Structural Analysis Division
Department of Nuclear Energy
Brookhaven National Laboratory
Upton, NY 11973

Seismic Qualification Review Team (SQRT)
Audit Report
for
Nine Mile Point Nuclear Station, Unit 2

Audit Date: July 8-12, 1985

INTRODUCTION

This report documents the evaluation of seismic qualification of some preselected seismic category I equipment for Nine Mile Point Nuclear Station, Unit 2. The report is prepared by Brookhaven National Laboratory (BNL) based upon an audit performed by the Seismic Qualification Review Team (SQRT) at the plant site in Upstate New York during July 8-12, 1985. The BNL review team consisted of J. Curreri, M. Kassir and K. Bandyopadhyay. The Nuclear Regulatory Commission (NRC) was represented by N. Romney for the SQRT audit.

A total of eighteen pieces of equipment, eight from Nuclear Steam Supply System (NSSS) and ten from the Balance of Plant (BOP), was audited. The audit consisted of site inspection of one or more samples of each equipment family followed by review of the pertinent seismic qualification documents as presented by Niagara Mohawk Power Corporation (NM) and its agents General Electric Company (GE) and Stone & Webster Engineering Company (S&W). The site installation was compared with the qualification mounting, and the qualification documents were reviewed to meet the adequacy of structural integrity and functional operability of the equipment. Due to energization of the equipment and/or unaccessability of the mounting, some installations could not be properly inspected. During the audit period, NM, GE and S&W described their qualification program through presentation, and interpretation and clarification of qualification reports.

The seismic evaluation of the equipment resulting from the audit is individually described in the following sections including the equipment-specific open issues requiring resolution for acceptance of its seismic qualification program. A listing of the audited equipment and a brief description of the findings including respective status are provided in the attached table. The generic open issues also requiring resolution for acceptance of the seismic qualification program are listed in the following subsection.

GENERIC OPEN ISSUES

1. a) The master list of equipment as presented did not fully agree with the qualification and installation status observed during the audit. Since this list is used by the staff to assess the status of the qualification program, the master list should be revised so that it provides the correct status. Pragmatically, at a given time, the master list may lag behind the true qualification or installation status; but it should never describe an equipment to be qualified or installed when it is not.

b) Upon completion, the applicant must confirm that all safety-related equipment is qualified and properly installed.

2. The nozzle loads and g-values assumed for qualification of an equipment should be verified and confirmed after the completion of the as-built piping analysis.

3. It was observed during the site inspection that for some equipment the installation was not complete or faulty (i.e., loose screws, missing panels, etc.). Accordingly, a "Reject Tag" was attached to most equipment. All equipment should be completely installed in accordance with the qualification documents. The equipment already installed should be brought back to the qualification status.

4. It was observed that the floor response spectra for the Control and Diesel Generator Building were recently revised exhibiting a frequency shift (ref. e.g., E&DCR P02502 dated January 12, 1985). It should be verified and confirmed that all equipment in this building is qualified to the revised response spectra since most equipment might have been procured prior to this revision.

5. A recent study by the applicant indicates that the vertical response spectra in the Control Building may be exceeded by as much as 50-60% at certain frequencies if the floor flexibility is accounted for in the response spectra generating analysis (ref. Niagara Mohawk letter NMP2L 0213, dated October 25, 1984). All equipment in the Control Building should be verified against this possible exceedance of vertical response spectra.

Hydrogen Analyzer Panel
(2CMS*PNL 66A)

The purpose of this panel is to monitor the percentage of hydrogen/oxygen in the containment atmosphere. There are two such panels in the plant. The inspected unit is a floor mounted cabinet (72" high by 30" wide by 30" deep) consisting of three compartments of approximately equal heights. The lower compartment contains horizontally mounted pump and motor for sampling the gas, the middle compartment holds two heat exchangers and a hot box mounted on steel channels and in the upper compartment there are several valves, indicators, monitors and other electronic instruments. The panel is a standard K-IV model supplied by Compsip Inc. (Delphi instrument and control systems). Its weight including the instruments is 1440 lbs., and is mounted vertically on a concrete floor by means of six 5/8" diameter anchors (of the drilled-in, wedge type) at elevation 240 feet of the Auxiliary Building - North Bay.

Stone and Webster's specification no. NMP2-C001C contains the design references and requirements of the equipment.

