A. Lee

Lee

PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SEP 29 1981

50-387
50-388

MEMORANDUM FOR: Zoltan R. Rosztoczy, Chief
Equipment Qualification Branch
Division of Engineering

FROM: Arnold Lee
Equipment Qualification Branch
Division of Engineering

THRU: Goutam Bagchi, Section Leader
Equipment Qualification Branch
Division of Engineering

SUBJECT: TRIP REPORT FOR SECOND SEISMIC QUALIFICATION REVIEW TEAM PLANT SITE AUDIT ON SUSQUEHANNA STEAM ELECTRIC STATION

Reference: Memo to Z. Rosztoczy from A. Lee on "Trip Report for Seismic Criteria Implementation Review-Meeting with Pennsylvania Power and Light Company on Susquehanna Steam Electric Station (SSES), March 16-20, 1981."

The Seismic Qualification Review Team (SQRT) conducted a second plant site audit at SSES on August 19-20, 1981. This audit is a followup of the SQRT review for SSES as initiated in the first SQRT site audit (see subject reference).

The background, review procedures, findings and conclusions of the meeting, and the required followup actions are summarized below. A list of attendees at the meeting is contained in Attachment I.

I. Background

In the first SQRT audit conducted during March 16-20, 1981, we found that six of the twenty-six pieces of equipment selected for review had not been completely qualified to the required seismic and hydrodynamic loads and therefore were not auditable. Based on this and the fact that only thirty-five percent of the total safety-related equipment were qualified at the time of audit, we considered the extent of completion of the applicant's qualification program to be insufficient to draw any conclusions regarding the acceptability of all the safety-related equipment. We informed the applicant at the exit interview of the site audit that the review team will conduct an additional audit when the qualification program is near complete.

After the site audit, the applicant requested a meeting in Bethesda with the staff on May 28, 1981, reporting the status of the equipment seismic and dynamic qualification program including the status of the applicant's Phase III new load requalification program. We had since reviewed the progress of the applicant's program and determined that the applicant would be ready for a second audit in August 1981.

XA Copy Has Been Sent to PDR

II. Review Procedures

The six pieces of equipment (See Attachment II.1) remained from the first site audit, all in balance of plant; these were subjected to in-depth review in the second audit. The review consisted of field observations of the actual equipment configuration and its installation, followed by the review of the corresponding test and/or analysis documents. Brief technical discussions were held during the review sessions to provide SQRT's feedback to the applicant on his equipment qualification program.

Regarding the Phase III new load requalification program, we also reviewed two sample qualification documents each of both NSSS (Core Spray Pump/Motor and RHR Heat Exchanger) and BOP (Drywell Unit Coolers and Hydrogen Recombiners), mainly to become aware of the methods and procedures used for requalification.

To enhance our confidence in the adequacy of overall equipment installation, we further reviewed the installation of ten randomly selected, additional pieces of equipment (See Attachment II.2). In addition, we audited the qualification documents of both NSSS and BOP equipment displayed in a document control center at the plant site. An exit conference was held on August 20, 1981, to summarize and conclude our audit.

III. Findings

For the six pieces of equipment audited, we found their qualification acceptable with the exception of certain details which need to be clarified by the applicant. For the ten pieces of equipment selected for additional walk-down, the Hydraulic Control Unit was found to have inadequately supported header pipes. Finally, audit of the applicant's qualification documents indicated that sufficient auditable links were not provided in NSSS equipment qualification documentation. The applicant has commited to resolve all the above outstanding issues within a time frame discussed in Section IV, Follow-up Actions.

As for the Phase III new load requalification programs, based on the applicant's presentation and the documents reviewed at the plant site, we conclude that the approach taken for requalification is acceptable.

IV. Follow-up Actions

In order to complete our review we have requested the applicant to provide the following information, within the schedule indicated:

✓(1) A statement which indicates that qualification documents for NSSS equipment have been improved to clearly demonstrate that combined seismic and hydrodynamic loads are considered in the qualification (2/28/82)

✓(2) For the valves audited, provide confirmation that the acceleration 'g' values used in the qualification are correspondingly equal to or less than those obtained from the final as-built piping analysis (12/31/81).

