UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Vincent Noonan, Chief
Equipment Qualification Branch
Division of Engineering

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

FROM: Arnold Lee
Equipment Qualification Branch
Division of Engineering

SUBJECT: TRIP REPORT FOR SECOND SEISMIC QUALIFICATION REVIEW TEAM PLANT SITE AUDIT ON SHOREHAM NUCLEAR POWER STATION UNIT 1 (SNPS-1)

Reference: Memo to Z. Rosztoczy from A. Lee on "Trip Report for Seismic Criteria Implementation Review Meeting with Long Island Lighting Company (LILCO) on Shoreham Nuclear Power Station Unit 1 (SNPS-1), May 12, 1981."

The Seismic Qualification Review Team (SQRT) consisting of staff from Equipment Qualification Branch (EQB), and from Brookhaven National Laboratory (BNL), the consultant, conducted a send plant site audit at Shoreham on August 31-September 3, 1982. This audit is a followup of the SQRT review for Shoreham 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 April 6-10, 1981, we found that motor-operated valves with LIMITORQUE operators had not been fully qualified to seismic and hydrodynamic loads, and, as a result, that only about forty percent of the total safety-related equipment were qualified at the time of the audit. In addition, we found that auditable links did not exist for most of the equipment qualification documents which were audited. Based on the above general finding we considered the extent of completion of the applicant's qualification program to be insufficient for us to draw any conclusions regarding the acceptability of all the safety-related equipment. We therefore informed the applicant during the first site audit that SQRT would conduct a second audit when the qualification program is near completion.

After the first site audit, the applicant had provided the SQRT with responses, contained in the submittals of May 15 and 28, 1981, to both the generic and equipment specific open items as identified during the site audit. The SQRT had reviewed these submittals and other information which was further provided to resolve some of the open items, and found that the applicant's responses were generally acceptable. We had since reviewed the progress of the applicant's program and based on his submittal of July 26, 1982, determined that the applicant was ready. Thus, a second audit was conducted in the week of August 31, 1982.

II. Review Procedures

Twelve pieces of NSSS and BOP equipment (see Attachment II) were selected prior to the audit for detail review. At plant site, three additional pieces were further selected for detail review, while other four pieces were further selected for document review only. This was done to check the conformance of the applicant's program to what it was claimed to be. The review consisted of field observations of the actual equipment configuration and its installation, followed by the review of the corresponding qualification documents. Brief and informal technical discussions were held each day after the review session to provide SQRT's feedback to the applicant on his equipment qualification program.

In this audit, we also reviewed the extent to which the Shoreham Mark II hydrodynamic loads confirmatory program was incorporated in the applicant's equipment seismic and dynamic qualification program. The objective of such confirmatory program is to evaluate the plant for final generic Long Term Program (LTP) LOCA steam condensation and SRV discharge load definitions, which has been designed to the Shoreham design basis loads.

III. Findings

For the fifteen pieces of equipment selected for detail document review and field examination, we found their qualification acceptable relative to the Shoreham design basis loads, with the exception of certain details which need to be clarified by the applicant (see Section IV). The information on confirmatory loads, however, was generally not available for review at the site. This same situation was also found in the four pieces of equipment which were selected for review of completeness of qualification documentation only.

The staff held discussions on the subject of confirmatory load equipment qualification with the applicant and requested that it be upgraded to the staff requirement. This subject therefore remains a generic open item and needs to be resolved among others as identified in the exit conference (see Section IV).

IV. Follow-up Actions

In order for us to complete the review, the applicant was requested to provide responses to the following list of generic open items, as identified in the exit conference of September 3, 1982. The applicant was also requested to provide resolutions, prior to the fuel load, to the following equipment specific open items resulted from the SQRT audit. For information on detail evaluation of each piece of equipment audited, please refer to BNL's report in Attachment III.

A. Generic Items

1. Qualification documentation needs to be improved in the following areas:

   a. A "road map" should be provided to define the qualification process for BOP equipment.

   b. Complete test reports should be included in BOP SQRT package.

   c. Single spectra included in SQRT package should be identified as limiting (worst case) spectra.

2. The latest confirmatory load spectra should be included in all SQRT package by the end of March 1983.

3. The latest confirmatory loads should be considered for the qualification of pipe mounted equipment, i.e., valves.

   Phase I - Prior to fuel load

   a. Provide verbal description of 30 piping sub-systems already analyzed

   b. Provide a list of pipe mounted equipment by Shoreham valve Mark No's in these sub-systems

   c. Demonstrate qualification to confirmatory load values for the valves listed.

   Phase II - Prior to operation above 5% power

   a. Identify all associated pipe mounted equipment for approximately 70 additional piping sub-systems.

   b. Assess existing margin of safety for accommodating the upper bound of any load increase that could result from the confirmatory loads.

   c. Where adequate margins of safety are not evident, perform analysis to demonstrate equipment qualification utilizing confirmatory loads.

4. Commit to establish a maintenance and surveillance program to maintain equipment in qualified status throughout the plant life prior to the fuel load.

5. Provide monthly status of equipment summary list and provide justification for those equipment which will be qualified after fuel load.

6. NSSS qualification documentation file should be located in Shoreham plant file system by June 1, 1983.

7. To satisfy requirements of IEEE Std. 323-1974, provide a written statement that margin to cover uncertainty in manufacturing and test exist for equipment qualified by test.

8. Cycling effects of hydrodynamic load should be addressed prior to fuel load, based on worst case consideration.

   a. For equipment qualified by analysis, cumulative fatigue usage factor should be demonstrated to be less than one. The SQRT may decide to review the adequacy of the analytical model used.

   b For equipment qualified by testing, the number of equivalent SRV cycle should be adequately defined.

9. Provide information of any field modifications made to the already qualified and installed equipment prior to fuel load.

B. Equipment Specific Items

1. Unit Cooler - 1-T46* UC-022

   A static deflection analysis was provided for the fan only. A clearance of .051" was noted between the fan and housing. Provide upgraded calculations to also include the deflection of the housing.

2. Permanent Control Rod Storage Rack - IF 16 * RAK-23

   a. The qualification loads report was not available in the SQRT file. Need clarification.

   b. Provide evidence of verification for the non-linear analysis code used.

   c. Loads were not properly defined (i.e., a time history was used, but there was no description of what it represented). Provide clarification.

3. 480 V Emergency Switchgear Bus 112

   a. The qualification report should be completed so that is includes a table of contents and sequentially numbered pages.

b. The test reports from test labs should be reviewed as part of the qualification documentation package.

4. 480 V Motor Control Centers - 1 R 24 * MCC 1120

a. Provide resolution to the concern regarding clearance problems between motor control centers MCC 1133 and MCC 1125, and battery chargers BC-01 and BC-B1 respectively.

b. The test reports from the test labs should be reviewed as part of the qualification package.

5. Service Water Pumps - 1P41* P-003

a. Provide information regarding the analysis to determine the pump's lowest natural frequency with consideration of the fluid mass.

b. The analysis indicates that fundamental mode natural frequency is less than the pump rotary speed of 30 cps. Provide assurance that no potential problem will arise if the frequencies of high modes are also within the pump speed.

c. Provide justification of decoupling x and y dynamic - degree-of-freedom in the frequency calculations.