The structural frame of the panel (without the instruments) is qualified by a combination of test and analysis. The qualification document presented during the audit visit is report No. 1035-2, "Seismic Qualification to IEEE-344-1975 of the Delphi IV Hydrogen Analyzer", prepared by Engineering Analysis and Test Company, Inc. and dated July 1980. In part II of this report, tests were performed to determine the resonant frequencies of the frame. Resonant frequencies were observed in the structural frame of the K-IV panel in both of the two horizontal directions. No resonances were found on the vertical direction. Along the longitudinal direction (X-direction), the frame exhibited a first mode of vibration at 19 Hz. Harmonics of this first mode were exhibited at multiples of this fundamental frequency. Transmissibilities of 9 to 27 were observed. Along the lateral direction (Y-axis),

a first mode of vibration was observed at 29.6 Hz. Harmonics of this mode were exhibited at multiples of the fundamental frequency and transmissibilities of 2 to 17 were observed.

In part I of the same report, the panel frame is seismically qualified by an equivalent static seismic analysis. The seismic load is obtained by assuming the acceleratioin to be 1.3 times the acceleration value at frequency 19 Hz from the RRS. For various modes of structural failure (plate bending, buckling, etc.), the panel is found to be structurally adequate to sustain the design basis seismic accelerations without incurring permanent deformation.

For the subassemblies and instruments the qualification is done by tests. This is documented in report No. 1035-1, "Prototype Qualification for Delphi Hydrogen Analyzer Systems K-III and K-IV", prepared by Engineering Analysis and Test Company, Inc., dated September 1981, and reviewed by Stone and Webster Engineering Corporation. Random multifrequency testing and seismic vibration tests were performed on the various components of the panel. All instruments were energized (as applicable) during the tests and the functional requirements were monitored to insure that the operation of the instruments was not impaired when subjected to the seismic testing. In the initial series of tests two anomalies were observed during the post -LOCA exposure. Both of these anomalies pertain to the sample pump. The sample pump bearings were observed to be fixed preventing the actuator arm from moving. The second anomaly concerns the sample pump diaphragms which were observed to be leaking. The sample pump bearings were modified and a different high temperature grease packing was used, and the pump was qualified in a later series of tests. No anomalies were observed in the diaphrams of the modified pump. A letter from the vendor, dated July 11, 1985, indicates that the installed sample pump contains the above mentioned modifications.

A question was raised concerning the test mounting attachments of the instruments in the compartments of the panel and whether they simulate the actual in-service mounting means. Stone and Webster personnel produced pictures of the actual laboratory tests. However, these picture were of poor quality and one can not ascertain clearly the nature of the mounting means employed in the seismic tests.

The electric motor of the sample pump (in the lower compartment of the panel) is a horizontal, foot mounted motor supplied by Reliance Electric Co. It is qualified by analysis and the qualification is documented in report no. 8UB-A30, "Seismic Analysis of Horizontal, foot mounted, Electric Motor for Comsip Delphi", prepared by Reliance Electric Motor Division and dated August 1980. It is essentially an equivalent static analysis using generic g-level loading (4.5 g in 3 directions which is higher than what is required) to insure that there are adequate design safety factors in the critical stresses and the shaft's deflection relative to the bearing.

The qualification of the mounting bolts of the panel to the concrete floor is discussed in Stone and Webster's report no. MS-1910, "Mounting Bolts for Hydrogen/Oxygen Gas Analyzer Panel", dated 7-20-84. An analysis is carried out which shows that the bolts can withstand the postulated SSE loading and will not adversely affect the seismic response of the panel.

Based on the above mentioned reports and the field inspection trip we have reached the conclusion that the Hydrogen/Oxygen Analyzer Panel is seismically qualified pending the confirmation that the mounting means of the various subassemblies and electrical instruments to the installed panel are at least equivalent to the corresponding ones used in the seismic tests.

Remote Shutdown Panel

The Remote Shutdown Panel (RSP) provides redundancy to the Control Room in case the Control Room is uninhabitable or cannot function.

The RSP consists of three free-standing cabinets identified as Section I, II and III. Each panel assembly is a welded steel cabinet enclosure with one or more access doors. The sections are mounted side-by-side with a specific distance between Section I and Section II, and with Section II and Section III bolted together. All are welded to the floor embedment plate. Each cabinet is 42"D and 90"H. The total length of the cabinets, including the 40" space between I and II, is about 280". The total weight is about 11,000 lbs. Wiring between cabinets is routed via enclosed roof-mounted cable tray assemblies.

