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TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

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- WBRD-50-391/83-18
- WBRD-50-391/83-19
- WBRD-50-391/83-20

U.S. Nuclear Regulatory Commission  
 Region II  
 Attention: Dr. J. Nelson Grace, Regional Administrator  
 101 Marietta Street, NW, Suite 2900  
 Atlanta, Georgia 30323

Dear Dr. Grace:

**WATTS BAR NUCLEAR PLANT (WBN) - UNIT 2 - PROGRAM DEFICIENCY: ALTERNATELY  
 ANALYZED PIPING - COMBINED FINAL REPORT FOR UNIT 2**

Our submittal dated November 24, 1982, on the subject alternate analysis program deficiency combined, for reporting purposes, the following 10 CFR 50.55(e) items: NCR WBN SWP 8160 (WBRD-50-390/82-01, -391/82-02), NCR WBN SWP 8220 (WBRD-50-390/82-57, -391/82-54), NCR WBN CEB 8218 (WBRD-50-390/82-59, -391/82-56), NCR 4164R (WBRD-50-390/82-73, -391/82-68), NCR WBN SWP 8231 (WBRD-50-390/82-74, -391/82-69), and NCR WBN SWP 8239 (WBRD-50-390/82-78, -391/82-74).

Subsequent to the November 24, 1982 submittal, three related nonconformances were identified and determined to be reportable under 10 CFR 50.55(e). These NCRs were initially reported to NRC-OIE Region II as NCRs WBN SWP 8264 (WBRD-50-390/83-19, -391/83-18), WBN SWP 8306 (WBRD-50-390/83-20, -391/83-19), and WBN SWP 8311 (WBRD-50-390/83-21, -391/83-20). NRC-OIE Region II was notified that these NCRs would be reported as part of the program deficiency and thus were addressed in the April 27, 1983 submittal on the program deficiency.

A final report for unit 1 and third combined interim report for unit 2 was submitted on October 14, 1983. Later combined interim reports for unit 2 were submitted on December 14, 1984, and March 1, and April 23, 1985. Enclosed is our final report for unit 2.

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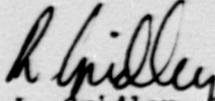
Dr. J. Nelson Grace

AUG 5 1986

If there are any questions, please get in touch with J. A. McDonald at  
(615) 365-8527.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

  
R. L. Gridley, Director  
Nuclear Safety and Licensing

Enclosure

cc (Enclosure):

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ENCLOSURE  
WATTS BAR NUCLEAR PLANT UNIT 2  
PROGRAM DEFICIENCY: ALTERNATELY ANALYZED PIPING  
NCRs WBN SWP 8160, WBN SWP 8252, WBN SWP 8238, WBN SWP 8231,  
WBN SWP 8220, WBN CEB 8218, WBN SWP 8264, WBN SWP 8306, WBN SWP 8311,  
AND 4164R  
10 CFR 50.55(e)  
FINAL COMBINED REPORT

Several nonconformance reports (NCRs) were written against various aspects of alternately analyzed piping at Watts Bar Nuclear Plant (WBN). This report consolidates those various NCRs.

NCR WBN SWP 8252

Description of Deficiency

A number of NCRs were written against various aspects of alternately analyzed piping for WBN. This NCR (WBN SWP 8252) was written to consolidate some of the various NCRs plus any other nonconforming items found during TVA's program to verify qualification/requalification of piping supported in accordance with TVA's Civil Engineering Branch (CEB) Report CEB 76-5, "Alternate Criteria for Piping Analysis and Support."

The specific conditions included in NCR WBN SWP 8252 are as follows:

- 1.a WBN SWP 8220 - Alternate analysis not properly documented. No engineering procedure to control alternate analysis.
- 1.b WBN CEB 8231 - Technical deficiencies in analysis.
- 1.c WBN CEB 8218 - Flanged joints not analyzed.
- 1.d WBN SWP 8160 - Interface between alternately analyzed piping and deadweight supported piping not correctly analyzed.
- 1.e WBN SWP 8306 - Aluminum piping not included in Alternate Analysis Criteria scope.
- 1.f WBN SWP 8311 - Schedule 10S stainless steel piping for diameters 6 inches and less not included in Alternate Analysis Criteria scope.

The causes for the deficiencies listed above can be attributed to TVA's failure to provide adequate analysis methods, analysis procedures, and adequately trained personnel in alternate analysis methods. All of the NCRs listed above have been closed except WBN SWP 8252. Only minor corrective action remains to be completed on NCR WBN SWP 8252.

### Safety Implications

The subject NCR identifies a programmatic deficiency in alternately analyzed safety-related piping systems. Due to the deficiencies identified in this NCR, some safety-related piping systems were found to be seismically unqualified and a seismic event could have caused the failure of some of these systems. The failure of safety-related piping systems could have adversely affected the safety of operations of the plant.

