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

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MEMORANDUM FOR: B. Joe Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

FROM: Vincent S. Noonan, Chief
Equipment Qualification Branch
Division of Engineering

SUBJECT: SEISMIC AND DYNAMIC QUALIFICATION REVIEW OF SAFETY-RELATED EQUIPMENT FOR COMANCHE PEAK UNIT #1

Docket No.: 50-445
Project Manager: S.B. Burwell

A site audit of the safety-related electric and mechanical equipment for Comanche Peak Unit #1 was performed by the NRC staff assisted by the staff from Brookhaven National Laboratory (BNL) between August 9 and August 13, 1982. An evaluation of the site audit is attached. A number of specific as well as generic concerns are listed in the attached evaluation.

The specific concerns should be resolved satisfactorily as a package instead of providing piece meal submittal. The generic concerns are applicable to the implementation of the entire program and the applicant is expected to address these concerns regarding equipment qualification throughout the entire plant and report in writing after all the generic concerns have been resolved. The generic concerns are summarized below:

(1) Most of the equipment inspected were not in a state ready for plant operation, for example temporary supports and straps, missing supports from accumulator line, missing nuts from U-bolts for charging pumps, spring mounted platform for compressor bottomed out. The deficiencies observed by the SQRT were compared against the check list that is maintained by the applicant to improve quality assurance (QA). However, the SQRT items did not appear in the QA check list.

The applicant should perform an independent inspection of the installation and supporting arrangement for seismic Category I equipment using personnel familiar with seismic qualification requirements, modify any deficiencies found, and provide a written report to the NRC staff on the inspection activity and the findings.

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(2) Other dynamic loads were not considered in some cases. Safety-related equipment must perform its function following seismic events as well as accidents. Accidents create mechanical loads and vibrations. Blowdown through relief valves and vibration created by two-phase flow condition in pumps are examples. In general the program did not address other dynamic loads, for example, vibratory loads on main steam relief valve during normal operation

An evaluation should be performed to assess the expected or probable mechanical loads including vibration following loss of coolant accidents, steam line break and feedline break, to identify equipment exposed to such loading, and to indicate how such loading may have been accounted for in the qualification of affected equipment.

(3) Effect of aging on seismic performance was not considered for some mechanical equipment such as pumps and valves. Aging consideration of mechanical equipment with age sensitive material can be just as important as in electric equipment.

It is necessary to perform an evaluation of failure modes of mechanical equipment associated with performance of age sensitive material and to report the results of the finding including recommendations, if any.

(4) Operability qualification of many complex equipment types was performed by analysis alone, for example charging pump, RHR pump, electric motors, compressors. Qualification by analysis alone can be accepted when structural integrity alone determine operability. Simulation of pressure, temperature, and flow effects combined with earthquake conditions cannot be satisfactorily incorporated in an analytical model. Equipment is required to be at its end of life condition before being subjected to seismic loading, it is then (after seismic event) required to perform its safety function during and after the accident condition. In the case of electric motors it is necessary to establish the qualified life through supporting test data.

Typical equipment representative of the types indicated above should be subjected to a confirmatory test program with a well defined schedule.

(5) In many cases it was observed that higher damping values representative of SSE stresses were used in analysis without any regard for the actual stress level, for example 4% damping value may have been used for SSE where the stress level is well within the elastic limit and only 2% damping value should have been used.

A comprehensive assessment is necessary with a confirmation that the use of improper damping values do not change the qualification status of any equipment.

(6) Equipment with lowest natural frequencies higher than 33 Hz (rigid equipment) was qualified by static analysis. This approach appears to have been used for equipment that are not rigid, for example, ECC accumulator with 22 Hz frequency.

A careful review should be performed and a confirmation provided to ensure that the qualification status of any safety-related equipment has not changed as a result.

(7) Although the applicant indicated that 85% of equipment is qualified, the qualification file is approved and established, and the equipment is properly installed; upon detailed examination of two items selected at random from the fully qualified and installed list, it was determined that the items were not installed and had incomplete documentation, for example electric hydrogen recombiner and nuclear instrumentation system.

Greater emphasis is needed to keep track of the qualification status of all safety-related equipment.

(8) Equipment qualification files are required to be maintained in an auditable manner for the life of the equipment. Westinghouse maintains a part of the document on behalf of the applicant. A clear definition is necessary as to what part of the files will be maintained by Westinghouse and what part will be maintained in the local file by the applicant directly. Those parts of the file that will be maintained by Westinghouse should be clearly identified in the local file. NRC staff should be informed after this documentation effort is complete.

In the area of equipment for the balance of the plant (BOP), the files were in very good shape with clear statement of criteria, good test specification and test reports. However, information on maintenance and surveillance requirements were missing. These files should be upgraded to include this information.

(9) When qualification was established by Westinghouse through generic tests, often the basic mounting information (number and size of bolts, required torque) was not specified. Similarly, when qualification is established by analysis frequently for equipment in both BOP and NSSS scope, the torque requirements are not specified. A thorough review of this issue is necessary.

(10) Electrical penetrations used in the plant require nitrogen pressure at all times to prevent potential for short circuit due to moisture ingress. However, the nitrogen supply system is not seismically qualified. The applicant should carefully review and justify why the nitrogen supply system should not be seismically qualified.

(11) For many equipment in mild environment the qualified life is dictated by the behavior of age sensitive materials, for example the life of motor winding insulation discussed in item (4) above. The applicant should address the issue of degradation of seismic performance due to aging for all safety-related equipment, and indicate how a reasonable assurance of seismic capability of safety-related equipment throughout the plant life can be obtained.

If you have any questions, please do not hesitate to contact me or Goutam Bagchi of my staff, who is the reviewer for Comanche Peak Unit #1.

Vincent S. Noonan, Chief
Equipment Qualification Branch
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Enclosure: As stated

cc: W. Johnston
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Commanche Peak Steam Electric Station
Plant Visit
Documentation Review
Introduction and Summary

This report deals ith the evaluation of the equipment that were selected by SQRT for Seismic Qualification audits at the Comanche Peak Steam Electric Station. A site visit was made during the period, August 9-13, 1982. This was the first Category I Plant audited by the BNL group. Unlike previous audits, this plant is required to satisfy both IEEE-323-1974 and IEEE-344-1975 criteria. Specifically, the new requirements include environmental aging, (sequencial testing) of all electrical equipment prior to dynamic testing. The BNL review team consisted of J. Curreri, M. Subudhi, A.J. Phillippacopoulos, M.T. Chang, and R. Alforque.

Prior to the plant visit, 30 pieces of equipment were selected for review by SQRT. Three additional pieces were later added as surprise items. One of these was BOP, while the other two were NSSS equipment. One of the originally selected items (i.e., BOP/18: Control Panel) was found to have incompleted documentation and hence was discarded from the review, although an installation visit was made. In accordance with our discussions with you during the audit, seven other BOP items (i.e., #5, 17, 20, 21, 22, 23, and 25) were dropped from the list. Thus, the final review consisted of 26 pieces of equipment for installation, out of which 25 pieces were also subjected to an in-depth documentation reivew. A listing of the 26 pieces of equipment is given below:

BOP

1 - 45KVA Class 1E Lighting Transformers & Accessories
2 - D.C. Swith Board and Distribution Panelboards
3 - Electric Penetration Assemblies
4 - Isolation Equipment and Cabinet CR-16

BOP (Cont'd)

6 - Chilled Water Recirc. Pump Motor

7 - Limitorque Motor Operator

9 - Borg-Warner Pneumatic-Hyd. Operator
16 in. 150 lbs. Gate Valve with Motor Operator

8&10 - 18 in., 900 lb. Feedwater Isolation Valve with Pneumatic Hydraulic Operator

11 - Motor

12 - Generator Control Panel

13 - Main Steam Isolation Valves

14 - Main Steam Relief Valves

15 - Filter Units:
1) Aux. Building Modular Train
2) Hydrogen Purge Modular Train
3) Control Room Make-Up

16 - Refrigeration Compressor Unit

18 - Control Panel

19 - Motors Panel

24 - Electronic Transmitters

NSSS

26 - CRDM

27 - Letdown Heat Exchangers

28 - Centrifugal Charging Pump

29 - ECCS Accumulators

30 - RHR Pump

Surprise Items

31 - 24" Motor Operated Valve

32 - Electric Hydrogen Recombiner

33 - Nuclear Instrumentation System

This review included an evaluation of the original qualification of all the above equipment both in terms of installation compliance and qualification documentation adequacy. Each individual equipment design was critically studied for structural and operational integrity during seismic and dynamic event. Some generic observations noted during the site audit are summarized as below:

1 - Findings from Walkdown:

The equipment installation status found during the walkdown was generally satisfactory, except for a few items which need to be checked for proper mounting.

2 - Review Criteria:

(a) All electrical equipment, in general, were qualified by the IEEE-323-1974, IEEE-344-1975 and other relevent guidelines.

(b) The environmental aging prior to seismic testing for mechanical equipment was not addressed.

(c) No consideration for accident loads were mentioned in any of the reviewed reports.

(d) The pumps, motors and compressors were qualified by analysis only without any testing.

(e) Use of higher damping values for SSE loadings without any consideration of higher stress levels that could be associated with them.

(f) Pipe mounted equipment needs to be verified for the qualified g-loads after completing the as-built analysis.

3 - Qualification Method:

(a) Since WECAN is a propriatory code its validity should be established.

(b) WCAP-8230 describing a general methodology for using 2-D analysis for a 3-D system should to be reviewed.

3 - Qualification Method (Cont'd):

(c) Single-axis test methods used for qualifying equipment should be justified.

(d) Use of static analysis in certain pieces of equipment should also be justified.

4 - Review Findings:

As an overall assessment, a large portion of work for qualifying equipment in this plant is completed. Details of the particular comments on the individual reviews are given in the evaluations that follow.

45KVA CLASS 1E LIGHTING TRANSFORMERS & ACCESSORIES

(CPX-ELTRET-01 Through 10, CP1-ELTRET-01 Through 06, CP1-EPTRET-05,06)

45KVA Transformers are used to provide electrical power to essential lighting systems. There are eighteen of these units at various floor levels in different buildings all over the plant site. These units are manufactured by the SQUARE D Company. Each has the appearance of a rectangal box (20" W x 30" L x 37" H) and weighs approximately 675 lbs. The design specifications used for this equipment are given in G&H Spec. 2323-ES-2D, 2323-SS-20, and in various standards and guidelines such as IEEE etc. Most of the units were mounted to the floor by four 1/2" bolts. In some cases, the units were mounted in similar fashion to brackets which were attached to the wall by six 1/2" bolts.

A field inspection to several units was conducted covering both types of mounting. All of the units were energized during the visit and hence, details pertaining to the transformer inner box were not verified by inspection. Mountings of the complete assembly were found to be rigid enough to withstand the RRS acceleration loads.

The equipment is qualified by tests which were performed at the Wyle Laboratory. The test report summarizing the procedure and findings is entitled, "Qualification Test Report for two 45KVA Transformers", Wyle Laboratory Test Report 44509-1, Rev. A, August 14, 1981. The report was approved by Gibbs & Hill. The equipment is qualified for both the mounting conditions and proper testing sequences for aging requirements which include both environmental as well as seismic. Since these units are located at various elevations of the plant, envelop RRS are developed for 2% and 3% damping for OBE and SSE, respectively. The TRS were always found to envelope the RRS for each of the loading cases. The dynamic tests include a frequency search in the frequency range of 1 to 35 Hz followed by multiple frequency multiple axis random tests.

The resonant frequencies are found to be 8 Hz in S/S, 6.5 and 30 Hz in F/B, 8, 15, 21, 30 Hz in vertical directions. The first specimen was found to be loose and the right hand coil and the bracket was broken during the first test. Bracing angles 3 x 3 x 1/4" were added and proper adjustments were made to the coils which resulted in subsequent successful tests. It can be said that for such a complex piece of equipment it would be difficult to predict all possible failure modes during a dynamic event by analysis alone. In addition to the above set of tests , the equipment was subjected to the following post-seismic tests; an insulation resistance test between winding, dielectric proof test, induced potential test, ratio test, and load test. According to the report, these tests indicated no adverse effects.

Based on our review of the reports, the field installation, and the clarification provided by the applicant, we have concluded that this equipment is adequately qualified.

DC SWITCHBOARD AND DC DISTRIBUTION PANELS

During the plant visit the following equipment were inspected:

Equipment	Tag No.
DC Swithcboard	CP1-EPSWED-01
DC Distribution Panel	CPX-ECDPED-02

Both of the above are manufactured by GE. They are located in the electrical building. From the inspection of the switchboard at the in-service mounting is was concluded that some electrical cables were still to be connected at the upper portion of the cabinet. A similar unit (tag number: CP1-EPSWED-02) located next to the unit that was inspected was energized at the time of the inspection. The field mounting referred to in the qualification reports was verified. With regards to the DC distribution panel, it was found that it consisted of a temporary ("home made") box mounted on a wall. This box which was constructed from wood had a set of Class 1E devices inside of it. A representative from Gibbs & Hill, Inc. said that they will install a proper rectangular metal distribution cabinet in the near future.

From a review of the qualification procedures, it was found that both the switchboard and the distribution panel were qualified by tests. Equipment sample units were tested at Wyle Laboratory. Aging considerations were taken into account. Test specimens were subjected to seismic aging by five OBE's and one SSE. Also, thermal aging of organic materials involved in this equipment was performed. According to the applicant, sequential testing in accordance to IEEE-323, 1974 was taken into account. The natural frequencies were obtained by resonance search in the range of 1-100 Hz. Multi-frequency and multi-axis random tests were performed. These indicated that the structural integrity and functionality requirements are satisfied. All of the above results are summarized in a report issued by David M. Rherible & Associates entitled, "Seismic Durability Qualification Report", 1180 TUSI117, Rev 3; April 1982. The report was approved by Gibbs and Hill.

Based on the information obtained during the SQRT audit, the above equipment is adequately qualified for the Comanche Peak plant. It should be noted, however, that the installation still has to be completed (especially the DC distribution panel).

ELECTRICAL PENETRATION ASSEMBLIES

(IE1 To IE81)

Electrical Penetration Assemblies (EPA) are installed in the containment structure pressure barrier or valve isolation tank in order to provide means for the continuity in power control and signal circuits while maintaining integrity of the barrier. These units are manufactured by Bunker Remo and are located at various elevations of the containment and safeguard buildings. The sizes of these units are 2", 5", 10", and 12". They are mounted to the penetration nozzles at the concrete wall. These are designed as per the G.H. Spec. 2323-ES-12 and 2323-SS-20. Some of these are installed with Junction boxes (J-box) in order to provide an additional safety factor. Each EPA is designed to maintain a blanket to prevent causing moisture inside the penetration tube and hence, Nitrogen supply into the unit is controlled by additional tubing and instrumentation devices.

Several EPA units were inspected from both inside and outside of the containment wall. The tubing and instrumentation for maintaining the Nitrogen environment and pressure integrity were also inspected. They were found to be installed to withstand seismic environment although they are categorized to be non-seismic equipment by Gibbs & Hill. Since it is important that this equipment should maintain the pressure integrity during a dynamic event, the Nitrogen supply system should have been considered to be Seismic Class 1 system.

The equipment is qualified by both test and analysis. The reports reviewed at the site were:

(1) Test Plan (Generic), Report No. 123-2159, Rev. 5a, 6-1-82.
(2) Seismic Qualification Test Report on Medium Voltage EPA I, II, Low Voltage EPA III, IV (Generic), Report No. 123-2159-16, Rev. 5.
(3) Design Qualification Test Report for CPSES, Report No. 123-2233, Rev. 7.
(4) Qualification of Junction Boxes, Report No. 123-2291, Rev. 0, 5-21-82.

All of the reports are prepared by Bunker Ramo and AET Laboratory, and were approved by Gibbs & Hill.

The qualification by test included a sequential testing procedure for both environmental and dynamic aging. It was then tested for frequency search followed by the seismic tests. During one of the OBE tests, the fixtures supporting the test specimen was found to be loosened and fixtures started sliding. However, the tests were performed successfully after fixings the above anomalies. Since this equipment is installed at various floor levels of the reactor building, an envelop RRS spectra was used for the qualification. The J-box was qualified both by tests and analysis.

The pressure leak test before and after the seismic test indicated that the seismic test sequence has a pressure loss of 6 psig, whereas, there is no significant loss during the normal condition. However, the constant supply of Nitrogen would be able to compensate this loss of pressure.

Based on our review of the supporting documents, field installations, and clarifications from the applicant the equipment is found to be qualified for the Comanche Peak site. The only issue needed to be further clarified is the categorization of the Nitrogen Supply System as non-seismic.

ISOLATION EQUIPMENT & CABINET CR-16

This equipment consists of a 30" D x 48" L x 90" H floor mounted cabinet which contains a number of solid state isolation measuring devices. The cabinet is located in the control building at an elevation of 830'. The devices (which in turn mounted to the cabinet) function to provide both necessary electrical isolation and physical separation between safety related and non-safety related annunciators, and sequence and computer signals originating from safety-related equipment. A number of such cabinets are mounted back to back in a row. Each of the cabinets are bolted to a common base by ten 5/8" bolts.

The qualification report, "Structural Analysis of Isolation Cabinet", No. A-302791-01, was originally prepared by Forney Engineering, dated, March 12, 1981. The solid state devices are qualified by tests which were performed by Forney Engineering. A report No. A-302761-01, dated May 13, 1981, describes the test results.

The cabinet on the other hand, is qualified by analysis. A report detailing the results was prepared by Forney Engineering with revisions provided by Gibbs & Hill. It is dated Nov. 15, 1981.

The "walk thru" on site inspection revealed the following:

(1) The seal on the door was damaged.

(2) One of the bolts used for the mounting of the component was loose.

(3) Cover plates for some terminal points were not in place.

Equipment aging tests due to temperature, humidity, and pressure, input voltage were performed and are reported in the previously mentioned report. Radiation aging was not considered because of the very low levels predicted for the control room.

The isolation devices were qualified by a test according to the IEEE 344, 1975 criteria. The main purpose of the test was to show that the devices maintain all the electrical operations after 5 OBE's, 1 SSE, and all possible aging processes. A single frequency, single axis test was carried out. The justification for using single axis test is that no significant coupling was observed during the test. However, the data for this justification is not provided in the report.

The cabinet was qualified by analysis. The computer program ICES STRUDL-II was used to find the mode shapes and natural frequencies. The displacement and stresses were calculated by equivalent static analysis. The critical stresses calculated under SSE and Dead Load were found to be under the allowable limits.

Based on the findings during the audit, the following items are needed to be resolved in order to qualify this equipment:

1) Correct the "Walk-Thru" findings.
2) Provide justification for single frequency-single axis test.