(3) For Control Panel (J05 A), provide clarification for the following:

(a) Dynamic relationship of the selected (reviewed) panel to the five panels tested and evaluated (12/31/81).

6/7/82

(b) Comparison of the maximum stress of the selected panel with the maximum stress of the five tested panels, and the basis for the evaluation (12/31/81).

6/7/82 (4) For Containment Vacuum Relief Valve (M 149) provide clarification for the consideration of the loads at the free end of the downcomer during qualification (12/31/81).

(5) For Hydraulic Control Unit (C12 D001), provide resolutions for inadequate support of header pipes (9/30/81).

V. Conclusions

Based on the result of the second audit, we conclude that an appropriate seismic and dynamic qualification program has been defined which will provide adequate assurance that such equipment will function properly during and after the excitation imposed by the Safe Shutdown Earthquake or hydrodynamic loads associated with discharges into the suppression pool, or by the combined earthquake and hydrodynamic loads. Our review of the applicant's qualification program including the Phase III new load requalification will be continued until it is completed, which is scheduled in June 1982.

Arnold Lee

Arnold Lee
Equipment Qualification Branch
Division of Engineering

Enclosure: As stated

cc: R. Vollmer
W. Johnston
R. Tedesco
B. Youngblood
G. Bagchi
R. Stark
T. Y. Chang
R. LaGrange
M. Haughey
R. Riggs
A. Lee
M. Reich, BNL
J. Singh, INEL
A. Schwencer

Attachment I

SQRT Second Plant Site Audit

SUSQUEHANNA STEAM ELECTRIC STATION

Exist Conference

August 20, 1981

List of Attendees

NRC

Arnold Lee

General Electric

R. W. Handy
W. C. Therber

Brookhaven National Laboratory

John Curreri
Mano Subudhi
A. J. Philippacopoulos

Pennsylvania Power & Light Company

R. McNamara
J. E. Rakowski
C. T. Coddington
W. E. Barberich
J. Bokansky
S. D. Pai
R. E. Moyer
F. Lahovski
Abdul K. Butt
J. D. Caherly

Bechtel

D. B. Hardie
R. Soderhorn
M. Castillo
R. A. Bitting
R. S. Rajagopal
Mahendra Shah
Larry Pulley

The third report describes a static test of the actuator with an equivalent load of 8 g and the maximum deflection corresponding to this is found to be .0487 inch. This deflection is claimed to be within the machining tolerances available for the stem and operator.

Based on our review, inspection of the installations and responses from the Bechtel engineers, we conclude that this equipment qualified for a design load of 3 g for OBE and 6 g for SSE conditions. However, it should be noted that in order to qualify the valve for the Susquehanna Site spectra, the g-values from the final piping analysis at the valve c.g. should not exceed the valves above.

OPEN ISSUE

(1) The g-values at the valve c.g. from the piping analysis should not exceed 3 g for OBE and 6 g for SSE loads in any direction.

(b) "High Frequency Seismic Testing of Limitorque SMB-3-150 and Limitorque SMB-000-2-DC", Test conducted by Acton Environmental Testing Corporation, Test Report #15780-1, dated August 6, 1980, VP #8856-P37-3-1.

(3) "Static Deflection Test Procedure for Active Valve Supplied to Bechtel Power Co." - prepared by Borg Warner Corp., Report No. 1840, dated April 29, 1981.

The valve is first analysed by using hand calculations as described in the first report. The lowest fundamental frequency about the weakest section of the valve assembly is found to be 40 Hz. The static analysis indicates that a maximum g-load of 8 g can be applied in both horizontal and vertical directions without exceeding the design stress limits. However, the piping analysis in which the valve is modeled with its actuator was not available during the visit. Hence, the actual g-load on the valve is not known in order to qualify the valve for the plant site.

