TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II

September 26, 1983

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WBRD-50-390/82-103
WBRD-50-391/82-97

U.S. Nuclear Regulatory Commission
Region II
Attn: Mr. James P. O'Reilly, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - VENTING OF HIGH POINTS IN ERCW SYSTEM - WBRD-50-390/82-103, WBRD-50-391/82-97 - FINAL REPORT

The subject deficiency was initially reported to NRC-OIE Inspector C. Burger on September 30, 1982 in accordance with 10 CFR 50.55(e) as NCR WBN MEB 8202. Interim reports were submitted on October 28, 1982 and February 25, April 28, and July 27, 1983. Enclosed is our final report.

If you have any questions, please get in touch with R. H. Shell at FTS 858-2688.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Licensing

Enclosure
cc (Enclosure):
Mr. Richard C. DeYoung, Director
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Records Center
Institute of Nuclear Power Operations
1100 Circle 75 Parkway, Suite 1500
Atlanta, Georgia 30339

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ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
VENTING OF HIGH POINTS IN ERCW SYSTEM
NCR WBN MEB 8202
WBRD-50-390/82-103, WBRD-50-391/82-97
10 CFR 50.55(e)
FINAL REPORT

Description of Deficiency

Air vents are provided at high points of piping systems to purge air trapped during initial filling, operation, or following maintenance functions. Manual vents are generally acceptable; however, TVA has determined that air may come out of solution due to heating or pressure drop in several safety-related coolers supplied with essential raw cooling water under accident conditions. Since access is restricted under such conditions, the manual vents would be unsuitable for these applications.

No analysis has been performed to identify the points in the system, if any, where automatic venting will be required. The cause of this deficiency is incomplete consideration of all design bases during the production of design criteria.

Safety Implications

Air liberation could cause air binding, reduce cooling water flow, induce flow oscillations, or cause excessive vibrations. Since cooling water is required to support operation of the safety-related coolers, loss of this function could render these coolers inoperative and thereby jeopardize plant safety.

Corrective Action

The Tennessee River serves as the water source for the ERCW system. Significant quantities of oxygen, as well as other atmospheric gases, are dissolved in the river water. As this water passes through the ERCW piping system, it undergoes changes of pressure and temperature. Henry's Law indicates the effect of such changes and shows that the gases will tend to come out of solution if temperature increases or if pressure decreases. An analysis was performed to identify those components for which air may come out of solution.

The fact that air might be released within the ERCW system is not in itself unacceptable. In fact, air is sometimes injected into piping systems to cushion the effects of cavitation. The key is the flow regime induced by this phenomenon and its effect on system thermal and hydraulic performance and structural design.

As air begins to come out of solution, the system passes through a series of flow regimes each having characteristic physical effects, bubbly flow, slug flow, plug flow, stratified flow, annular flow, and misty flow. Vigander[1]

[1]"Watts Bar Nuclear Plant Consideration of the ERCW Air Liberation Study," Report Number WR28-1-85-105, by Svein Vigander, July 1983.

states that "In the absence of air traps, . . . air in bubbly flow has no significant adverse impact on pipe flow." Therefore, if it could be shown that all cooler loops remained within the bubbly flow regime, no flow problems would be expected.

Vigander further states that the transition from bubbly flow to slug flow has been studied by several researchers and may be defined on a void fraction versus Froude number map. Therefore, an analysis was performed in which Henry's Law was used to calculate the void fraction (i.e., the ratio of volume of air released to the total water volume) of each cooler loop assuming that all dissolved air was released at the point of minimum static pressure within the piping. All loops found to be in the bubbly flow regime were considered acceptable and excluded from further study. The following loops were found to be in the slug flow regime:

1. Component Cooling System (CCS) Heat Exchanger
2. Emergency Gas Treatment Room (EGTR) Cooler
3. Auxiliary Control Air Compressors
4. Spent Fuel Pit and Thermal Barrier Booster (SFP and TBB) Pump Room Coolers
5. Upper Containment Ventilation (UCV) Coolers

Simpson[2] has stated that pulsing and vibration from slug flow should only be expected for values of Froude ($V/\sqrt{gD}$) 0.31 to 1.0. Of the five loops above, only the EGTR cooler is within this range. Lowering the modulating valve located in the cooler discharge line approximately 13 feet brings this loop within the bubbly flow regime. This change will be implemented under ECN 4238. All modifications associated with ECN 4238 will be completed by April 2, 1984.

Although the UCV cooler has a Froude number less than 0.31, the void fraction is quite high, indicating release of considerable quantities of low energy air. This air would not be expected to cause problems based on Simpson's criteria; however, a relatively minor change will bring this loop within the bubbly flow regime and at the same time make the manual throttling valves downstream of the coolers accessible during normal operation. This change simply involves moving the manual throttling valves outside containment to a location just upstream of the automatic temperature control valves. This is approximately 85 feet below their present location. This change will be made under ECN 4239 for unit 1 and ECN 4240 for unit 2. Construction work associated with ECN 4239 will be completed by December 30, 1983, and work associated with ECN 4240 will be completed by September 28, 1984.

Air liberation is not expected to be a problem in any of the remaining loops.

Deficiencies of this type will be avoided in the future by incorporating procedures into ERCW Design Guide DG-M3.3 to check for air liberation on future plants. This will be completed by September 28, 1984.

[2]"Sizing Piping for Process Plants," Chemical Engineering, by Larry L. Simpson, June 17, 1968.