Omaha Public Power District
1623 Harney Omaha, Nebraska 68102-2247
402/536-4000

April 16, 1990
LIC-90-0303

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, DC 20555

Reference: (1) Docket No. 50-285
(2) Licensee Event Report 90-03, March 19, 1990 (LIC-90-0225)

Gentlemen:

Subject: Licensee Event Report 90-03, Revision 1 for the Fort Calhoun Station

Please find attached Licensee Event Report 90-03, Revision 1 dated April 16, 1990. Revised sections are indicated by vertical lines in the margins. This report is being submitted per requirements of 10 CFR 50.73(a)(2)(ii)(B), and is the result of additional design analyses.

If you should have any questions, please contact me.

Sincerely,

W. G. Gates

W. G. Gates
Division Manager
Nuclear Operations

WGG/tcm

Attachment

c: R. D. Martin, NRC Regional Administrator
A. Bournia, NRC Project Manager
P. H. Harrell, NRC Senior Resident Inspector
INPO Records Center
American Nuclear Insurers

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Fort Calhoun Station Unit No. 1	0 5 0 0 0 2 8 5	1 OF 0 6

TITLE (4): Containment Piping Systems Outside Design Basis

EVENT DATE (5) MONTH	DAY	YEAR	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	REPORT DATE (7) MONTH	DAY	YEAR	OTHER FACILITIES INVOLVED (8) FACILITY NAMES	DOCKET NUMBER(S)
0 2	1 6	9 0	9 0	— 0 0 3 —	0 1	0 4	1 6	9 0	N	0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 0 8 3

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
20.405(a)(1)(iv)	X 50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER AREA CODE	
Bernard Van Sant, Lead Mechanical Engineer	4 0 2	6 3 6 - 2 4 3 7

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) X NO

EXPECTED SUBMISSION DATE (15) MONTH DAY YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

Reanalysis of the Auxiliary Feedwater (AFW) lines and the Steam Generator Blowdown (SGB) lines inside containment revealed overstressed conditions as defined by the original design basis. Rigid seismic restraints, installed to control seismic inertia, excessively restricted the thermal movement of the lines and caused stresses to exceed design basis piping code allowables. Further analysis of the AFW piping demonstrated that the stresses incurred due to thermal expansion fell within the criteria of ASME approved code exception cases, but outside the normal stress limits of the code used in the USAR.

A revised seismic analysis of the Main Steam and Safety Injection piping inside containment established that these lines were not overstressed; however, a review of the support loads and capacities determined that several supports on these systems were loaded beyond design capacity.

The corrective actions include functional testing of the Auxiliary Feedwater System, non-destructive examination of the AFW and SGB piping, visual inspection for gross discernible damage, and modifications to the supports to comply with design basis during the current refueling outage. If all modifications can not be completed, operation until modification completion will be justified by a Safety Analysis for Operability.

The Fort Calhoun Station Updated Safety Analysis Report (USAR) requires certain piping to be designed within the limits of the United States of America Standard (USAS) piping code B31.7 (1968 Draft). This code was essentially duplicated and expanded with the implementation of the American Society of Mechanical Engineers (ASME) codes for Class 2 and 3 piping and components (1971). Since that time, several exception cases have been documented where piping stresses exceed normal allowable limits, but have been found to be acceptable with an adequate margin of safety. These exceptions have been approved and incorporated into the ASME code (1981) and are considered acceptable per the ASME code (ASME Code Cases N-319 & N-47-28 and ASME Section III NB-3653.7). The USAR does not incorporate these exceptions because it reflects USAS piping code B31.7 (1968 Draft) and was not revised to incorporate the ASME code cases noted above.

The Main Steam (MS), Auxiliary Feedwater (AFW), Safety Injection (SI), and Steam Generator Blowdown (SGB) piping systems inside containment are all defined as Seismic Class I in the USAR.

As a part of a response to deficiencies found during a Safety System Outage Modification Inspection (SSOMI) in 1985, all large bore Critical Quality Element (CQE) piping systems at Fort Calhoun Station are currently being reanalyzed for Thermal Anchor Motion (TAM), nozzle loadings, Seismic Anchor Motion (SAM), and Zero Period Acceleration (ZPA) considerations. The highest priority has been placed on evaluation of reactor coolant connected systems. The analyses of these large bore reactor coolant connected piping systems have now been completed.