Chilled Water Recirculation Pump Motor

Model No. Frame 324 TS

The pump-gear-motor assembly is mounted to the floor of the electrical building at elevation 778'-0". Four 5/8" diameter bolts are used for the field mounting of the motor to the common base of the assembly. The in-service mounting was verified during inspection at the plant site. The vendor of the motor is Siemens-Allis, Inc. This motor is qualified by analysis which was carried out by the McDonald Engineering Analysis Co. Gibbs & Hill, Inc. reviewed this analysis and found it satisfactory. Natural frequencies were found to be very high, and based on this, only a static analysis was performed. The motor was idealized by beam elements. The ICES-STRUDL computer program was used. Stresses and deflections were calculated for the various components of the motor. It is demonstrated that these are below the allowables. Questions pertaining to the evaluation of the motor hold down bolt allowables were also resolved.

With regards to seismic enviromental effects, Report 8LR-90325 by Siemens-Allis Inc., mentions that the motor does not involve any materials which are age-sensitive for seismic environments. However, according to the design specifications given for the motor, bearing life is only predicted to be 15 years. Furthermore, winding insulation life is predicted to be 16 years. Considering the fact that this motor will not be required to function during and after postulated accident conditions, it is concluded that qualification is sufficient without including the aging effects.

Based on the inspection of the motor and the review of the pertinent qualfication reports, it is concluded that the equipment is qualified provided that a proper maintenance schedule will be established by the applicant.

LIMITORQUE MOTOR OPERATOR

The Limitorque Motor Operator functions to open the valve that provides sodium hydroxide flow upon receipt of the spray-actuation signal. This equipment measurements are approximately, 10" by 12" by 18". Two motor operators are required for each unit. The two operators investigated were located in the Safeguards Building at the 712' level.

The qualification report is entitled, "Actuator Qualification Report," No. B-0058. It is dated Nov. 12, 1980. This report was prepared by Limitorque, and was reviewed by Gibbs & Hill. The vendor for this equipment is ITT Grinell Valve Co. The equipment was designed according to Gibbs & Hill specifications No. 2323-MS-20B and No. 2323-SS-20.

During the inspection one meter glass was found broken, one handle cap was missing and one motor screw was found to be loose. It was explained that these problems occurred during the shipment of the equipment from the manufacturer to the plant site.

In addition, it was also found that an I-beam extends up about 3 ft. from the floor and is only separated from the operator motor by a 1/4" gap. From observation, it is possible that the I-beam would touch the operator and damage it during a seismic event.

The motor operator was qualified by test. In the test report, test results demonstrated that the excitation in one direction did not produce significant response in another direction. This type of single axis excitation was repeated for each axis to ensure no coupling arises between three directions, thus, justifying the use of a single axis test. Since there is no resonant frequency found lower than 33 Hz, a sine beat excitation at 33 Hz was used in the test in accordance with IEEE-344, 1975 sec. 6.6.2 requirement.

Seismic fatigue effects are considered by simulation of 5 OBE's followed by 1 SSE. No physical damage was observed.

Thermal, mechanical and radiation aging were also included in the report, according to IEEE 323, 1974 requirements.

Based on our review of the documents provided by Gibbs & Hill and findings during the site visit, we conclude that this equipment is qualified for seismic and dynamic loadings.

16 INCH 150 LB GATE VALVE WITH MOTOR OPERATOR

(NVD Part No. 75800-2)

There are two such valves located in the Safeguards Building at an elevation of 803'-3". Each valve is mounted to a 16 inch containment spray pipeline and weighs about 4380 lbs. with the operator. This valve allows recirculation of containment spray water during an accident condition. Each valve is enclosed inside a large vessel which is seismically supported by the containment wall. The piping system holding the valve assembly passes through the vessel and the ends are welded to the vessel. The valve is designed according to the Gibbs & Hill specification 2323-MS-20B.1, Rev. 2 and 2323-SS-20.

During the site inspection, the valve was found to be mounted to the pipe through full penetration welding and the operator was flange connected to the valve body. The enclosing vessel is installed to collect the contaminated water leakage (if any). The collected water is automatically drained after the level switch indicates a critical water level in the tank. Cable installation coming out of the valve was not completed at the time of the site visit.

The valve itself is qualified by a static analysis followed by a static test. The static calculation has indicated a natural frequency of 44.3 Hz. The static test with a horizontal load of 3g and a vertical load of 2g demonstrated no operability problem in the valve function. The static analysis indicates adequate structural integrity in the valve for the above g-levels. The report summarizing these results is entitled, "Seismic Analysis", Report No. NSR 75800-2, Rev. A, Oct. 19, 1979.

The operator of this valve is one of the Limitorque motor operators. Gibbs & Hill has a generic document (# B0058, dated Jan. 11, 1980) qualifying all the SMB type operators. This report includes all the environmental testings as required by IEEE-323, 1974, followed by the seismic testing per IEEE-344, 1975. No particular problems have been noted from their tests.

Based on our reivew of reports, field installations, and responses from the applicant, we conclude tht this equipment is qualified for the Comanche Peak site. However, as with all pipe mounted equipment, the final as-built piping analysis results for the g-loads at the valve center of gravity should be verified against 'he qualified g-load indicated in the SQRT forms.

18 INCH 900 LB FEEDWATER ISOLATION VALVE WITH
BORG-WARNER PNEUMATIC HYDRAULIC OPERATOR

(NVD Part Nos. 38991 & 75830)

During the audit it was established that SQRT ite ; 8 and 10 belong to the same equipment. Item 8 refers to the operator which is installed for the valve under item 10. Therefore, both of these SQRT items were reviewed together for qualification.

Four of these valves are mounted to the steam generator feedwater lines and they serve as the feedwater isolation separating the safety-related piping from the non-safety-system. They are located in separate cells in the Safeguards Building at an elevation of 856'-3". Each assembly has an approximate height of 7 feet and is pipe-mounted. It is designed as per the Gibbs & Hill specifications 2323-MS-20B.1, Rev. 2 and 2323-SS-20.

The valve ends are full penetration welded to the 18 inch pipeline. The operator is flange mounted to the valve body by eight 3/4 inch bolts. The unsupported valve assembly is held by the piping systems which were found to be properly supported at either side of the valve locarion. The valve operator has a motor operator and a hydraulic operator with nitrogen accumulator. During the visit it was found that the hydraulic operator serves as a redundant system to back up the motor operator in case of ary malfunction.

The valve assembly consists of the valve body, operators, solenoid valve, motor, pressure switches and an accumulator tank. The valve body is qualified by a simple static calculation for a load of 3g horizontally and 2g in the vertical direction. The fundamental frequency was found to be 54.8 Hz. It was subjected to a static deflection test to demonstrate the operability of the valve. The report summarizes these results as entitled, "Seismic Report of 18"-900 # CSFW Isolation Valve with Pneumatic Hydraulic Operator," NSR75830, Rev. A, dated Feb. 20, 1980. It was preparea by the Nuclear Valve Division of Borg-Warner and was approved by Gibbs & Hill.

The valve operator assembly, on the other hand, is qualified by tests. The report summarizing the findings is entitled, "Qualification Test Plan and Test Results Report For a Pneumatic Hydraulic Operator P/N 38991", Report No. 1736, Rev. A, Nov. 21, 1978. The report includes two additional reports: Wyle Laboratory Test Report, No. 57530, April 13, 1980 and Acton Environmental Test Laboratory, No. AETL MJO-5480-7968, June 16, 1978. The equipment was tested for environmental aging before it was subjected to the multi-axis multi-frequency random testings. The resonance search revealed no frequencies below 33 Hz. Hence, a sine beat test at 33 Hz was considered for an OBE level of 4.5g and a SSE level of 6.5g. The assembly was found to perform the required safety functions after all tests.

During the site inspection several temporary pipe supports were found in the vicinity of the valve installations. However, we were later informed that the pipe support installation was as yet not completed in this area.

Since the equipment is pipe mounted, the qualification g-level is established by the company prior to the piping analysis. Hence, the final as-built calculations still need to be verified to assure that the g-loads at the valve from the piping analysis do not exceed the qualified g-levels.

Based on our review of reports, field installations, and the clarifications provided by applicant, this equipment is qualified except for final verification of design g-load against the piping as-built analysis results.

Service Water System-Traveling
Water Screens-Motors

Model No. Frame 182T/CPX-SWTSTS-01 M

This equipment functions to drive the traveling water screens and is located in the service water intake structure. The unit consists of a 1.5 horsepower motor mounted on a bracket which in turn is attached to a gear drive. The in-service mounting conditions were verified during the plant walkdown inspection. The unit is not a safety related equipment and it was qualified by analysis. The pertinent qualification report is entitled:

"Summary Report, Seismic Analysis of Horizontal Foot Mounted Electric Motor", (date 4/20/77) Reliance Electric Co.

This report was reviewed and approved by Gibbs & Hill, Inc. An equivalent static analyses was performed with RRS obtained by the in-structure response spectra for the intake structure using 1.5 times the peak response spectrum. A company computer program (Program 706) was utilized for the qualification of the motor. According to Gibbs and Hill this program has been verified. Calculational results from this program were presented to the review team. From these, the report concluded that stresses and deflections comply with the specified allowables.

Representatives from G&H claimed that the combined service and seismic stress in the coil end turns of the motor are below design limits. A study was performed to justify that the stress analysis of winding end turns can be omitted from qualification procedures of random wound motors. This study indicated that there are safety factors in the order to 8:1 for most of the cases involving these types of motors encountered in nuclear plants.

A report detailing the results of the above study was presented to the review team. The report which is entitled "Seismic Report 78-R-33, Justification for Omission of Routine End Turn Stress Analyses for Random Wound Motors", July 10, 1978, has been approved by Gibbs and Hill (12/7/81). While the applicant agrees that this report was not intended as a specific qualification report for this equipment, it is claimed that it has generic applicability for the problem at hand.

As far as environmental aging is concerned, it is to be noted that this motor is not required to perform any safety function during or after possible accidents and thus no aging tests are required. Since the motor is exposed directly to variable weather conditions, it is suggested that maintenance procedures be instituted.

Based on the in-service inspection of the motor, the results of the analysis performed for its qualification, it is concluded that this equipment is qualified.

DIESEL GENERATOR LOCAL CONTROL PANEL

(CPI-MEDGEE-01 & CPI-MEDGEE-02)

The diesel generator local panel is a steel rectangular cabinet, about 122" long, 72" wide and 114" high and weighs about 9200 lbs. Two units were physically inspected and found to have been installed at the proper plant locations; two other units were not yet installed in place but these are intended for the second generating plant. The units that were physically inspected are designated CPI-MEDGEE-01-1DG01B and CPI-MEDGEE-02-1DG02B. Both units are installed at the Safeguard Building at elevation 810'-6". Each unit is mounted in place by 8 bolts, 3/4 inch nominal size. As the name implies, the diesel generator local panel is a part of the diesel system and its satisfactory functional operability is required both for hot standby and cold shutdown. This panel houses various relays, switches, and other components necessary to monitor and control the operation of the diesel generator.

The main relevant qualification document for these panels is a test report by Wyle Laboratories, namely, Test Report # 58176, dated August 10, 1977, and entitled, "Seismic Testing of One Neutral Grounding Cabinet, One Generator Control Panel, and One Engine Control Panel for Delaval Engine and Compressor Division". This report was reviewed and approved by Gibbs & Hill on Nov. 30, 1977.

The test report indicated that the test panel was mounted to a fixture by 8 SAE grade 5, 3/4 inch bolts. It was pointed out that the SAE grade 5 bolt is the weakest grade for such an application, thus, the test mounting procedure was claimed to be conservative. During the test, some components were missing and were substituted by a 21-lb mass. Gibbs & Hill made an assurance, however, that the substitute mass did not result in a significant deviation in the dynamic characteristics of the panel. Furthermore, the test panel did not contain sequentially tested and aged component; to this effect, Gibbs & Hill, again made the assurance that they have currently an ongoing program for performing the sequential testing and aging of the relevant components. The resulting documentations for this will be available as soon as the test program is completed.

The test panel, as described by Wyle Test Report No. 58176, was subjected to a multi-frequency, bi-axial test with the Test Response Spectra (TRS) consistently enveloping the required response spectra (RRS). During the resonance search, the test panel was subjected to a frequency sweep from 1 Hz to 35 Hz and then back to 1 Hz at one octave/min. with an input level of 0.2g peak. The natural frequencies were determined to be 25 Hz (side/side), 10 Hz (front/back), 23 Hz (vertical).

The test panel was subjected to six (6) 1/2 SSE's and six (6) SSE's in the z-y axis and seven (7) 1/2 SSE's and eight (8) SSE's in the x-y-axis; damping was assumed to be 2%, both for 1/2 SSE and SSE loadings. The test was conducted at 1/3 octave frequency increments from 1.1 Hz to 100 Hz. During the test, 12 accelerometers were positioned at various points to monitor the response while two accelerometers were used as control accelerometers.

The first test resulted in panel failure at 5 Hz at the welds in the four vertical support channels. Repairs were conducted and structural reinforcement was added. Subsequent testing was successful, hence, it is claimed that structural integrity of the panel was demonstrated. Furthermore, Gibbs & Hill made the assurance that the modification during the test has been incorporated in the panel design specifications.

Based on the review of the documentation, the equipment is considered qualified provided (1) the results of the sequential testing and aging of the relevant components would determine the design adequacy, and (2) the dynamic qualification of the panel together with the individual components will not alter the design conclusions.

Main Steam Isolation Valve
[612 (WCC) GJMMPTY 32 x 32 x 34]

The main steam isolation valve is a 45° flite-flow globe valve whose primary function is to seal off uncontrolled steam flow in the event of a steam line rupture. The approximate dimensions of this valve, including the actuator, are 90" long, 43" wide and 145" high. It weighs about 31,300 lbs. The primary vendor is Rockwell International Inc. The valve is designated as model #612 (WCC) GJMMPTY 32 x 32 x 34 and fabricated according to Gibbs & Hill Specification 2323-MS-76 and 2323-SS-20. A total of four valves are necessary for the Steam Generator Steam Line System which consists of four lines for each of the two nuclear generating units. These valves are required for both the hot standby and the cold shutdown. These valves are installed at elevation 877'-6" in the Safeguard Building.

Four valves, all Rockwell International Model #612 (WCC) GJMMPTY 32 x 32 x 34, were physically inspected in the Safeguard Building at elevation 877"-6". All valves have been mounted and welded in place; some pipe supports, though, were not yet permanently in place. Gibbs and Hill made the assurance that all supports will be properly attached soon. Each valve is composed of five primary components for qualification purposes, namely: a) Main Steam Isolation Valve (MSIV), b) MSIV By-Pass valve, c) MSIV Actuator, d) MSIV By-Pass Valve Operator, and e) MSIV Limit Switches.

The qualification documents related to the valve body and its upper structure were prepared by Rockwell International, and are described in RAL 2033/RAL 3066, which was subsequently revised and approved by Gibbs & Hill. In this report, an analyses is presented to demonstrate the structural integrity of the valve body and its upper structure. The calculation shows a combined natural frequency of 33.8 hz. Since this frequeny is higher than 33 hz, it is claimed that the structure is rigid, thus justifying static analysis only. The same argument has been presented for the by-pass valve assembly, where it is also shown that the natural frequency of the by-pass piping is 38.1 hz. The subsequent static analysis indicated stresses below the allowable levels for normal, upset, emergency and faulted conditions. The analysis included loadings such as steam impingement from by-pass line break, internal pressure, thermal expansion, sustained loads, deadweight, transients and seismic.

The operability of the valve is claimed to have been demonstrated by similarity. Report # RAL-1038 describes the static deflection test that was performed on the valve wherein the minimum natural frequency was calculated to be 40.5 hz. with an input of 6.9 g. The resulting frequency and critical deflection were compared to the test results, at the same g-level input, of a smaller valve, Fig. # 1612 GJMMPTY; a discussion describing the similarity of the two valves is also presented in the report. The static deflection test and the subsequent calculations of the MSIV showed a maximum critical deflection of 0.054 in. at a location of 53 inches above the top of the bonnet, whereas tests of the smaller valve indicated satisfactory operation with a deflection of 0.191 in. Thus, it is claimed that operability of the MSIV has been demonstrated.

The MSIV actuator is Model #OPC-03928-CSVA, fabricated by Greer Hydrualics, Inc. This is a cylindrical, hydraulic actuator which is attached to the valve body by 12 bolts, each 7/8 in. nominal size. Rockwell International, Report No. 2872-01, describes the tests conducted to qualify the actuator. The tests included thermal and operational aging, thermal accident, and a single-frequency, multi-axis test; they indicated satisfactory results. A major question, however, is the qualified life of the actuator which is shown to be 4.5 years at 104°F, or 1.68 years at 120°F due to components made of ethylene propylene. In addition, Grier Hydraulics, Inc. is no longer producing this type of actuator and replacements would have to be made by Rockwell International. TUSI, however, made the assurance to review this matter further and take steps to address this question. Any replacement, however, should be properly qualified in order to insure that the dynamic characteristics of the MSIV is still within satisfactory level. Furthermore, the effect of sudden valve closure upon the dynamics of the MISV as a whole should be addressed since the operator was dynamically tested separately, and the deflection test was done statically.

The MSIV by-pass valve is made by Rockwell International, Model No. 4"-4016 JMMPQTY. It is pipe-mounted and welded in place. It is needed during warm-up of the MSIV and it provides pressure equalization. It is a 4-in. globe valve and weighs about 3630 lb. Including the actuator, its approximate dimensions are 18" L x 17" W x 52" H.

The piping analysis for the system with the by-pass valve was performed using the NASTRAN computer code. As mentioned earlier, the structure was claimed to be rigid since the minimum natural frequency was above 33 Hz. Subsequent calculations indicated a max. critical deflection of 0.0007" at the gland whereas, the allowable deflection to assure functional operability is claimed to be 0.006". Furthermore, the calculated stresses were found to be below the allowable levels.

The operator of the by-pass valve is Model No. VOL-38U PD18860, fabricated by Paul-Monroe Hydraulics, Inc. It is mounted to the valve body by means of 4 bolts, each 3/4 inch nominal size. It is a linear valve operator which weighs about 250 lbs (with oil); its dimensions are approximately 17" L x 15" W x 23" H. This valve operator was qualified by test as described in Report No. PA86384. During the test, the resonance frequency was determined to be over 35 Hz. Seismic aging test was performed with the application of 5 OBE's and one SSE. Also, vibration aging tests were conducted at 0.75 g from 25 to 100 to 25 Hz at 2 octaves per minute and for 90 minutes in each axis. After various tests, it is claimed that there was no visible structural damage and no change in operational performance.

were qualified by testing one switch assembly as described in Report No. RAL-7034/QTR111. This report was originally prepared by NAMCO controls and approved by Gibbs & Hill. No resonances were found below 33 Hz. Environmental aging was performed prior to seismic. In addition, plant-induced vibration aging test wre done for 1/3 x 10^6 cycles at 0.75 g and 100 Hz. After completion of the tests, it was claimed that the switch operated satisfactorily and that there was no cross-coupling.

