Westinghouse Electric Corporation
Water Reactor Divisions

Nuclear Technology Division
Box 355
Pittsburgh Pennsylvania 15230

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D. G. Eisenhut
Acting Director
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20014

Dear Sir:

Subject: Framatome Reactor Vessel Nozzle Cracking

In late September of this year, an article was published in Nucleonics Week (September 27, 1979) indicating that the Westinghouse French licensee had observed the occurrence of cracking in the nozzle region of French fabricated reactor vessels. Subsequently, members of the Engineering Branch staff of DOR contacted Mr. R. J. Sero of my staff to request information on the incident. The NRC staff members requested periodic updates as Westinghouse investigations continued. The attachment summarizes the information resulting from Westinghouse investigations to date. Some of this information was presented by Westinghouse at a meeting between the NRC staff and Northern States Power Co. on November 26, 1979. This information is also being transmitted to all utilities with Westinghouse plants in operation or under construction.

Please contact Mr. R. J. Sero if you need any additional information.

Sincerely yours,

T. M. Anderson, Manager
Nuclear Safety Department

RJS/TMA/rli

Attachment

cc: V. S. Noonan
J. P. Knight
W. S. Hazelton

Dupe of
7912280338

ATTACHMENT

PROBLEM DEFINITION

Cracks have been detected by the Westinghouse French licensee in the heat affected zone (HAZ) of the low alloy steel base material of reactor vessel nozzles after performing the cladding operation on the bore of the nozzles. The cracks have been detected by both destructive and non-destructive (Ultrasonic Testing) examinations. The cracks appear to be confined to the HAZ produced by the second layer of cladding. They are oriented perpendicular to the cladding direction. The cracks exist in a broad area of the nozzle bore but are more prevalent in the thicker section of the nozzle. The cracks are relatively small with a maximum length of 1.0 inch and a maximum depth of 0.280 inches.

In order to detect the cracks, the French have made use of a twin transducer 70° angle beam UT technique. This technique differs from the 45° and 60° UT techniques commonly used for in-service inspections (ISI) in the United States.

The French believe that the cracking is hydrogen-induced and may be associated with manganese inclusions and/or carbon segregation in the base metal. The hydrogen introduction is believed to be the result of the welding process/heat treatment used to clad the carbon steel base metal with stainless steel.

WESTINGHOUSE ACTIONS

As a result of the identification of the cracking indications by the French, Westinghouse undertook the following actions:

- Survey of all reactor vessel manufacturers who have fabricated vessels for Westinghouse to verify that the same welding process/heat treatment believed to result in the cracking detected by the French has not been used in the fabrication of other vessels.

- For reactor vessels manufactured for Westinghouse by the French: determine what welding process/heat treatment was used; inspect available nozzles for indications; remove boat samples of indications for examination by Westinghouse R&D; and obtain affected nozzles for further examination and for use in the development of an ISI technique, as appropriate.

- Begin efforts to perform Fracture Mechanics Analyses for vessel nozzles which were manufactured by the French, and which are in service. Survey of information showed that the only domestic plants affected are Prairie Island Units 1 and 2.

- Initiate a research program to perform hydrogen diffusion calculations for the conditions in question.

STATUS OF WESTINGHOUSE ACTIONS

- Survey of Reactor Vessel Vendors

The Westinghouse survey has been completed, and we have concluded that the welding process/heat treatment used by Combustion Engineering, Babcock and Wilcox, and Chicago Bridge and Iron should preclude the occurrence of hydrogen-induced cracking. However, five domestic reactor vessels manufactured by Rotterdam Dock Yard for Westinghouse are still under investigation. These five reactor vessels are: Maguire Unit 2, Catawba Unit 1, Sequoyah Unit 1, Watts Bar Unit 1, and Watts Bar Unit 2.

- Examinations of French Reactor Vessel Nozzles

Westinghouse has had three French-manufactured nozzles examined by the French with the 70° UT technique to determine their condition. These nozzles, constructed for the Offshore Power Systems reactor

vessels, were manufactured using strip cladding rather than two-wire welding process (used on the Prairie Island vessels) and similar heat treatments. Each of the nozzles had some indications which the French would classify as repairable. Westinghouse requested that three boat samples of the indications be removed and returned to the U.S. for further examination. These boat samples have been received and are under investigation.

- Development of ISI

Westinghouse is having two of the affected French nozzles transported to the U.S. for use in development of an ISI technique to examine the Prairie Island vessels. In addition, appropriate criteria for use in the 70° UT inspection will also be developed.

- Fracture Mechanics Evaluation

Preliminary fracture mechanics analyses have been performed for the Prairie Island reactor vessel nozzles to quantify the margin of safety if cracks similar to those found by the French exist in the nozzles. Those analyses considered fatigue crack growth assuming the plant is operated in a load-follow manner and determined the critical flaw size for a LOCA and MSLB. The results of these analyses demonstrate that any base metal flaw less than 1/2 of an inch in depth will not propagate sufficiently by fatigue to achieve the size necessary to impair vessel integrity for the subject accident conditions. Since the indications observed to date are far less than 1/2 of an inch in depth, there is no safety question involved in continued plant operation.

- Hydrogen Diffusion Calculations

These calculations are underway and should be complete by the end the year.

FUTURE WESTINGHOUSE ACTIONS

- Westinghouse intends to continue to examine boat samples from the affected Offshore Power Systems vessels to confirm cause of cracking indications.

- The ISI techniques and tool modifications will be complete in time to support the Prairie Island inspection outage in mid-1980.

- Westinghouse will inform all utilities with Westinghouse-designed plants in operation or under construction of the status of our investigations.

- Fracture mechanics analyses for Northern States Power Company will be completed and results available prior to the mid-1980 inspection outage.