6. Main Steam Isolation Valve - 1B21*AOV - 081

a. Provide justification that the rapid closure of the valve which was not accounted for in qualification has negligible effects on the operability of MSIV.

b. Assure proper surveillance to insure adequate columns lubrication.

7. RCIC Turbine - IE51*TU-005

a. The turbine in the plant (GS-1) is not the same as the one in the test report (GS-2). Establish dynamic similarity.

b. Since the qualification is dependent on some modifications, report to NRC when implementation of the modifications is completed.

8. Pressure Transmitter - 1C41*PT-002

a. Field mounting configuration is different than that in the test. Provide assurance that the resulting response spectrum at the equipment mounting location in the test would envelop the required response spectrum at the equipment mounting location in the field.

b. Documentations that justify the similarity of the untested models to the tested units should be included in the overall qualification documentation package.

9. 120 Volt Distribution Panel - 1R35*PNL-R2

Field mounting condition is different than that in the test. Provide justification that the qualification is valid from the view point of dynamic similarity.

10. General

The SQRT disagreed with GE's use of single frequency/single axis testing method to qualify some shipped loose items. The applicant was requested to provide the description of the items for which this qualification method was used.

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 confirmatory load reassessment will be continued until the previously mentioned generic and equipment specific concerns are all resolved.

Arnold Lee
Equipment Qualification Branch
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Enclosure: As stated

cc: R. Vollmer
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Attachment I
SQRT Second Plant Site Audit
SHOREHAM NUCLEAR POWER STATION UNIT 1
Exit Conference
September 3, 1982

List of Attendees

NRC

G. Bagchi
A. Lee

Brookhaven National Laboratory

J. Curreri
M. Subudhi
R. Alforque
M. Chang

Stone & Webster

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G. Fi[illegible]e

Long Island Lighting Company

J. Valentc
M. H. Milligan
J. L. Smith
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W. J. Museler
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General Electric Company

R. Hardy

EDS Nuclear, Inc.

G. DeGrass
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UNICO

W. J. Riess

Attachment II

SHOREHAM SQRT AUDIT

Selected Equipment List

BOP Equipment

1. UNIT COOLERS-RBSVS (1T46*US-022)
2. PERM CR STOR RACKS (1F16*RAK-23)
3. 480 V EMER SWGR BUS 112 (1R23*SWG-112)
4. MOTOR OPERATED VALVE-RHR (1E11*MOV055A)
5. MOTOR OPERATED VALVE-NB (1B21*MOV068A)
6. 480 V MOTOR CONT CENTE (1R24*MC1120)
7. SERVICE WATER PUMPS (1P41*P-003)

* 8. Emergency 120 V Distribution Panel - 1R35*PNL-R2

NSSS Equipment

9. ISOLATION VALVE-MS (1B21*AOV081)
10. CRD HYDRA CONT UNIT (1C11*HCU-01)
11. HPCI PUMPS & BOOSTER (1E41*P-016)
12. RCIC TURBINE (1E51*TU-005)
13. HPIC LEAK DET RK (1H21*PNL-36)

*14. Pressure Transmitter - 1C41*PT-002

*15. Level Switch - 1E41-N014

*Surprise items selected at the plant site.

Attachment III

Shoreham Nuclear Power Station - 1

Plant Visit

Documentation Review

Introduction and Summary

Oct. 20, 1982

The second seismic qualification audit of the Shoreham Nuclear Power Station-1 (SNPS-1) was conducted during the week of August 31 - September 3, 1982. The Brookhaven National Laboratory (BNL) Review Tea was composed of J. Curreri, M. Subudhi, P. Bezler, M.T. Chang, and R. Alforque. The results and findings of the review conducted by the BNL team are contained in this report.

Several weeks before the actual plant visit, the owner-utility, Long Island Lighting Company (LILCO), was given notice of the specific equipment to be audited. There were 7 Balance-of-Plant (BOP) and 5 Nuclear Steam Supply System (NSSS) pieces of equipment selected by the Seismic Qualification Review Team (SQRT). LILCO was informed that the selected equipment would be audited to verify completeness of seismic and dynamic qualification documentation and installation. During the actual audit, 2 NSSS, and 1 BOP equipment were added to the original equipment list. These additional pieces of equipment represent surprise items and are intended to help the SQRT reach a fair extrapolated judgement as to the qualification status of the entire plant.

The dynamic loads for the Shoreham plant were recently upgraded to be in conformance with the definitions of the final generic long term program (LTP) hydrodynamic loads. These new loads are referred to in the enclosed reports as "confirmatory loads". According to Stone & Webster, for the secondary containment, the confirmatory RRS are in most cases bounded by the original design basis RRS. For the primary containment however, the confirmatory loads are higher, especially in the high frequency range near 60 Hz. Under BOP scope, all mechanical equipment has been reevaluated whereas only selected piping systems have been reassessed. Under NSSS scope all class 1E equipment are being reevaluated for the new confirmatory loads.

With respect to the audit, the following is a listing of equipment reviewed during the site visit:

Balance-of-Plant (BOP)

1) Unit Coolers - RBSVS
2) Permanent Control Rod Storage Racks
3) 480-Volt Emergency Switchgear Bus 112
4) Motor-Operated Valve - RHR
5) Motor-Operated Valve - NB
6) 480-Volt Motor Control Center
7) Service Water Pump
8) Distribution Panel

Nuclear Steam Supply System (NSSS)

9) Isolation Valve - MS
10) Hydraulic Control Units
11) High-Pressure Coolant Injection Pumps and Boosters
12) Reactor Core Isolation Cooling (RCIC) Turbine
13) High-Pressure Coolant Injection Leak Detection Rack
14) Differential Pressure Transmitters
15) Level Switches

All items except equipment numbers 8, 14 and 15 were selected prior to the plant site audit. The remaining equipment were chosen at the site as surprise items.

In general, based on the results of the audit, the status of the installation and documentation was found satisfactory. Details of the equipment-specific evaluations as a result of the audit conducted by the Brookhaven National Laboratory (BNL) Team are contained in the individual equipment reports that follow.

RBSVS Unit Cooler

(1T46*UC-022A)

(Reactor Building Standby Ventilation System)

The function of this unit is to maintain the Motor Generating Room at design temperature during both normal and emergency conditions. Air is driven by the fan into the cooling unit where running water is used as cooling media.

Buffalo Forge is the vendor for 4 units of RBSVS coolers in the Shoreham Plant. All of these are located inside the Secondary Containment. The Unit ID Nos. are: 1T46 * UC-022A & B, 1T46 * UC-021A&B. The unit inspected was 1T46 * UC-022-A, located at elevation 161'. This unit is approximately 60" High, 51" wide and 84" long. Its weight is 1819 lbs.

The main qualification report was prepared by McMahon Engineering Company for Buffalo Forge Company. Stone & Webster made the final review. This report is entitled "Seismi Analysis Report" No. 80N-27781, dated January 1981. The Stone & Webster Specification SH1-276 for unit coolers and cooling coils, dated 8/31/81 is also used. As indicated in the summary sheets, a letter, dated 9/17/79 with Job Order No. 11600.06, File No. 212.2.9 to Buffalo Forge Company from E.J. Brabazon, Stone & Webster Engineering Corporation, specifies the loadings and is used as a reference. The letter was, however, not provided with the document.