In conclusion, based on the review of the installation and the available documentation, the equipment is considered qualified except of the following items: a) Measures should be implemented to insure proper surveillance and preventative maintenance on the equipment especially upon the actuators whose qualified life is of major concern, and (b) Impact loading due to sudden valve closure should be addressed.

MAIN STEAM RELIEF VALVE

The main steam relief valve serves to relieve the steam pressure from the main steam line. This is accomplished through a discharge piping system which is connected to a secondary system. These valves are attached to the main steam line at the 877.5" level. Two units, each of which contained 4 valves were located in the Safeguard Building. Unit 1 was inspected during the plant walk down. The documentation for this qualification is FQP-5A-1, dated Sept. 27, 1979, prepared by Fisher Controls Company and reviewed by Gibbs & Hill.

For one of the valves that were inspected it was observed that the two snubbers which were supposed to be placed, had not been properly installed. These two snubbers are to provide additional restraint to the valve from the wall by connecting one end of the snubber to the top operator and the other end to the wall. Upon inspection it was found that one snubber is attached on one side to the top operators of the valve and remained unattached to the wall, while the other snubber (which is supposed to be in the perpendicular direction), was missing.

The 8" by 6" SRV's were qualified by tests performed at the Wyle Laboratory in California. The required acceleration in each direction was obtained from piping analysis performed for the main steam lines. From the tests, the natural frequencies were determined. A resonance search was performed in the frequency range between 1 and 64 cps. This test showed that the lowest predominant modes occur at 26 and 32 CPS in the front/back and side/side directions, respectively. Single frequency, multiple axis tests were performed. The tests demonstrated that the equipment had sufficient functional and structural integrity for 5 OBE and 1 SSE inputs. No malfunction or structural degradation was observed during and after the tests.

Environmental aging was performed on a test specimen prior to the seismic testing. According to the sighted report, it produced no adverse effects on the performance of the specimen.

Based on our review of the documents provided by Gibbs & Hill and findings during the site visit, we conclude that this equipment is satisfactory for seismic and dynamic qualification.

FILTER UNITS

The air conditioning and filter units are used as part of the primary plant exhaust system. Three separate systems were examined. These units include the auxiliary building modular trains, the hydrogen purge modular train and the control room make-up.

The qualification examination covered the electrical components associated with these units. The auxiliary building modular trains are located at the 886'-6" level and at the 873'-6" level. This system is a high efficiency charcoal absorber which is used to filter the radioactive effluent released to the environment to permissible levels during loss of offsite power or following a LOCA. The CPX-VAFUPK-1 & 2 units are located in the Auxiliary Building. They take the surrounding air and send filtered air back up the stack. The hydrogen purge modular trains are used to remove the radio-iodine in the hydrogen purge exhaust following a LOCA. The third system, the filter units for the control room make-up, are used to filter the incoming make-up in the control room. It is used for maintaining the room overpressure and to remove radioactive contaminates from the make-up following a DBA.

The housings associated with these filters are over 26' long rectangular structures. The larger unit is approximately 8 feet by 8 feet accross the cross-section through which the air flows. The other two are about half the size in cros-section.

All of the support housings have been shown to be rigid. This was done by analysis in three other documents. This includes CVI Report No. B558-9931, Seismic Analysis Auxiliary Building Modular Trains, dated November 15, 1977 which I requested.

This was not part of the original documentation that was supplied regarding the electrical components. Following my request, the Report No. B558-9331 was produced. The document did conclude that the structure housing had a high natural frequency.

The qualification document for the electrical components of the filter units are contained in a Test Report entitled, "Nuclear Qualification Program for CVI Incorporated Air Conditioning and Filter Units for Commanche Peak Steam Electric Station Unit Nos. 1 and 2". This is Test Report No. 15928-A which was prepared by Acton Environmental Testing Corporation and is dated Oct. 20, 1981. The report was approved by R. Lamothe of Acton. There is no documented approval as yet by Gibbs & Hill because it is still under review by them.

A test sequence was performed which included the following:

Baseline functional testing.
Radiation.
Aging.
Post aging functional testing.
Seismic.
Post seismic functional testing.
Humidity and post humidity functional testing.

The radiation testing were not actually performed. However, a radiation susceptibility analysis was provided in lieu of testing. An examination of the materials present in the test items showed that levels of 4 x 10^4 rads were not significant with respect to radiation damage. It was concluded that radiation posed no hazard and so was not performed. The radiation evaluation report itself served to document that the equipment will function under radiation.

A "weak link" rationale was used for thermal aging. The time and temperature for accelerated aging of a test unit composed of several materials was determined for that material in the test with the lowest activation energy. This is the approach that was recommended by BNL to the NRC during a meeting in Washington on August 13, 1981. It represents a conservative approach to the problem. The aging times that were calculated included the added 10% margin as required by IEEE 323-1974.

Seismic aging was accomplished with 5 OBE's followed by one SSE, in accordance with IEEE 344-1975. During and after the series of tests previously listed, the electrical components operated without malfunction.

In summary, the electrical components of the Filter Units were tested in accordance with the required environmental and dynamic loadings. No malfunctions were recorded. The equipment functioned as required during and after these loadings.

Open Issues:

The qualification documentation for this equipment was not complete. This is because the package itself is still under review by Gibbs and Hill and so their acceptance has not as yet been given. The acceptance letter from Gibbs and Hill is required before a decision on acceptance of this equipment can be made.

REFRIGERATION COMPRESSOR UNIT

The York R-12 Refrigeration Compressor Units are used for the Control Room air conditioning system. There are four units. All are located at the 854' 4" level. Each unit is about 96" long by 32" wide and about 50" high. A unit weighs about 3600 lbs.

The qualification document is Dynatech R/D Co. Report No. 1727, dated Sept. 11, 1980, entitled, "Seismic Analysis of Refrigeration Compressor Unit". The computer code STARDYNE was used for the finite element determination of the natural frequencies and normal modes. The structure was analyzed for the SSE earthquake using the absolute sum of the response spectra. The acceleration due to gravity was added to the vertical seismic acceleration to account for the seismic displacement.

The refrigeration compressor units are supported by six isolation springs. Flexible sections of piping are used on the piping systems that eminate from the unit. Structural contact between the unit and the surrounding structure is through these springs or flexible connectors. It turns out that there is a small clearance gap that should be maintained between the base of the unit and the structural base. The spring isolation design of the four different units had four different clearance settings. In one unit, the clearance was about 1/4" before contact would be established between the isolation and the solid base. Two of the units had clearances that were not uniform and appeared to be up to 3/8 inch. In the fourth unit, there was no clearance at all and the springs permitted the unit to bottom out and sit directly on the solid base support.

The qualification document discloses that the spring isolation design permits vertical translation of 1/16 inch before contact is made with a resiliant snubber stop. But the use of the STARDYNE computer code is applicable for the analysis of linear systems only. The spring isolated compressor has a strong non-linearity. An assumption is therefore made in the analysis that an impact factor of 2 will be applied to the calculation of the seismic forces.

The analytical results using the program STARDYNE show three mode shapes with frequencies less than 33 Hz. These are all rigid, rocking and translation modes.

When the unit contacts the snubbers, the stiffness values increase, which changes the natural frequencies. The report states that the damping increases along with the increased stiffness from a value of 2% to something between 10 to 17%.

The stiffening effect increases the forces in the unit. The higher natural frequency places the unit near the peak of the response spectra for the linear problem. It is rationalized that the impact factor of 2 should be enough to take care of this effect. In addition, the higher damping should also help.

All of this is highly speculative. The factor of 2 is a maximum factor only for the transient analysis of a linear problem. There is no such limit on the impact factor for a non-linear case. Impact factors much higher than 2 could easily develop. This is especially so in this case where rocking modes are involved. The different clearances for each of the four units and, indeed, around each unit, makes this problem one in which the 1/16 inch snubber clearance may very well be short-circuited by the edge contact due to rocking.

When the unit contacts the snubbers, the vertical stiffness increases. In addition to the stiffness change, the report states that the damping also increases from about 2% to about 10 to 17%. The large increase in damping was presumably obtained by a test of the isolation system in which the maximum magnification at resonance is compared to the level of excitation. This procedure is not acceptable in non-linear systems. The reason is that the magnification is limited not only by the energy dissipated in the system (as in the linear case) but also by the nature of the non-linearity itself. For the same amount of damping, the magnification of a linear system is different from the magnification of a non-linear system. The greater the non-linearity, the greater the reduction of the magnification, even though the damping remains constant. In fact, the measurement of damping in a non-linear system is a very tricky business and has no standard procedure. But linear techniques have to be substantially changed and interpreted if they are to be of any use at all for the non-linear case.

Using the linear assumption, the qualification report shows a table of stress results. The isolation bolt stress is calculated to be 36964 psi compared to an allowable stress of 38776 psi. The proximity of a computed developed stress to the allowable is much too close for comfort for a case in which so many assumptions were made and overall rationalizations developed to show that the comparison is adequate. It is necessary that some of these assumptions (higher damping) cancel other assumptions (limitation of impact by a factor of only 2) if the hoped for margin of safety is to be maintained. All of this must occur even though the clearance gap around the base is different in each of the four units.

What it boils down to is that the York R-12 Refrigeration Compressor Units with its isolated base is a highly complex piece of equipment. As such, it is required that a test be performed to show the functionality of the base with the compressor unit. Analysis alone is not adequate to establish the functional integrity of the unit under environmental and seismic excitation. This is especially so because of the non-linear design of the base and the uncertainties associated with the complexities of its response. This piece of equipment requires that tests be performed to establish that the system will work for the life of the plant or for a shorter period for which a maintenance plan must be established. The dynamic environment that the compressor will see will be considerably changed when the isolation system bottoms out. It is necessary that the test establishes that the isolation system will not age during the period of anticipated use, that it will hold together during the seismic events and that the refrigeration-compressor unit functions as a result of these events.

Open Issues:

A test according to IEEE-344-1975, is required to establish functional capability because of the complexity of the equipment. The equipment should be evaluated for aging effects prior to seismic.

CONTROL PANEL

The control panel is a complex structure which actually consists of three adjacent panels. The field inspection revealed several potential problem areas. These were mainly associated with the manner in which the three separate units were joined together. The top portion of the central panel was connected to the two side panels. A length of angle iron, approximately 5/16" thick, was used for this purpose.

On one of these, the bolt was missing. On all of these connections, it appears as though there is only a small screw, perhaps a #10 or #12 which connects one end of the angle to the panel as compared to a 3/8" bolt which is used to join the two angles. The joint used very different bolt sizes and seemed incompatible. The side clearance between these units varied from zero on one unit to perhaps 3/8". If this gap is traversed during a seismic event, the panels will impact each other and develop high accelerations.

In any case, further investigation was not undertaken since this item was scratched from the agenda. The reason is that the analytical portion of the qualification is still in progress by Gibbs and Hill and was not available at the time of the visit.

Open Issues:

This item could not be reviewed since the analytical report has not been completed. However, the analysis should carefully examine the actual installed joint characteristic between adjacent units and compare this with the assumed condition. The influence of the installed side clearance on the analysis should also be weighed.

MOTORS GENERAL

During the in-plant visit three motors were inspected. These units are included in BOP Item #19 (see SQRT Audit Equipment List). Specifically, these are:

Motor-I: R-12 compressor motor for UPS and Distribution room coolers (Frame 326 TS, Model TADP).

Motor-II: Fan motors for UPS and Distribution. Room coolers (Frame 215T, Model TBDP).

Motor-III: Air compressor motor for UPS and Distribution Room coolers (Frame 143T, Model TBFC).

The horsepower rating of the respective units are:

Motor-I: 50 HP.

Motor-II: 10 HP.

Motor-III: 1 HP.

From the in-service visit, it was found that the model number for some of the motors were different than those shown in the SQRT forms. Moreover, their installation was found to be incomplete. All the motors are made by Westinghouse and are located in the electrical building. Their qualification was performed by analysis, using Westinghouse in-house computer programs.

Westinghouse considers that testing is not necessary for the qualification of these motors. Only analysis was performed in accordance to IEEE-344-1975. In this analysis, the motors are considered as mounted on a base. The analysis provides the stresses at the mounting bolts and Westinghouse claims that this data can be used for the evaluation of the bolts by those who are "responsible for them". The motor units are considered to be rigid (main flexibility is reflected by the shaft-rotor assembly) and are analyzed statically. Stresses and deflections were computed and it was demonstrated that their values are below the allowables. The seismic disturbance is considered to have small effect on the stator winding as compared to the electromagnetic forces. Thus, the stator winding is not seismically analyzed.

In terms of aging, it was determined that the primary effect of radiation on the hardware, castings and shaft steel would be Gamma radiation heating. However, the magnitude of this heating was found to be low enough so that it will not affect the components. With respect to the life of the bearings, Westinghouse calculated that the life of the bearings would exceed 40 years of continuous duty.

Generally speaking, from the review of these motors, it was concluded that the specification regarding aging according to IEEE-323-1974 were not fully taken into account. Westinghouse claimed that there is an on going program on aging which should answer questions pertaining to the motors. Some reports related to this Westinghouse effort were indeed presented at the SQRT review meetings. It is hoped that BNL will have a chance to review the aging work being carried by Westinghouse, in much greater detail.

From the inspection, it was concluded that the in-service installation of these motors were incomplete. In addition, from discussion at the audit, it was determined that these motors are safety related and therefore analysis alone is not adequate for demonstrating their functional qualification. Based on these observations these motors are not qualified.

ELECTRONIC TRANSMITTERS

The Rosemount Electronic Transmitters are electro-mechanical devices which are used to monitor pressure or flow. There are fifty-five such transmitters in Unit 1. They are installed at various places in the plant from an elevation of 750 feet to a elevation of 873 feet. Six of these units which were installed at levels from 773 feet to 835 feet were examined.

The transmitters are contained in a rectangular box-like chassis which measures 4-1/2" x 4-1/2" x 9". They each weigh about 13 pounds. They are mounted by four 5/16 inch bolts in rigid frames or to wall supports.

The test was performed by the Wyle Laboratory. The results are outlined in Wyle Report No. 45353-1. The maximum response spectrum was used to qualify the equipment by test (the TRS exceeded the maximum RRS). Simultaneous bi-axial multi-frequency random excitation was imposed in the horizontal and vertical direction for a duration of 30 seconds. Five OBE's followed by one SSE were performed. A total of eleven transmitters were tested.

This safety related equipment is used in many locations both inside and outside the containment and so has been qualified in accordance with IEEE 323-1974. Aging techniques were applied to simulate a period of 10 years.

The qualification document shows that there was a very real attempt to define the aging process for a 10 year period and to relate this to the failure mechanism of the equipment. In all, the procedures outlined in IEEE 323-1974 were followed. The report is entitled, "Qualification Report for Pressure Transmitters Rosemount Model 1153, Series B". It was accepted on March 27, 1981 by Robert E. Ballard, Project Manager for Gibbs & Hill.

Detailed aging requirements and procedures have not currently been established. There is no generally accepted accelerated conditioning methodology available which will, without question of validity, put a specific assembly of parts in the precise state of age of some future time had the equipment been operated in a real time frame for the age under consideration.

Accordingly, the following report includes some of the details of the tests that were adopted at Rosemount to qualify their transmitters. It looks like an earnest effort at aging qualification.

According to the Rosemount document, the determination of a rational test procedure started with the evaluation of failure mechanisms. Failure mechanisms which could result in the degradation of transmitter performance were defined. This includes the electronic housing, the sensor module, the pressure retaining hardware and the electronic components. A table of failure mechanisms summarizes the sixteen that were identified.

"Imminent Failure Modes" were examined separately for each of the four major sub-assemblies of the system. The aging mechanism which could cause that failure mode were then identified and listed in a table of stress factors which attempt to quantify the degree of the effect on the failure mode. The documents state that the stress factor ranking is based partly on the results of four years of developmental testing of pressure transmitters for the nemonstrate their post
accident functioning capability. This was done by thermal aging for an additional 4.7 days at an external ambient temperature of 123°C.

failures and the stress factors which could trigger these mechanisms.

The list of stress factors shows that some accelerated aging techniques involve more than one stress factor. The procedure used was to determine that all stress factors were applied at least during one test sequence. After assuring that all stress factors were simulated, the series application of the tests for the stress factors, which have only minor or moderate effects, also covered combination of the same stress factors with relatively large effect.

High stress factors were examined separately where they were correlated in a table of aging mechanisms. A program to simulate a 10 year qualified life was established in accordance with IEEE 323 1974. A 10% margin was then added.

The following tests were considered:

Temperature cycling - environmental
Pressure, external ambient
Relative humidity
Radiation
Vibration, environmental
Chemical reagents
Power on/off.

Prior experience with the Rosemount Pressure Transmitter showed that the integrated circuits were particulary sensitive to environmental exposure. The use of the Arhenus equation showed that a accelerated aging period of 38 days at a temperature of 254°F would be required to simulate the 10 year period.

It is shown that using the aging parameters for the integrated circuits significantly overage t e transformers, t wire, the o-rings, the solder joints and other components.

Aging tests were therefore selected at 125°C for 38 days to simulate 10 years. The temperature of 125°C was used because most electronic components have this value as their upper temperature rating. A margin of 10% is required by IEEE 323 1974. An additional 10% was added on top of the required 10% for added conservatism. The final accelerated aging time was determined to be 47 days at 123°C.

Following the accident testing sequence, the transmitters were aged for a real time period of 1 year beyond the 10 years to demonstrate their post accident functioning capability. This was done by thermal aging for an additional 4.7 days at an external ambient temperature of 123°C.

In summary, the equipment was aged for a 10 year period according to the requirements of IEEE 323-1974 and IEEE-344-1975. The equipment performed as required without compromise of structural integrity or functional performance and is capable of withstanding the seismic load defined at the most severe location.

Open Issues:

None.

Control Rod Drive Mechanisms (CRDM)
(Model No. L106 - A)

The control rod drive mechanisms are very large complex pieces of equipment located on the top of the Reactor Pressure Vessel at an elevation of 860' inside the Containment Building. The equipment is approximately 30' high in structure and has a diameter as big as the reactor vessel. It is directly mounted to the RPV cap by fifty-four 7" diameter bolts. Additionally six struts are provided at the top of the unit for seismic restraint. An overhead platform structure on two rails is provided at the top to serve as a missile shield for the unit. It is manufactured by Westinghouse-Electro Mechanical Division. It is designed as per the Specification E-Spec 677470, Rev. 2 and Rev. 4.