The motor operator was qualified by test only. The report (2a) describes the valve capability to withstand a 3 g load for OBE and 6 g for SSE in a frequency range of 0-33 Hz. No adverse effect was noticed after the test. In order to include the effect of hydrodynamic loads, the equipment was again tested as reported in item (2b). According to this report, the resonance search could not find any frequency below 100 Hz for the actuator. As a result, the original report still qualifies for the higher frequency range.

MR-8856-P14B: Motor Operated Globe Valves, 1500#

(Borg Warner with SMB-000-5 Limitorque Motor)

Each reactor unit has a two-inch motor operated globe valve (1500# rating) located in the drywell at an elevation of 719'-0". The function of the valve is to achieve containment isolation and to maintain the inert nitrogen gas environment in the drywell. The valve is categorized as an active component and must function during and after an OBE or SSE coupled with a hydrodynamic event. The valve is mounted in line with the 2"-CCA-GB-MO-126 03 instrument gas piping system via socket welds. The valve is located in the vertical leg of the pipe and is extended upward in a slanted position of 30° angle with the vertical. The valve is designed as per the Bechtel Specification 8856-P14, Rev. 9, dated September 19, 1980.

The reports qualifying the valve are listed as follows:

(1) "Design Report of 2.0 Inch Y-Type Globe Valve-Stainless Steel-Motor Operated for Susquehanna Steam Electric Station Units 1 and 2", Report #NSR-74660, Rev. B, VP #8856-P14BC-47-3, dated May 21, 1981. The report is prepared by Borg Warhev and approved by Bechtel.

(2) Limitorque Test Reports"

(a) "Report of Seismic Test on SMB-000-5 Motor Actuator for Limitorque Corp.", prepared by AERO NAV Lab, Report No. 5771, dated October 17, 1975, VP #8856-P14BC-65-1.

OPEN ISSUE

(1) The g-values at the valve c.g. from the piping analysis should not exceed the following limit in any duration.

Valve Size	OBE	SSE
300#	3 g	6 g
150#	3 g	5.07 g

(b) "High Frequency Seismic Testing of Limitorque SMB-3-150 and Limitorque SMB-000-2-DC", Test conducted by Acton Environmental Testing Corporation, Test Report #15780-1 dated August 6, 1980, VP #8856-P37-3-1.

The reports in item (1) describe the valve qualification with the motor actuators by using a finite element analysis of the assembly. The fundamental frequencies found from the analysis are 55 Hz for 300# rated unit and 35.7 Hz for 150# rated unit. The former one is limited to 7.33 g in each direction by the Yoke 1 g stress conditions. Similarly, the latter valve is limited to 5.07 g in any direction by the stress limits at the body-bonnet bolts.

The reports under item (2) qualify the operator for the seismic combination with the hydrodynamic loads. The original report in (2a) qualifies three valve actuator for 3 g OBE and 6 g SSE loads in the frequency range up to 33 Hz. The second report later confirms that the actuator does not possess any fundamental frequency less than 100 Hz. Thus, the original report is sufficiently demonstrates the actuator capability to withstand loads within 100 Hz. The test reports indicate no valve malfunctions after the test.

Based on our review, inspection of the installations and applicant's responses, we conclude that the 300# rated valve is qualified for a load of 3 g for OBE and 6 g for SSE, whereas the 150# ratio valve is qualified for a load of 3 g for OBE and 5.07 g for SSE in any direction of the valve orientation. It should be noted that the piping results for g-value at the respective valve actuators should be bounded by the above limit values in order to be qualified for the Susquehanna Site dynamic environment.

