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

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF SPECIAL PROJECTS

NUCLEAR PERFORMANCE PLAN, VOLUME 3, SECTION III.7.0

INTERGRANULAR STRESS CORROSION CRACKING

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNIT 2

DOCKET NO. 50-260

1.0 INTRODUCTION

The Tennessee Valley Authority (TVA or the licensee) has experienced intergranular stress corrosion cracking (IGSCC) of several components in each of the three units at Browns Ferry. IGSCC in the austenitic stainless steel piping systems for reactor coolant has been an identified problem for boiling water reactors (BWR) for about 12 years. Extensive studies have identified the conditions favorable for IGSCC and developed mitigation methods for each of the conditions in austenitic steel piping systems. For other systems and components, the items affected tend not to be made monolithic by welding, but are relatively small, discrete parts which can be replaced with materials not susceptible to IGSCC, or if they are weldments, they are relative small in size or number and can be monitored and replaced/repaired as necessary.

2.0 EVALUATION

2.1 IGSCC Status of Reactor Attached Piping and Safe Ends

TVA has utilized a number of mitigation methods in treating the 180 welds in the austenitic stainless steel reactor coolant piping over 4 inches in diameter which is exposed to reactor coolant over 200°F up to the second isolation valve refer to Generic Letter (GL) 84-11 and 88-01. Of the 180 weld joints, there remain eleven welds in non-resistant material which have had no mitigation actions. There are five untreated welds in non-resistant material within penetrations. TVA plans to either remove the welds by design or overlay clad these welds on the inside surface which is exposed to reactor coolant. There are six welds in the Core Spray System where the austenitic stainless steel piping has been replaced by carbon steel piping but austenitic stainless steel fittings are still in use and these bimetallic or dissimilar metal joints must undergo a mitigation action. TVA has indicated that these particular joints will be induction heating stress improvement (IHSI) treated by the conclusion of the next outage.

TVA has not completed post-IHSI inspections of 71 welds which have been IHSI treated. Because TVA had not performed sample expansion inspections under the terms stipulated in GL-84-11 and required in our letter of March 26, 1986 letter to them, the staff has previously concluded that all remaining post-IHSI inspections be performed before restart in its Safety Evaluation of TVA's response to GL-88-11 and GL-88-01 (December 8, 1988). The stipulation was that if any crack indications were found after IHSI in the 25 percent sample inspected, another 25 percent of the welds IHSI treated that had exposure since original licensing would be inspected. TVA has replaced recirculation inlet safe ends on Unit 2 due to IGSCC. In addition, TVA has made arrangements to install hydrogen water chemistry treatment facilities to Browns Ferry Unit 2 and this may be activated during mid-cycle or by the end of the next refueling outage.

2.2 Jet Pump Hold Down Beams

In response to IE Bulletin No. 80-07, TVA performed the required inspections and reported the results by letter dated October 20, 1980. No cracks were found. The failure mechanism was determined to be intergranular stress corrosion cracking. General Electric (GE), the vendor, made replacement beam assemblies from material more IGSCC resistant. TVA replaced all jet pump beam assemblies on Unit 2 as documented in Inspection Report 50-260/84-16.

2.3 Shroud Head Bolts

Shroud head bolt cracking has been observed in several BWR plants. The failure mechanism has been identified by GE as IGSCC. All 48 of these bolts have been inspected by GE using a special ultrasonic process developed for the specific geometry. TVA reported 13 shroud head bolts cracked.

TVA plans to replace all of the cracked bolts with new or borrowed bolts from another unit prior to restart. TVA also plans to establish a program for periodic reinspection of these shroud bolts.

