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

ENCLOSURE

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATING TO THE MICROBIOLOGICALLY INDUCED CORROSION PROGRAM

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

DOCKET NOS. 50-390 AND 50-391

1.0 INTRODUCTION

In the early 1980s, corrosion product buildup in the essential raw cooling water (ERCW) system resulted in replacement of the carbon steel piping with 316 austenitic stainless steel. In addition, the main yard ERCW headers were lined with concrete. Technical Instruction TI-27 was implemented to assure system cleanliness during ERCW breaches and TI-31.13 was instituted to monitor wall thinning resulting from cavitation, two-phase erosion/corrosion, microbiologically induced corrosion (MIC) and generalized corrosion.

In August 1986, MIC caused leaks in the butt welds of 12-inch diameter, 316 austenitic stainless steel ERCW piping. The response to Generic Letter (GL) 89-13, "Service Water System Problems Affecting Safety-Related Equipment" was transmitted to NRC on January 26, 1990. TI-36, issued in August 1990, describes the program for monitoring, detection, assessment of extent, and control of MIC.

In April 1991, TI-106 was issued to evaluate welds with leaks by a representative sample of ERCW welds which are radiographed to trend MIC growth in the remaining ERCW welds. The applicant submitted the MIC program report on February 26, 1991. On January 11, 1991, the NRC staff visited Watts Bar for a discussion and on-site review of the MIC program. The staff has reviewed TI-27, 31.13, 36 and 106 and the applicant's letters dated January 26, 1990 (response to Generic Letter 89-13), and February 26, 1991 (MIC program report), and presents the finding in this safety evaluation.

2.0 EVALUATION

A. Inspection

TI-31.13, "Wall Thinning Monitoring Program for Cavitation, Microbiologically Induced Corrosion, and Dual Phase Erosion/Corrosion," is utilized to obtain information to determine repair or replacement intervals to prevent through-wall leaks and to trend the rate of degradation. TI-31.13 provides recommended ERCW inspection locations by ultrasonic testing (UT) for cavitation, MIC, and two-phase erosion/corrosion.

TI-106 addresses radiographic examination (RT) of butt-welded ERCW stainless steel piping to evaluate MIC damage. It also provides data to trend MIC damage in the ERCW welds. Based on the RT results, the structural integrity of the welds will be evaluated. All leaking welds identified will be repaired or replaced during the next scheduled outage exceeding 30 days but no later than the next refueling outage.

B. Surveillance

TI-36 describes the program for monitoring, detection, assessment of the degree, and the control of MIC at the Watts Bar Nuclear Plant. This program encompasses:

- the monitoring of plant systems for biological activity and the degree of corrosion after biocide treatment,
- the assessment of the degree of MIC, the degree of stainless steel butt weld damage, and the distribution of carbon steel piping damage,
- the control of MIC by appropriate water treatment, and
- the control of MIC during layup.

A comprehensive corrosion monitoring program has been established to monitor the effectiveness of the biocide and dispersant/corrosion inhibitor treatment. The monitoring program includes:

- Betz Cosmos portable corrosion monitor
- Weight loss coupon racks
- Total residual oxidant analyzer
- Visual observation test spool pieces
- Sessile bacteria bead monitors

Monitoring of ERCW with surveillance coupon, biocide levels, electrochemical probes, and representative chemical samples provides valuable data of the effectiveness of the treatment program and can alert the operator to changes in either the environment or the corrosion response of materials.

C. Leak Position

The staff's position on continued operation after detection of a leaking pipe is that a repair/replacement in accordance with the American Society of Mechanical Engineers (ASME) Code Section XI is required. If the applicant desires relief from ASME Code Section XI repair/replacement requirements, the provisions of Generic Letter 90-05 should be followed.

D. Cleaning

TI-27 provides the criteria for internal and external surface cleaning and cleanliness of fluid systems and components during initial installation modification, and maintenance activities. This TI was implemented to ensure system cleanliness during system breaches.