MR 8856-P12B: Motor Operated Gate Valves, 150# and 300#
(MCC Pacific Valves FA-5250/5252 with Limitorque
SMB-000-5 Motor Operator)

Each reactor unit is equipped with two sets of 150# motor operated gate valves and two sets of the same valves at 300# rating. One of each kind of valves is mounted to the piping system in series at one location to achieve RHR service water isolation. All are located in the Reactor Building at an elevation of 670'-0". The 150# valve unit is flange mounted by using eight 5/8" bolts whereas the 300# unit is welded to the pipe (6-HBC-GT-MO-F073 A, B and 6-GBB-GT-MO-5075A, B). Each valve has a Limitorque SMB-000-5 type motor actuator bolted to the yoke. The equipment is designed as per the Bechtel Specification 8856-P12, Rev. 13, dated May 12, 1980.

Following are the reports qualifying the valve for all the dynamic loads:

1(a) "Seismic Analysis: 6" figure 2355 with Limitorque SMB-000", Report #FA-5250, Rev. 3, dated June 10, 1980, VP #8856-P12BC-74. The report is prepared by Pacific Valves and approved by Bechtel.

(b) "Seismic Analysis: 6" figure 2155G with Limitorque SMB-00", Report #FA-5252, Rev. 2, dated October 1, 1980, VP #8856-P12BC-76. The report is prepared by Pacific Valves and approved by Bechtel.

(2) Limitorque Test Reports:

(a) "Report of Seismic Test on SMB-000-5 Motor Actuator for Limitorque Corporation", prepared by AERO NAV Lab, ETL Report No. 5771 dated October 17, 1975, VP #8856-P12BC-101.

M-159: Nuclear Safety and Relief Valves

A typical nuclear safety and relief valve was inspected. The valve is located in the Reactor Building at elevation 719 ft. The valve is classified as passive equipment. Its function is associated with the containment instrument gas system. The vendor is J.E. Lonergan Company. The valve was designed according to Bechtel Specification 8856-M-159.

Since the valve is passive the basic qualificational requirement is that the valve will maintain its structural integrity for both seismic and hydrodynamic loads. Qualification is justified by an analysis which is reported in a document entitled:

> "Seismic calculations, safety and relief valves for Pennsylvania Power and Light Susquehanna Station, Berwick, Pennsylvania, Unit 2," Lonergan No. 510138-1.

In the analysis both operating forces and piping loads were considered. The total stresses in the valve were found to be below the allowables.

Based on the review of the analysis performed for the qualification of the equipment, the in plant installation and the clarifications provided by the applicant during the site visit we conclude that this equipment is qualified.

OPEN ISSUES:

NONE.

utilized to compute section stresses at particular locations of the valve. Such items as rigid beams, trunnion plate supports, actuator cylinder, pivot arm, shank tube, shaft support etc. were checked.

In modeling the valve-downcomer system the mass of the water in the submerged portion of the downcomer also considered. The downcomer piping was restrained with braces according to recommendations given to NUS Corp. by Bechtel.

At the time of the inspection the suppression pool was filled with water and only a portion of the downcomer bracing was visible. However, according to the applicant some modifications had to be made to the bracing members.

During the in plant visit the SQRT team requested the applicant to make some corrections on the SQRT form. These involved many clarifications to the item described on the form. The corrections were made at the plant site on a newly submitted a corrected SQRT form.

OPEN ISSUES:

(1) Provide assurance that the changes from 0.5 to 0.4 psi set pressure for all valves is carried and tested for compliance to correct stress and strain limits. Justify that such changes will not affect the operation of the containment atmosphere control system of the unit.

(2) Provide assurance that proper modifications to the down comer bracing system were made. In particular, provide the nessecary technical information.

The effects due to deadweight, pressure and the dynamic loads were assessed for the operating components of the valve. From the calculation of the modal characteristics of the valve-downcomer dynamic model it was concluded that the lowest natural frequency was below 33 Hz. Therefore a complete dynamic analysis was used for the assessment of dynamic loads. Upset and emergency load combinations were considered. The maximum stresses were computed for various load combinations and compared to the normal allowables. NUS concludes that all stresses except for the main shaft were found to be satisfactory.