The seismic qualification is done by analysis. Acton Environmental Testing Corporation performed a finite element analysis of each section, using the STARDYNE code. Section I was done independently from Sections II and III. The cable trays were not considered in the dynamic responses.

The Acton Report No. 18202-83N-3, dated 12/22/83, is entitled, "Seismic Structural Qualification of Electro-Mechanics Panels 405 Section I and Sections II and III Assembly for Nine Mile Point Nuclear Generating Station Unit 2 per Stone and Webster Specification No. NMP2-C061G".

The structures were modeled as plates and beams with two "worst case" subpanels modeled so that the minimum natural frequency would be obtained. Additionally, the material density was increased by 6 percent to account for the wiring distributed throughout the panel. It was determined that the lowest natural frequency of the structures was higher than 33 Hz.

The models were subjected to the loadings due to the required DBE plus the gravity load. The calculated stresses were significantly lower that the allowble stesses.

The qualification of the cable trays which are mounted on the tops of the various structures is contained in a separate Stone and Webster calculation report, J.O. No. 12177, dated 5/23/85. A static analysis is performed in which the displacements, previously calculated in the Action finite element report, are imposed on the cable trays. The resulting stresses on the cable trays and supports and on the structures of Sections I, II and III are shown to be acceptable.

The RSP houses a number of equipment, including power supplies, banks of transfer and control switches, pushbutton switches, circuit cards, temperature selectors, transmitters and recorders signal conditioning circuits, indicators for various kinds of measurements and many relays. The qualification report for all of the equipment housed in the RSP was not available at the time of the audit in July 1985.

The results of the audit, therefore, show that the structure is qualified but that the instrumentation and equipment remains to be qualified and so this is an open item.

Foxboro N-2ES Cabinets
(2CES*P28, etc.)

The Foxboro racks (model N-2ES, style B) are vertical, floor mounted cabinets, 32" wide x 36-1/2" deep x 89.4" high, located in the Relay Room of the Control Building at elevation 288"-6". There are eight such racks in the plant. The inspected rack is bolted to the floor. The weight of each rack with its content is approximately 1042 lbs. There are instrument modules mounted in four 2 ANU-D nests which in turn are mounted at the top level of two N-2ES racks (one on each side).

The instruments must perform their required class 1E functions and the rack-mounted modules must have adequate structural integrity under postulated OBE and SSE seismic environment.

The qualification is done mainly by tests and it is described in this report for the panel cabinet as well as the individual instruments in the modules. The pertinent design requirements are given in Stone and Webster's Specification No. C071L, "Control Room Instrumentation and Racks", Revision 1 and Add. 1 and E&DCR P02502, dated 1/12/85.

The panel is qualifed by a combination of test and analysis. The following documents, prepared by Foxboro, were produced during the audit to substantiate the qualification:

1) Report No. Q0AAB01 - Rev. A, "A Class 1E Qualification of Equipment to Generic Service Conditions", dated 1/7/83.

2) Report No. Q0AAA20, parts 1 & 2, dated 1/12/83 with letter from Foxboro dated 6/5/80. Also, Appendix A, Revision A, "SSE Floor Response

Spectra for Testing", dated 7/30/80. This section demonstrates the validity of the single unit tests.

3) Report No. QOAAA04, part 1, "Seismic Vibration Test Procedure", Revision B, dated 12/19/77.

The purpose of the analysis in report No. (2) above, is to show the validity of the test results of a single unit for the multibay unit cabinets. A dynamic analysis was carried out which revealed that the lowest natural frequency was 12.8 Hz in the side-to-side direction.

During the seismic test the panel was bolted to the shake table and no modifications were required as a result of the tests. The cabinet was qualified with a 50ft-lb torque on the mounting bolts. However, it was not clear how this torque value would be maintained during the entire life of the plant with the possibility of relaxation and creep.