### Corrective Action - Programmatic (includes all NCRs listed under WBN SWP 8252)

A 100 percent verification of all WBN unit 2 piping supported by alternate analysis methods was carried out by a personal services contractor and TVA's Division of Nuclear Engineering (DNE). The verification program involved piping for which supports had been field located in accordance with TVA drawing series 47A053 (for process pipes), 47A051 and 47A052 (for instrument lines), and 47A054 (for control air lines). These drawings provide guidelines for locating and installing seismic supports.

Some verification by CEB was accomplished using their "TPIPE" computer program procedures. Instrument and control air qualification was determined by separate calculations, and is documented by CEB calculation CEB 830914 001. CEB 76-5 has been revised to clarify deficient areas of the criteria and to provide guidelines in some previously unaddressed areas. The 47A053 drawings have been revised under Engineering Change Notice (ECN) 3542 to clarify details and instructions, and to require all piping supported by TVA's Division of Nuclear Construction (NU CON), in accordance with these notes, to be reviewed by DNE.

Office of Engineering (OE) Special Engineering Procedure (SEP) 82-18 "Program for Alternate Analysis Fix - Coordinating, Documenting, and Verifying" was written and issued on September 17, 1982 to control the documentation and verification of the alternate analysis fix, and of the 100 percent review for piping which was alternately analyzed per CEB 76-5 before August 27, 1982. All affected supports were verified as adequate or were revised and corrected either under ECN 3213 (engineered supports) or through variances (typical supports). Watts Bar Engineering Project (WBEP) Engineering Procedure (EP) 43.21 "Alternate Analysis of Piping Systems - Documenting and Verifying," was utilized for all new alternate analyses initiated after August 27, 1982. Each existing pipe support design was reviewed for adequacy, with respect to the associated piping analysis and the requirements of the WBN Pipe Support Design Manual, under ECN 4858. ECN 4858 incorporated the unit 2 work originally included in ECN 3213 which remained incomplete as of May 9, 1984.

For reasons of economics, expediency, and better accuracy, the majority of the analysis verification described above has been performed utilizing computer techniques. Primarily, simplified analysis (TPIPE) methods were used, which meet all current criteria and are documented and controlled by the WBN Simplified Analysis Handbook.

In summary, all work is complete except for the final review of less than 100 supports and minor revisions to WBN Design Criteria WB-DC-40-31.7, "Analysis of Category I and I(L) Piping Systems," and the WBN Simplified Analysis Handbook to more fully define the simplified analysis techniques.

Information regarding the specific NCRs covered under WBN SWP 8252 is included below, along with information on the other NCRs included in this report.

1.a NCR WBN SWP 8220

Description of Deficiency

In performing alternate analysis on seismically supported piping for WBN, the TVA analyst did not comply with WBN Design Criteria documents WB-DC-40-31.7, sections 6.4 and 6.5, and WB-DC-40-31.9 "Location and Design of Piping Supports and Supplemental Steel in Category I Structures" sections 6.2.1a and 7.2.6. The nonconforming areas involve the specific methods of preparing calculation packages and other documentation per instructions in the criteria. The design project (WBEP) developed 47A053 drawing notes (based on CEB 76-5) which provided instructions to NU CON to be used to locate supports on most two-inch and smaller piping. These notes did not require appropriate documentation and verification. In addition, WBEP did not have an engineering procedure to control the analysis work involved with alternately analyzed piping.

Safety Implications

Alternate analysis performed on seismically supported piping did not comply with the requirements of Design Criteria WB-DC-40-31.7 and WB-DC-40-31.9. Due to the lack of documentation of the methods used in preparing the alternate analysis calculation packages and the lack of a procedure to control alternate analysis, TVA lacked the assurance that the subject supports were adequate. Thus, TVA assumes that if this condition had remained uncorrected, a condition existed which potentially could have had adverse effects on the safety of operations of the plant.

Corrective Action

OE-SEP 82-18 "Program for Alternate Analysis Fix-Coordinating, Documenting, and Verifying" requires the preparation of adequate documentation for process piping. The 47A053 drawings have been revised to require all piping supported in accordance with the drawing notes to be reviewed by WBEP. In addition, WBEP has developed the required documentation per WBEP-EP 43.21 and the WBN Simplified Analysis Handbook. Due to the generic nature of the qualification of the instrument and control air lines, CEB's calculation packages and the 47A051, 47A052, and 47A054 drawing series are considered to be adequate documentation.