This equipment is qualified by analysis. Natural frequencies of the cooler assembly are obtained by using a computer program called "VIBRA". The brief introduction about the scheme used for analysis indicates that the stiffness and mass matrix are first obtained through a static analysis package "STRESS". The "VIBRA" code is then used to condense the number of degrees of freedom to a few and then to perform the eigenvalue analysis on the reduced degree of freedom system. It is found that the lowest natural frequencies in three directions are all larger than 5 Hz. Since, from the response spectrum at 150', the frequencies at which the high peak accelerations occur are all well below 5 Hz, it is reasoned that each modal contribution to the total response based on the given spectrum is minimal. Therefore a static analysis is chosen to analyze the equipment.

This equipment was analytically subjected to RRS loads along three orthogonal axes. The stresses in the equipment caused by these inputs are evaluated for each three orthogonal axes. The critical structural element was found to be located at the housing support leg weld, where under the operating load, dead load, seismic and hydrodynamic load the stress is 14245 psi. This value is lower than the allowed 18000 psi allowable limit.

The clearance between fan wheel and housing was calculated by considering the deflection of the fan wheel from its original position only. The possible deflection of the housing which has to be taken into account in calculating clearance was not found.

The IEEE 344-1975 requirements have been satisfied. However, a more detailed calculation including the relative displacement between the housing and the fan wheel should be provided to justify that the 0.051" clearance is not exceeded.

1F16 * RAK-23: Perm. Core Storage Racks

The spent fuel and control rod storage racks are located in the spent fuel pool on the fuel handling floor at the 137' elevation of the secondary containment. There are about thirty-two rectangular racks (71" x 71" x 169" H) which support rectangular vertical tubes for fuel or control rod storage. Three different models of such racks are identified as 1F16 * RAK-22/23/24. Each unit approximately weighs 15,400 lbs. when empty and 80,000 lbs. when full (without any water). Legs of each rack rest on adapter pads which are bolted to the embedments. The design of this equipment is based on S&W Specification, SH1-427. These racks are categorized as passive equipment and hence the structural integrity is the only requirement for qualification.

The equipment was originally qualified by an equivalent static analysis with an acceleration of 0.5 g and the results were summarized in the report, entitled "Mechanical Analysis Report: Spent Fuel and Control Rod Storage Racks for Shoreham Nuclear Power Station Unit 1", LIL-T-297, Rev. 1, 6182, prepared by UST & D Design Services Inc. This report refers only to the design aspects of the structures with an earthquake load considered together with other loads. Non-linear effects due to fluid and gaps were not considered and thus, at first, these documents were found to be inadequate for qualifying the racks.

On request, another report entitled "Seismic Analysis: Spent Fuel and Control Rod Storage Racks for Shoreham Nuclear Power Station Unit 1", LIL-T-296, Rev. 1, Vol. 1 & 2, prepared by UST & D Design Services Inc. (dated 10/21/81) was submitted for review. All the calculations in this report were made by Wachter Associates Inc. A nonlinear dynamic time history analysis method was used to incorporate the effects of (a) the fuel assemblies impacting the fuel box walls and (b) the rack tipping due to horizontal seismic loads (since the vertical tiedowns have been removed). The resulting support reactions were combined using SRSS method to determine design seismic loads for the racks and the embedments. The computer code used for this analysis is RACKOE.

Several items were not clear during the review process. First the input time history for the nonlinear analysis does not refer to the kind of loading conditions (e.g., hydrodynamic, seismic) assumed for the design or confirmatory loads. The final design should consider the new confirmatory loads. Secondly, the validity of the computer code RACKOE cannot be established. Hence, a benchmark report for validating this code is needed for review.

In summary, following open items remain to be resolved:

(a) The qualifying report LIL-T-296 was not available in the original SQRT package. An explanation was requested at the site visit.

(b) Provide evidence of validity of the computer code RACKOE.

(c) Time histories used in the report in item (a) require an explanation as to the type of loads they represent.

480V Emergency Switchgear Bus 112

The Emergency Switch Bus is used to step down the voltage from 4160 volts to 480 volts. It is a large cabinet 156" long, 90" high and 68" deep. An 8175 lb. transformer is housed within it. The total weight is 10975 lbs. The Emergency Switchgear units are located in the Control Building at the 25' elevation.

The qualification documentation is contained in the report "Seismic Certification Report for class 1E Electrical equipment, #33-48359, April 27, 1976 and #33-48359A,B,C, dated 9/30/79. The report was prepared by I-T-E Imperial Corporation. The report was approved by J. Gwinn of Stone & Webster on 7/12/76.

The equipment was qualified by test. The switchgear had accelerometers mounted at various locations throughout its structure. These instruments provided information on the natural frequencies of the cabinet. They were also used to develop localized reference TRS for particular equipment which was subsequently tested separately. The reference TRS was generated and compared with the RRS for any component installed in that location. To map the dynamic response of the various locations of the structure, a total of 24 accelerometers were used.

The natural frequencies of the switchgear were reported to be 4.5 Hz and 6.0 Hz. The graphs which are contained in the qualification material show that the TRS exceeded the RRS in the region of the natural frequencies by at least 20%. Multifrequency biaxial tests were performed over the frequency range of 1 to 100 Hz. A table is included in the report which lists the required "g" level for each component of the switchgear and compares it with the capability level of the device. In all cases, the devices were tested to accelerations in excess of the required levels.

The cabinet tests were done at Wyle Labs, Huntsville, Alabama. Their report is Wyle #42686-1. However, only certain excerpted pages of this report are included in the documentation file for this equipment. The entire report was not available at the time of the SQRT visit. The I.T.T report summarizes the Wyle report.

The same procedure was used in reporting the results of the other tests that were done on other equipment items. For example, the Control Switch Type C77 were tested at the East-West Technology Corporation located in Babylon, NY. The test lab report was not included, but the test was summarized in the qualification report by I.T.T.

From a review of the documentation which was available at the time of the SQRT visit, the Emergency Switchgear appears to be qualified for the required Shoreham dynamic loads. It was shown that this equipment could withstand these loads without compromising operability during and after the seismic event.

There are two areas, however, in which the documentation was deficient. The first has to do with format and the second with substance.

The I.T.T. qualification document #33-48359 does not have sequentially numbered pages nor a table of contents. Whether it is complete, or whether some parts of it are now missing or how it could be determined in the future that pages are missing is a problem, because of this editorial deficiency in format and presentation. It does not give the appearance of being finalized even though there are acceptances of the document.

The second deficiency is concerned with the incompleteness of the documentation. Summaries of test reports does not convey enough of the substance of the test for qualification. The summaries contain no discussion of anomalies, for example. The occurrence of an anomaly during a test should be reported. This should be done in sufficient detail so that a reliable understanding is obtained by the reviewer regarding the nature and significance of the problem and the reliability of its resolution. Whatever the nature of the anomaly, it should be a part of the qualification documentation along with the test results. If the original test reports from the test labs are not available, it is not known whether the summary has omitted some problems areas and discloses only that the equipment passed the test. The summaries are fine but the qualification documentation should have included the original.