E. Treatment

Biocide treatment will be implemented when the microbiological level is greater than 10^4 CFU (colony-forming units)/ml. Visual examinations are periodically performed on carbon and stainless steel outside surfaces of components for through-wall leaks and nodule deposits. Non-destructive examinations (NDE) are performed on plant systems and/or components based on the results of biological monitoring. If a system that contains stainless steel pipings is found to have a through-wall leak at welds and heat-affected zones, the defect size and distribution is determined for a structural integrity analysis to determine the remaining margin. A system that contains carbon steel piping is evaluated to determine that the minimum wall thickness meets the requirements specified in the design calculations.

The applicant has installed a bromine/chorine biocide injection system for treatment of the new water system, including the ERCW. Hypobromous (HOB) and hypochlorous acid (HOCL) are injected into the raw water cooling system by passing a side stream through a bed of granular bromo-chloro-dimethyldantoin. An on-line dispersant/corrosion inhibitor treatment system has been selected to chemically treat iron and MIC corrosion deposits. The chemical composition consists of zinc sulfate and tetra-sodium polyphosphate corrosion inhibitors with either a polyphosphate or dimethyl amide as a penetrant/dispersant or other equivalent. The applicant indicates that it may take one to two years to clean up the MIC deposits. The applicant has indicated that the on-line dispersant/ corrosion inhibitor treatment was selected to prevent blockage or damage to instrumentation or equipment.

There is a concern about initiating biocide treatment without prior cleansing of a system. It is important that fouled systems be cleaned as a first step for mitigation of corrosion. It is then possible that treatments can be effective in preventing the recurrence of the problem (Reference 1). Addition of most inhibitors to treat MIC is unlikely to have any effect at all unless the biological growth has been removed from the surfaces either mechanically or chemically, and the microbial infestation has been controlled (Reference 2). It is to be stressed, however, that the cleaning method employed must completely remove the slime, scale and other material, since if some material is left over, corrosion in the pit may proceed (Reference 3). One of the components in the applicant's proposed dispersant/corrosion inhibitor treatment program (polyphosphates) can be broken down by some microorganisms rendering it ineffective as a corrosion inhibitor (Reference 3). Some biocides and corrosion inhibitors are ineffective in penetrating the MIC tubercles and therefore, are

ineffective in controlling MIC corrosion. Ozone and hydrogen peroxides, strong oxidizing biocides with greater penetrating power than chlorine, have been used for treatment of existing MIC. To assure effective (i.e., immediate) MIC control, mechanical or chemical cleaning of the ERCW appears necessary. The use of online dispersant/corrosion inhibitor treatment in conjunction with biocide treatment may take up to 24 months to attain effective MIC control.

3.0 CONCLUSION

The staff concludes that the Watts Bar MIC program for detection, assessment, and control of MIC in the ERCW system, if properly implemented, and commitments in Enclosure 2 of the applicant's February 2, 1991 letter are met, will provide reasonable assurance that this system will not lose its capability to perform its safety function due to MIC damage. However, if leakage should occur, the requirements of Generic Letter 90-05 shall apply, and a written request for relief is required for the interim period until a code repair is made during the next scheduled outage exceeding 30 days, but no later than the next refueling outage. Although not a safety concern, the use of biocides and the proposed dispersant/corrosion inhibitor treatment program without prior cleaning of the system may not be as effective as would be expected for a ERCW that had been previously mechanically or chemically cleaned. The cleaning would remove slime, scale, and other material and would improve the effectiveness of biocide and dispersant/corrosion inhibitor treatment.

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References

1) EPRI NP.5580, "Source book for Microbiologically Influenced Corrosion in Nuclear Power Plants," G.J. Licina, 1988.

2) EPRI ER.6345, "Microbial Corrosion: 1980 Workshop Proceedings," Section 7, "Cleaning Methods and Philosophy of Cleaning to Prevent or Mitigate Microbiological Influenced Corrosion," B.D. Fillers, April 1989.

3) EPRI NP.4582, "A Study of Microbiologically Influenced Corrosion in Nuclear Power Plants and a Practical Guide for Countermeasures," D.H. Pope, May 1986.