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

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

FROM: Arnold Lee
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.

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 Jun , 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

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	CECO	Brookhaven
A. Lee	T. Tramm	R. Alforgue
M. Haughey	K. Ainger	R. Hoder
D. Reiff	J. Westermeier	M. Subudhi
K. Kiper		M. Chang
		P. Turtzo

S & L	Westinghouse
K. Adlon	J. Mc Inerny
K. Green	C. Draughon
J. Mattingly	L. Walker
R. Raheja	
G. K. Roy	
D. Thorpe	

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 (OFH01 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)

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

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 included 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.

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 1-1/8" 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. 1N-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 orresponding natural frequencies between the two models

were quite close. Furthermore, since the analytical natural frequencies were lower than the test frequencies 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.

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 anchored 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 10/22/76. 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 in 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 were 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 conducted in each axis from 1 to 33 Hz at a frequency sweep rate of one octave per minute with 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 over-speed 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 revi[illegible]y 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-CM[illegible]-425579-BN, E-Spec 95344[illegible], 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-82[illegible], 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 8577D47, 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 2.0×10^8 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 presently 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 single 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 B14-0648-2TS.

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 83 in. high, and weighs about 8000 lbs. The model number of each pump is 8 x 20 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 qualification 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 includes 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 inducer 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. 1163, 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 a 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

Westinghouse generally for "Operability Test Procedures for ITT Grinnell Diaphragm Valve" No. SV-QT-129. These documents have not been, however, finalized or approved by Westinghouse. Furthermore, using the bend test as a substitute for the dynamic analysis is of questionable value unless a full range of test procedures were covered in the "bend test" specifically the strains and stresses occurring during various phases of bending should be mointored. Without this the results of the bend test are limited. Finally, using simple static bending force without simulating the real pressure, temperature and transient flow conditions for the purpose of qualifying mechanical operability requires documented verification.

In summary, based on the review, the following items remain open for this equipment.

1) An analysis for the valve body should be performed.
2) An alternate procedure is recommended for the bend test to prove operability of the valve.