The instruments were qualified by testing. The mounting of the instrument modules resembles the field mounting. During the test, the functional nests and power supplies to be qualified were energized and the functioning modules were monitored. Where applicable, the outputs of the relays were monitored for spurious openings and/or closures, and logic functions were operated during the testing. All nests were energized and de-energized 45 times before the seismic tests. The cabinets contain the following instruments:

(a) Pressure Switch (2CCP*PSLX90A):

The switch is required for low pressure alarm for reactor recirculating pump cooler and control of motor operated valves. It is a small electronic gadget measuring 4.5" x 1.8" x 3" and weighing approximately 3.59 lbs. It is

qualified by test and report no. QOAAB34, Rev. A., "Type Test Report 2AO-L2C-R, Style A", prepared by Foxboro and dated 12/7/82, describes the test procedures. The actual testing was done at ACTON/NTS Laboratories. During and SSE event in the left-to-right plane, one output of the relay chattered. The report indicates that "At the time of this report, Foxboro is in the process of investigating other relays which, hopefully, would perform satisfactorily at the SSE level." The maximum contact chatter duration during testing was not precisely defined nor subsequently justified.

(b) Signal Selector (2CMS*TY131):

The signal selector (2AP and SSL) is required for monitoring the high temperature in the containment area. It is a small electronic gadget weighing 1.49 lbs only and having dimensions 4.2" x 0.8" x 1.7". The "AP" is attached to the rack by screws and the "SSL" is clipped on the AP. Its qualification is discussed in Foxboro's Report No. QOAAB38, Rev. A, "Type Test Report for 2AP + SSL, Style B", dated 3/14/79. The actual seismic testing was done at NTS-ACTON Laboratories. The equipment successfully passed the test and no modifications were required.

(c) Relay Logic Card (2HVP*TYV11A):

The relay logic card is part of the standby Diesel Generator Building ventilation system. It's function is to control the temperature in the standby Diesel Generator Room. It has dimensions of 4.6" x 1" x 0.6" and weighs approximately 0.93 16s. It is mounted with screws on the rack. The qualification is done by tests performed at NTS-ACTON Laboratories and the report is in Foxboro's document No. QOAAB40, Rev. A, "Type Test Report for 2AX + URS Style B", dated 2/23/79. No anomalies were observed in the seismic test program.

(d) Power Supplies (2CEC*PWRS828):

The instrument power supply is a box type instrument measuring 3.8" x 6.8" x 6.3" and weighing approximately 53.5 lbs. It is attached to the Foxboro rack with screws. Its model no. is GE H13-P828. Its structural integrity and class 1E performance were assured by tests. Report No. QOAAB25, Rev. A, "Type Test Report for 2 ARPS-A6-B+BB2", prepared by Foxboro, dated 3/30/79, describes the qualification rationale. The actual test was done at ACTUN/NTS Laboratories. The equipment successfully passed the test.

Based upon our walk-thru inspection and review of the qualification documents during the audit, we have reached the conclusion that the qualification of the Foxboro N-2ES cabinets is open pending the resolution of the following concerns:

1) The maximum contact chatter duration during testing was not precisely defined nor subsequently justified. This finding is generic for all Foxboro devices.

2) The cabinet was qualified with a 50ft-lb torque on mounting bolts. It was not demonstrated how this torque value will be maintained on regular mounting bolts during the entire life of the plant with the possibility of relaxation and creep.

600V AC Emergency Panel

The 600V AC Emergency Panel distributes 600V AC power to various class 1E loads including:

1) Unit heaters
2) Division I uninterruptable power supply
3) 120V AC control circuits via a class 1E step down transformer
4) Division I battery charger

The panel is of moderate size and measures 38"Wx17"Dx90"H. It weighs 400 lbs. It is located in the control building at the 261' level where it is wall mounted through an intermediate structure of square tubing. The panel houses a number of molded case circuit breakers and fusable vaccum-break switches.

The panel is qualified by tests performed at Wyle Laboratories, Huntsville, Alabama. The test report is No. 45662-1, dated, June 18, 1981. The seismic test program consisted of resonance search testing and phase incoherent biaxial random multifrequency testing in each of two test orientations. The tested panel was instrumented with accelerometers, electrically powered and monitored for functional operation during the seismic test program. Seventeen channels of electrical monitoring were used to record spurious operation, including contact chatter before, during and after seismic excitation. Five OBE tests, followed by SSE tests, were performed in both FB/V and the SS/V orientations of the tested panel. Because of some initial anomalies regarding function, additional tests were performed before satisfactory operation was obtained. The report indicates that the anomalies occurred because of the excessive bounding of the RRS by the TRS in the vertical direction. When the TRS was reduced somewhat, but still enveloping the RRS, no further anomalies occurred.