2.4 Control Blade Cracking

This issue was identified recently, and the industry is presently in the process of gathering data. The cracking mechanism has been identified by GE as stress corrosion cracking. However, other factors such as weld configuration and water chemistry have been found to be of significance. The influence of the various factors, rates of occurrence, means of mitigating or eliminating the cause of the cracking, and the regulatory approach remain to be determined. TVA is participating in the industry's effort to build an experience data base. Prior to restart, a selected number of control blades from Unit 2 will be inspected. The inspection will be an in-core remote visual examination of the upper portion of the control blades while they are in the fully inserted position. TVA's participation in the industry data base generation will provide TVA with current and definitive information which will allow them to make informed decisions in addressing the issue.

2.5. Control Rod Drive Collet Tube Cracking

Control rod drive collet retainer tube cracking has been observed in BWRs since 1975. TVA has a control rod drive rebuild maintenance program in place which requires inspection of tubes on a periodic basis. Tubes are liquid penetrant examined per the vendor's recommended criteria. TVA has demonstrated an adequate approach in addressing this problem.

2.6 RHR Pump Wear Rings

All of the Unit 2 RHR pumps have had their upper and lower impeller wear rings replaced with original specification material. Also, two of the crosstie RHR pumps to Unit 2 will have their wear rings replaced prior to Unit 2 restart. The mitigation action of hydrogen water chemistry for the stainless steel piping along with well controlled water chemistry may provide the necessary environment to control this IGSCC problem along with the other IGSCC occurrences.

2.7 Shroud Access Cover Weld Cracking

The NRC issued Information Notice No. 88-03 on February 2, 1988 titled, "Cracks in Shroud Support Access Hole Cover Welds." The notice alerted boiling water reactor licensees of the potential for cracking in these welds. TVA contracted with GE to perform a special ultrasonic inspection to determine if there was cracking in these welds. The inspections were performed as reported in Inspection Reports 50-260/88-06 and 88-15. No crack indications were found. The mitigation action of hydrogen water chemistry for the stainless steel piping along with a well controlled water chemistry program may provide the necessary environment to control this IGSCC problem along with the other IGSCC occurrences.

3.0 CONCLUSIONS

The staff's view of TVA's program for mitigation of IGSCC of BWR austenitic stainless steel piping was expressed in our SE of December 8, 1988. There are 71 welds that have received the induction heat stress improvement (IHSI) treatment which have not been post-IHSI inspected. The staff believes that there have been enough instances of IGSCC indications in the piping to require post-IHSI inspection of these 71 welds prior to restart to demonstrate that there are no significant IGSCC flaws present in these welds. Our evaluation of your response will be covered under the review of GL 88-01.

The other instances of IGSCC in the various components have been addressed adequately by TVA.

Principal Contributor: D. Smith

Dated: December 30, 1988

cc:
General Counsel
Tennessee Valley Authority
400 West Summit Hill Drive
E11 B33
Knoxville, Tennessee 37902

Mr. R. L. Gridley
Tennessee Valley Authority
5N 157B Lookout Place
Chattanooga, Tennessee 37402-2801

Mr. C. Mason
Tennessee Valley Authority
Browns Ferry Nuclear Plant
P.O. Box 2000
Decatur, Alabama 35602

Mr. P. Carier
Tennessee Valley Authority
Browns Ferry Nuclear Plant
P.O. Box 2000
Decatur, Alabama 35602

Mr. D. L. Williams
Tennessee Valley Authority
400 West Summit Hill Drive
W10 B85
Knoxville, Tennessee 37902

Chairman, Limestone County Commission
P.O. Box 188
Athens, Alabama 35611

Claude Earl Fox, M.D.
State Health Officer
State Department of Public Health
State Office Building
Montgomery, Alabama 36130

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street, N.W.
Atlanta, Georgia 30323

Resident Inspector/Browns Ferry NP
U.S. Nuclear Regulatory Commission
Route 12, Box 637
Athens, Alabama 35611

Dr. Henry Myers, Science Advisor
Committee on Interior
and Insular Affairs
U. S. House of Representatives
Washington, D.C. 20515

Tennessee Valley Authority
Rockville Office
11921 Rockville Pike
Suite 402
Rockville, Maryland 20852