The open items for the 480 V Switchgear are:

1. The qualification report should be completed so that it includes a table of contents and sequentially numbered pages.

2. The test reports from the test labs should be reviewed as part of the qualification package.

Motor Operated Valve
(1E11 * MOV055)

There are seven of these motor operated globe valves installed in the plant. The valves are identified by Stone & Webster Mark No.'s 1E11 * MOV055A,B, 1E11 8 MOV056 A,B, 1E41 * MOV047, 048, 1E51 * MOV047. They serve as shut off or by pass valves in the Residual Heat Removal System, High Pressure Coolant Injection System and the Reactor Core Isolation Cooling System. The valve identified by 1E51 * MOV047 is required for cold standby while the remaining valves are not required for either cold or hot standby.

The valve bodies were manufactured by Velan Engineering Co. while the valve operators were manufactured by the Limitorque Corp. The valves were purchased to comply with S&W Specification SH1-253 for Motor Operated Carbon Steel valves 2 inches and smaller. The valve yoke was qualified by hand calculation as presented in Belan Engineering Co. prepared report entitled "Seismic Analysis 1" Forged Bonnetless Globe Valve, Report No. SR-6190, Rev. 2, dated 2/3/82. The operator was qualified by test as presented in the Action Environmental Testing Corp. Report entitled "Seismic Qualification for Actuator", SMB-000,SMB-4 Report No. 16511-11, dated 4/2/82.

The field-inspected valve was identified by S/W Mark No. 1E11 * MOV055A. This valve serves as a RHR Heat Exchanger Shell Vent Valve. The valve body bore the valve Serial No. 935-1 and the operator, the No. 19816. The valve was pipe mounted in a vertical orientation with the valve operator offset of one side. The valve electrical leads were satisfactorily supported over the entire distance that could be observed.

The valve yoke was qualified by hand calculations using the equivalent static analysis method. The g load used in the qualification were 5.3 horizontal and 2.7 g vertical. These g levels equal or exceed the valve loads predicted with the piping code NUPIPE for all valves in this group. The fundamental frequency for the valve yoke was calculated to be 74 Hz using a beam model. Operability was demonstrated by computing the maximum valve stem deflection which was below the allowable value of .005".

The valve operators were qualified by test using single axis, sine beat tests, five beats for a given frequency and 15 cycles/beat increased at 1/3 octave intervals to input levels of 10 g horizontal and 10 g vertical from 20-100 Hz. During the tests the operator was clamped to the operator head. The operability of the operators was demonstrated by stroking the operator before, during and after the tests. No anomolies were noted.

Based on the review, the equipment is found acceptable for the Shoreham plant.

Motor Operated Valve, 1B21 * MOV068

Sixteen of these motor operated globe valves are installed in various systems of the plant. The valves are identified by Stone & Webster Mark Numbers: 1B21 * MOV068A,B,C,D,83,84,85, 1E32 * MOV024,025,026,027, 1E41 * MOV039,049 and 1E51 * MOV036,038,046. They serve as shut off or drain valves for the Main Steam System, Reactor Vessel Head Vent, Lube Oil Cooler Control System, RCIC Flow By-Pass and various vacuum systems. Valves with the S/W Mark No. 1B21 * MOV068A,B,C,D are required for the hot standby condition, while the remaining valves are not required for either hot or cold standby.

The valve bodies were manufactured by Velan Engineering co. while the valve operators were manufactured by the Limitorque Corp. The valves were purchased to comply with S&W Specification SH1-253 for Motor Operated Carbon steel valves 2 inches and smaller. The valve yoke was qualified by hand calculations as presented in the Velan Engineering Co. prepared report entitled, "Seismic Analysis - 2 " Bonnetless Globe Valve, Report No. SR-6188 Rev. C, dated 4/7/82. The operators were qualified by test as presented in the Action Environmental Testing Corp. report entitled, "Seismic Qualification for Actuator SMB-000, SMB-4, Report No. 16511, dated 4/2/82. This latter report is one of a series of reports which qualify Limitorque operators in a generic fashion.

The valve that was field inspected was identified by S/W Mark No. 1B21 * MOV068A. This is the second isolation valve in the main steam drain line. The valve body bore the valve Serial No. 310265. The valve was pipe mounted and oriented in a horizontal plane with the operator bolted to it with four 1/2" bolts. The pipe supports were stiff enough so that manual shaking of the system did not produce any noticeable response. The electrical leads to the valve operator were installed in a professional fashion and were satisfactorily supported over the entire distance that could be observed. The valve identified by S/W Mark No. 1B2 * MOV068C could be visually observed form the same location and appeared to have the same structural and electrical configuration.

In the hand calculations the valve yoke assembly is qualified by the equivalent static method. The static load is the product of the design valve acceleration and the valve mass. It is treated as a concentrated force acting at the location which will produce the highest stresses in the weakest section. In this calculation the resultant of the vertical and horizontal g loads is in fact taken as a single load acting in the transverse direction on the valve yoke (the most severe load orientation). For the original analysis a resultant g load of 3 g's was considered. This valve was later updated to the final design load which corresponds to 2.31 g F/B horizontal, 3.74 g S/S horizontal and 3.22 g vertical. These analysis g loads were determined from the piping anlayses and exceed the worst case loading for all valves in this group. The fundamental natural frequency of the yoke was calculated as 78 Hz, when idealized as a beam model. Lastly, operability was demonstrated by computing valve stem deflections, which were found to be below the maximum allowable deflection of .005".

The valve operators were qualified by test using single axis, sine beat tests to input levels of 10 g horizontal and 10 g vertical from 20 to 100 Hz. During tests the operators were clamped at their mounting plate to the actuator head. The operability of the operators was demonstrated by stroking the operator before, during and after the tests. No anomolies were noted during the tests which were witnessed and verified.

Based on the information made available during the review, the equipment is qualified for the Shoreham Nuclear Power Station-1.

480V Motor Control Centers

The 480V Motor Control Centers (MCC) are used to supply emergency power. The MCC units must start and stop electric motors in various Emergency Core Cooling Systems (ECCS). There are 30 such units at Shoreham at various locations from the 21' level to the 160' level. These are floor mounted cabinets 20" x 20" x 92" high. The cabinet weight is 600 lbs. Three of these units were actually inspected. These include numbers 1120, 1125 and 1133.

The qualification reports are:

1) Square-D Seismic Qualification Report for Model 4 MCC and Control Devices, 108-1.01-L2 dated August 2, 1974,
2) Square-D Seismic Test Report 8998-10.09-L7 dated March 25, 1976.
3) Square-D Seismic Qualification Report for Model 4 MCC, 8998-10.09-L12-R dated May; 24, 1977, Virgil C. Summer Nuclear Station.

All cabinets of all motor control centers are identical. But, the Class 1E electrical components vary from cabinet to cabinet, depending on the particular application. To qualify all configurations, the vendor separately tested each of 5 different location arrangements. For each arrangement, different pieces of equipment were placed in the area of the most severe environment and tested. During the test the contacts of relays were monitored both in the emergized and de-energized condition to demonstrate that a change in state does not occur for a time interval of greater than 2 MS. The MCC's were qualified by random multi-frequency phase incoherent biaxial tests to the TRS acceleration levels which enveloped the horizontal and vertical RRS over the frequency range from 1 to 100 Hz. The input ZPA acceleration of 1.6 horizontal and 1.1g vertical were about twice as high as the required ZPA acceleration.