The CRDM is a magnetically operated jack. An arrangement of three magnets which are energized in a controlled sequence by a power cycler enables the withdrawal or insertion of the control rods in discrete steps. In older designs, four Capped Latch Housings (CLH) were provided in the CRDM design. In this particular model these do not exist. The basic function of this equipment is important to control the nuclear reaction in the reactor pressure vessel and hence is used to shutdown the plant in the event of an accident.

The equipment is designed as a generic item and the detailed calculations are reported in the Westinghouse report, "Stress and Thermal Report of Type L106A and L106B CRDM", S.O. M308, M309, M313, M314, January 31, 1974 Engineering Memorandum No. 4531, Rev. 2, 4-12-76. The report refers to the drawing 618J796 which does not match with those reported in SQRT forms. The computer code FEAAS-6 was used for individual assembly stress calculations. It is designed according to the ASME Section III through Winter 71 Addendum for structural integrity. However, the operability during normal or accident condition was not demonstrated in this report.

The plant specific design documentations were not available during the site audit and hence, no conclusions can be drawn regarding the design adequacy of this equipment.

The CRDM has 53 separate control rods and requires air-conditioning for proper functions. However, according to Westinghouse it could operate without air flow for a considerable amount of time (i.e., 8-10 hrs.). Thus, the HVAC unit on the top of the platform above the CRDM is classified to be non-seismic under the Gibbs & Hill scope. A report entitled "Seismic Qualification Report of CRDM Ventilation System Duct Work and Supports for CPSES", Corporate Consulting & Development Co. Report # A-476-82, 6-25-82 was reviewed during the audit and was found to be satisfactory for the site specific loads.

There exist some other issues which were raised during the site audit. They include (1) the use of higher damping for SSE without any justification for larger stress level, (2) nonlinear analysis of square plates with gaps at the top of the CRDM and the wire ties used to support cables from each control rod, (3) the calcuation of fundamental frequency for the insertion and withdrawal position of control rods and their effects on the seismic qualification, (4) demonstration of safe drop of control rods by testing during the seismic condition, (5) as mentioned previously, site specific seismic qualification documentation is also required.

Thus, the qualification of this equipment requires future resolution of the above first four issues and the review of the site specific design documentations.

Letdown Heat Exchanger

The Letdown Heat Exchanger is used to cool the letdown flow before admitting it to the chemical volume control system. It is a large horizontal cylindrical vessel which is 17'7" long and 22" diameter. It weighs 7650 lbs.

The qualification document is "Seismic Analysis of Horizontal Letdown Heat Exchanger "WNES P. O. #546-AA2-215350-BMP OAT Job # 2268-1 written by Dr. Alan I. Soler and dated May 28, 1975.

Document TM-130, Supplement to Rev. 1 dated 2/18/76 replied to questions that were asked by Westinghouse. The qualification document was approved by J.J. Urbanshi on 3/24/76.

The qualification is by analysis in which a conservative approach is taken by adding absolutely the maximum reaction effects for each load case on each nozzle. All simultaneous combinations of horizontal and vertical loadings are considered.

The analysis for the natural frequency was done using a finite element Westinghouse code called WECAN. The results show that the natural frequency is high. The original qualification was done in two dimensions. Then, using the code WCAP-8230, entitled "Application of Multi-Directional Seismic Input in the Design of Components", requalified for 3D loading floor response spectrum.

Using this procedure, checks were made to examine the stresses for the design loadings. It was then determined if the increased loadings are acceptable under the 3D requirement. If the faulted condition stresses were compared to either upset or normal allowables and found to be acceptable, no analysis was done and the equipment was accepted as qualified. A comparison of the requalified 3-D loads show that the 2-D design loads are acceptable.

In summary, the Letdown Heat Exchanger was analyzed to determine the worst combination of seismic and nozzle loading. The local stresses in the critical areas were less than the allowables under faulted loading conditions. The equipment would therefore normally be qualified for the dynamic loadings imposed.

There are two aspects that should be checked. The first has to do with the acceptability of the procedure for comparing 2-D generated results with a 3-D requirement. This is contained in WCAP-8230 and should be examined. The second has to do with an observation of two secondary pipe lines that go into the equipment. This refers to 2 parallel vertically extending 1"D pipe lines which come off the end of the heat exchanger. Each has a valve in the line. This system has only a vertically extending support with no horizontal support. There is no indication that a horizontal support is anticipated. But by local excitation, it appears as though the "as-is" natural frequency is in the exciting spectrum. After investigation, I understand that the support analysis for this portion of the system is not complete as yet.

The qualification acceptance of the documentation of this equipment anticipates a satisfactory resolution of both of these problems.

It should be noted that the second item, the piping support analysis, is similar to the request that was made regarding Item NSSS # 29, the Accumulator, at the time of the field inspection, it was observed that the installation had a 3" pipe about 25' long that went from the bottom of the accumulator to the top. There were valves in the line and there was no external indication of any planned supports. Local excitation showed that the natural frequency was in the region of the excitation spectrum. In this case, a piping analysis which was not part of the qualification documentation was located by Don Woodlan of TUSI. The drawing shows that there are plans to install 3 intermediate pipng supports. This is DWG., GHH-SI-RB-1-048 and so the question was satisfactorily resolved.

Open Issues:

1. Produce documentation to show tht the 1"D piping off the end of the heat exchanger is qualified for the dynamic environment.

2. A review of WCAP-8230 should be done, as mentioned in the generic issues.

Centrifugal Charging Pump

Model No. 2-1/2 RLIJ

The assembly which consists of a pump, gear drive and motor, was inspected during the plant visit. It is located in the auxiliary building at an elevation of 810'. During the inspection it was observed that some of the snubbers for the piping surrounding this equipment were missing. Also, other temporary supports were found. Furthermore, the casing of the gear drive was found loose and some U-bolts on the assembly not bolted down. Another unit located near the inspected unit also in the auxiliary building was found to be in a better shape.

The assembly of pump-gear-motor is mounted to the floor with sixteen 1 inch diameter bolts. The in-service mounting described in the SQRT form to the floor was verified. The set of qualifiction documents given in SQRT form pertaining to this assembly were reviewed during the in plant visit. Essentially, analytical methods were used for the seismic qualification. Natural frequencies were found to be higher than 35 Hz, and thus a static analysis was performed. The resulting stresses at critical parts of the equipment were found to be below the allowables. The maximum deflection of the motor rotor was calculated to be much less than the allowable required for functional operability. The qualification of the motor was carried out by Westinghouse ("Seismic Analysis of Centrifugal Charging/Safety Injection Pump Motors for Commanche Peak Nuclear Station" by WH). The corresponding RRS from the in-structure response spectra of the auxiliary building are lower than the generic Westinghouse acceleration levels. Sequential testing including aging was not addressed. Westinghouse representatives claimed that there is an ongoing large test program with this subject. Particular concerns of the SQRT Review Team, specifically for sequential testing of the motor of the charging pump were not satisfied. The subject of sequential testing was addressed as a generic concern at the exit meeting of the review.

The entire assembly of pump-gear drive-motor was not tested. No sufficient evidence was presented if all dynamic loads pertaining to this equipment were considered for the qualification. Moreover, aging effects were not taken into consideration. Based on the information obtained during the SQRT review, this equipment assembly is required for both hot standby and cold shutdown. However, no adequate justification is given that the equipment will perform its functions under all required conditions. Although calculations were presented for individual components, such conclusion cannot establish the overall safety function of the entire assembly. Furthermore, the installation has not as yet been completed.

Based on the above, this equipment is considered as not qualified.

ECCS Accumulator

The Accumulator is a vertical pressure vessel which provides cooling water for cases involving primary system depressurization. The qualification reports for this equipment are BTI-PJ-75015, Rev. 1, dated April 30, 1975, and BTI-76057 dated June 4, 1976. Both were prepared by Basic Technology, Inc. and reviewed by Westinghouse.

The two accumulators investigated are 253" high with diameters of 138". They are located in the Reactor Building. One at the 832.5' level and the other at the 842.5' level.

One pipe connected to the Accumulator is raised up and attached to the wall by a snubber. Upon inspection it was found that the snubber was not completely installed.

Contrary to what was reported in the SQRT form, the Accumulator was found to be qualified by dynamic analysis only. A summary dynamic analysis shown during the site visit by the Westinghouse representative was used to qualify the Accumulator. This summary contained only 2 pages of brief information giving results from Westinghouse's Computer Program WECAN, which was used to obtain natural frequencies and to perfrom the dynamic analysis on the equipment. It is felt that some further explanations with regard to the way WECAN was used and especially how the accumulator was modeled should be provided.

Prior to making a dynamic analysis, an equivalent static analysis was performed. The justification for this according to Westinghouse was that only one resonant frequency (i.e., 22 cps) was below the 33 hz limit. The "g" value used in this analysis was large enough to cover the magnitude of RRS corresponding to this frequency, including broadening effect uncertainties. These results are given in (report BTI-PJ-75015) which was prepared by Basic

Technology. During the audit, Westinghouse requested that these results be considered as preliminary and that only the dynamic analysis results be considered.

The RRS used in the analysis is for the level at 832.5' only. RRS at 842.5' level is not used. Upon examination, it was found that a lot of difference exist between these two spectra.

Simplified two-dimensional analysis was used throughout the report. The justification for using two dimensional analysis to represent a 3-D system is explained in WCAP-8230. This report is a general report and may not be specifically applicable for many different cases.

Based on the review of the documents provided by Westinghouse, the folowing items still remain open:

1) The verification of the computer program WECAN.

2) The verification of the document WCAP-8230.

3) Justification that the RRS at 832.5' envelope the RRS at 842.5'.

Residual Heat Removal Pump

1. Pump

The RHR pump inspected is located in the safeguards building at an elevation 773.5'. It is a single stage centifugal pump. The pump-motor system is oriented in the vertical direction and is bolted to a pedestal which in turn is attached to the floor. During the inspection some temporary supports were found. The pump was qualified by analysis. The qualification g-levels (2.1 g in all directions) were obtained by a Westinghouse procedure which converts 2D input levels to 3D levels. The ZPA levels of RRS used for the seismic qualification compare favorably with those of the in-structure spectra obtained for the safeguards building of the plant. The pertinent qualification report is:

> "Structural Integrity and Operability Analysis of RHR Pump", ME-174", prepared by the McDonald Engineering Analysis Company (date 10/9/79).

According to the applicant, the report was approved by the Nuclear Pump Design Division of Ingersall Rand. According to the report, it was found that the natural frequencies of the pump are in the rigid range and thus a static analysis was selected for its qualification. A stick model of the equipment was analyzed by the ICES-STRUDL computer code. Also for internal pressure evaluations the NASTRAN program was employed. Based on stress and deflection evaluations and their comparison with the allowables it was shown that the RHR pump satisfies structural integrity and operability requirements.

2. Motor

The main qualification document for the motor drive is report # M010101. This report, dated July 30, 1982, was prepared and approved by Westinghouse. This report attempts to show that the motor is qualified by analysis alone. The seismic load qualification levels for SSE was 2.1 g in each of the three orthogonal directions. These levels, however, are based upon a Westinghouse report, WCAP-8230, which uses a 2-dimensional analysis to represent a 3-dimensional system. Since WCAP-8230 has not been fully reviewed and validated by NRC, the seismic input loads used in the analysis to qualify the motor drive are inconclusive.

Assuming that WCAP-8230 is valid, a review of report #M010101 still showed a few mistakes and discrepancies in terms of signs and calculations. These were discussed with Westinghouse who gave assurances that they would be corrected. It should be noted, that the report was in handwritten form and apparently prepared only a short time before the audit.

An analytical attempt to show that the motor will still operate during a seismic event has been included in report # M010101. This is done by calculating the maximum deflection of rotor(by hand and using the WECAN Code) and then showing that this maximum critical deflection is below the allowable rotor-stator clearance. Sequential testing, including aging, has not been addressed, however. Since this is a complex composite electrical equipment consisting of non-metallic and metallic components it is felt that it is difficult to demonstrate functional capability without environment and subsequent seismic testing.

In summary, the following open items remain to be resolved before this equipment is considered qualified:

Pump:

a) Clarify how additional dynamic loads were included.
b) All temporary supports must be replaced with those required by the design.

Motor:

a) Provide evidence that methodology described in WCAP-8230 is valid.
b) For functional integrity, the motor should be subsequentially tested for environmental and dynamic loads.

24 Inch Motor Operated Butterfly Valve
(1 HV-4512)

This valve is one of three additional pieces of equipment selected at the plant site (as Surprise items) in order to evaluate the completeness of the qualification procedure employed by the applicant. From the equipment list it was later discovered that the documentation was incomplete and no SQRT forms were available.

During the site inspection, two of these units were visited. These were mounted to the component cooling system. The information regarding the number of such units, its service function, sizes, and other details were not available. The valve has a Limitorque Motor Operator and is located in the Auxiliary Building at an elevation of 823'-0". The valve body was full penetration weld mounted to the 24" pipe and the operator assembly was flange connected to the valve. During the inspection, several nuts were found to be loose. One seal to a chamber for electrical control connections of the operator were not properly closed. Some temporary supports for other piping systems were installed in the vicinity of this equipment. However, a QA/QC tag was marked and attached to the equipment. Later verification of the QA/QC tag revealed no such problems as mentioned in the QA check. It should be noted that the above kind of problems would be very difficult to notice unless somebody climbs up to the valve and inspects the equipment carefully.

The report qualifying this equipment is entitled "Seismic and Environmental Qualification for Butterfly Valves", Volume II, October 18, 1979. It is prepared by Fisher Controls Co. The design of the valve is based on the GH Specification 2323-MS-600. The fundamental frequency of the valve with SMB/15-TT3BC type of operator was found to be 44 Hz. The report contains a Wyle Report # 43431-1 called "Seismic Simulation Test Program on Four Valves" dated April 20, 1977. This report refers to the seismic test including a packing leakage test for checking the seals. It was later retested and the results documented in the Wyle Report # 43966-1, dated May 10, 1978. The equipment passed through the tests without any problems.

The test program consisted of resonant search testing and single frequency (sine load) testing in each of the two test orientations. The specimens were tested for leakage, prior and after the simulated seismic excitations.

The Limitorque Motor Operator, on the other hand, was qualified by generic testing which includes the environmental followed by seismic tests. The main report describing the test procedure and findings is identified as Report # B0058 dated January 11, 1980.

The qualification of this equipment is subjected to the completion of proper installation of electrical control chamber seal plate on the operator as mentioned in this report. In addition, the valve design g-values should be further verified for the as-built piping analysis g-loads since this is required for all pipe-mounted equipment.

Electric Hydrogen Recombiner

This equipment is another "surprise item" which was selected for review during the in-plant visit. Although the aplicant's submittal to NRC showed this item to be fully qualified and installed, it was actually in the site warehouse, and it could not be physically examined. While, some aspects pertaining to the qualification of the recombiner were explained during the SQRT audit, it is felt an additional review of this equipment needs to be done. Some of the pertinent findings regarding the recombiner are:

1 - No comparison was given between site specific RRS and the TRS used for qualification. The vertical spectra are of particular concern.

2 - The test plan presented did not show the mounting arrangements.

3 - The damping values of TRS and RRS are different. Specifically the TRS corresponds to 5% damping whereas the RRS is for 4% damping.

4 - The bolt sizes to be installed were left to be chosen by the installer.

5 - The sequence of qualification testing was not clear, and it was not clear as to how its ability to recombine hydrogen with available oxygen was verified following the seismic and accident condition testing.

Based on the above items and until the in-service installation is completed, no conclusion can be reached with regards to the qualification of the recombiner.

Nuclear Instrumentation System (NIS)

This equipment was selected for inspection during the visit at the plant as a "surprise item". In carrying out the walk down inspection for the equipment, it was found that the installation was incomplete. Essentially, the cabinet was empty and it was obvious that the majority of the electrical components had as yet to be installed into the cabinet. The latter is shop connected to a mounting channel and field bolted on the floor of the Control Room at elevation 830'. Electrical wires were not even connected to the few items already located inside the cabinet.

The NIS is a class 1E electrical unit manufactured by Westinghouse. In the SQRT form given to the review team by Westinghouse representatives (hand written) it is specified that the equipment is available for inspection. Details pertaining to the seismic qualification of the NIS were discussed with Westinghouse representative James Parello. A synopsis of the seismic qualification procedure was presented to the SQRT review team. From this discussion, it was concluded that the natural frequencies of this equipment were obtained by lab test. The resonant frequencies are:

5.0 Hz	S/S
7.7 Hz	F/B
> 33 Hz	V

For the seismic qualification, a single-axis test was performed. Westinghouse claimed that a single-axis test is appropriate for the NIS. A sine-beat waveform was applied in each of the principal axes. A two-bay cabinet was first tested. Subsequently, a multi-frequency test was performed on a one-bay cabinet. During the high-level test the drawer latch mechanisms repeatedly failed. This resulted in a modification of the drawer lock designs. These units were probably installed in other Westinghouse plants and it's our opinion that it would be prudent to check what (if any) modifications were carried out for similar equipment in these plants.

With regards to the possible aging effects on the electrical components of the NIS, Westinghouse stated that IEEE-323-1974 standards were followed in all testing procedures.

Based on the in-service inspection and the discussions with Westinghouse representative, it is concluded that this equipment is qualified provided that its installation will be properly completed.

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

PDR

Lee

12/20/82

50-454

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 and Mary Haughey
Equipment Qualification Branch
Division of Engineering

SUBJECT: TRIP REPORT FOR SEISMIC CRITERIA IMPLEMENTATION REVIEW MEETING WITH COMMONWEALTH EDISON COMPANY (CECO) ON BYRON NUCLEAR PLANTS

The Seismic Qualification Review Team (SQRT), consisting of staff from Equipment Qualification Branch (EQB), and from Brookhaven National Laboratory (BNL), the consultant, conducted a plant site audit at Byron 1 Nuclear Station on September 13 to September 17, 1982. The purpose of the audit is two-fold: (1) to perform a plant site review of the seismic and dynamic qualification methods, procedures, and results for selected safety-related mechanical and electrical equipment and their supporting structures, (2) to observe the field installation of the equipment in order to verify and validate equipment modeling employed in the qualification program.

The background, review procedures, findings and the required follow-up actions are summarized below. A list of attendees at the conference is contained in Attachment I, and a list of the equipment selected for audit is shown in Attachment II.

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I. Background

The applicant has described the equipment qualification program in Sections 3.9 and 3.10 of the Final Safety Analysis Report, consisting of dynamic testing and analysis, used to confirm the ability of seismic Category I mechanical and electrical (includes instrumentation, control and electrical) equipment and their supports, to function properly during and after the safe shutdown earthquake (SSE) specified for the plant.