1.b NCR WBN SWP 8231

Description of Dificiency

WBN alternate analyses did not meet all the requirements of CEB 76-5 and WB-DC-40-31.7. A joint CEB-WBEP review showed generic technical deficiencies on analyses by CEB and WBEP using CEB 76-5 and the 47A053 series drawings in the following areas:

1. Maximum seismic spans exceeded, particularly near elbows, tees, and valves.
2. Thermal and end point evaluations inadequate.
3. Axial supports not specified as required.
4. Some load sources not properly considered.

Safety Implications

Deficiencies in the application of alternate analyses could have allowed piping to be installed which was not seismically qualified. During a seismic event, this could possibly have led to a failure of some safety-related systems. As such, this deficiency could have adversely affected the safety of operations of the plant.

Corrective Action

As described in the programmatic corrective action, CEB's verification was accomplished in accordance with the normal analysis procedures which required each of the items, noted in the description of deficiency above, to be addressed.

The verification methods utilized by WBEP as described in OE-SEP 82-18 required each of the above deficiencies to be addressed. Specifically, Attachment 6 of SEP 82-18 addresses these items for piping qualified by CEB 76-5, and Attachment 7 of SEP-18 addresses these items for piping qualified by other methods.

1.c NCR WBN CEB 8218

Description of Deficiency

Flanged joints on ANS Safety Classes 2 and 3 systems, which were analyzed using CEB 76-5, were not evaluated as required by ASME Section III, paragraph NC-3647. Design Criteria WB-DC-40-31.7 did not address flange qualification. CEB 76-5 stated in the introduction that it is the responsibility of the designer to verify flange design, but gave no method of accomplishing this work. This verification had not been done by the designer.

### Safety Implications

Flange joints are used in a number of safety-related systems such as the essential raw cooling water system and the component cooling water system. As a result of this deficiency, the flanged joints on these systems could have become overstressed and could have failed during a seismic event. This could have adversely affected the safety of operations of the plant.

### Corrective Action

CEB 76-5 has been revised to add Appendix H to address flange qualifications. OE-SEP 82-18, Attachment 6, now addresses the qualification of flanges. Design Criteria WB-DC-40-31.7 has been revised by CEB to add a requirement for the verification of flange qualification.

#### 1.d NCR WBN SWP 8160

### Description of Deficiency

Some areas in seismic Category I buildings requiring maintenance of the pressure boundary of the high pressure fire protection system during a seismic event, are not noted in design drawings in accordance with the WBN Supplemental Fire Protection Design Criteria and Supplemental Recommendations. These areas are defined to contain equipment which is essential for safe plant operation. Piping in these essential areas was not interfaced with adjoining piping (which does not require pressure boundary maintenance) in accordance with WB-DC-40-31.9. This criteria requires that the support analysis be carried two changes of pipe direction beyond the area requiring maintenance of the pressure boundary.

### Safety Implications

Inadvertent water spray from a postulated fire protection system pipe break, within the affected areas, could have damaged essential equipment. This could have adversely affected the safety of operations of the plant.

### Corrective Action

CEB 76-5, Sections 5.5.1, 5.5.2, and 5.5.3 now address the appropriate interface requirements. OE-SEP 82-18, Attachments 1, 2, and 3 expand and clarify these requirements.

#### 1.e NCR WBN SWP 8306

### Description of Deficiency

Aluminum piping was used for the demineralized water system in many areas. Portions of this piping were alternately analyzed per CEB 76-5. However, CEB 76-5 did not include aluminum piping in its scope.

Consequently, data and support information for steel piping were erroneously used for aluminum piping.

Safety Implications

The purpose of seismically qualifying demineralized water piping is to protect safety-related equipment from the effects of a pipe break. Thus, had this condition remained uncorrected, a seismic event could have led to a pipe break which could have damaged safety-related equipment in the vicinity. This could have adversely affected the safety of operations of the plant.

Corrective Action

CEB 76-5 has been revised to add section 5.6.2 which provides criteria for aluminum piping. Piping stress analysis was verified by the use of this criteria and other verification methods.

1.f NCR WBN SWP 8311

Description of Deficiency

Schedule 10S stainless steel piping was used for portions of the primary water makeup system (six inches and smaller in diameter). Some of this piping was alternately analyzed per CEB 76-5. The scope of CEB 76-5 did not include schedule 10S stainless steel piping for diameters six inches and smaller. Consequently, analysis and support data for normal weight stainless steel piping was erroneously used for schedule 10S stainless steel piping.

Safety Implications

The purpose of seismically qualifying primary water makeup system piping is to protect safety-related equipment from the effects of a pipe break. Thus, had this condition remained uncorrected, a seismic event could have led to a pipe break which could have damaged safety-related equipment in the vicinity. This could have adversely affected the safety of operations of the plant.

Corrective Action

CEB 76-5 has been revised to add Appendix I which provides criteria for Schedule 10S stainless steel piping. Piping stress analysis was verified using Appendix I criteria and other verification methods.