The tests showed that the MCC's had sufficient structural integrity to withstand the prescribed random environment without failure. The operability of the separated electrical equipment, including breakers, relays and starters was also demonstrated during the tests. These were no structural, mechanical or electrical failures during the tests.

It was concluded that the 480V Motor Control Centers successfully passed the dynamic test requirements.

However, there still remains two areas of concern regarding this equipment. The first is the fact that original documents were not examined. The seismic qualification report notes that the actual vibration tests were done at Wyle Labs at Huntsville, Alabama. A total of 229 tests were performed. The Wyle report #42701-1 is excerpted and is referenced but was not available during the time of the SQRT audit. Whether any anomalies developed during all of these tests could therefore not be determined. It is only known, that the electrical and mechanical equipment as finally accepted passed the tests. Whether these were the original equipment which passed or whether some fixes were needed before they passed is not known. This could have been established if the Wyle Lab reports were available.

The second area of concern has to do with the installation of two of these cabinets. During the inspection visit, it was noted that Motor Control Centers 1125 and 1133 were both mounted very close to a battery charger cabinet. There was only about 1/2" clearance between the MCC's and the solid state cabinets. In any case, it looked as though the gap could be traversed during a seismic event, causing an impact load to occur. This problem should be studied and resolved. In addition, other MCC's should be examined to determine whether a similar problem exists.

The open issues are:

1) The clearance problem between the motor control centers and the battery charger cabinets should be resolved.

2) The test reports from the test labs should be reviewed as part of the qualification documentation that is available for examination. This is also noted as an open item for SQRT Item # BOP/3.

Service Water Pump
(1P41*P-003C)

The service water pump functions to provide the cooling water for safety related systems throughout the plant. The pump assembly weighs 15,250 lbs and has a length of 37.75'. There are four Model No. 16 x 26 C - VM pumps inside the screeenwall building. The ID Nos. of the four pumps are 1P41 * P003A, 1P41 * P0038, 1P41 * P003C, 1P41 * P-003D. The unit inspected was 1P41 * P-003C. Since the assembly is rather long, there are several supporting locations. The assembly is mounted vertically and is supported to the floor at the 20'6" level. Furthermore, it is restrained horizontally at the 6'2" and 9' 1 1/2" levels. Sixteen 2" diameter bolts equally spaced on housing flange are used to attach the pump to the floor.

The pump is designed according to Stone & Webster "Specification for Service Pumps" which is certified to be in compliance with ASME Boiler and Pressure Vessel Code, Sec. III NA 3250. The report "Seismic-Stress Analysis of Vertical Pumps" No. 230629/32 prepared by McDonald Engineering Analysis Company for the vendor, Bingham-Willamette, is the main document for seismic qualification. Design Drawing No. 11600.002-2.23-1A is also provided for reference purposes.

The frequencies at which high peak accelerations occur for the response spectrums at the 20'6" level are all below 22 Hz. Since the calculated natural frequencies from ICES-STRUDL computer code are all above 22 Hz, the modal contribution to the total response based on the response spectrum at 20'6" level is claimed to be minimal. Hence, a static analysis was performed.

The pump was modeled as an idealized 2 dimensional model. Using dynamic condensation, the model was rearranged so that the natural frequencies in the x and y directions are obtained independently. Since the coupled motion between x and y direction can be of importance and some particular mode could arise combined motions in the x and y directions, the assumption that modes in x and y direction are independent from each other needs verification.

The lower part of the pump is supposed to operate while immersed under water. During the operation the pump delivers water from the sump. The induced added-fluid mass in the vertical column will alter the natural frequencies of the pump assemblies and thus should be taken into consideration. However, the added mass effect was not addressed in the report.

The pump operability was verified by analyzing the shaft deflection and impeller clearance under seismic, operating, and nozzle loads. It was found after calculation, that the shaft exhibits a maximum deflection of 0.05" this is smaller than the maximum allowable of 0.06". The impeller has a maximum deflection of 0.001" which is smaller than the 0.009 "allowable. Thus it is claimed that the clearances are adequate enough to provide the operable conditions for the pump.

Based on the findings of the audit, the open items can be summarized as follows:

1) The fluid mass effect should be considered in the dynamic analysis.
2) It has to be assured that the natural frequencies are within the rotary frequencies of the pump.
3) Decoupling of the x and y degree of freedom in the dynamic analysis needs to be verified.

Distribution Panel
(1R35*PNL-R2)

These distribution panels are cabinets which house various breaker switches. The function of the Breaker Distribution Panel is to protect the safety-related electrical cables from current overload and to protect the system from widespread damage. The Breaker Switches whose ID are: 1P-30A-BA1030, 1P-20A-BA1020, 1P-15A-BA1015 were housed in a cabinet. There are two types of D'.tribution Panels namely, 1R35 * PNL-B2 and 1R35 * PNL-R2. The one chosen fo. on-site inspection is of type 1R35 * PNL-R2. This unit is located in the Secondary Containment at the 112' elevation level.

The sheet metal rectangular housing cabinet is 30" high, 19" wide and 8" deep. The whole panel weighs 150 lbs. The cabinet is mounted to the wall through a frame which is made up of vertical and horizontal double channel members. This frame structure is welded to four back ears located on the back of the cabinet and attached to the wall by 4 bolts.

The equipment was seismically qualified by testing to IEEE-344-1975 Standards. The qualification report is entitled "Seismic Simulation Test Program on a Breaker Distribution Panel", dated 10/18/80. This is essentially testing report from Wyle Laboratory prepared for Systems Control Corp. and approved by Stone & Webster on 2/2/81.

The test program consisted of biaxial random multifrequency testing and resonance search testing in each of the two test orientations. The specimen was subjected to 30-second duratinn biaxial multi-frequency random motion which was amplitude controlled in one-third octave bandwidths spaced over a frequency range that varied from 1 Hz to 100 Hz.

Discrepancy was found when the on-site mounting was compared with that of the test mounting. The actual mounting is via a frame which must be capable to withstand the severe earthquake that could act on the distribution panel. The test mounting documented in the report consists of two vertical bars bolted to the cabinet and welded to the shaking table which could exhibit dynamic characteristics different from that of the installed configuration.

According to the test report page 10, test run 18, which is the SSE test in the side-to-side/vertical orientation, the interior panel which formed a frame around the braker switches had slipped loose from its original clamped position. The sliding clamps which hold this panel in place were bent and loose. The same conditions were also indicated for test run 19 which was carried out in the side-to-side/vertical orientation. This problem was later corrected by adjusting the bolting of the interior panel. This change is documented in E&DCR P-3586.

Electrical monitoring was also conducted during the test. Only two electrical monitoring channels among the others were recorded on an oscillograph recorder during the Seismic Simulation Test Program. These channels were used to monitor one breaker in the open position and another breaker in the closed position for any unauthorized contact change-of-state lasting 2 milliseconds or more. It was demonstrated that the specimen satisfied these requirements. It is also noted that even when the structural problems occurred on test run 18 & 19, no effects vis-a-vis the electrical functional operability of the equipment were noticed.

It is required that the TRS of the panel that was actually tested should adequately envelop the RRS of the Shoreham panel. It is not explained in the document that the tested panel has been compared to RRS at worst floor where class 1E mounted equipments are located. However, figures in the document do show that the TRS conservatively envelops the Shoreham RRS.