Post test inspection revealed that the left and right sides of the raised circuit breaker housing had been damaged. Two triangular gussets were welded to the mounting bracket of the circuit breaker to correct the anomaly. Additionally, the circuit breaker housing was secured to the cover panel with three self tapping screws. Further study of the test results revealed a change of state had also occurred. Analysis of the input data established that a higher than required input had been applied vertically. The horizontal and vertical inputs were adjusted so that the TRS enveloped the RRS, but not excessively so. Following these changes in the system, the required series of five UBE's and one SSE were successfully completed.

The actual installation of the 600V AC Emergency Panel is somewhat different from the tested panel. The installed panel spans the distance between two parallel sqaure cross-sectioned tubes. The back of the panel between the mounting points is not in contact with the supporting structure. However, the tested panel was flush mounted to the supports to which it was bolted. This difference between the as-tested and as-installed panel must be addressed and reviewed.

The status of this piece of equipment is therefore still open. It must be shown that the as-installed equipment is structurally and dynamically the same as the tested equipment. Furthermore, the changes that were made to the equipment to pass the seismic test should be permanent changes that are recorded in the specification for this piece of equipment.

Diesel Generator
(2EGS*EG1)

The standby diesel generator is an 122-ton power generator supplied by Cooper Energy Services (Model KSV-16-T). It is located in the Diesel Generator Building at elevation 261 feet. The functional requirement of the diesel generator is to supply power to safety-related equipment in case there is loss of offsite power supply. The inspected equipment has overall dimensions of 43'-0" x 14'-0" x 15'-5" and is mounted to the floor by 51 bolts of various sizes. During the walk-through inspection, it was found that loose shim plates were used to mount the generator skid.

The design requirements of the diesel generator are described in Stone and Webster's Specification No. NMP2-E031A, addenda 1 through 6. Its operability and structural integrity during seismic events are demonstrated through a combination of analysis and tests.

There are a total of 41 qualification documents covering the main unit and its associated devices and mounting means. These reports are tabulated in attachment II of the SQRT form.

A response spectrum model analysis developed by the vendor, Cooper Energy Services, is used to qualify the engine structure. A suitable mathematical model is devised and subjected to SSE horizontal and vertical response spectra, and the results are compared to the OBE limits. The stresses from the three loadings were combined using the SRSS method. This combined stress was added directly to the streses from gravity and operating loads. For cases when the dynamic vertical seismic loading was small, a static vertical loading is included in the dynamic load. The engine structure was found rigid. The systems which are mounted on the main engine structure are analyzed with the "g" values obtained from the analysis of the main engine structure. Cooper

Engineering Services also generated the amplified response spectra at different points of the diesel generator where various components are mounted. This was done analytically using the dynamic characteristics like mode shapes and modal participation factors of the main engine structure.

The control system components are qualified by dynamic testing. Document No. CES-0407-38, "Testing of Control System Components" which contains Wyle Report No. WR-83-06, and dated 9/8/83, describes the tests performed. The components were subjected to sine sweeps from 1 to 40 Hz at the rate of 0.5 octave/min to 2 octaves/min for 0.2g. Then they were subjected to biaxial phase incoherent random multifrequency input motion having frequencies in one-third octave bandwidth. The test was performed in four orientations. The test response spectra (TRS) enveloped the required response spectra.

The governor actuator and the overspeed governor were tested. The test program consisted of resonance search testing, random multifrequency testing, and single frequency testing in each of two test orientations. After completion of the qualification level testing, the specimens were subjected to fragility level random multifrequency testing. The random multifrequency testing consisted of five (5) OBE tests followed by two (2) SSE tests over the frequency range of 1-40 Hz at one-third octave intervals. The ac outlet box was also tested by a biaxial random multifrequency test in four orientations. Lube oil thermostatic valve was qualified through analysis and testing. The thermostatic elements were tested to determine their fragility level. They were subjected to a series of increasingly severe sine sweeps at the rate of two octaves/min from 1-50 Hz at a level of 2.0g. Each subsequent sweep had its level increased by 2g up to 16g.

Auxiliary skid piping, jacket water standpipe, fuel oil filter and strainer, turbocharger lube oil filter, jacket water cooler, lube oil heat exchanger, and generator stator and brush mounting structure were all analyzed

by model response spectrum analysis method. The remaining components were qualified by static analysis.

Torsional natural frequencies of the crankshaft were determined by analysis. Torsional stresses were also determined at several locations of the crankshaft due to the stimulation torques at the potentially significant critical speeds. Torsional vibration characteristics of the unit are found to have no adverse effect on the operation of the unit.