Instead of specifying a shaft made from a stronger material overcome the main shaft overstress problem, Bechtel decided to reduce the set pressure from 0.5 to 0.4 psi. This change will reduce the total stress acting on the shaft from 38,974 psi to 32,214 psi. The latter stress falls below the allowable stress, which is equal to 33,000 psi.

The STARDYNE computer code was used for the dynamic analysis. The same code was also utilized to evaluate the static stress and strains due to the operating pressure and deadweight loads. Additional analyses to evaluate the spring and activator cylinder rods, behavior, as well as to compute the torque in the main shaft, the displacements etc. were also performed.

These additional calculations were carried out to provide a better check of some of the simulations and assumptions made in modeling the valve-downcomer pipe system. First, overall values for displacements and stresses were obtained from the STARDYNE code. These values were then further

M-149: Containment Vacuum Relief Valves

These valves are mounted on the downcomers in the vicinity of the drywell floor. Each of the Susquehanna units has ten such valves which are arranged as an assembly of two valves on each of the downcomers associated with this type of equipment. The valves can operate either manually or by remote control. The latter is accomplished via an interacting solenoid and is used only to check the functionality of the valve.

The vendor of this equipment is, Anderson Greenwood and Co. of Houston, Texas. As stated by the vendor, the valves are designed in accordance to the Bechtel Generic Reference Design Specification 8856-G-22, entitled:

> "General Project Requirements for Design Assessment and Qualification of Seismic Category I Equipment and Equipment Supports for Seismic and Hydrodynamic Loads for Susquehanna Steam Electric Station, Units 1 and 2", October 15, 1979.

These valves were qualified to withstand both seismic and hydrodynamic loads. The latter includes LOCA and SRV loads. The qualification is based on an analysis performed by the NUS Corporation. The analytical procedures used for the qualification of the valves are documented in technical report entitled:

> "Seismic Analysis of a Drywell Floor Pressure Relief Valve for the Susquehanna Steam Electric Station, Units 1 and 2, NUS-3803", NUS Corporation, Rockville, Maryland 20850 (Revisions 1 and 2).

There were no resonant frequencies determined in each of the three orthogonal directions as a result of the resonant survey. In addition, there was no evidence of mechanical damage, deterioration, or loss of functional integrity of the solenoid valves during the tests. The solenoid valves were pressurized to 750 psig and there was no evidence of any leakage before, during or after the test series.

It is concluded that the pilot solenoid valves are dynamically qualified and will function during the excitation levels that are imposed by the piping system. Since the piping stress analysis is not yet complete, it is important that the piping supports are designed to maintain all seismic and hydrodynamic loads below the maximum accelerations for which these valves were tested.

J-69-Solenoid Valve

The Solenoid Valves that were reviewed are pilot valves for the diaphragm actuated process valve. These are in the core isolation cooling and high pressure coolant injection systems. The pilot solenoid valves, Model 315-9101-3 and 315-9101-4 are located in the Reactor Building at elevations 645' to 818". The valve that was inspected is located in the Reactor Building at the 645' elevation. The valves are qualified to withstand Seismic, LOCA and hydrodynamic loading conditions without any deterioration or loss of integrity.

The valves were qualified by test. The Qualification Report Number V/P 8856-J69-8-18-1 is entitled, "Report of Test for Seismic Qualification of Four Solenoid Valves for Circle Seal Controls", dated 6/24/81. The report was approved by A.W. Davis of the Bechtel Power Corporation on 7/1/81. A dynamic test was performed 1 Hz to 100 Hz from on 2 ac (P.O. J69) and 2 dc (P.O. 69B) solenoid valves. A resonant frequency search was conducted with peak input vertical and horizontal accelerations of 0.2g's at a sweep rate of 2 octaves per minute. Mulitfrequency tests were conducted for which the TRS enveloped the RRS. Peak horizontal and vertical accelerations were 6.0g for OBE testing and 12.0g for SSE testing (5 OBE and 1 SSE, 30 sec. duration). The solenoid valves were vertically mounted to a bulkhead type test fixture to simulate in-service mounting conditions as closely as was practical.

conclusions of the five tested panels. Clarification is therefore needed for the following:

a) What is the dynamic relationship of the selected (reviewed) panel to the five tested panels?

b) How does the maximum stress of the selected panel compare with the maximum expected stress of the five tested panels and what is the basis for the evaluation?