In summary, this equipment satisfies the IEEE requirements except that the mounting simulation used in the test needs to be justified from a dynamic similarity viewpoint.

Main Steam Isolation Valves

The main steam isolation valves (MSIV's) function to provide rapid closure in order to isolate the primary containment for high pressure steam service during normal/emergency conditions. There are eight (8) valves in the plant. All of these are manufactured by Rockwell International and are located in the drywell, outside of the steam tunnel. The valves are all 1612 Jimmy Flite Flow valves fabricated in accordance with GE Purchase Specification #21A9230. Each valve is an air-operated globe valve and weighs approximately 12,030 lbs (flooded). The valves are pipe-mounted and welded in place to the main steam piping. These components are classified as active and thus they have to maintain both their structural and functional integrity during any faulted event. In order to demonstrate that the valves will maintain their structural integrity when subjected to a combined seismic and hydrodynamic loading, an analytical approached was used. For functional integrity, or operability, a combination of analysis and tests was employed.

The following documents describe the analysis performed in order to demonstrate structural integrity: (1) Report #22A6416, Main Steam Stress Report, (2) VPF #2793-60-3, Rev. 2, Design Calculations, and (3) VPF #2793-41-2, Seismic Calculations, June 16, 1970. The results of the calculations indicated that under both seismic and hydrodynamic loading, a maximum calculated moment of about 547,662 in-lbs occurs at the valve body-bonnet centerline. The allowable moment at this point is 678,700 in-lbs, thus, there is a ratio of 0.81 between the calculated and the allowable value. SAP IV was used to analyze the dynamic model of the valves and the main steam piping. Support considerations in the model seemed to be reasonably representative of the actual support conditions.

Report #NEDE-24122-2 describes the test performed on the valve actuator. The actuator assembly was mounted on a 45-degree test fixture, which, in turn, was mounted on a shake table. The tests performed were sine sweep, transfer function, sine dwell at resonance for 30 seconds, dual axis random response spectrum, and damping tests. The resonance frequency was determined to be approximately 8 Hz. The transmissibility was about 5 with the valve open, and about 9, with the valve closed.

During the test, there were instances that the valve hesitated, and at one point, the test was stopped to grease the four valve operator guide columns so that the valve would fully open. Apparently the columns had galled and roughened due to steel-to- steel rubbing; there was also some indications of an alignment problem. The valve, however, never failed to close, and since its safety function is to close, it is claimed that the test demonstrated functional integrity during a seismic event.

During the test, the maximum stress was found to be 65,000 psi for an input of 1.45 g peak-to-peak. In addition, a fragility test was run with the input g level increasing up to 4g peak-to-peak, horizontal, at which point the columns yielded slightly leaving a permanent deflection of about 3/16 in. near the top. Based on the test results, it is recommended that periodical surveillance, or preventative maintenance be carried out, especially with respect to column lubrication. Furthermore, one concern was not addressed during the test, this is the effect upon the dynamics of the system of a sudden impact loading due to rapid valve closure during a seismic event. General Electric gave the assurance, however, that this concern will be properly addressed.

In conclusion, based on the findings and data made available during the audit, the equ pment is considered qualified with the exception of the following items which should be properly addressed:

a) The effect upon the dynamics of the system of a sudden impact loading due to rapid valve closure, and
b) Proper surveillance to insure adequate column lubrication.

C11-D001: Hydraulic Control Unit

Each Hydraulic Control Unit (HCU) controls the insertion and withdrawal of a control rod inside the reactor pressure vessel. It functions to activate the SCRAM Pilot Valve and the associated SCRAM components during a SCRAM cycle. There are 137 of these units located at two locations of the secondary containment at an elevation of 78'. Each unit consists of several pipes or tubes, valves, tanks, and various other components. It has an overall dimension of 22" W x 102" H x 20" D and weighs 785 lbs. All components were tied to a frame structure which is bolted to the floor via four 1/2" diameter bolts. Several such units are installed in a line back to back with another line of such equipment. Several small tubes of sizes 3/4" and 1" diameter from each HCU are then connected to common headers.

The equipment is manufactured by GE and because of its complicated arrangement it was qualified by both test and analysis. The main reports containing the qualification documentation are:

(1) "1973 HCU Seismic Test", Document No. 384HA183, Rev. 0, July 16, 1973.
(2) "Seismic Analysis of the Hydraulic Unit", GE Document No. 383HA853, Rev. 0, February 13, 1973.

These reports refer to HCU assembly drawing no. GE-761E500.

Both seismic and hydrodynamic loads were considered in qualifying this equipment. According to the reports, the responses due to pool swell, annulus pressurization and chugging need not be considered since these loads have no effect at the installed location of these units. The equipment is required to maintain the structural integrity to the extent that a SCRAM cycle can be sucessfully completed. A SCRAM, which is the principal operational requirement of the HCU, is performed by activation of air pilot valves V117 and V118, when the device is in the prepared SCRAM condition. For a sucessful SCRAM, the accumulator pressure of the device must decrease from 1510 psig to 750 psig within 2 seconds or less from the time of activation of the air pilot valves.

A test was conducted on two units at Wyle Laboratories at ambient condition and the results were reported in the Wyle Test Report No. 153540 dated 8/29/73. Of the two specimens tested, one corresponds to the unit used at Shoreham site. The test sequence consisted of a initial note on pressure and time data for functional integrity, a resonance search followed by a single axis multifrequency sine beat tests. The resonance search had a sweep rate of 1 octave per minute at an input excitation of 0.15 g. The first few fundamental frequencies are:

S/S: 2.75, 4.5, 8.5, 14 Hz
F/B: 2.0, 4.2, 7.75, 12.5 Hz
Vert: 10.0, 38.0, 41.0, 49.5 Hz

The specimen was then subjected to excitation at the predominate natural frequencies identified in the resonance search. The excitation consisted of an 8-cycle sine beat at four increments of levels ranging from .5 g to 1.2 g. A functional SCRAM was performed at the end of the test and appropriate pressure and time data were recorded to compare with the acceptable standards.

Three separate dynamic analysis of the unit were performed with different boundary simulations using the computer code SAMIS. The weakest structural member was identified to be in the frame. However, the stress level for this component did not exceed the allowables.

The equipment was further reassessed for the newly developed confirmatory loads and were found to be within the design basis. The small lines coming out from each of the units are under Stone and Webster's scope and these were found to be well supported. Although, no report regarding these line designs were reviewed, S&W stated that they were designed in accordance to their (small) piping design specifications.

Based on our review, this equipment is found to be qualified for the Shoreham Site.

High Pressure Coolant Injection Pump
(E41-C001)

The High Pressure Coolant Injection (HPCI) pump is classified as an active equipment and is required to maintain both its structural and functional integrity during and after any postulated seismic event. The pump ID is designated as E41-C001. The main pump is designated as 12 x 17 type RHCH while the booster, is designated as 12 x 17 type DSK. Both were fabricated by Pacific Pumps. They are mounted on a common base plate with a gearbox in between them and located at an elevation of 8' in the secondary containment. There are 22 bolts, 1-1/2"-nominal size diameter that holds the assembly to the base. The total weight of the assembly, which includes the main and booster pumps, base plate and gear box is approximately 28,500 lbs. The main function of the HPCI pump is to provide the reactor pressure vessel with high pressure coolant (water) in the event of a small line break which would not result in pressure vessel depressurization.