The pertinent reports for the above mentioned tests and analyses are given in attachment II of the SQRT form. These reports do indicate that there is substantial margin between the g-level used and the maximum required acceleration level. However, no satisfactory answers were given concerning the following issues:

1) No justification was provided for acceptability of the anomalies observed during testing of various devices.

2) The nozzle loads assumed for analysis of the engine mounted system was not confirmed.

3) The use of loose shim plates in mounting the generator skid was not justified.

Accordingly, the seismic qualification of the diesel generator at the Nine Mile Point - Unit 2 Power Plant is open pending the satisfactory resolution of the above mentioned concerns.

Motor Operated Gate Valve

The Motor Operated Gate Valve (2SWP*MOV30A) is used to control the flow of service water in the North Intake System. The valve is 48" wide X 72" high with a 4-1/2 diameter steam drive, and weighs 6916 lbs. It is manufactured by Henry Pratt Company. The motor operator and floorstand are located at the 285' level of the Screenwell building.

The MOV is qualified by a combination of analysis and test. The analysis portion was done to show that the natural frequencies of the motor operator and its various components, both separately and as a system, are all above a frequency of 33 Hz. The test portion was done to demonstrate the structural adequacy and operability of the valve assemblies. The test was intended to be generic in nature so as to envelop the seimsic excitation at many nuclear power plants, including 9 Mile, Unit 2. Because of the generic nature of the test program, the magnitudes and durations of the tests were more severe than the specific requirements at Nine Mile Point Unit 2.

The valve assemblies were pressurized and operated before, during and after the tests to demonstrate functional operability during a series of dynamic tests. A baseline data test, a sine scan vibration aging test of the operators, a sine scan test to determine natural frequencies, a series of sine beat tests for seismic and hydrodynamic loads, and sine beat fragility tests were all done. Seat leakage was monitored in the baseline test. The two lower limit switches were monitored for contact chatter in excess of two milliseconds.

The test program, documented in S&W J.O. 12177, details the dynamic requirements for seismic loads, which include hydrodynamic loads specific to Mark II and Mark III BWR plants. A second test phase was intended to develop and demonstrate adequacy of the required inpsection/adjustment program for the Limitorque operators. This was in response to the anomalies experienced

with the operation during the initial phase of the qualification program. The anomalies included excessive chatter, failure of the rotor to transfer motion at all or to transfer completely and excessive loosening of screws. In some instances, the chatter resulted in failure of the operator to complete the stroke.

As a result of these anomalies, a standard for bolt torque and a standard for the adjustment of the geared finger assembly were developed. These standards were made part of the Electrical Test Procedure for NMP2 as is noted in S&W document "Motor Operated Valves" approved NMP2, 8/25/84, QA CAT I, II, III".

Using the standards for bolt tightening and geared finder adjustment, it was shown by further tests that the unit performed properly. There was no indication of contact chatter or physical damage during the tests. It is concluded that, by test and by analysis, the motor operated rotary gate valve 2SWP*MOV3UA is qualified for the seismic environment at Nine Mile, Unit 2.

Service Water Pump
(2SWP*P1A)

The service water assembly inspected during the audit consists of a horizontal centrifugal pump manufactured by Gould Pumps Inc. (modal 3415 M, size 14" x 16" - 22 H) connected to a 600 hp Westinghouse electric motor through a flexible coupling. The assembly is mounted to the floor by means of 10 - 1-3/4" bolts at elevation 224 feet of the Screenwell Building. The weight of the equipment (when wet) is 13,810 lbs and its overall dimensions are 11' 4" long x 6' 0" wide x 5' 2-1/4" high. It is required to provide cooling water to safety-related equipment. There are six such units in the Nine Mile Point Unit 2 plant.

Stone and Webster specifications no. NMP-2-P222X through addendum no. 8 W/E and DCR P02, 455A govern the design of the water pump.

