CORE SPRAY LINE TEE-BOX ANALYSIS REPORT
for
PEACH BOTTOM ATOMIC POWER STATION, UNIT 3

Modification P00541

September 15, 1995

Summary

With the assumption that the core shroud horizontal welds are fully cracked and the core shroud stabilizers are installed, the analysis of the core spray tee-box junction header brackets does not support the plant design basis of 5 Design Earthquake (DE, same as OBE) events or 50 cycles as indicated in Section C.5.3.6 of the Peach Bottom FSAR. Therefore, Modification P00541 has been initiated to provide a revised analysis which demonstrates that the brackets are acceptable with the core shroud repair installed (Modification P00435).

The revised seismic analysis has been performed assuming partial cracking without the installation of the core shroud stabilizers corresponding to the maximum allowable cracking allowed by the GENE screening criteria document (GENE-523-A076-0895, Peach Bottom specific) which follows the BWRVIP screening criteria. This analysis is conservative because the stabilizers will be installed which will reduce the deflections affecting the core spray Tee-Box repair brackets even further from that which was analyzed.

The piping stresses satisfy the requirements of Article NB-3600 of ASME Section III. Appendix A is a summary of the results obtained by solution of Subarticle NB-3650 equations for all significant joints in the piping system. The maximum fatigue usage factor is 0.120.

The brackets and the piping attachment stresses are analyzed according to NB-3200 requirements. The maximum usage factor is 0.693. The main contribution to the fatigue usage is the relative Operating Bases Earthquake (OBE, same as DE) anchor displacements between the shroud penetration and the RPV nozzle. The value of relative displacement is 0.4" zero to peak, 0.8" peak to peak. The total cycles assumed for this load is 50 cycles (5 OBE events).

The revised analysis of the core spray Tee-Box junction header brackets described above <u>does</u> support the plant design basis of the 50 earthquake cycles (DE) as indicated in Section C.5.3.6 of the Peach Bottom UFSAR, with the core shroud horizontal welds postulated to be partially cracked to the limit described, and the core shroud stabilizers installed (Modification P00435).

Seismic Analysis

1.0 Summary

The seismic analysis of Peach Bottom 3 has been re-performed to obtain the relative anchor movement of the core spray piping subjected to the OBE. Due to the excess anchor displacement obtained previously (Reference 1), a refined analysis with the assumption of partially cracked shroud welds (H1 through H7) was carried out. The partial cracking corresponded to the maximum allowable cracking allowed by the GENE screening criteria, document GENE-523-A076-0895. The seismic re-analysis with partial cracking was performed without the shroud repair stabilizers included in the model. This modeling assumption is conservative. If the repair system were to be included in the seismic model, the resulting shroud/RPV relative motion will be less than the results obtained without them. H8 weld was considered to the same extent as the Shroud Mechanical Repair Program, Seismic Report GENE-771-60-0994 Rev. 2, page 6, which indicates that it's effect is not significant enough to affect the previous Revision 1 results with the H8 weld intact.

2.0 Analysis Model

In order to obtain the core spray piping anchor movement, the E-W seismic model from Reference 1 with the all welds cracked condition as postulated was chosen for the analysis. The East-West model was used since it produces slightly higher results than the North-South model. The all welds cracked case was used since this postulated crack scenario produces the maximum shroud displacement. The model was modified as follows:

(1) The shroud repair hardware elements (the linear and the rotational springs in the model) were de-activated (simulated with soft spring stiffness).

(2) Nodes located at the piping anchors on the Reactor Pressure Vessel (RPV) and on the shroud were added. A fictitious beam element was also added with one end at the piping anchor on the shroud, and the other end located at the same elevation as the piping anchor on the RPV, such that a linear spring element at this location could be added for the purpose of obtaining relative anchor movement of the piping (Figure 1, Reference 1).

3.0 Analysis Inputs

(1) OBE ground motion acceleration time history as used for the shroud repair seismic analysis documented in Reference 1.

(2) Stiffness for the partially cracked weld calculations are located in the Shroud Repair Design Record File (GE DRF-B13-01732).

4.0 Analysis Cases

E-W Model, All cracked welds as hinges - with rotational stiffness 1.84×10^6 ft-kip/rad at each of the H1 through H7 welds.

5.0 Seismic Analysis Results

The following results were obtained and used for subsequent fatigue analysis of the CS piping. The fatigue analysis is described elsewhere.

(1) The maximum relative anchor movement of the core spray piping:

d = 0.4 in.--single amplitude, i.e., zero to peak.

(2) The response spectra at the core spray piping anchor points:

a. Response spectrum curves at RPV and shroud.
b. Response spectra at RPV and shroud in digital form.

(3) Displacement time history for the relative anchor movement of the core spray piping.

References

(1) GENE-771-60-0994, Revision 2, Shroud Mechanical Repair Program - Peach Bottom Units 2 & 3 Seismic Analysis, June 1995.