The qualification of this equipment was accomplished by analysis only. Justification for this approach is that the main pump, gearbox and booster pump are mounted rigidly to the base in such a manner that the minimum natural frequency is above 60 Hz. The analysis was carried out mostly with the aid of various computer programs, namely: BMDAT, CANBM, CONBM, MDLF and STRESS. In addition to the detailed description of the analysis done on the major components of the HPCI pump assembly (with the exception of the gearbox), a description and validation of the computer programs are also included in report #VPF 2740-180-1 entitled, "Seismic Analysis of the High Pressure Coolant Injection Pump", issued by General Electric, dated July 16, 1979. Generally, lumped-mass models were utilized to obtain vibration data and modal displacements. Results from the analysis were used to evaluate interference problems and to determine internal dynamic stresses within the structural members. The seismic part of the analysis used ZPA values of 1.5 g, horizontal, and 1.0 g, vertical. Results of the calculations showed that there was no interference when the shaft is subjected to a combination of horizontal and vertical seismic loadings. Furthermore, maximum stress locations for the entire structure were identified and the calculated stresses were compared with the allowable values. In all cases, positive margins were found; margin is defined as the difference between the allowable minus the calculated values.

A separate analysis was performed for the gear assembly. Again, the lowest natural frequency was above 60 Hz, thus justifying static analysis. Stresses due to seismic loads were added to normal operating stresses to determine total stress levels at critical points in the assembly. It is claimed that the stresses at other points would be less than at the points chosen for analysis. The calculated stress levels were found to be well below the minimum yield strengths of the materials. Furthermore, these was no apparent interference problem and the bearing loads were all within the capability of the bearing material.

In order to demonstrate that the pump is also qualified when subjected to "confirmatory" loads, a revision of the original analysis was performed. Results from this analysis are documented in report #KSI-E41C001, dated Oct. 23, 1980. A static coefficient of 1.5 was applied to the original 1.5 g, horizontal and 1.0 g, vertical. The calculated stresses were found to be within the allowable limits stipulated in the ASME section III code. Seal flush piping and lube oil piping were further analyzed and determined to be adequate for a maximum unsupported length of 48" as specified in the instruction manual. Finally, the calculated critical deflections affecting operability, especially between rotating and stationary parts, due to seismic and hydrodynamic loads were also found to be also within acceptable limits.

Based on the findings and the data made available during the audit, the equipment is considered qualified.

1E51 * TU-005: RCIC Turbine

The Reactor Core Isolation Cooling (RCIC) turbine drives the RCIC pump which provides high pressure cooling water to the reactor. This equipment is normally used during shutdown isolation events. One such unit is located in the secondary containment at an elevation of 8'. The turbine is manufactured by the Terry Steam Turbine Co. and is installed to the floor via six 1" bolts fastened to two large pedestals. The pump is also installed at the same location. The two units are connected via a flexible coupling system. The equipment is designed as per GE specifications GE 21A9201, Rev. 4, dated 11/22/72 and GE 21A9201AK, Rev. 3, dated 4/17/73.

The principal supporting document for qualifying this equipment for dynamic loads is entitled "Design and Seismic Documentation", Engineering Library Log No. 20302. The report was prepared by Terry Corporation, and is dated October 1976. The document refers to the turbine model GS-2N and includes Wyle Test Report No. 58038, and Terry Report No. 20299. The equipment was qualified by test because it consists of many components. These include such items as limitorque operator, trip solenoid, trip and throttle valve, governor, oil cooler, and various electrical devices. The pedestral was designed by analysis which is describecd in the report entitled "Design Analysis Calculations", VPF 2757-33-4, dated 11-24-71. Since the frequency of this structure in very high, static anlaysis was used to qualify the pedestral. In addition, several other documents relating to the turbine were reviewed during the audit.

The turbine model (GS-1) installed at the Shoreham site is very similar to the one (i.e., GS-2N) qualified in the supporting documentations. A report entitled "Report on the Seismic capability of RCIC turbines (GS-1 and GS-2)", prepared by the Terry Steam Turbine Co., VPF-2757-35-1, May 25, 1970 includes some analytical justification for the two models. There are two pedestal couplings for Model GS-1, whereas, there is only one coupling for modes GS-2.

analytical justification is that the natural frequency of either model is above 100 Hz and hence no amplification of RRS can affect turbine performance. However, at first there were not enough justifications to conclude that the two models exhibited the same dynamic characteristics.

In a later addition to the review, GE submitted a qualification report entitled "Environmental Qualification Report for GS-2N RCIC turbine electrical accessories and electronic control system", VPF # 3622-527-1, Rev. 1, dated 4/21/80, which describes tests results performed as per the requirements in IEEE-323-1974, IEEE-344-1975, and IEEE-383-1974. These included environmental aging performed by the Terry Corporation followed by seismic testing at Wyle Laboratory. The test results were found to be satisfactory and in compliance with the requirements. In addition, a GE departmental memo entitled "Shoreham RCIC Turbine Seismic Similarity Analysis", dated August 27, 1982 from J.C. Kelso and E. Intrator to G.I. Samstad, R.L. Lebre and R.W. Hardy includes a detailed study of the two different turbine models (i.e., GS-1 and GS-2). According to this memo several field changes (referred as FDI's) are required in the installed turbine at Shoreham in order to justify that both models exhibit similar dynamic reponses. After incorporating all changes mentioned in the above memo, the similarity between the two turbine models seems to be justifiable.

The original testing included a frequency search followed by a multiaxis multifrequency test. The laboratory mountings were properly simulated. The recent test with environmental aging has included all the components attached to the turbine. The confirmatory loads were not considered in the test which used the design basis RRS. Since this equipment is located not very far from the HPCI pump, there will be no difference between the design basis RRS for the HPCI pump and that for the RCIC turbine. A comparison between this RRS and the confirmatory load RRS, indicates tht there is no particular problem for qualifying this equipment for the confirmatory loads.

Completion of all the field changes as included in the Similarity Analysis is required, however, before accepting the qualification of this equipment.

HPCI Leak Detection Rack, 1H21*PNL-36

The HPCI Leak Detector Rack is a braced frame panel which weighs 500 lbs. and has overall dimensions of 30" x 30" x 84" high. It is located in the Reactor Building at the 8' level. It is used to measure the differential pressure between the core spray line and the top of the core plate.

The panel is identical in structure to the H21-P036, 30" panel which was previously reviewed and accepted as dynamically qualified for the dynamic loads at Shoreham. The structure is qualified by similarity to other panels which were tested to the IEEE 344-1975 criteria. The qualification document compares the related mass, stiffness and damping characteristics of the Shoreham rack and the tested rack. It is shown that lower transmissibilities should develop for the Shoreham rack. Therefore, the rack should be structurally capable of accepting the Shoreham loads. A multifrequency, multiaxis test was used to evaluate the dynamic characteristics and capabilities of the similar panels that were tested. The instruments which are mounted on the rack were tested separately to malfunction levels which are shown to be adequately higher than the expected levels at their location.