The plant site review was performed to determine the extent to which the qualification of equipment, as installed in Byron 1, meets the current licensing criteria described in IEEE 344-1975, "Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations," and Regulatory Guides 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis," 1.100, "Seismic Qualification of Electrical Equipment for Nuclear Power Plants," and the Standard Review Plan (NUREG-0800) Section 3.10. Conformance with these criteria is required to satisfy the applicable portions of the General Design Criteria in 1, 2, 4, 14, 18 and 30 of Appendix A to 10 CFR Part 50, as well as, Appendix B to 10 CFR Part 50 and Appendix A to 10 CFR Part 100.

Seismic Category I structures of Byron Station were originally designed using reduced seismic input motion derived from a deconvolution analysis. Because of the shallow overburden on the bedrock and a significant dip displaying over a large frequency range in foundation level response spectra, such input motion was not acceptable to the staff (See SER Section 3.7.1). As a result of a series of meetings, including a telephone conference on June, 1982 with Commonwealth Edison Company, an agreement was reached which required that the adequacy of the safety-related equipment needed for safe shutdown of the plant be reassessed using the design response spectra of the Marble Hill Nuclear Plant. The latter were developed in accordance with the current staff requirements and were acceptable to the staff. In other words, for equipment in the safe shutdown system, the Marble Hill response spectra instead of the original design spectra are considered as licensing basis spectra. The applicant had been requested to provide for each piece of such equipment a summary statement describing the reassessment, as well as the corresponding Marble Hill spectra used. Such information should be documented and filed with the remainder of the qualification documentation package for the site audit.

II. Review Procedures

Prior to the site visit, the SQRT reviewed the equipment seismic qualification information contained in the pertinent FSAR sections and the reports referenced therein. A representative sample of safety-related mechanical and electrical equipment, including 11 in NSSS and 14 in BOP scopes as shown in Attachment II, were selected for the plant site review. 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 the equipment qualification. An exit conference was held to summarize and conclude the plant site visit.

III. Review Endings

In general, the site audit revealed that the applicant's seismic and dynamic equipment qualification program had not progressed sufficiently for the staff to judge the Byron 1 equipment qualification program to be acceptable. The audit has therefore been termed inconclusive.

Based on our review of the selected equipment, the areas of deficiencies, of both generic and equipment specific natures, were identified to the applicant during the audit as well as in the exit conference on September 17, 1982. These are summarized in Attachment III, the BNL evaluation report.

IV. Follow-up Actions

The applicant should be committed to improve his equipment qualification program and correct all the deficiencies as identified in Section III. The results should be submitted for the staff review and, at that time, the schedule for a second plant site audit will then be determined.

V. Conclusion

Based on the result of the audit, we conclude that the extent of completion of the applicant's qualification program to be insufficient for SQRT to draw any conclusions with regard to the acceptability of all the safety-related equipment. As we have informed the applicant in the exit conference, the review team will conduct a second audit, the level of which has not yet been determined, when the program is near completion.

Arnold Lee
Equipment Qualification Branch
Division of Engineering

Enclosure: As stated

cc: R. Vollmer
W. Johnston
T. Novak
B. J. Youngblood
L. Olshan
T. Y. Chang
R. Wright
D. Reiff
J. Jackson
J. Singh, INEL
M. Subudhi, BNL
B. Miller, BNL
M. Haughey
A. Lee

Attachment I

Attendance List
Byron Plant Site Audit

Exit Conference (9/17/82)

NRC

A. Lee
M. Haughey
D. Reiff
K. Kiper

CECO

T. Tramm
K. Ainger
J. Westermeier

Brookhaven

R. Alforgue
R. Hoder
M. Subudhi
M. Chang
P. Turtzo

S & L

K. Adlon
K. Green
J. Mattingly
R. Raheja
G. K. Roy
D. Thorpe

Westinghouse

J. Mc Inerny
C. Draughon
L. Walker

Attachment II

Byron SQRT Audit (9/13-9/17/82) Equipment List

BOP Equipment

	1.	Electrical Penetration Assemblies (1AP84EA-EC)
	2.	Switchgear (1AP74E)
**	3.	Fuse Panel (1DC10J)
**	4.	Level Switch Vendor Model (#A103F)
	5.	New Fuel Racks (0FH01 GA, B, C)
	6.	Hydrogen Recombiner (00G08SA, B)
	7.	Motor Operated Globe Valve - AF (1AF013A-H)
	8.	Motor Operated Gate Valve - CS (1CS009A, B)
+	9.	Compressed Air Operated Gate Valve - MS (1MS001A-D)
+	10.	Motor Operated Butterfly Valve - SX(1SX027A, B)
**	11.	Auxiliary Feedwater Pump (1AF01PA, PB)
+**	12.	Essential Service Water Pump (1SX01PA, PB)
*	13.	Hydrogen Recombiner Control Panel (00G04J & 6J)
*	14.	Diesel Generator Governor

NSSS Equipment

	15.	Containment Pressure Transmitter (Report ID.ESE-4)
	16.	DAM Indicators (Report ID.ESE-14)
**	17.	Main Control Board (Report ID.J)
**	18.	CRDM (Report ID.J)
**	19.	RCS Fast Response RTD's (Report ID.ESE-7)
**	20.	Valve Limit Switches (Report ID.HE-3)
**	21.	Motor Operated Gate Valve - RH(1RH8701A, B)
**	22.	Motor Operated Gate Valve - CC (1CC9414)
**	23.	RHR Pump (1RH01,PA, PB)
+	24.	Safety Injection Pump (1SI01PA, PB)
+*	25.	Air Operated Valve - RCS(1RY8028)

* Surprise items selected at site on 9/13/82
\+ Pumps & Valves common to PVORT audit items
** Items require M. Hill reassessment

Electrical Penetration Assemblies
(1AP84EA-EC)

During the plant site installation inspection it was found that the original selection of this equipment was made for the Unit 2 Reactor Building instead of Unit 1, which should have been the case. The Unit 1 Electrical Penetration Assembly (EPA) was, then, inspected during the audit. Although both reactor units are equipped with this equipment which in turn serve similar functions, they are manufactured by different companies. The Unit 2 EPA is manufactured by the Bunker Remo, whereas Unit 1 EPA is made by Conax Corporation.

One of the units is installed in the containment wall pressure barrier in order to provide means for the continuity in power control and signal circuits while maintaining integrity of the barrier. The EPA unit is mounted to the 18" sleeve which is anchored to the wall via 16 1-1/3" bolts. Electrical cables run through the length of the sleeve from the inside plate to the outside plate. It is located at an elevation of 419'-0" and is designed as per the Sargent and Lundy Specification F/L-2804-01, Amendment 4.

The installation of the equipment was found to be complete. However, the instrumentation lines which were designed to supply nitrogen gas to the EPA from the supply bottles, were not completely supported. Although, maintaining a nitrogen environment inside the equipment is necessary, these lines were categorized to be non-seismic. One compressor unit used to pump nitrogen from the bottles which were also not properly supported, was found to be properly installed for seismic loadings.

The following supporting documents were reviewed for the design of this equipment.

(1) "Seismic Analysis of Electrical Penetration Assemblies for Byron/Braidwood Stations", Conax Corp., No. IPS-368, Rev. B, 5/12/80.
(2) "Stress Report for Electrical Penetration Assemblies for Byron/Braidwood Stations", Conax Corp., IPS-367, Rev. C, 5/1/80.

These reports were not available to us for review until the end of the audit because the original equipment selection was referred to the reactor Unit 2 equipment as mentioned earlier. Although in the equipment list it was marked complete, the SQRT forms were completed only after our request for the Unit 1 item.

The qualification reports of this equipment were made by analysis using simplified equations. No aging or testing reports were available for review. After questioning the responsible engineer from Sargent and Lundy, we were told that although such documents describing the environmental aging and qualification testing existed, however, they could not be available at the time of audit.

Based on our review of the analytical reports and field installation, the following items remain as open issues:

(1) The report describing the environmental aging and qualification testings need to be reviewed.
(2) Categorization of the Nitrogen Supply System as non-seismic needs to be explained.

6900 V Switchgear

This switchgear assembly functions to control the off-and-on activities of the pumps and transformers. There are two transformer switchgears and three pump switchgears in one assembly unit. Each unit contains six cubicles. The dimensions of each cubicle is 96" deep, 36" wide and 90-3/8" high. Wiring and electrical components are enclosed in the cubicles whereas manual operated parts pertaining to the gears are placed outside of the cubicles.

The main qualification report for this equipment is entitled "Qualification Report on Class 1E Nuclear Safety Related Switchgear" No. IN-11252-Y1, dated November 1981. This report was prepared by Westinghouse and reviewed by Sargent and Lundy. This switchgear was designed according to Sargent and Lundy specification, F/L-2737-01. The cabinets are plug welded to 1/2 ft steel strips located on their bottom surfaces. These 1/2 ft steel strips are subsequently anchored to the floor via bolts (the type of bolt was not clarified during the visit). There are also bolts connecting the various cubicles to each other in order to ensure the integrity of the assembly. The size and number of these bolts also are not known.

The particular switchgear reviewed during the site visit was located in the Auxiliary Building at an elevation of 451 ft. It is to be noted that the SQRT form shows it to be at the 450 ft elevation. Usually this type of inaccuracy would not be noted. However, since this was not the only incidence of inaccuracy for this plant we make note of it.

The discussion of the seismic qualification report is not focused directly on the model (6900 V) under investigation. Instead a generic model (7500 V) of different size (108" wide, 104" deep, 116.4" high) is used. The dynamic similarity between the present model and the generic model were studied by comparing mode shapes and natural frequencies for the 7600 V model with those obtained analytically for the 6900 V model. Similar mode shapes were found. Also the corresponding natural frequencies between the two models were quite close. Furthermore, since the analytical natural frequencies were lower than the test frequ. ıcies for the generic model and were closer to the peak of the input spectrum, it is claimed that the response to this peak input for the generic model will be higher and thus more conservative.

No Radiation Aging or Temperature Aging was conducted because the Switchgear is considered to be located in a mild environment.

Based on the findings made as a result of the review, the equipment is deemed acceptable for the Byron Plant. Generic issued pertaining to documentation however, still need to be resolved.

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

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(516) 282
FTS 666 2429

November 17, 1982

Mr. Vince Noonan, Chief
Equipment Qualification Branch
MS P-1030
Phillips Building
7920 Norfolk Avenue
Bethesda, MD 20014

Dear Mr. Noonan:

Enclosed please find our summary reports for the twenty-five pieces of equipment items that were reviewed by BNL during the SQRT audit carried out for the Byron Nuclear Power Station in Illinois during the week of September 13-17, 1982.

As noted in the specific reviews of the equipment items, some open issues still remain to be resolved at a future date. We are of course prepared to evaluate responses to these open issues as soon as they become available to us.

Sincerely,

M. Subudhi, Group Leader
Qualification Analysis Group

jm
Enc.
cc: G. Bagchi
A. Lee ✓

Attachment III

Byron Nuclear Power Station - Unit 1
Plant Visit
Documentation Review
Introduction and Summary

The seismic qualification audit of the Byron Nuclear Power Station Unit 1 was conducted during the week of September 13 - September 17, 1982. The Brookhaven National Laboratory (BNL) Review Team was composed of M. Subudhi, M. T. Chang and R. Alforque of the Structural Analysis Division. The results and findings of the review conducted by the BNL Review Team are contained in this report.

Several weeks before the actual plant visit, the owner-utility, Commonwealth Edison, was given notice of the specific equipment to be audited. There were 12 Balance-of-Plant (BOP) and 10 Nuclear Steam Supply System (NSSS) pieces of equipment selected by the Seismic Qualification Review Team (SQRT). Commonwealth Edison was informed that the selected equipment would be audited to verify completeness of seismic and dynamic qualification documentation and installation. During the actual audit, 1 NSSS, and 2 BOP pieces of equipment were added to the original equipment list. These additional pieces of equipment represent unscheduled or "surprise" items for review and are intended to help the SQRT reach a fair extrapolated judgement as to the qualification status of the entire plant.

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

Balance-of-Plant (BOP)

1. Electrical Penetration Assemblies
2. Switchgear
3. Fuse Panel
4. Level Switch Vendor Model
5. New Fuel Racks
6. Hydrogen Recombiner
7. Motor Operated Globe Valve

8. Motor Operated Gate Valve
9. Main Steam Isolation Valve and Actuator
10. Motor Operated Butterfly Valve
11. Auxiliary Feedwater Pump
12. Essential Service Water Pump
13. Hydrogen Recombiner Control Panel
14. Diesel Generator Governor

NSSS Equipment

15. Containment Pressure Transmitter
16. DAM Indicators
17. Main Control Board
18. CRDM
19. RCS Fast Response RTS's
20. Valve Limit Switches
21. Motor Operated Gate Valve
22. Motor Operated Gate Valve
23. RHR Pump
24. Safety Injection Pump
25. Air Operated Valve

All items except equipment numbers 13, 14 and 25 were selected prior to the plant site audit. The remaining equipment were chosen at the site as additional unscheduled items.

The Seismic Qualification Team was accompanied by the Pump and Valve Review Team through the entire period of the audit. Some of the items were investigated jointly by two teams with emphasis placed on different points, however. The items which were investigated jointly were equipment numbers 9, 10. 12, 24 and 25.

A number of generic concerns arose during the audit and remained unsettled until the end. Some of the concerns have made the Review Team's evaluation more difficult. The primary concerns were:

1. Commonwealth Edison supporting staff at the audit did not appear to have overall understanding of the program. Commitments to sequential test requirements per IEEE 323-1974 and IEEE 344-1975 for Byron as a Category I plant were not appreciated by the utility staff.

2. Despite the original claim that the equipment selected for audit had already been completely installed, including attached tubing and wiring seven out of 25 pieces of equipment audited were found on the contrary. For example, RTD, main control board, CRDM, hydrogen recombiner, and electrical penetration assemblies.

3. Despite the original claim that the equipment selected for audit had already been completely qualified with auditable links established, a number of equipment audited were found on the contrary. For example, main control board, PAM indicator, and electrical penetration assemblies.

4. Based on items 2, 3 and 4 it was felt that the equipment seismic and dynamic qualification was less than 85 percent complete at the time of audit. Such percentage calculation should have been made on the basis of assembly, rather than component qualification.

5. BOP SQRT (long) forms had generally been poorly prepared. Some information was either missing, inaccurate, or not up to date.

6. Despite repeated request, several key documents were not provided to the SQRT for review until the very end of the audit. This made our audit very difficult.

7. Most sequential testing informatin was not provided when requested. Byron plant is a Category I plant in accordance with NUREG-0588. Furthermore, according to Standard Review Plan (NUREG-0800) Section 3.10, the staff acceptance criteria calls for verification that seismic and dynamic qualification is performed in the proper sequences of the overall qualification program. Evidence of sequential testing information should therefore have been provided.

8. Some of the pumps and valves audited were qualified by analysis. Commitment to a scheduled qualification test program for some representative pumps and valves should therefore be established and accepted by the SQRT. Operability verification using static bend tests without simulating the pressure, temperature and flow from normal, transient, and accident conditions combined in accordance with the applicable criteria is not acceptable for active pumps and valves. Where the state-of-the-art or the equipment size precludes complete testing, additional justification with supporting tests on similar design or smaller scale should be provided.

9. Complete information of qualification reassessment against Marble Hill spectra was not ncluded with qualification document package after having been requested for equipment in safe shutdown system. For each piece of such equipment a summary statement describing the reassessment, as well as the corresponding Marble Hill spectra used, should be documented and filed with the remainder of the qualification documentation package.

10. A surveillance and maintenance program for all equipment with an estimated qualified life less than 40 years needs to be established.

11. A filing system capable of retrieving qualification documents needs to be established. Complete and auditable records of equipment qualification must be available and maintained by the applicant, for the life of the plant, at a central location. These records should be updated and maintained current as equipment is replaced, further tested or otherwise further qualified.

In general, based on the results of the audit, the status of the installation and its documentation was not satisfactory. The audit is termed inconclusive and a need for a second review is indicated. Details of the equipment-specific evaluations as a result of the audit conducted by the Brookhaven National Laboratory (BNL) Seismic Qualfication Team are contained in the individual equipment reports that follows.

Fuse Panel and Associated Instruments

The following items are contained in the Fuse Panel cabinet:

24 GE CR 151B terminal blocks
2 Marathon terminal blocks
70 ITC fuse pullout holders
140 Fuse Cartridges
1 West type AR Relay

The cabinet dimensions are 72" long, 90" high and 18" wide and its weight is approximately 1500 lbs. It is located in the DC switchgear room which in turn is located in the Auxiliary Building. The equipment is designed according to Sargent and Lundy specification No. F/L-2788.

The qualification document for the cabinet and its associated instruments are described in a test report prepared for the vendor, System Control, by Wyle Laboratories. It is identified as Report No. 44982-1, Rev. A, dated 2/5/80. This report was reviewed and approved by Sargent and Lundy.

There are two Fuse Panels in this plant. The model number of the unit investigated during the field trip was 1DC10J. Mounting of the cabinet is accomplished via welded attachment to steel base plates which are bolted to the floor. During the time of the site visit the bottom of the cabinet was as yet not welded to the base plates. Furthermore, some discrepancies were found to exist between the mounting information given in the SQRT form and those shown in the design drawings. In the SQRT form the plate thickness and anchor bolt were given respectively as 1/2" thick and 1/2" nominal, whereas on the design drawing they are given as 1/4" thick and 5/8" nominal.

This equipment was qualified by testing. Specifically, the tests consisted of a single axis resonance search and multiple axis random excitation inputs. The spectral graphs which were included in the qualification report showed that the TRS exceeded the RRS in the frequency range of 0-50 Hz. Therefore the equipment was tested to accelerations in excess of the required level. The resonance search was performed in the frequency range of 1 to 40 Hz. The results showed that the natural frequency was 25 Hz in the S/S direction and 17 Hz in the F/B direction. No amplification of the excitation was observed in the vertical direction, therefore the natural frequency is taken to be above 40 Hz.

Since this is an electrical piece of equipment, functional tests need to be carried out to show that the equipment performs its required electrical functions during and after 5 OBE's and 1 SSE (see IEEE 344-1975). No tests of this type were however described in any of the qualification documents.

In summary, the following items remain open:

1) Electrical functional operability test needs to be demonstrated as per IEEE 344-1975 requirement.
2) Cabinet installation is not complete.
3) Errors in the description of the mounting conditions in SQRT form should be corrected.

Level Switches

These level switches are safety-related devices manufactured by Magnetrol for Cooper Energy Services. Four Magnetrol A103F units required dynamic qualification. The pertinent reference design specification for qualification requirement is Sargent and Lundy's Spec. S/L-2742. Each level switch is made up from three sub-assemblies, namely, (1) sensing unit, (2) a switch housing, and (3) a switch mechanism. The ID of the unit that was physically inspected to verify completeness of installation was 1LSDG115A. This unit is mounted on the jacket-water standpipe of the diesel generator coolant piping. This switch monitors the level of circulating cooling water and insures that safe operating conditions are maintained for the diesel generator in the event of a loss-of-electric-power (LOEP) situation.