The reanalysis of the auxiliary feedwater lines between the Steam Generators and the containment side isolation valves revealed two 45 degree elbows to be in an overstressed condition as defined by the USAR Appendix F, Section F.2.1. Rigid seismic restraints, installed on the valves to control seismic inertia, excessively restrict the thermal movement of the lines and cause stresses outside the limits of the USAS code. However, further analysis of the piping demonstrated that the stresses incurred in the piping elbows due to thermal expansion fall within the criteria of the approved ASME code exceptions noted above. Hence, the as-built configuration was allowed by the current ASME code case exceptions, but not allowed by the USAS code referenced in the USAR. For this reason, the piping was potentially outside the design basis, but still considered operable because the stresses calculated fell within that allowed by ASME code exceptions.

At 1450, on February 16, 1990, the piping was determined to be outside the plant design basis as specified in the USAR. At this time, the plant was at approximately 78 percent power and decreasing as part of a planned shutdown for a refueling outage. Subsequently, a "one hour" report was made to the NRC at 1548 pursuant to 10 CFR 50.72(b)(1)(ii)(B). This event is also reportable pursuant to 10 CFR 50.73(a)(2)(ii)(B). The plant later entered Mode 5, Refueling Shutdown, as planned.

The Main Steam (MS) and Safety Injection (SI) piping subsystems were reanalyzed and the pipe stresses found to be within design basis. Review of the new support loads generated showed six MS supports and twelve SI supports were outside their design basis criteria. These supports typically failed to meet the design basis in one or more of the following ways:

(1) Base plate material exceeded design basis stress allowables.

(2) Catalog ratings for standard components such as clamps were exceeded.

(3) Safety factors mandated by NRC for concrete anchors were exceeded.

At 1059 hours CST on March 16, 1990, the MS and SI piping supports were determined to be outside the plant design basis as specified in the USAR. At that time the plant was in Mode 5 for a scheduled refueling outage. The NRC was notified pursuant to 10 CFR 50.72(b)(2)(i). Because of the relationship to the AFW piping event previously reported, the MS and SI support event is being reported pursuant to 10 CFR 50.73(a)(2)(ii) as a revision to this LER.

The initial results of the Steam Generator Blowdown (SGB) pipe stress analysis concluded that the piping and supports were within the design basis code allowables. This analysis was based upon the support locations and types depicted on the piping isometrics. The calculation identified a discrepancy between the isometric drawing and the support drawing; the isometric drawing identified two supports (FWH-103 and FWH-166) as spring hangers, and the support details depicted them as rigid restraints. The Design Basis Document support verification walkdown program performed during the 1988 refueling outage did not not identify this discrepancy, so it was assumed that the isometric drawing was correct. Field walkdowns conducted between March 12 and 23, 1990 revealed that the two supports were rigid restraints, not spring hangers. The analysis was rerun using the as-built configuration; it showed the SGB piping near the Steam Generator 2A nozzle was overstressed, similar to the AFW piping, when thermal expansion was considered.

At 1450 hours CST on March 28, 1990, the SGB piping was determined to be outside the plant design basis as specified in the USAR, based on the analyzed overstressed condition. At that time the plant was in Mode 5 for a scheduled refueling outage. The NRC was notified pursuant to 10 CFR 50.72(b)(2)(i). Because of the relationship to the AFW piping event previously reported, the SGB piping event is being reported pursuant to 10 CFR 50.73(a)(2)(ii) as a revision to this LER.

Investigation of the problems revealed that a design deficiency for the AFW system has existed since original plant construction. The original design analysis accounts for stresses due to thermal expansion in the piping without the rigid restraints. During plant construction, the contracted architect/engineer (A/E) altered the design to incorporate the additional rigid supports for seismic considerations without reanalyzing for stresses due to thermal expansion. Since thermal expansion provisions were not incorporated into the as-built configuration, additional stresses resulted.

The piping was reanalyzed in 1979 to address concerns raised in NRC IE Bulletins 79-02 and 79-14. Omaha Public Power District (OPPD) contracted a second outside engineering firm to perform this analysis. The consultant did not include TAM loads in the models during the reanalysis. The 1985 SSOMI audit discovered this deficiency and prompted the current generic review of all large bore CQE piping for TAM.

The primary cause of these events is attributed to design and analysis deficiencies by the original plant A/E and the consulting firm which performed the 1979 reanalysis. Both companies failed to adequately consider TAM and other factors while designing system changes. The precise root cause can not be determined due to an insufficient amount of information and documentation concerning practices and procedures utilized by both companies.

A contributing factor to the MS, SI, and SGB problems was inadequate procedural guidance on content of documents for the procurement of services. For the 1979 reanalysis contract agreement, the required extent of the reanalysis of the seismic supports was not properly documented.