Fatigue Analysis

1. Introduction

1.1 Background

Peach Bottom Atomic Power Station Unit 3 has two Core Spray Lines (CSL) which enter the Reactor Pressure Vessel (RPV) at the 120 degree and 240 degree azimuth locations. A set of two 316L Stainless Steel (SS) reinforcement brackets were previously added to connect the T-Box to the CSL pipes to prevent pipe separation from the T-Box. This connection is made by applying fillet welds on both sides of the brackets.

1.2 Purpose

The purpose of the analysis is to demonstrate the seismic structural adequacy of the CSL and reinforcement brackets at Peach Bottom Unit 3. The analysis is contained in Design Record Files (DRF) B13-01732 and B11-00642.

This revision incorporates the revised relative seismic displacement (for OBE, same as DE) at the shroud penetration to be 0.400 inches instead of 1.2 inches. The total number of equivalent cycles is 50 cycles instead of 10 cycles which was used in the previous report.

2.0 Summary and Conclusions

2.1 Scope

This report covers only the CSL pipes from the thermal sleeve at the RPV nozzle to the CSL supports before the shroud penetration, including the elbows to the penetration sleeve, but excluding the penetration sleeve.

2.2 ASME III Code Compliance

The piping stresses satisfy the requirements of Article NB-3600 of ASME Section III. A Summary of the results obtained by solution of Subarticle NB-3650 equations for all significant joints in the piping system is contained in Appendix D of the analysis located in the reference DRFs, and contained herein as Appendix A-3. The maximum primary stress ratio is the primary membrane stress for service level D condition. The stress value is 14,400 psi as compared to allowable stress of 37,000 psi. The maximum thermal expansion stress (Equation 12) for pipe element per NB-3600 is 21,338 psi with a stress ratio of 0.42. The maximum equation 13 stress is 5,513 psi. The maximum fatigue usage factor is 0.120. This occurs at the lower elbow connection to the shroud inlet and is a conservative value because the flexibility of the shroud penetration is not considered in this analysis. The main contribution of the fatigue usage is due to the relative Operating Base Earthquake anchor displacements between the shroud penetration and the RPV nozzle. The value of relative displacement is 0.400" 0-peak, 0.800 peak to peak. The total cycles assumed for this load is 50 cycles.

In the analysis it was assumed that there are 50 cycles with total separation between T-Box and core spray pipe. All the piping stresses are within the allowable limits.

The brackets and the piping attachment stresses are analyzed according to NE 3200 requirements. The results are tabulated in Appendix A-1 and A-2. The maximum usage factor is 0.693. This is at the T-Box bracket fillet weld to the pipe. The main contribution to the fatigue usage is due to OBED. The maximum primary stress is the Level B condition. The primary-membrane-stress-plus-primary-bending-stress is 15,100 psi. The stress is within the allowable of 25,500 psi limit. The maximum stress for Service Level D is 32,800 psi.

A conservative stress concentration value of 4.0, which includes a 1.2 factor for bending components and 3.33 for peak stresses is used for the fatigue analysis.

APPENDIX A - STRESS SUMMARY

A-1: T-box Bracket Stresses per NB-3200

Service Level	Calculated Stress Intensity (ksi)	Allowable Stress (ksi)
Normal/Upset (Primary)	16.3	1.5Sm = 25.5
Normal/Upset (Primary + Sec. excluding thermal bending)	29.1	3.0Sm = 51.0
Normal/Upset (Primary + Secondary)	71.0	N/A
Service Level C	16.3	2.25Sm = 38.25
Service Level D	20.9	3.0Sm = 51.0
Max. Cumulative Usage	0.693	1.0

A-2: Pipe Elements to T-box Bracket per NB-3200

Service Level	Calculated Stress Intensity (ksi)	Allowable Stress (ksi)
Normal/Upset (Primary)	15.1	1.5Sm = 25.5
Normal/Upset (Primary + Sec. excluding thermal bending)	13.2	3.0Sm = 51.0
Normal/Upset (Primary + Secondary)	36.1	N/A
Service Level C	25.7	2.25Sm = 38.25
Service Level D	32.8	3.0Sm = 51.0
Max. Cumulative Usage	0.51	1.0

A-3: Pipe Elbows and Components per NB-3600

Service Level	Calculated Stress Intensity (ksi)	Allowable Stress (ksi)
Normal/Upset (Primary)	10.9	1.5Sm = 25.5
Normal/Upset (Primary + Sec. excluding thermal bending)	5.5	3.0Sm = 51.0
Normal/Upset (Primary + Secondary)	157.0	N/A
Service Level C	10.9	2.25Sm = 38.25
Service Level D	14.4	3.0Sm = 51.0
Max. Cumulative Usage	0.120	1.0
Thermal Exp. (Eq. 12)	21.4	3.0Sm = 51.0