The main documentation relevant to the qualification of the devices is report # 43235-1, dated May 2, 1977 prepared by Wyle Laboratories. This document, however, was only available in microfiche, and reviewing it was not that simple. Firstly, the available viewing machine was not capable of making a hard copy. Another machine, located elsewhere, was capable of making hard copies, however, the size of these copies were so small that the prints were almost illegible, and thus very difficult to read. Essentially the main qualification document was not in an auditable form.

Another issue pertaining to this equipment involves sequential testing. Although the switches are located within the diesel generator room, and they are not exposed to the harsh environment within the primary containment, they are always subjected to higher-than-normal temperatures since the diesel generator room has to be kept at higher temperatures in order to facilitate easy start- up. Therefore, thermal aging of the organic components of the switch, such as the seals, (at least) needs to be addressed. Essentially, it should be demonstrated that the degradation resulting from any aging mechanism, would not compromise the structural and functional integrity of the equipment.

Finally, the test at Wyle Laboratories was performed on a different type of level switch. In order to qualify the level switches at the Byron plant, an adequate physical description should be made comparing the two different types of switches and their dynamic similitude. Also, the Test Response Spectrum (TRS) for this particular equipment should be based upon the Marble Hill Spectra with the addition of an adequate margin as stipulated in IEEE Std. 323-1974. In view of the above, it is felt that the SQRT long forms should be correspondingly updated and all the missing items should be provided.

In summary, based on the audit and the available documentation during the review, although the installation of the field-inspected level switch was found to be satisfactory, a conclusion regarding the overall seismic qualification status of the equipment cannot at the present be made. It is felt that a judgement can be achieved after the following issues are properly addressed:

a) Provide a documentation package in a form that allows verification by experienced personnel other than the qualifiers. This documentation should contain the performance requirements, the qualification method, the results, and the justifications; an auditable link should be provided between specifications and test results,
b) Evidence should be provided that the switch can still perform its safety-related function even at the end of its qualified life, i.e., evidence of compliance to the sequential test requirements of IEEE-Std. 323-1974 and IEEE Std. 344-1975,
c) Use the Marble Hill Spectra, including an adequate margin, to demonstrate the seismic qualification of the switch, i.e., comparison of the test response spectra (TRS) to the corresponding Marble Hill Spectra should be made, and
d) Update the SQRT long forms to reflect additional information.

New Fuel Racks

New Fuel Racks are used to store the new fuel assembly supply before inserting it into the reactor core. There are 132 fuel spaces banked into three rows in a pool at an elevation of 401'-0" in the Fuel Handling Building. Each row consists of a 22 x 2 square can array and its bottom is supported at the floor with intermittent guides at both the upper and lower ends. The support structure is bolted to the floor and walls. Each fuel can is vertical and holds one new fuel assembly. These racks are designed as per the Sargent and Lundy Specification F/L 2743.

This equipment item is required to qualify for structural integrity in order to contain the new fuel assemblies and hence, can be considered to be passive. During field inspection this structure was found to be properly supported to withstand the seismic loadings.

The report describing the qualification procedure is entitled "Structural Analysis of the New Fuel Racks for Byron Station and Braidwood Station", prepared by NUS Corporation, Tech. Report # 2063, dated February 16, 1978. It is qualified by analysis alone. The computer code STARDYNE was used for the analysis. The following loads were considerd in the analysis: Dead weight, OBE at 2% damping, SSE at 4% damping, and abnormal loads due to accidental drop and postulated stuck fuel. These loads were combined by using a NUS code known as COMBINE.

A 3-D grid/can model was used to calculate the frequency and mode shapes. Equivalent static anlaysis was performed for the horizontal loadings, whereas, a dynamic analysis was done for the vertical loading conditions. During the review process, a number of questions were raised in justifying the input g-level, static analysis instead of dynamic, and the frequency calculations. It was concluded that the overall design of this equipment is within the acceptable stress level.

Based on our review, inspection of the field installation and clarifications made by the applicant, this equipment is found to be qualified for the Byron site. However, the SQRT forms are required to be revised for completeness.

Hydrogen Recombiner

The major function of the Hydrogen Recombiner is to prevent explosive concentration of hydrogen from forming in the reactor containment as a result of a LOCA. There are four Hydrogen Recombiners in the Byron Plant. These models are identified by ID numbers, 0G085A, 0G085B, 0G04J and 0G0GJ respectively. The particular recombiner investigated during the site visit was 0G085A. It is located in the Auxiliary Building at the 401' level.

The main document used for the qualification of this equipment is entitled "Hydrogen Recombiner System & Power Control Cabinet" dated 8/25/80, No. 58362, Rev. A. The primary portion of the document is the test report prepared by the Wyle Laboratories for the vendor, Rockwell International. This equipment was designed in accordance to Sargent and Lundy Specification, F/L 2845.

The recombiner assembly consists of the analyzer box, the motor-blower assembly and the steel mounting pad. The steel mounting pad serves as a steel base support for the recombiner and is archored to floor via 8 1-1/2" nominal bolts. Several problems were found during the walkdown part of the visit: (1) the electrical wires were not connected to the recombiner and (2) the lid of the switch box was missing.

The recombiner was seismically qualified by test. The specimen was first subjected to a sinusoidal frequency sweep in each of the three orthogonol axes (i.e., separately one by one) to determine the natural frequencies. The sweep was conducted in each axis for a frequency range from 1 to 33 Hz. The frequency sweep rate of the tests were one octave per minute with a table input level of 0.2 g peak. The specimen was also subjected to biaxial seismic random motions. These random motions were applied over a frequency range of 1.25 to 35 Hz. Independent signal sources were used for the horizontal and vertical axes so that input phasing was random. Each filter incorporated an amplitude control that was adjusted in such a manner that the motion enveloped the RRS for the OBE and SSE. During the SSE tests, the entire assembly remained non-operating to simulate a shutdown situation. During the OBE tests, all electrical and functional systems on the recombiner were powered to simulate and check operability for normal operating conditions.

Based on the findings made during the field visit this equipment is considered seismically qualified. It should, however, be verified that the proper electrical wires and switch box lid is installed on the unit.

Motor-Operated Globe Valves
(1AF013A-H)

The motor-operated globe valves were inspected to verify completeness of installation. The eight (8) units requiring qualification were designated as 1AF013A to H and are located in the Auxiliary Feedwater System of the plant. The primary function of these valves is to isolate, whenever necessary, the auxiliary feedwater line from the steam generator. The vendor for these valves is Velan Engineering Companies and the specification is designated as F/L-2718-3. Each valve is a 4 in. globe valve and weighs approximately 245 lbs. Each is weld-mounted to the auxiliary feedwater piping line in a parallel arrangement.

The installation of these valves was considered acceptable. Unfortunately, however, upon request, there was no qualification documentation available for review, thus, the information given in the SQRT form could not be verified against the actual referenced documents. Obviously no conclusion can be reached as to the qualification status of the equipment until a thorough review of the related documentations can be carried out.

Motor-Operated Gate Valves
(1CS009A&B)

The motor-operated gate valves that were inspected to verify the adequacy of installation were designated by ID numbers 1CS009A&B. The vendor of the two valves is Anchor/Darling, while the operator of each unit is a Limitorque operator SB-0-25 type. Each valve is a 16 in. motor-operated gate valve and the assembly weighs about 2879 lbs. The valves are located in the Auxiliary Building at elevation 355 ft. Each unit is mounted and welded to the containment spray piping. They are required for containment spray pump isolation. The reference design specification for qualification requirements was Specification # F/L-2974-3.

The valve assembly is qualified by a combination of analysis and test. Static analysis was employed to demonstrate the structural and functional capability of the equipment. The theoretical development and the results of this analysis are contained in a report by Anchor/Darling entitled "Static Seismic Analysis Report" dated July 8, 1977. In addition to the analytical approach, qualification type-testing was performed on the Limitorque operator SB-0-25 by Aero-Nav Laboratories, Inc. The results of this seismic test is contained in an Aero-Nav report entitled "Report of Seismic Test on SB-0-25 Motor Actuator for Limitorque Corporation", dated October 22, 1975. This report was reviewed and approved by Sargent and Lundy and is documented in Sargent and Lundy File # EMD-009266. Also, the previously mentioned static analysis report by Anchor/Darling was reviewed and accepted by Sargent and Lundy on July 15, 1977. It is also documented in Sargent and Lundy File # EMD -009267.

The static analysis report showed a combination of operational and seismic loadings. The OBE/SSE g-loads were: 2.25/3.0g (side-to-side), 2.25/2.5g (front-to-back), 2.5/3.0g (vertical). The results of the analysis indicated that the stresses and deflections at various selected critical locations were below the allowable values. A justification for the static analysis approach was demonstrated by showing that the natural frequency was above 33 Hz.

The test of the Limitorque operator by Aero-Nav was done in the following manner. Limitorque Corporation submitted a specimen mounted on a base plate and Aero-Nav affixed the assembly to the table of a seismic simulator. The axis the steam nut was oriented vertically and the actuator was connected electrically to a control console supplied by Limitorque. The specimen was first subjected to a resonant frequency search ranging from 5 to 33 Hz, in discrete increasing steps of 1 Hz. The applied excitation levels varied from 0.1 to 0.75 g peak leveling at each frequency for a period of not less than six (6) seconds. It was determined that there was no resonance below 33 Hz. Following this, a sesmic dwell test was performed at 33 Hz. for each of the 3 orthogonal axes. Several runs were performed at an input of 5.0g in each of the three axis; one run was performed at an input of 6.25g in each axis. In each run the dwell time of the applied excitation was 30 seconds, and the actuator was operated open to close seat, then back to open. In all cases there was no evidence of external physical damage and hence it is claimed that functional operability has been demonstrated and the operator is qualified.

It could not be ascertained, however, whether the test mounting condition reflects the actual case since the specimen was only mounted to a base plate not to the actual valve body. The dynamic effects of the opening and closing of the valve operator upon the pipe-mounted valve body was not clear and should be addressed. Furthermore, an attempt should be made to identify age-sensitive components, if any, and to demonstrate that the equipment still maintain its structural and functional integrity when subjected to a seismic event at the end of its qualified life.

In conclusion, the valves were found to have been installed in an acceptable manner, and they are considered qualified except that the following items should be clarified:

a) That the overall valve assembly does not have a resonance frequency that could be excited by the sudden closing or opening of the operator during a seismic event leading to damaging consequences.

b) Identification of age-sensitive components, if any, and then following the sequential test requirements.

Main Steam Isolation Valve and Actuator

The function of the main steam isolation valve is to provide rapid closure to isolate the primary containment from high pressure steam under extreme conditions. There are four such valves in the plant. All of the valves are manufactured by the Anchor Darling Valve Company. The valves are located in the Main Steam Tunnel of the Auxiliary Building at the 377' level.

An analysis method was used to demonstrate the structural integrity of the valve body while laboratory tests were performed to demonstrate the structural integrity of the actuator. The document that describes the analysis of the valve is entitled "Static Seismic Analysis Report/ Main Steam Isolation Valves", No. E-6105, Rev. A, dated 10/??/76. The report was prepared by Anchor Darling Valve Company and was reviewed and accepted by Sargent and Lundy. The document that contains the test results of the actuator is entitled "Qualification Test Report of a Self-contained Hydraulic Valve Actuator", No. X43847-2, dated 7/14/78. It was prepared by Wyle Laboratories and was reviewed and accepted by Sargent and Lundy.

The model number for the actuator in the SQRT form, i.e., 64324-C, could not be found on the equipment examined during the plant-site visit. The Sargent and Lundy representative explained that the problem occurred because they replaced or substituted an actuator which was made by a different manufacturer. However, he stressed that the difference between two models had been taken into consideration and specific data for the substitute model has also been documented.

A rough calculation based on the stiffness of the components of the valve assembly was used to find the lowest natural frequency. Since the lowest natural frequency was larger than 35 Hz, a static analysis was performed. Thermal, dead weight, pressure, seismic and opeational thrust load are all considered as an equivalent static load. The results showed that all the stresses in the critical locations were below the allowable limits.

Seismic qualification of the actuator was demonstrated by test. Sine sweeps from 2 Hz to 150 Hz at a sweep rate of one octave per minute were used to find the natural frequencies. The natural frequencies that were recorded were 24 Hz in the lateral direction and 22 Hz in the longitudinal direction. No resonant frequencies were found below 33 Hz in the vertical direction. The specimen was then subjected to sine beat tests at the most significant natural frequencies found earlier. The input was chosen as the mimimum of five beats with 10 oscillations per beat and two second pause between beats. Five OBE tests followed by 1 SSE test was performed in each test axis. It was found after completion of the SSE test that leakage occurred around the pilot-operated check valve and the hydraulic 4-way valve. Additionally after the OBE test needle valves "F" and "F1" were found closed. Nevertheless, operation of the actuator was not affected.

In conclusion, based on the findings made during the audit review, this equipment is found to be acceptable for the Byron Plant.

Motor Operated Butterfly Valve
(1SX027A, B)

Two Motor Operated Butterfly Valves are installed in the 16" Essential Service Water piping lines for containment isolation. These units are manufactured by Jamesbury Corporation and each is driven by a SMB-000 type Limitorque operators. The composite weight of each valve is 525 lbs. Each valve is vertically mounted to the pipe by sixteen 1 inch bolts on the side of the valve unit. The operator is mounted to the valve body in the vertical plane. Both units are located in the Auxiliary Building at an elevation of 395'.

During site inspection, the valves were found to be properly mounted. In the vicinity of these valves, there are several other valves which were temporarily supported from the walls. It was later found that the pipe support in this area had not yet been completed.

The equipment was qualified by analysis. The report describing the analysis is entitled "Seismic Qualification of Valves covered by Commonwealth Edison Company, Purchase Order Nos. 803067 and 803068 for the Byron and Braidwood Stations and processed under Jamesbury Order Nos. NC48856/57 and ND48858/59", Jamesbury Corporation Report No. JHA-76-71, EMD File No. 010426, dated September 21, 1977. This report includes all the design calculations of a nuclear valve under ASME code requirements. Although the valve body is the same as that installed at Byron site, the calculations were made for the valve with a different motor operator model (type SMB000/2-HBG actuator).

The first fundamental frequency of the Byron site valve unit was calculated to be 66 Hz by using an approximate method of comparing the length and weight of the two operators. Since this frequency is well in the rigid range. a static coefficients were used in the analysis. The following table gives the design values used considered in this report.

	S/S	F/B	V
OBE	2.25 g	2.25 g	2.5 g
SSE	3.0 g	2.5 g	3.0 g

The reports qualifying the operator were not available for review at the site audit.

Based on our review and field inspections, the following open issues need to be resolved:

(1) Reports qualifying the valve operator including environmental and dynamic aging tests and seismic testing are needed for review.
(2) The equipment should be reassessed for the Marble Hill Spectra.
(3) SQRT forms for the valve operator should be completed.

Auxiliary Feedwater Pumps and Drives

The auxiliary feedwater pumps are installed in the Auxiliary Building at elevation 383 ft. There are four (4) units at this particular elevation and these pieces of equipment are designated as 1&2AF01PA&B. Each unit is bolted to a steel base plate which is in turn anchored to the floor by means of 22 bolts. Each pump is approximately 104 in. x 55 in. x 63 in. in dimensions, and weighs 8150 lbs. in the dry condition. Essentially the pumps can be described as centifugal barrel pumps, horizontally mounted. One-half of the units are diesel-driven and each assembly is coupled by a speed-increaser; the other half are motor driven. The review of the qualification status, therefore, was carried out for each major component in the assembly, i.e., pump, diesel-drive, motor, and speed-increaser.

The pump vendor was identified to be Dresser Industries-Pacific Pumps Division. The pertinent specification is F/L-2758-C. The vendor performed a natural frequency test by exciting the pump assembly with a 200-lb. force over a 10 to 220 Hz. frequency range in three different directions: horizontal, vertical, and axial. It was determined that there was no significant resonances below 33 Hz. Henceforth, they proceeded to qualify the pump by analysis and hand calculations. Results of the calculations indicated that the stresses and deflections at selected critical locations are below the allowable values, thus establishing the structural and functional integrity of the equipment. The relevant reports regarding this matter are included Sargent & Lundy EMD File Numbers 018115, and 019835, and have been reviewed and accepted by Sargent and Lundy.

The diesel-drive was manufactured by Stewart and Stevenson Services, Inc. per Sargent and Lundy Specification # F/L-2891. The diesel-drive and control panel were qualified by subjecting them to a seismic simulation test at Wyle Laboratories The test program consisted of resonance search testing and two series of biaxial random multifrequency testing in each of two test orientations. The specimens were electrically powered during the test. During the test, the coupling between the diesel engine and the right angle gear box was loose and vendor representatives determined that this was caused by excessive flexibility in the engine mounts. Modifications were made and the coupling reinstalled; and the test was completed without further problems. Sargent and Lundy gave the assurance that all modifications during the test have been included in the installed units. It is further assured that the test mounting conditions simulated the in-service mounting configurations very closely. The relevant reports regarding this matter have been reviewed and accepted by Sargent and Lundy and are included in their File # EMD-020714.

The motor-drive was manufactured by Westinghouse Electric Corporation, Large Motor Division in accordance with Sargent and Lundy Specification # F/L-2718. In a manner similar to the qualification of the pump, the vendor first established the natural frequency of the motor by test. It was determined that the lowest natural frequency was 38 Hz. As a consequence, an analytical approach was employed to demonstrate the structural and functional integrity of the motor. Results of the calculations revealed that stresses and deflections at selected critical locations are below their respective allowable values, hence, it is claimed that the motor is qualified. The pertinent reports regarding the qualification of the motor have been reviewed and accepted by Sargent and Lundy and included in their File # 023682.

The last component, i.e., the speed-increaser, was fabricated by Weston Gear Corporation, Power Transmission Division in accordance with Sargent and Lundy Specification No. F/L-2758C. In appearance, it is a rectangular box, 22 in. x 40 in. x 50 in. and weighs about 2950 lbs. Its model number is 4113A. Like the pump and the motor, this component was qualified by analysis after establishing that the lowest natural frequency was greater than 33 Hz.

Stresses and deflections at selected critical locations were again shown to be below the allowble limits, thus demonstrating the structural and functional integrity of the component. The reports about the qualification of the speed-increaser have been reviewed and accepted by Sargent and Lundy and included in their File # 011921.

It should be noted that in all the qualification documents mentioned earlier, the sequential test requirements were not addressed at all. Also with the exception of the diesel-drive and control panel, all other components were qualified by analysis. ANSI/IEEE Std. 344-1975 stipulates that it should be shown that a series of operating basis earthquakes (OBE) followed by a safe-shutdown earthquake (SSE) will not result in failure of the equipment to perform its Class 1E function. This is particularly hard to show for a complex electrical equipment, such as the motor-drive, for example, without some type-test data. In addition, parts of the whole assembly that are susceptible to any aging mechanism should be identified and it should be demonstrated that any resulting degradation will not compromise the structural and functional integrity of the equipment to perform its intended safety function even at the end of its qualified life.