There was an additional factor which allowed the design discrepancy to remain undetected by OPPD for an extended period. Both the original design and the reanalysis were contracted tasks. Since OPPD did not have the resources required to provide a detailed additional review of each contractor's work, the expertise and the approved Quality Assurance (QA) programs of the contractors were relied upon.

The impact on the ability of the AFW, SGB, MS, and SI Systems to perform their design function was examined. For the AFW system, the TAM loads induce secondary stresses in the piping which could lead to plastic ratcheting and/or fatigue failure of the piping component material or brittle fracture of the cast iron containment isolation valve yoke (which is restrained and acts as a structural load path). An operability analysis based on ASME Code Cases N-319 & N-47-28 and ASME Section III NB-3653.7 has demonstrated that although the elbow stresses exceed normal code allowables, the associated strains and thermal ratcheting check are within acceptable limits to preclude material failure. The valve yoke stresses have been determined to have sufficient margin to prevent brittle fracture. The deflection and bending stress of the valve stem were calculated and determined to be acceptable, and the valve judged to be operable under the predicted loading.

A detailed analysis of the rigid support effect on the SGB piping could not be performed until the support dimensions and tolerances could be verified. It was determined that all design basis criteria could be met with the rigid supports removed.

The affected portions of the MS and SI systems were evaluated as operable based on a reduced but adequate safety margin provided by the design of the piping and supports. Due to the limited resources available, a complete failure modes and effects analysis was not completed.

The following corrective actions have been completed:

1. Safety Analysis for Operability (SAO) 90-003 was issued on February 18, 1990. The Auxiliary Feedwater System was functionally tested per SP-FW-14 on February 17, 1990. This testing cycled the valves in question under operating loads, which provided further evidence of operability.

2. A third outside engineering firm performed an independent review of the results of the reanalysis completed in 1979. This review found the results of the reanalysis acceptable with the exception of the findings noted in the SSOMI audit.

3. Since 1979, OPPD Design Engineering has augmented the engineering staff with personnel having a higher level of expertise and has made provision for acquiring supplemental contract personnel with expertise in engineering areas as required for independent review. These additional resources help provide a more thorough review of contract work.

4. Fort Calhoun Station Training has begun implementation of a training program for appropriate Design Engineering personnel. These programs address Quality Assurance, System design training, and procurement of materials and services. Currently, the Quality Assurance and Procurement training courses are in place. The on-going training in these areas will aid in preparation of comprehensive procurement documents requesting services and provide a basic knowledge of what type of vendor QA program is required for assurance of quality work.

5. Magnetic particle inspections for cracks in the affected Auxiliary Feedwater isolation valve operator yokes was performed on April 3, 1990. No recordable indications or defects were found.

6. Magnetic particle inspections of the Auxiliary Feedwater piping elbows were performed on April 3, 1990. No recordable indications or defects were found.

7. Plant Level Design Basis Document PLDBD-51, Seismic Criteria, has been issued. This document provides all required design basis information for use in future seismic analyses.

The following corrective actions will be implemented as follows:

1. Nondestructive examination of the SGB piping will be performed prior to startup from the current refueling outage to determine if any surface defects requiring further evaluation per ASME Section XI are present.

2. A verification will be performed to determine the tolerances on the rigid supports for the SGB piping. The tolerances will be used to analyze the effect on system operability of the rigid supports. This analysis will be completed prior to completion of the current outage.

3. The rigid supports on the SGB piping will be removed during the current refueling outage. The affected AFW, MS, and SI piping restraints will be modified during the current refueling outage to comply with the USAS code and the USAR design basis. If these modifications can not be completed prior to the end of the current outage, a Safety Analysis for Operability will be implemented to justify operation; any remaining modification work will be completed during the 1991 refueling outage.

4. The Production Engineering procedure for Procurement of Materials and Services (GEI-32) will be changed to provide guidance concerning content of documents for the procurement of services as specified in the OPPD Quality Assurance Plan (Sec 4.1). These changes will help assure that documentation for procurement of services is completed in accordance with the current QA plan. The changes will be implemented by November 30, 1990.

5. Mechanical Engineering Instruction MEI-5 is being created to provide guidance in the design and analysis of piping supports. This document will be completed by December 30, 1990.

6. Mechanical Engineering Instruction MEI-6 is being created to provide guidance in the analysis and evaluation of computerized pipe stress calculations. This document will be completed by August 30, 1990.

LER 89-021 also concerned deficiencies in contracted design tasks.