2. WBN SWP 8238 - Axial Restraint Not Provided By Supports

Description of Deficiency

A discrepancy existed in rigorously and alternately analyzed support detail drawings in the essential raw cooling water system. The supports use a Unistrut clamp as an axial restraint. The washers were specified in the bill of material for the supports.

Although the washers can physically be placed in either of two positions, one which will restrain the pipe and the other which will not, the location of the washers was not specified. Normal construction practice was to place the washers in the position eliminating axial restraint if a washer was called for. As a result, washers were installed in positions which eliminated axial restraint, when the designer intended otherwise.

#### Safety Implications

If a pipe is designed to be supported axially and is not supported axially, then the pipe can be overstressed during a design basis event or during normal operation. This could lead to pipe failure and degradation of a safety-related system.

#### Corrective Action

All engineered pipe support drawings which utilized Unistrut clamps for axial restraint were reviewed to determine whether washers were specified to be used. If a washer was specified for use, the drawing was revised to eliminate the washer between the Unistrut strip and clamp. This NCR is now closed.

### 3. NCR WBN SWP 8264 - Incorrectly Analyzed Typical Supports for Small Process Piping

#### Description of Deficiency

Some small piping supports were not designed consistently with the allowed installation. Small process piping support drawings were identified as having the following conditions:

1. Drawing 47A053-151 was analyzed with an overall length of 100 inches in lieu of the 120 inch overall length. This condition would lower the allowable loading capacity.
2. Drawing 47A053-138 was not adequate for use as a typical for the worst possible loading conditions. This support required additional limitations on its use.
3. Drawing 47A053-3 allowed fillet welds between the lug and the support angle. This could have resulted in an overstressed weld due to the moment.
4. Drawing 47A053-136 showed a vertical, horizontal, and axial restraint without specifying the maximum axial span lengths. NU COM could have used this typical for axial spans in excess of the support design.

### Safety Implications

The use of fillet welds allowed on drawing 47A053-3 could have caused overstressed welds at lugs and support angle connections. The lack of a maximum axial span length on drawing 47A053-136 could have allowed pipes to be overstressed due to excessive spacing. Thus, deficiencies in these supports could have caused safety-related pipe failures under design basis accident conditions. This could have adversely affected the safety of operations of the plant.

### Corrective Action

DNE has completed its evaluation of all affected supports. As necessary, supports were revised and issued under ECN 3213 as follows:

#### 47A053-3

Plan Alternate I - Revised to eliminate the torsional moment that will be induced to the pipe by the lugs. Plan Alternate II - The existing, standard Riser pipe clamp was replaced by a heavy-duty Riser pipe clamp. This heavy-duty clamp will resist the loads in the negative axial direction and in the positive and negative lateral directions of the pipe. Plan Alternate III - The heavy-duty Riser pipe clamp was structurally encased to provide resistance for loads in the positive and negative axial and lateral directions of the pipe.

#### 47A053-136, -138, and -151

These drawings were revised to provide limitation of their application by the addition of a note on the applicable drawing, clarifying the use of the drawing.

The actions above are adequate for supports that will be installed in the future.

All supports installed before the issuance of this NCR have been identified, and have been revised/modified as required. This NCR is now closed.

#### 4. NCR 4164R - Spacing Requirements on Seismic Pipe Supports not Properly Considered

##### Description of Deficiency

Support spacing requirements for spans with concentrated weights, as specified on TVA drawings 45A053-15B and 45A053-1A, were not followed. Initial investigation of this deficiency indicated that TVA personnel had incorrectly interpreted 45A053 notes. In some instances, the apparent cause of the misinterpretations was vaguely written criteria.

### Safety Implications

This deficiency affected a number of safety-related systems. Because of the improper interpretation of 45A053 notes concerning spacing requirements, seismic criteria for seismic Category I or I(L) systems could have been invalidated. This could have resulted in the failure of affected supports during a seismic event. This could have adversely affected the function of affected safety-related systems, and subsequently, could have adversely affected the safety of operations of the plant.

### Corrective Action

All piping supported by NU CON in accordance with the 47A053 series drawings, before August 27, 1982, was included and reviewed under the 100 percent verification of alternately analyzed piping. The 47A053 drawings were revised under ECN 3213 to clarify spacing requirements for spans with concentrated weights. This NCR is now closed.

### Summary - Unit 2

All corrective action, both programmatic and specific, as discussed above, will be completed for WBN unit 2 by hot functional testing.

The corrective actions, as stated above, will prevent recurrence of this deficiency. Presently, initial unit 2 analyses, and any total reanalysis, are being performed using simplified (TPIPE) analysis in accordance with the WBN Simplified Analysis Handbook.