During the audit, it was found that the SQRT forms contained numerous missing and wrong informations such as mounting conditions, stress values, etc. Sargent and Lundy, however, gave the assurance to rectify the omissions and mistakes.

The installation of the equipment was determined to be acceptable. The coupling dust cover, however, was found to be too flexible, but assurances were given to correct the situation.

In conclusion, although the installation is considered adequate. The overall qualification status of the equipment, however, cannot be ascertained due to the inadequacy of the documents. The following items should be addressed before reaching a final conclusion regarding the qualification status of the equipment:

a) Parts, that are susceptible to any aging mechanism should be identified,
b) The qualified life of the equipment should be established; it should be shown that the equipment will perform its intended safety function even at the end of its qualified life, and
c) The SQRT form should be revised to rectify the erroneous informations and missing items.

Essential Service Water Pump and Motor
(1SX01PA, PB)

The Essential Service Water Pump and Motor assembly supplies cooling water to various equipment important for safety and hence is categorized as active equipment. It is required to operate during and after postulated dynamic and accident events. The pump is manufactured by Bingham-Willamette Company and is coupled with a Westinghouse motor via a flexible coupling. The entire assembly is bolted to a base plate by 12 - 3/4" bolts, which in turn is embedded on a concrete platform. Two such units are located in the Auxiliary Building at an elevation of 330'. They are designed as per the Sargent and Lundy Specification F/L-2758-A, dated 5/4/77.

The equipment was found to be properly installed at the specified locations. The suction and discharge lines were found to be adequately supported near the pump nozzles to isolate any transfer of large nozzle loads. A discrepancy in the specified flow rate of 24000 gpm for the pump was found in the plate attached to the pump, which shows 2400 gpm. Later, it was discovered that the plate was marked wrong. The motor has a fan cooler at the top and a conduit box attached to its side.

The file containing all the qualification documents is identified as File # CQD-EMD-013704. It was reviewed by Sargent and Lundy on 4/5/82. However, the acceptance of the design documents was not completed and no evidence to this regard was included in the package.

The report qualifying the pump is entitled "Seismic-Stress Analysis of Horizontal Pumps. Size and Type: 24 x 30 x 30 HSA 1 Stage", Report No. ME-523, prepared by McDonald Engineering Analysis Co., Inc., dated March 23, 1978. The pump is designed as per the requirements in the Sargent and Lundy

Specification # F/L-2758 A, Addenda 1-5 and ASME Section III, Class 3, 1974 Ed. through Winter 74 addendum. The pump is qualified by analysis alone. The computer code ICES-STRUDL was used for performing a static analysis of a beam type finite element model of the pump. A g-load of 1g for OBE and 1.5g for SSE were applied in each direction of the pump model. The valves satisfy the adequate margin for using static analysis when compared to the site spectra. The impeller and casing clearance was calculated in a very crude way and the operability is established on the basis that this clearance value is smaller than the allowable for any possible interference.

The motor is also qualified by analysis and the results are summarized in the report entitled "Seismic Analysis of Essential Service Water Pump Motors for Byron and Braidwood Nuclear Power Station", EMD file # 020056, dated 7/31-78. It is a proprietory document of Westinghouse Electric Corp., Heavy Industry Motor Division. The computer code WECAN was used to analyse the model. The conduit box and other components were included in the model. A static analysis approach was used since the frequency search testing conducted at Westinghouse during the week of June 19, 1978 found the first fundamental frequency above 33 Hz.

Both pump and motor werc qualified separately. No composite model was analyzed including the coupling between the two components. Experience was used to qualify the leakage from the shaft seals due to small amounts of shaft deflection.

Based on our review, field inspection, and clarifications provided by the applicant, the following open issues are required to be resolved in the future:

(1) The base plate supporting the pump-motor assembly should be simulated in the model properly.

(2) The motor should have been qualified by test as required by the specification.

(3) The environmental and sequential testings for non-metallic components, should have been addressed in the qualification.

(4) This equipment is required to be reassessed for the Marble Hill Spectra.

(5) The SQRT forms should be completed.

Hydrogen Recombiner Control Panel

This Hydrogen Recombiner Control Panel is a cabinet which contains various breaker switches to control the function of the Hydrogen Recombiner. There is only one control panel in the Byron Plant to control the four hydrogen recombiners in the plant. This control panel is identified by serial number 111A and is located in the Auxiliary Building at the 401' level.

The equipment was seismically qualified by testing to IEEE-344-1975 Standards. The qualification report is entitled "Seismic Testing of Recombiner Power and Control Cabinet Assemblies", No. 58362-1, dated 12/7/78. This was essentially a testing report from Wyle Laboratory prepared for Sargent and Lundy. It was reviewed and accepted by Sargent and Lundy.

The four sides of the panel base were welded to four steel strips. These steel plate strips were then bolted to the floor. During the plant walk-down, we were notified that the panel was recently moved from its original location to the present site at the 401' level. Since the present floor was not prepared to serve as a foundation of the panel, gaps existed between the steel strips and the floor because the floor was not flat. Corrections were made by inserting additional small plates (i.e., shims) into the gaps.

Resonance search testing was used to find the lowest natural frequencies of this equipment. Sinusoidal frequency sweeps in each of the three orthogonal axes were made. One sweep was co[illegible] each axis from 1 to 33 Hz at a frequency sweep rate of one octave pe[illegible] th input level of 0.2 g. The results showed that the natural frequency was 26 Hz in the S/S direction and F/B direction and 33 Hz in the vertical direction. The test program also consisted of multiple axes, multiple frequency tests where random motions were applied independently with with random phasing. It was observed that the equipment continued to perform its intended function and remained undamaged after 5 OBE's and 1 SSE.

No aging tests were performed because the environment where the control panel is located is considered to be mild.

In conclusion, based on the findings made during the audit, this equipment is considered seismically qualified for the Byron Plant.

Diesel-Generator Governor

The diesel-generator governor is mounted high on the generator end of the engine. The speed governor actuator model number is EGB-50 P/LS and the overspeed trip governor model number is UG-8L. The vendor is identified to be Woodward for Cooper Energy Services. There is one unit per engine which is located in the Auxiliary Building at elevation 401 ft. This equipment is needed to regulate the diesel-generator in case there is loss-of-electric-power (LOEP) event.

The installation of the equipment was considered satisfactory. But the documents to support the qualification status was not yet in an auditable form. The SQRT form was only filled out during the audit; this is significant since this equipment is a surprise item and its status reflects that of the remainder of the safety-related equipment that were claimed complete but were not audited. In addition, the qualification document was only available on microfiche. A photostatic copy was later made available and an attempt was made to read and review this report. Unfortunately, the prints were very small and some portions were illegible. It is, thus difficult to ascertain the qualification status of the equipment.

The qualification is based on a test report by Wyle Laboratories. The report was reviewed and accepted by Sargent and Lundy. This is supposed to be included in the Sargent and Lundy EMD File No. 015593. It is claimed that the test report would show that the governor is qualified. This claim however, cannot be verified until a thorough review of the pertinent documents will be made.

Thus, in conclusion, while the installation is adequate, the final qualification status of the equipments awaits the availability and review of the pertinent qualification documentation.

Differential Pressure Transmitters

The four differential pressure transmitters that were audited during this qualification review are located at various places within the Auxiliary Building. In particular, two (2) units, i.e., PT934 and PT937, are located at elevation 433 ft. while the other two (2), PT935 and PT936, are at elevation 454 ft. The vendor was identified as Barton and each unit carries the manufacturer model number 752. They have a pressure range that varies from 0 to 50 psig. The physical dimension of each unit is 5-11/16 in. x 12-5/16 in. x 7-3/4 in., while the weight is about 14 lbs. each. They are primarily used to measure containment pressure and they are part of the safety injection system. Each unit is bolted rigidly by means of four (4) bolts, 5/16 in. nominal size each, to a support structure provided by Sargent and Lundy. Some reference documents and specifications relevant to qualification are the following: P.O. No. 457787, E-Spec. 953328 R3, and WCAP 8587, Suppl. 1 EQDP ESE-4.

The pertinent seismic qualification reports are designated as WCAP 8687 Suppl. 2-E04A&B (Proprietory). These are test qualification reports, entitled "Differential Pressure Transmitters - Qualification Group B"; E04A is dated May, 1980 while E04B, March, 1981. The reports indicated that the seismic test was completed on new equipment employing multi-axis multifrequency generic-type inputs.

It is claimed that the generic required response spectra contain significant margin with respect to any single plant application. This was verified for Byron-1 by comparing the corresponding applicable response spectra. These reports were prepared and reviewed by Westinghouse (NID).

The test units were mounted to a rigid test fixture with its principal horizontal axes mounted 45-degrees to the test input. Five operating-basis earthquakes (OBE's) were applied in the initial test position prior to safe-shutdown earthquake (SSE) testing. Apparently, the results of the tests were acceptable. Westinghouse maintained that during the estimated 5-yr. qualified life of these devices, there are no in-service aging mechanisms capable of reducing their capability to perform their safety-related function. In view of this claim, the seismic testing of the new, un-aged transmitters, as described above, is not prejudiced by any in-service aging mechanisms. The result of the aging tests which is expected to establish to above claim were not yet available, however, hence this claim could not be verified. In addition, assuming that the aging tests will reveal that the above claim is valid, a proper surveillance and maintenance program should be established since the qualified life of the equipment is only five (5) years.

In conclusion, it was found that the installation of the pressure transmitters was acceptable. Therefore, the equipment is considered qualified except that the following concerns should be addressed:

a) The aging test results should be made available for review; these results should show that there are no in-service aging mechanisms that can affect the structural and functional integrity of the equipment throughout its qualified life, and
b) A proper surveillance and maintenance program should be established and implemented.

PAM Indicators
(VX-252)

Post Accident Monitor (PAM) indicators are used to read the pressure, temperature, flow and fluid level at various locations in the plant. These indicators were installed in the control room on the main control board at an elevation of 451'. There are 47 such units and each was mounted vertically to the main control board panel with bakelite backing by two barrier screws and two support screws. Each has an appearance of a rectangular shape (6" x 6" x 2") and weighs approximately 1 pound. These particular units serve to monitor post-accident process parameters. They were manufactured by Westinghouse Relay and Instrumentation Division (RID) and were designed as per the specifications P.O. #546-CML-425579-BN, E-Spec 953445, Rev. 1, WCAP-8587, Supp. 1.

The equipment was qualified by test only. The test procedure included sequential environmental aging followed by seismic tests. The Westinghouse documentation package describing the test procedures and results is entitled "Equipment Qualification Data Package: Indicators-Post Accident Monitoring", EQDP-ESE-14, Rev. 3, dated 7/81. The test report is a part of this package and is identified as "Equipment Qualification Test Report - W - RID indicators (Post Accident Monitoring) (Environmental and Seismic Design Verification Testing), WCAP-8687, Supp. 2-E14A, Rev. 1, dated July 1981. Fourteen (V x 252) indicators manufactured by Westinghouse were tested.

According to the required specification, the test specimen is required to simulate the loss of HVAC by 12 hours of continuous operation at extreme temperature and humidity conditions. It is then required to withstand seismic response spectrum of 28g maximum acceleration for SSE. The test procedure, in addition, included 50 hrs. of operation at ambient environment followed by seismic testing.

Initial qualification tests were conducted on two current and two voltage meters. The test results showed significant shifts (75%) on some voltage meters after both the environmental and seismic tests. It was believed that this was due to curing treatment used when attaching the pointer to the cross piece. The cure was affected by use of a soldering iron. Since the current meters did not exhibit any such problem, it was assumed that the curing procedure used for these units was proper.

A new heat treatment process was developed that consisted of baking the assembled pointer and cross piece at 100°C for 16 hrs. 6 voltage meters consisting of 2 previously tested ones and 4 new units were cured by this process and retested. The environmental tests were performed sucessfully but shifts were observed in some of the meter outputs after the seismic tests. Furthermore, due to additional tests the two old units were damaged because of fatigue.

Six new meters were then tested for all the above problems and tested for three additional SSE conditions. Of these two meters failed; one got stuck due to bending of the pointer and one had a broken target. It should be noted however that they all survived one SSE at an input g-level of 6g. Following the seismic and environmental testings, a check that included both calibration and a visual inspection was performed and found to be acceptable.

Based on our review, field inspection and the clarifications provided by Westinghouse, it was found that this equipment is qualified for the Byron site provided the following issues are resolved:

(1) It was not clear in the report whether 5 OBE tests were made after the environmental aging and prior to the SSE, and, whether the equipment was rotated for other axis input during the test. Further clarification of this procedure is needed.

(2) The final qualification of these meters depend on the Main Control Board (MCB) analysis and the RRS developed at the meter locations in the MCB. After this analysis is completed (expected date 6/83), the g-loads should be compared with the qualified level.

(3) The current test procedure has predicted the qualified life of these meters to be 5 years. Hence, a surveillance and maintenance program is required to monitor these meters over 40 years of plant life.

(4) The installation of all the meters has not been completed by the SQRT audit date. This should be completed.

Main Control Board
(Model # 1190E76 - NSSS
20275-M1, M11, M21 - BOP)

The Main Control Board (MCB) is located in the control room of the Auxiliary Building at an elevation of 451'. It consists of eight individual panel sections arranged in a "U" configuration. Both Westinghouse and Sargent and Lundy are responsible for the design of this equipment. These panels hold all the instrumentation controls and monitor the entire plant operation. They were welded to the floor embedments as per the drawing 1190E76, Rev. 4.

During the site visit this equipment was found to be in an incomplete stage. The panels were almost installed to the floor. Several table panels were lying on the area floor without being properly supported. All instruments were not completely installed. Thus, it was concluded that installation of this equipment was not complete.

According to the SQRT forms, the equipment is qualified by combination of test and analysis. However, no report referring to these were available for review. We were informed that they will be made available around June 1983.

The qualification procedure employed by Westinghouse included a three dimensional finite element analysis using time history inputs generated from the Sargent and Lundy spectra. This analysis provides the instrument location g-level and RRS for further qualification of these instruments. Some test on similar panels will be made to support these analysis results. The weld size of the panel mounting to the floor will be based on the forces/moments calculated at the support points.

Since the reports qualifying this equipment were not available and the installation was incomplete, this equipment is not yet qualified for the Byron plant.

Control Rod Drive Mechanism
(Model # L106-A)

The Control Rod Drive Mechanisms (CRDM) are very large complex pieces of equipment mounted on the top of the reactor vessel at an elevation of 426' inside the Reactor Building. The equipment is approximately 30' high and has a diameter of 12' which is as large as the reactor vessel. Additionally, six struts are provided at the top of the unit for seismic restraint. The blower unit is integrated with the CRMD assembly. It is manufactured by the Electro Mechanical Division of Westinghouse and is designed as per the Specification E-Spec 677470, Rev. 3 and E-Spec 953516, Rev. 0.

The CRDM is a magnetically operated jack. An arrangement of three magnets which are energized in a controlled sequence by a power cycler enables the withdrawal or insertion of the control rods in discrete steps. As the rod is withdrawn the fission rate increases, while inserting the rod slows fission. Each CRDM is threaded to an adapter on the top of the RPV and is coupled to the control rod directly below. The assembly is consists of a latch assembly, pressure vessel, operating coil stack and drive rod assembly.

The equipment is qualified by analysis alone. The analysis is performed in four parts:

(1) A generic stress and thermal analysis was performed to determine maximum allowable moment loading on the CRDMs, as per ASME Design requirements. The report summarizing this is entitled "Stress and Thermal Report of Type L106A and L106B CRDM", S.O. M308, M309, M313, and M314, Engineering Memorandum #4531, Westinghouse report, dated January 31, 1974 with Rev. 1 dated August 19, 1975 and Rev. 2 dated April 12, 1976.

(2) A plant specific seismic response spectra analysis and a LOCA time history analysis were performed. The moments from this analysis were combined by the SRSS method and the results were compared with the faulted condition allowable moments. The following reports summarizes the analysis:

(a) "Dynamic Analysis of Reactor Pressure Vessel for Postulated LOCA: Byron/Braidwood Power Stations", WCAP-8939, August 1977.

(b) "CRDM Analysis", CAE-117, a compilation of several different calculations, dated 11/13/81.

The LOCA analysis includes a finite element model of the CRDM without the RPV. A direct integration transient analysis was performed using the computer code DARI-WOSTAS. The hydraulic transients were calculated by the code MULTIFLEX. The validation of these codes are documented in the reports entitled "Documentation of Selected Westinghouse Structural Analysis Computer Codes" - WCAP-8252, April 1974 and "Vertical and Transverse Vibration of Reactor Internal Structures", WCAP-8134, Dec. 1973. The displacement data for LOCA of RPV was fed into the CRDM analysis and the forces considered in the analysis include loads applied to the RPV from the attached RCL piping, loads in the outside of the reactor vessel caused by asymmetric pressurization of the reactor cavity and loads on the reator internals caused by the depressurization wave travelling into and around the internals.

The CRDM analysis, on the other hand, was performed using a 3-D finite element model including the RPV. The model includes beam type elements and lumped masses for fans, hoists, and cable trays. The seismic analysis of this model was performed by using the response spectrum approach. Both the analyses moments were then combined for comparison with allowables.

(3) This part involves a generic analysis of the Seismic Sleeve and is reported in the document "Stress Report for the 2.47 inch Contact Length Seismic Sleeves", CAE-S.O. M375, WEMD EM#5241, Rev. 1, March 24, 1980. It includes an elastic analysis of the seismic sleeve configuration defined by the drawing 8377D47, Rev. 2 by the use of the code WECAN.

(4) The final phase of the program includes a specific plant comparison of the generic CRDM reports with the Byron Specification Unit to assure that all loads are acceptable. The report summarizing these results is entitled "Commonwealth Edison Company Byron Project-Unit 1 & 2 CRDM Pressure Boundary and Seismic Sleeve Summary Report", CAE-S.O. M375, CBE-S.O. M377, EM# 5324, dated April 30, 1979. The analysis pertaining to this report is still in the process of qualification because of overstress condition in the seismic sleeve under faulted loads.

Because of the complexity in the CRDM assembly, the operability of this equipment cannot be established by analysis alone. A test set-up was made involving a full size prototype 17 x 17 twelve feet fuel assembly, guide tube, and RCC. The scram time of the RCC through the guide tube could be deflected with a side force similar to the hydraulic flow load in a full scale plant model. The results were found to have little effect on the scram time. These are summarized in the report entitled "SCRAM Deflection Test Report 17 x 17 guide tubes, 96" and 150", WCAP-9251, December 1977. It should, however, be noted that this test could not assure the scram time 2.2 sec during a seismic event. The Westinghouse engineer informed us that a seismic test was performed in Japan satisfactorily, however, no report supporting this contention was submitted for review.