Vibration tests were also conducted on the electrical devices that are mounted on the panel. The tests include a sinusoidal resonance search as well as five OBE aging runs, one SSE qualification run and a hydrodynamic fatigue loading consisting of a continuous 30 minute run in each of four biaxial directions. The devices were mounted to the test panel in a manner which simulated their service mounting. The test panel was than mounted to the test fixture which was rigid within 1-100 Hz bandwidth. The test panel fixture assembly was then attached to the shaker table.

The results show that for the worst combination of loads, the maximum stress in the panel is only 39% of the allowable stresss. Hence, fatigue loading should not be a problem. All panel mounted devices remained functional during and after the testing. There was no damage to the devices or to the mounting hardware.

The documentation therefore adequately demonstrates the structural integrity of the five tested panels. However, the basis for the dynamic similarity to the Control Panel 1C-681, 2C-681 at the Susquehanna plant needs to be more clearly defined. The similarity is not presented as a simple geometric scaling up or down where an assessment might be made on the basis of the dynamic changes that would be expected. The documentation discloses that the tested panels were selected to include the various elevation and corresponding response spectra as well as the highest weight per linear foot to yield the highest reponse. The mounting conditions were also considered in the selection. But specific qualitative and quantitative data is needed to substantiate that the panels that were inspected actually fall within the

The dynamic qualification of the Control Panel is shown by similarity. Five selected panels were analyzed using the response spectrum method as implemented in the SAP5A program. The selected panels were 0C883B, 0C661A2, 2C201B, 2C694 and 2C222. Input spectra were those obtained from the envelops of floor response spectra over the elevations that applied for each panel. The individual floor response spectra for each of the elevations were enveloped for each load case. Dynamic load combinations included the absolute sum of SSE + LOCA + SRV. Damping was taken at 2%. In addition, the N-S and E-W spectra were enveloped to obtain a single set of horizontal spectra to be used for each horizontal direction.

A response spectrum analysis was performed for each of the five selected panels following the Bechtel Specification 8856-G-22, "General Project Requirements for Design Assessment and Qualification of Seismic Category I Equipment and Equipment Supports for Seismic and Hydrodynamic Loads for Susquehanna Steam Electric Station", Units 1 and 2 (Revision 4). The purpose of the analysis was to ensure that the maximum stresses, deflections, and accelerations at nodal points were less than the allowable valves.

In situ tests were carried out to establish the justification of the finite element computer model. The final computer models of the panels were modified so that the lowest structural frequencies and mode shapes matched the test results.

"J-05A: Control Panel"

The Control Panel is located in the control room at the 729' level. There are actually two adjacent panels separate to the Control Panel . The first is identified as a 48" wide panel, 1C-681, which mounts the instruments and systems for the Control Building HVAC equipment associated with Unit 1. The second is an 84" wide panel, 2C-681, which contains the Control Building HVAC associated with the common plant systems. There are three dynamic qualification reports for this equipment. These are:

1) "Analysis of Control and HVAC Panels for Seismic and Hydrodynamic Loads." (Bechtel V.P. #8856-J8-2 through J8-7). This is a Computech, Inc. Report and was approved by P. Edlinger of Bechtel on 5/19/81.
2) "Test of Electrical Devices" (V.P. #8856-E-407-3-1) Acton Test Report, Rev. 2, 6/10/81, accepted by M. Castillo of Bechtel on 6/25/81.
3) "In-situ Dynamics-Testing", (V.P. #8856-J-8-8-2), prepared by Bechtel and approved by P. Edlinger on 6/9/81.