

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401  
400 Chestnut Street Tower II

REGION II  
ATLANTA, GEORGIA

May 20, 1983

83 MAY 23 10:34

WBRD-50-390/82-55  
WPRD-50-391/82-52

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 - DEFICIENCIES IN CEMENT MORTAR  
LINING BY AMERON - WBRD-50-390/82-55, WBRD-50-391/82-52 - FINAL REPORT

The subject deficiency was initially reported to NRC-OIE Inspector R. V. Crlenjak on May 21, 1982 in accordance with 10 CFR 50.55(e) as NCR 4117R. Our first interim report was submitted on June 21, 1982. Subsequent to the first submittal, similar deficiencies (NCRs 4133R R1 and 4163R) were determined to be reportable. Our second interim report was submitted on August 6, 1982 and included NCRs 4117R, 4133R R1, and 4163R. Subsequent to the second submittal, a similar deficiency (NCR 4270R) was determined to be reportable. Our third interim report was submitted on October 28, 1982 and included NCRs 4117R, 4133R R1, 4163R, and 4270R. Enclosed is our final report. We consider 10 CFR Part 21 applicable to this condition.

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

Very truly yours,

TENNESSEE VALLEY AUTHORITY

*D S Kammer*

for L. M. Mills, Manager  
Nuclear Licensing

Enclosure

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

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

8305250435 830520  
PDR ADOCK 05000390  
S PDR

OFFICIAL COPY

IE 27

ENCLOSURE

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2  
DEFICIENCIES IN CEMENT MORTAR LINING BY AMERON  
NCR'S 4117R, 4133R R1, 4163R, 4270R R2  
WBRD-50-390/82-55, WBRD-50-391/82-52  
10 CFR 50.55(e)  
FINAL REPORT

Description of Deficiency

In order to alleviate the detrimental effects of corrosion on the flow passing capability of large carbon steel piping headers and, thereby, to help ensure adequate flow to system components over the plant lifetime, TVA decided to apply a cement mortar lining to the yard portion of the essential raw cooling water (ERCW) system at Watts Bar Nuclear Plant (see the final report dated September 23, 1981, on nonconformance report (NCR) WBN NEB 8017).

During installation, cement mortar lining which does not comply with the governing specifications (i.e., TVA Technical Specification 5225 R0 and TVA Watts Bar Nuclear Plant Construction Specification N3M-921 R0) has been applied to the interior of the ERCW system piping by Ameron Pipe Lining Division of Kenilworth, New Jersey. The nature and apparent cause of these deviations from the specifications reported on NCR 4117R are as follows:

1. In some instances, mortar samples taken indicated higher slumps than those specified due to the addition of an excessive amount of water during batching.
2. In some instances, mortar temperatures exceeded the maximum specified due to the fact that some mortar components were stored in such a way that they were too warm before batching began.
3. During curing of the cement mortar lining, relative humidity readings consistently fell below the minimum specified value due to the requirement to remove end caps from the lined piping sections while taking relative humidity readings.
4. Surface cracks exist which exceed the maximum specified value due to improper curing and excessive heat caused by solar radiation on the exterior of the pipe.
5. In some instances, lining thicknesses are less than that specified.
6. In some instances, lined sections were left uncapped after exit of personnel.
7. One mortar sample taken indicated a slightly lower compressive strength than that specified.

Similar deviations from the specifications have been identified on NCR 4133R R1 and NCR 4163R. Also, one compressive strength sample significantly lower than that specified was documented on NCR 4133R R1.

NCR 4270R R2 documents deficiencies in repair work performed by Ameron; specifically (1) the quality of a large number of repaired areas is indeterminate since Ameron construction personnel state that inadequate vendor quality assurance records were kept, (2) in some instances where cement-mortar lining was applied by hand over the full pipe circumference, the top half of the pipe was lined, the edges of the lining were tapered to a thin feathered edge, and the lining was permitted to cure for approximately 30 minutes before the bottom half of the pipe was lined. When the bottom half was lined, cement-mortar lining was placed over the feathered edge forming a laminated area on each side of the pipe, and (3) curing compound was not applied to repairs and weld zones as specified by Construction Specification No. N3M921.

### Safety Implications

The application of cement mortar lining in a way which does not comply with the governing specifications increases the probability that cement mortar lining spalling might occur during a seismic event. If pieces of the spalled mortar were carried along by the cooling water supplying the heat exchangers, which are designed to dissipate safety-related heat loads, flow could be restricted, thus reducing the capacity of the heat exchangers to remove their design heat loads. Therefore, this condition could have jeopardized the safe operation of the plant had it remained uncorrected.

### Corrective Actions

A visual inspection of the installed cement mortar lining was performed, and all available test data was reviewed. The corrective action for each deviation, as listed above in the description of deficiency, from the specification noted on NCR 4117R is as follows:

1. High slump - Compressive strength tests performed on samples taken at the same time the slump tests were performed do not indicate unacceptably low strength concrete. Therefore, the sections of lining for which high slump was recorded are acceptable. In the future, if high slumps are encountered, the mortar will be wasted as required by N3M-921.
2. High mortar temperature - Compressive strength tests performed on samples taken at the same time the high mortar temperatures were recorded do not indicate unacceptably low strength concrete. Therefore, the sections of lining for which high mortar temperatures were recorded are acceptable. In the future, steps will be taken to protect the mix components from solar heating and, if required, ice will be used in the mortar mix to reduce excessive temperatures as required by N3M-921.