In addition, no demonstration of calculating the effects of the fundamental frequency for the insertion and withdrawal positions of control rods has been reviewed. Later we were informed that the frequency variation in these positions was insignificant. WCAP #8653 which summarizes this study was not available during the audit.

During the site audit it was found that this equipment installation at its location was not complete. In fact, the equipment was covered with plastic covers, the mounting bolts were not in place and the equipment was not in a position to inspect for design compliance.

Based on our review and site inspection it is required to resolve the following open issues:

(1) Demonstrate the safe drop of control rods by testing during a seismic event.
(2) The equipment should be reassessed for the Marble Hill Spectra as required for this plant.
(3) The overstress condition in the seismic sleeve should be resolved.
(4) The blower fans for the HVAC integrated to the CRDM and the cables coming out of each control rods were considered as concentrated masses in the analyses. Provide an explanation that the physical structure of these are not going to affect the overall dynamics of the CRDM analysis.
(5) WCAP #8653 summarizing the calculation of fundamental frequencies at different rod positions needs to be reviewed.
(6) The installation of the equipment should be completed.

RCS Bypass and Well-Mounted RTD
(Models: 21204 and 21205)

The Resistance Temperature Detector (RTD) units are installed in the Reactor Coolant System pipelines of the Byron plant to measure the fluid temperature at various operational phases of the reactor. There are eighteen narrow range (i.e., 530-650°F for cold leg) RTDs yet to be installed in the RCS bypass manifold lines. Sixteen are to be installed and two are spare items. Eight wide range (i.e., 0-700°F) RTDs were installed in the RCS piping. All of these items are manufactured by Rd F Co. and are designed as per the Specification #953337, Rev.0, WCAP 8587, Supp. 1. Each has an appearance of an elongated rod shape and weighs approximately 5-6 lbs. All of those units will be installed in the containment building at an elevation of 393'. Each unit is mounted to the piping system directly.

During the site inspection of the wide range units which were installed at the time of audit, we were told that the neck of these units were found to be broken during the test. Hence, additional reinforcement was provided at this location of each unit.

The equipment was qualified by test alone. The document files summarizing the test procedure and findings are entitled "Equipment Qualification Data Package: Resistance Temperature Detector: RCS/Bypass manifold", EQDP-ESE-5, Rev. 3, dated 3/82 for narrow range and EQDP-ESE-6, Rev. 4, dated 4/82 for wide range. Each package contains a test report entitled "Equipment Qualification Test Report, Resistance Temperature Detector (RCS-Bypass) (Seismic and Environmental Testing), March 82, WCAP-8687, Supp. 2, E05A, Rev. 1 for narrow range and E06A, Rev. 2 for wide range.

The test program for this equipment was conducted in the following sequence:

(1) Inspection
(2) Operation - Normal Condition (static calibration)
(3) Thermal aging, thermal cycling
(4) Static Calibration
(5) Radiation, Normal and Post-Accident
(6) Static Calibration
(7) Environmental Vibration Induced Aging
(8) OBE, SSE
(9) Static Calibration
(10) High Energy Line Break (HELB) Simulation
(11) Post HELB Simulation
(12) Static Calibration
(13) Inspection

A section of the reactor coolant bypass manifold was used for mounting the RCS bypass RTDs. The RTDs were inserted into the test fixture in accordance with Westinghouse drawing 2650C29, Rev. 1 and torqued to 200 in-lbs. The testing was performed as a single frequency multiaxial sinusoidal dwell test to simulate possible piping fitting properties. The tests included 21 discrete frequencies and the test specimen was rotated by 90° for each of the 4 test configurations with respect to the input motion. Input levels were increased by a factor of 1.8 to account for fixture orientation.

Initial testing sequence including seismic was acceptable. Cable was modified as a result of HELB testing. Retesting of cable was acceptable. It should be rated that flow induced and pipe vibration tests were conducted to mechanically age the component prior to the seismic tests. For seismic tests, 5 OBE and 4 SSE tests were conducted at g-levels of 4g for OBE and 5.7g for SSE.

It has been concluded after completing all the tests that the qualified life for the narrow range detectors is 20 years and that of the wide range detectors is 10 years.

Based on our review, field installation and explanations provided by the Westinghouse engineer, the equipment is found to be qualified for the Byron site. However, the following open items need to be resolved:

(1) A surveillance program should be established to monitor the short qualified life of these units.
(2) The installation of the narrow range units should be completed.
(3) The equipment should be reassessed for the Marble Hill Spectra.

Valve Limit Switches
(EA-180 & EA-740)

Two types of externally-mounted limit switches were audited during the plant visit, namely, models EA-180 and EA-740. These limit switches are attached to valves at various locations throughout the plant. In particular, according to Westinghouse, there are 70 limit switches for 35 different valves which are located in various safety-related systems. These limit switches are used to indicate valve position. The units that were inspected in the field were designated ID numbers 1SI8871 and 1SI8889D. Each unit is about 3-in. x 2-1/2-in. x 6-1/2 in. in size and weighs approximately 5 lbs. An individual switch is mounted to the valve in a cantilevered manner by means of 2 bolts, each of which is 5/16 in. nominal size. The vendor for these switches was identified to be NAMCO. The pertinent design specifications are designated as WCAP-8587-Supplement 1-EQDP HE-3/ PO 457110/457113, and WCAP-9688.

Qualification of these switches was accomplished via type-testing. The relevant qualification reports are WCAP 8687 EQDP HE-3 and WCAP-8687. The pertinent report was entitled "NAMCO Externally-Mounted Valve Limit Switches, Rev. 1" dated July, 1981. The report was prepared and reviewed by Westinghouse (NTD).

One switch from each type (two switches total), with the most severe mounting configuration, was selected and type-tested. In addition, five other limit switches. representing various mechanical features within each design family, were thermally and mechanically aged and then vibration/seismic tested. All seven switches were thermally aged for a time period and temperature equivalent to a qualified life of 10 years, and mechanically aged to a total of 100,000 cycles. The first two specimens were additionally subjected to a gamma radiation dose of 2.0 x 10^8 rads. Then all seven switches were seismically tested by employing continuous sine dwell tests at aprroximately 1/4 octave intervals from 1 to 33 Hz. It is claimed that the acceleration amplitudes contained sufficient conservation over the 4.0g level. This single frequency, single axis test method was repeated in each of the three (3) orthogonal axes. Five (5) OBE tests followed by one (1) SSE were applied in each orientation, and the switch was actuated during each sine dwell. After completion of the seismic tests, the limit switch assemblies were performance tested. All switches successfully completed the above tests.

The tests were conducted generically in order to envelop various plant-specific spectra in various nuclear power plants and sites that Westinghouse is involved with. With respect to Byron-1, in particular, the "worst case" spectra from the piping analysis should be identified and compared with the test acceleration input. Westinghouse gave the assurance, however, that in all cases the test acceleration levels enveloped all plant-specific acceleration values. Nevertheless, documentation regarding this matter should be included in the overall qualification package. It should be noted that the Marble Hill Spectra should be employed to the piping analysis wherever applicable.

In conclusion, it was found that the field-inspected limit switches were adequately installed. The switches are considered qualified, except that it should be shown: (1) that the "worst case" plant-specific acceleration level is covered by the generic test-acceleration levels, and (2) that a proper surveillance program be implemented, since the qualified life of these switches is only 10 years.

Motor-Operated Gate Valve
(1RH8701A&B)

The two valves with ID numbers 1RH8701A&B, are identical in all aspects except that 8701B has an external switch assembly whereas 8701A has a built-in one. The former is located at elevation 379 ft. and the later at elevation 386 ft.-6 in., in the Containment Building. The model number for 8701A is 12000GM88SEH00 and for 8701B, 12000GM88SEH01. Both valves are 12-in. gate valves, and weigh approximately 4975 lbs. each. They have the same dimensions: 52-in. x 95-in. x 24-in. The vendor for both valves was identified to be Westinghouse Electric Corp. (Electro-Mechanical Division). These valves are installed in the Residual Heat Removal (RHR) System and their primary function is for containment isolation. Each valve is mounted and welded to the pipe at particular locations along the RHR piping system. The pertinent reference specifications for these valves is General Specification g-678852 Rev. 2.

The qualification report for both valves is designated as Engineering Memorandum No. 4981-1, dated December 20, 1978. It was prepared and reviewed by Westinghouse Electric Corporation (Electro-Mechanical Division). The analytical model was two-dimensional translated into an equivalent three-dimensional system based on report WCAP-8230 which, as mentioned, is currently under review for validation by the NRC staff. The report showed that there was no natural frequency below 60 Hz. The applied acceleration loads were based on the piping analysis of the system which includes the valves. The seismic loads were combined with other loading conditions and it was shown that the calculated stresses and deflections at some critical locations were below their respective allowable values. The applied acceleration loads for 8701B, however, were below their corresponding plant-specific acceleration levels. Westinghouse gave assurance that requalification will be made according to plant-specific acceleration levels. In addition, the piping analysis, upon which the valve acceleration loads were based, has to be re-evaluated based on the applicable Marble Hill Spectra. In view of these factors, it is deemed that the results of the analysis are present inconclusive.

Westinghouse also mentioned that the operator of these valves is currently being tested for qualification purposes and the relevant documentation will be available in the future. It should be pointed out that since the valve opeator is being tested separately, the cross-coupling effect of the operator and valve body as a sing e inter-connected dynamic system should also be addressed. Furthermore, the various mechanisms of aging, and sequential test requirements should be addressed and implemented.

In conclusion, although it was found that the installation of the valves was acceptable, the available documentation during the audit was inadequate. Thus, no rational conclusion can be made with regards to the qualification status of the equipment.

ASME Class 2 Motor Operated Gate Valve

This motor operated valve is located in the Auxiliary Building at the 395' elevation. It is connected to the pressure relieve tank and is placed only several feet from the containment wall. The function of the valve is to provide containment isolation for the component cooling system. It is required for the Hot Standby situations. The particular valve inspected during the field trip was identified by model number B14-064B-2TS.

The valve was manufactured by Velan Engineering Company in accordance to Westinghouse general specification G-678852, Rev. 2 dated 3/14/77. The valve was qualified by hand calculation as described in the Velan Engineering Co. report entitled "Engineering Calculation DR-1039", Report No. DR-1039, Rev. 2, dated 3/26/76.

The inspected valve was identified by ID No. 709596KY with operating frequency of 60 Hz, operating pressure 150 psig and maximum temperature change of 75°C. The valve was pipe mounted in the horizontal position. The actuator was offset on one side of the pipe and connected vertically to the valve. The valve body was welded to the supporting pipe via a Butte weld.

The natural frequency in the supposed worst possible direction which corresponds to the side by side bending motion of the whole valve assembly was calculated. This assumed lowest frequency of 45 Hz was used as a justification for applying an equivalent static analysis. The g loads used in the qualification were 2.1 g in two horizontal and vertical direction. These g loads have been verified with the valve loads predicted by the piping analysis. In order to simplify the calculation of actual the three-dimensional loadings were translated into two-dimensional equivalent loading by a method described in the Westinghouse document WCAP-8230. It should be noted, however, that this procedure has not as yet been accepted by NRC. Most stresses at critical locations were checked against their maximum allowable limits and safe margins were found. However, shear stresses for the 3/4" Bonnet Bolts which could be critical were not calculated.

No tests were performed on the actuator of the valve. The argument was the that actuator was assumed to behave like a lumped mass under dynamic loadings. However, whether the structural integrity of the actuator itself could be maintained under seismic and operating loads or not still remain to be verified by calculating the deflections and stresses.

In summary, several open items remain before dynamic qualification of this equipment is deemed acceptable. These are:

1) Evaluate the shear stresses for the Bonnet Bolts.
2) Perform tests on the actuator.
3) Verification of Westinghouse document WCAP-8230 for using the two-dimensional approach.

Residual Heat Removal Pump and Motor Assembly

The Residual Heat Removal (RHR) pump-and-motor assemblies are located in the Auxiliary Building at elevation 346 ft. There are two (2) units required per plant and both units for Byron-1 were field-inspected for adequacy of installation. Each unit is approximately 44 in. diameter and 33 in. high, and weighs about 8000 lbs. The model number of each pump is 8 x 0 WDF. The pump has a design pumping capacity of 3000 gpm. The vendor was identified as Ingersoll-Rand, and the pertinent reference specifications are: (a) For the pump: E-Spec # 678815 Rev. 2 plus addendum E-952487 Rev. 2 and Interim Change # 1 and 2, (b) for the motor: E-Spec # 677474 Rev. 0 plus addendum E-952346 Rev. 3 and Interim Change # 2.

In addition to the primary function of residual heat removal, these pump-and-motor assemblies are also required for low-pressure injection in the event of containment depressurization. Hence, they are located in both the residual heat removal system and the safety injection system.

The RHR pump is mounted to a reinforced concrete pedestal by means of 3 bolts, each 2 in. nominal size. The pump casting is welded to the inlet and outlet piping; directly mounted and bolted on top of the pump is the motor drive.

The whole assembly is qualified by analysis. The qualification report for the pump is ME-174, entitled "Pump Seismic: Structural Integrity and Operability Analysis". This report was prepared by McDonald Engineering Analysis Co. and reviewed and accepted by both Ingersoll Rand and Westinghouse. For the motor, the report is S.O. 74F12681 entitled "Motor Seismic: Seismic Analysis". This report was prepared by Westinghouse (LMD) in Buffalo and reviewed and approved by Westinghouse (NTD).

Results of the analysis showed that the stresses and deflections at selected critical locations are all below the allowable values for the following loading combinations: (a) normal + SSE + max. nozzle loads, and (b) Normal + OBE + max. nozzle loads. Prior to the structural calculations, it was shown that there was no resonance below 33 Hz. thus justifying static analysis. Based on the comparison of the calculated values to the allowble values, it was claimed that the equipment is qualified.

It should be noted, however, that the analytical model was two-dimensional translated into a three-dimensional system using the method described in WCAP-8230 which is still currently under NRC review. In addition the motor drive is such a complicated electrical piece of equipment which contains organic materials that may be age-sensitive. Therefore, components that are susceptible to the various mechanisms of aging, such as operational and environmental, should be identified. In general, type-testing should be considered in order to demonstrate that at the end of the equipment's qualified life it can still perform its safety-related function when subjected to a series of OBE's followed by an SSE.

The installation of the pump and motor assembly was generally acceptable except that some small-bore piping were found to be too flexible. This concern should be addressed either by justifying the present as-built condition of the small-bore piping or adding more stiffeners wherever necessary.

In conclusion, the following areas of concern should be addressed before reaching a final judgement as to the qualificatio^ status of the equipment:

a) NRC validation and approval of WCAP-8230
b) Aging, and implementation of the sequential test requirements, and
c) Justify the as-built condition of the small-bore piping, (or add more supports).

Safety Injection Pump

The function of the Safety Injection Pump is to supply borated water into the Reactor Coolant System during a loss of coolant accident in order to prevent rapid depressurization. Two Safety Injection Pumps are used in this plant. Both are identified by model numbers 3"-JHF-10 and are located at the 364' level in the Auxiliary Building. The pump assembly inc'udes the pump, gear, motor, auxiliary systems and associated piping. The assembly is mounted to the floor with ten 1" (nominal) bolts. The overall dimension of the unit are 180" long, 44" wide and 53" high. The unit total weight is 12,375 lb.

The documents that provide the seismic design calculations for the pump are K-363 and K-386, Rev. 3. These were prepared by Pacific Pumps. The document that provides the seismic design calculations for the motor is 75F32374. This document was prepared by the Westinghouse Large Motor Division. The specification used are E-spec 678815, Rev. 2 for the pump and E-spec 677474 for the motor.

Tests were performed to determine the natural resonant frequencies of the pump assembly. The indu r was mounted on the pump assembly in three positions so that the vertical, axial and transverse excitation was transmitted to the pump. Frequency sweep was carried out from 1.5 Hz up to 200 Hz. The natural frequencies were found to be above 35 Hz. The test results were used as a justification that a static analysis is adequate for evaluation of stresses and deflections for the expected loading conditions.

In reviewing the qualification documents, it was noted that there was no calculation made to show that clearances between rotary and stationary parts would always be maintained. When notified about this, the Westinghouse representatives submitted a one page supplement where shaft calculation are given. Unfortunately, the assumption that all loads are concentrated and act at the center of the shaft is different from the actual situation where the loads are rather uniformly distributed.

The operating loads consist of torsional, shaft, normal pressure, gravity and nozzle load from neighboring piping system. These three-dimensional loadings are interpreted as equivalent two-dimensional loadings according to Westinghouse document WCAP-8230. The procedure for using the two-dimensional equivalent has not as yet been verified by NRC.

In summary, the following items remain open:

1) Provide evidence that the clearance between the shaft and surrounding components is adequate for the pump to function normally.
2) Provide verification of the method described in Westinghouse document WCAP-8230.

8028 Air Operated Valve

This air operated valve is located outside of the containment wall in the Auxiliary Building at the 387' level. The pipe line in which this particular valve is seated was not connected to the reactor coolant system when the audit was made. Valve dimensions including the actuator and yoke are 55" long and 18" x 20" in the other directions. The approximate weight of the unit is 323 lbs.

As is typically the case for pipe mounted equipment, the analysis regarding the adequacy of the supports for the piping system in which this valve is contained is treated only in the piping analysis report. Thus no comments regarding the adequacy of the pipe supports can be made.

Two reports are used in qualifying this equipment. One is entitled "Natural Frequency Analysis Report" No. 1612, Rev. 1, dated 3/18/75 while the other is entitled "Seismic Analysis" No. 1'63, Rev. 5, dated 2/12/75. Both reports were prepared by ITT ORINELL and reviewed by Westinghouse. The latter report mainly described an approximate analysis method which is used to find the fundamental frequency in the assumed "weakest" direction. The assumption further is that the frequency would be the lowest in this assumed direction. Since the calculated frequency was 54 Hz which is well over 35 Hz, it is justified that an equivalent static analysis could be performed in accordance with IEEE 344, 1975 standards. In this analysis the Yoke, Adapter Bushing, Bonnet and Boltings are all assumed to have simple shapes and were thus simply modeled as supported beams. The actuator was assumed to be rigid lumped mass.

No stress analysis pertaining to the valve body was included in the report. Although the thickness of the valve body had been checked for conformance with ASME specification, no checks were made to ascertain whether or not the stress levels would exceed the allowables under extreme earthquake conditions. The Westinghouse representative claimed that a "bend test" could be used as an alternative to the stress analysis to evaluate earthquake effects on the valve body. The so called "bend test" has been used by