information to unequivocally answer this question; the generic analyses that we have done to this point have not led us to identify any specific plants where the support system NDTT is above the operating temperature.

(2) Our judgment is that the NDTT of the support system structure in some plants may exceed the operating temperature before the end of the plant license.

We note that both of these responses are judgmental because we do not yet have sufficient information to be more definite, but we intend to perform such plant specific analyses in our continuing program.

We have responded to your questions as you posed them -- in the context of support structure material NDTT relative to the operating temperature of the support structure. While we agree that NDTT can provide a convenient indication of fracture toughness, and that one can put the problem in perspective by referring to NDTT, we note that resolution of this issue will be done in terms of a comprehensive fracture mechanics analysis, combining the stresses, the material properties (of which the NDT temperature is an important part), and a flaw size large enough to initiate a fracture.

Based on the analyses that have been performed and on our engineering judgment, we believe that the embrittlement of reactor vessel support structures does not pose an immediate threat to the safety of nuclear power plants. An important consideration that has contributed to our belief is that the failure of vessel supports does not lead to the failure of the piping. Work done by LLNL on a different project used a modelling assumption that support failure automatically resulted in piping failure. For that project, this was a conservative,

simplifying assumption. The staff has reviewed other analyses that consider the effects of component support failure on pipe breaks. Those analyses show that support failure is not likely to result in pipe failure. Further, recent structural analyses performed by the staff, and employing very conservative assumptions, show that reactor vessels can be supported on their inlet and outlet piping alone, without benefit of the support structures. In addition, our preliminary investigations indicate that shield-tank and column supports, although exposed to neutron fluxes at mid-height of the core, and skirt-type supports have a low likelihood of failure because (1) there is a large degree of redundancy associated with these designs, (2) the loading for these designs is primarily compressive, (3) the columns have no welds and essentially no thermal stresses in the high-flux zone, and (4) the end-of-life fluence for the skirts is very low.

Investigations regarding the impact of the HFIR data on the likelihood of failure for other vessel support designs are still underway. While we recognize that there may be tensile stresses within the structures that could cause cracking, and that there may be more embrittlement than originally anticipated, we do not believe that there is an immediate threat to the safety of nuclear power plants.

The Department of Energy is aware of this issue of embrittlement of reactor support structures having recently conducted a workshop on this topic at Sandia National Laboratory. The conclusion of the workshop was that there is no immediate problem with LWR support structures. However, the workshop focussed primarily on shield tanks and reached its conclusion primarily on the basis of industry work which did not emphasize embrittlement rate effects, nor did it include some of the additional sources of tensile stresses that we have been considering such as welding residual stresses or excessive friction in the slider assembly. EPRI has prepared an analysis of the support structure embrittlement on behalf of the industry that shows an increase in NDTT of 200°F for a 40-year life rather than the 400°F as determined in the ORNL work. We must point out that at this time, our contractor ORNL has reviewed the EPRI analysis and does not agree with it. EPRI, in cooperation with the NUPLEX Technical Subcommittee is, however, continuing to investigate the impact of embrittlement on the neutron shield tank and columnar support designs.

The NRC view of the DOE and industry work is that while we agree with the conclusion of no immediate safety problem, we are working to develop an adequate data base of information on designs, toughness, embrittlement, loads and flaws so that we can make a prompt and correct assessment of the situation.

We are actively researching this issue with the objectives of (1) identifying those plants with support structures that currently are susceptible to brittle failure at the operating temperature, (2) identifying those plants with support structures that may become susceptible to brittle failure at the operating temperature, and (3) defining appropriate actions for those plants. To achieve the first two objectives, we have asked the ORNL HSST Program staff to summarize the reactors by categories of support structures and submit, by February 1988, an estimate of time and cost for analysis of up to five distinct support structures. Our intent is to complete the analyses by the end of FY88. The ORNL analyses will include considerations of rates of embrittlement, peculiarities of support structures, variability of both the materials involved

and the potential loads, and combinations of stresses resulting from fabrication effects and normal and accident loading conditions. From the results of these analyses, we expect to be able to achieve our first two objectives. Subsequently, the staff will define appropriate actions for any plants that have, or are expected to have, supports susceptible to brittle failure.

The issue of support structure degradation involves the combined effects of low dose rate, low temperature, and spectrum softening on irradiation damage; analyses will make use of the HFIR results as these are the only such results currently available which include at least combined low dose rate and low temperature effects. Spectrum softening effects will be included in the ongoing research program. Final resolution of these questions on combined effects will require several years of work before enough data can be developed to provide a confident answer. A principal reason for the extended time for resolution comes from the need for study of materials from decommissioned reactors, such as the testing of steel to be removed from the shield tank of the Shippingport reactor. We plan to remove the samples in the Spring of 1988 with the testing to follow as soon as practical. Samples from other reactors undergoing decommissioning will be obtained and tested as they become available in the future. We also are in touch with Naval Reactors to determine if they have any pertinent information which could be shared with us on this issue.

Finally, the staff will review the regulations covering protection against brittle fracture for components and their supports and will review whether further requirements are needed, such as inspection or sampling of materials.

As we continue to develop pertinent information on this subject, we will keep you informed.

Original Signed By
V. Stello

Victor Stello, Jr.
Executive Director for Operations

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