3. Low relative humidity - Visual inspection of the lining did not reveal unacceptable cracking due to improper curing. Therefore, the section of lining for which low relative humidity was measured are acceptable. Tests performed with a strip chart type humidity recorder have shown that if end caps are placed on lined piping sections and if water is introduced into the pipe, an acceptable relative humidity will result. Since the act of measuring relative humidity is in and of itself detrimental to that end, a specification revision notice (SRN-N3M-921-3) has been issued to specify a procedure to ensure proper curing and to delete the requirement of humidity measurements.
4. Surface cracks - The areas of cement mortar lining in header 2A and 2B which had surface cracks were inundated with water for approximately 12 days. At the end of this period the water was removed from these piping segments and the surface cracks were remeasured. The results showed that the surface crack widths were reduced an average of 52 percent. Since the original maximum crack criteria had been established assuming inundation with water, SRN-N3M-921-6 was issued to increase the maximum acceptable surface crack width from 0.02 inches to 0.033 inches for those cracks which have not been inundated by water. The surface cracks have been repaired as required by the revised specification.
5. Mortar thickness - Minimum lining thickness requirements have been reviewed in light of the American Water Works Association's Standard for Cement Mortar Lining (AWWA-C602), which suggests 3/8-inch thickness for "old" pipe and 1/4-inch thickness for "new" pipe. After excavation and inspection of system piping, it has been determined that the pipe being lined fit the definition for "new" pipe and that thicknesses as thin as 1/4-inch are acceptable even though this thickness is less than the thickness originally specified. Accordingly, sections of lining for which the mortar thickness is less than that specified but greater than 1/4-inch are acceptable, and a specification revision notice (SRN-N3M-921-3) has been issued to revise the thickness requirements to allow lining thicknesses as small as 1/4-inch.
6. Caps on ends removed - Visual inspection of the lining did not reveal unacceptable cracking due to improper curing. Therefore, the sections of lining for which the end caps have been found to be removed are acceptable. The contractor has reinstructed his personnel on the importance of replacing end caps, and TVA has limited access into lined sections to authorized personnel.
7. Low compressive strength - The compressive strength of all samples are not significantly below that specified. Therefore, in accordance with a statistical analysis (CEB 820701 003), the section of lining for which the low compressive strength was measured is acceptable.

Also, corrective actions taken to rectify the nonconforming conditions reported on NCR 4117R has been taken for the similar nonconforming conditions reported on NCR 4133R R1 and NCR 4163R. The single average compressive strength sample reported on NCR 4133R R1 which was significantly lower than that specified has been analyzed statistically together with 143 other average compressive strength samples. All compressive strength sample data analyzed fall within a normalized distribution curve and therefore the segment of cement mortar lining which this compressive strength sample represents is concluded to be acceptable. Visual examination gives no indication of deficiencies and no remedial action is required. No actions to prevent similar low compressive strength samples are required since Ameron has completed the cement lining.

Corrective action in the areas reported on NCRs 4117R, 4133R R1, and 4163R with surface cracks was completed August 15, 1982.

Corrective actions for the deficiencies identified by NCR 4270R R2 are as follows:

1. TVA audited Ameron's quality assurance records during the week of May 2, 1983, to verify that Ameron recorded the information required by technical specification 5225 for the areas identified in NCR 4270R R2. Three deficiencies associated with Ameron's documentation and the documentation process between Ameron and TVA were identified in the audit. These three deficiencies have been determined to be nonreportable and as such do not represent conditions which could be adverse to the safe operations of the plant.
2. A representative sample specimen of the hand-lined cement-mortar lining, which was laminated and tapered to a feather edge, was removed from pipe segment SP-17-2B after the lining had cured approximately three days. The lamination was approximately three to four inches as measured along the circumference of the pipe. An adequate amount of bonding existed between the laminated layers of mortar. About one-half inch of the thinnest portion of feather-edge mortar spalled off easily. Although this half inch portion may spall off during a less severe service condition than a seismic event, the layer of mortar remaining underneath is of adequate thickness and structural integrity to fulfill all the design functions of mortar lining. It is concluded on the basis of this sample examination that the feather edge lining is acceptable as installed in both SP-17-2B and any other similarly laminated areas which employed this method.
3. Visual inspection of repair and weld zone areas where curing compound had not been applied revealed no indication of inadequate curing. Since these areas conform to the crack inspection criteria in the revised construction specification N3M-921, it is concluded they are acceptable as-is. Contractor personnel were reinstructed that curing compound shall be applied to repaired areas and to weld zones.

ERCW pipe lining and repairs were completed on September 22, 1982.

Cement-mortar lining in the ERCW system at Bellefonte Nuclear Plant was completed in mid-December 1982 and was affected by many of the above actions. The procedural changes made for Watts Bar Nuclear Plant have been incorporated in the appropriate specifications for Bellefonte.