The only difference between the HPCI Leak Detection Rack and the 30" rack previously reviewed is the addition of a Differential Pressure Switch, Barton 288, drawing # 145C3009. This device has a dynamic malfunction capability of 17 g, 13.8 g and 10 g in the front to back, side to side and vertical direction, respectively. This is at least twice as high as the expected accelerations at the location of the instrument of 3 g, 6.5 g and 2.3 g in these same directions.

The HPCI Leak Detection Rack, and the instruments mounted on the rack, are accepted as structurally and functionally qualified for the dynamic loads at Shoreham.

There are no open issues.

Differential Pressure Transmitters

Differential pressure transmitters are required to maintain structural integrity as well as functional operability when subjected to seismic and hydrodynamic loads. These transmitters are all fabricated by Rosemount, and are designated as Model #1151. They are installed at various locations throughout the plant. The ID numbers given by GE for these instruments are as follows: PPD #'s 145C3240 (1), 163C1558 (1), 163C1560 (3), 163C1561 (1), 163C1563 (1), 163C1564 (1). The numbers enclosed in parenthesis refer to the corresponding quantity of the designated instrument. They were qualified by carrying out test on the unit with ID numbers 163C1561 and 163C1564, and then extending the qualification to all the rest by similarity.

During the test to determine resonance frequencies, each device was mounted to a pipe which was in turn clamped to a shake table. The frequency search was carried out from 4 to 70 Hz. It was found that there were no resonance below 33 Hz, although there was a minor spike at 7 Hz (F/B). According to GE, this spike was not large enough to be considered as a resonance. For the OBE and SSE tests, the devices were mounted to a local rack. Then a multi-frequency, multi-axis vibration test was conducted, and the operability of the device was monitored. For an input acceleration level of 7.0 g ZPA, the devices were found to maintain both structural and functional integrity during and after the dynamic test. The test procedures and the corresponding results are described in a document designated as GE DRF A00-794-10, dated 1980 and entitled "Seismic Test of Perry Local Panels". The tests described in this report, however, included several other instruments also mounted to the local rack and then subjected to generic-type acceleration loadings.

In order to justify that the acceleration loading during the test was adequate to cover the required response spectra, G.E. referred to a study by Stone & Webster documented in report #S.W. J.O. No. 116.000 dated Sept. 2, 1982. This report described an analysis performed on three (3) types of stands used at SNPS-1. A typical "worst case" model of each of the three stand types was developed based on an as-built survey of various stands in the Secondary Containment and Turbine/Control Buildings. Each model was analyzed using the ICES STRUDL-II computer code. This computer program was used to obtain a single maximum acceleration value from an Amplified Response Spectra (ARS) input. Then the spectra at the instrument mounting location was produced by using another computer program, called CSMP, which has a time history input. The resulting response spectra were then enveloped by the Required Response Spectra (RRS). Comparison of the Required Response Spectra and the Test Response Spectra (TRS) showed that the TRS indeed enveloped the RRS. In view of this, it is claimed that since the test devices operated during and after the dynamic testing, they are dynamically qualified. It is to be noted, however, that the actual mounting conditions, differ from the test mounting conditions.

Finally, although GE had explained resonably the similarity of the devices, documentations that justify the similarity of the untested models to the tested units, should be included in the overall qualification documentation package. In general, however, the instruments are considered qualified, based on the available data during the audit, except that the following items should be addressed:

a) It should be demonstrated that the test mounting condition simulates the actual mounting condition, and that,

b) Documentation attesting to the similarity of the different instruments, (as stated in the previous paragraph) be included in the overall qualification package.

Level Switches

Level switches, E41-N014 and E51-N010, are class 1E passive devices which function to monitor the drainage from the main steam line. These particular devices are fabricated by Magnetrol, and are designated as Model # 5.0 - 751. They are built in accordance to design specification number PPD #159C4294, 159C4361. These level switches consist of the following three sub-assemblies: (1) Sensing unit, (2) switch housing, and (3) the switch mechanism. The sensing unit, is made up from a pressure vessel and a float; the pressure boundary seal is a spirally wound (with 316SS) asbestos gasket between the enclosing tube and the sensing unit pressure vessel. The switch housing is made from metal with seals from viton and silicon rubber. The switch assembly consists of 2 microswitches manufactured by Microswitch, a division of Honeywell, Inc.

Qualification of these level switches was done by showing similarity with models, S-751-17-7 and 402-X-MPG-M14H, which were dynamically tested. GE Report No. 710-17-12 HC-17-7, dated Aug. 10, 1982 states that the sensing unit sub-assemblies of the 5.0-751 (installed unit) and the S-751-17-7-EP/VPX-S1MD4DC-S1M4DC (tested unit) are similar, and thus qualification of one can be extended to the other. Furthermore, the same report states that the switch housing of the 751 and the 402-X-MPG-M14H are similar and both are sealed with viton and silicon rubber O-rings and grommets. Also, the switch mechanism, of the 5.0-751 is the same switch assembly mechanism used in the 402-X-MPG-M14H. Hence, it is claimed that qualification of the 402-X-MPG-M14H is extended to the 5.0-751.

The relevant test document is report #43235-1, dated May 2, 1977 written by Wyle Laboratories. This report describes the test performed on various specimens namely, Magnetrol International Model Nos. BCS-751, 75-17-7, 291, 402 and A153F liquid level controls. The five level controls were mounted on test fixtures which were subsequently welded flush to the top of the shake table in each test orientation. A low level biaxial sine sweep test at a rate of one octave per minute was performed over the frequency range of 1 Hz to 60 Hz to establish major resonances in each test orientation; transmissibility plots of the specimen response were presented. Following the resonance search, a qualification multifrequency test with a random waveform input consisting of frequency bandwidths spaced one-third octave apart over the frequency range of 1 Hz to 40 Hz was carried out. The amplitude of each test frequency was independently adjusted in each axis until the TRS enveloped the RRS. The motion was analyzed by a spectrum analyzer at a damping of 2% for OBE tests and 3% for SSE. Five (5) OBE tests were applied to the specimens prior to the application of one SSE in each test orientation. The result of this qualification test demonstrated that the specimens possessed sufficient structural integrity to withstand the prescribed seismic environment.

After the qualification tests, the specimens were further subjected to high-level multifrequency tests in each spatial orientation to demonstrate that the equipment could withstand higher acceleration loads than the RRS levels. This test was directed by the Magnetrol Technical Representative, and the motion was analyzed at 5% damping. The results of this test showed that both the 751-17-7 and the 402 were structurally sound to withstand even the higher applied seismic loads.

Finally, switch contact voltage drop and switch actuation functional tests were performed. All models, except 402, seemed to possess sufficient integrity to withstand, without compromise of function, the prescribed qualification simulated seismic environment. The switch assembly of the Model 402, however, failed to actuate when the water level was lowered. This is an area of concern since from the similarity report, the switch assembly of the 402 is the same as that of the installed unit i.e., model 5.0-751. It is claimed, however, that Magnetrol requested Model 402 to be returned to the factory, where it was tested successfully and subsequently disassembled for further examination. Magnetrol claimed, in a letter report attached to NEDE 43235-1, that nothing was found that could have prevented proper operation at Wyle Laboratories, and that evidence was found that foreign material might have been present to impair operation during testing. Furthermore, G.E. claimed that for passive devices such as the level switches, structural integrity is all that is really required for qualification.

In conclusion, the equipment is considered qualified for the Shoreham plant based on the information made available during the audit.