The assembly is qualified by analysis. Report no. ME1158, "Seismic-Stress Analysis of AMSE Section III Class 3 Pumps", by McDonald Engineering Analysis Company, Inc. dated 5-18-85, contains an analysis of the model of the assembly to establish its structural integrity and functional capability. The loading considered includes SSE inertia, maximum nozzle and operating loads. A standard STRUDL computer program is used to determine the lowest natural frequency (34.1 Hz) and the critical stresses and deflections. The calculations of stresses are based on horizontal/vertical SSE acceleration of 1.0g/1.2g while the deflections are based on horizontal/vertical accelerations of 0.5g/0.5g, respectively. The required SSE accelerations are 0.23g/0.19g. The critical stress turns out to be in the pump hold down bolts (29,792 psi in tension) while the allowable stress is 29,956 psi. This is acceptable because of the large factor of safety in the input acceleration level used in the analysis. The critical deflection is computed to be 0.005" at the impeller/housing location for which a clearance of 0.007" is available. In this manner the structural integrity of the assembly is established.

The motor is qualified by report no. 77F14708, "Seismic Analysis of Seismic Water Pump Motor", prepared by Westinghouse Corporation and dated 5-4-79. A combination of tests and analysis is used in the report for qualification purposes. A static seismic analysis utilizing Westinghouse computer program no. ME9032, is used to determine the critical stresses and deflections in the motor components. The computer program is not available in the qualification report and hence could not be reviewed to ascertain its assumption and methodology. However, Stone and Webster's personnel confirmed that they had checked code ME9032 and are satisfied of its adequacy. The results indicate that during a design basis earthquake of the specified magnitude (higher than what is required at the Nine Mile Point Unit 2 plant), the maximum stresses in the motor components are lower than the allowable, the maximum deflections in the motor will cause neither interference nor excessive misalignment, the bearing loads are within the acceptable limits, and the motor feet will not deform.

The main conduit box was also bump-tested (impact test) to determine its natural frequency in the three principal directions (axial, lateral and vertical). The lowest natural frequency was determined to be in the rigid range (53 Hz).

A question was raised during the audit concerning the torsional frequency of the motor. Stone and Webster personnel produced an in-house computer analysis and hand calculations, dated June 26, 1985, to show that the torsional frequency is 2003 rpm while the motor's critical speed is 1185 rpm (a difference of about 69%). This is acceptble and it is suggested that the calculations and summary sheet should be included in the qualification documents of the service water pump.

The installed motor hold-down bolts appear to have been inserted into the base without proper nuts or enclosure means. Shims were also used to achieve

leveling of the motor. Under dynamic loadings both bolts and shims could become loose and cause disengagement. A question was raised during the audit concerning the engaged lengths of the bolts and the necessary analysis to ensure structural integrity when subjected to seismic and operating loads. The effects of the hold-down bolts on the flexible coupling misalignment (axial and angular) should also be addressed.

Based upon our review of the field installation and the various reports, we conclude that the following item should be resolved for seismic qualification of the service water pump:

Provide assurance that the motor hold-down bolts and shims do not become loose and the motor-pump alignment is maintained under normal vibration and postulated seismic loading. The bolts should also be checked for structural integrity.

18" - 300 lbs. Butterfly Valve
(2RHS*MOV9A)

The 18" motor operated valve is part of the RHR system. During normal operation of the plant, this valve remains open, and its function is to provide a flow path to the RHR heat exchanger for reactor shutdown, suppression pool and containment spray. The inspected valve is pipe mounted and located in the Auxiliary Building - North Bay - at the 200 feet level. Its weight (including the actuator) is 1414 lbs. The valve's vendor is Posi Seal Inc. and the actuator (model no. SMB-00-10) is by Limitorque. There are two such valves in the plant. The design specification of the valve is Stone and Webster's document no. NMP2-P304D, Revision 1.

The qualification documents show that the valve assembly is qualified by a combination of tests and analysis. The valve's body is seismically qualified by means of an equivalent static analysis given in report no. 34077-01, "Nuclear Seismic Analysis", prepared by Posi Seal International, Inc. and dated 9-27-84. The analysis demonstrates the adequacy of the valve's body to withstand the normal operating and seismic loads with ample margin of safety in the postulated level of g-loading in each of three orthogonal directions.

The operability of the valve is demonstrated by means of a static deflection test described in report no. 340770T-01, "Static Seismic Operability Test Procedure and Results", prepared by Posi Seal International, Inc. and dated 1-7-85. The report shows that the valve retained its ability to operate in its intended manner when subjected to a static force equivalent in magnitude to the postulated seismic force and applied at the center of gravity of the actuator. The force being 3636 lbs. which is equivalent to an acceleration level of 7.5 g (A force of 3 g is required at the installed location.) The valve/actuator cycled three times at this load level with no interference to functional operability.

Report no. B0058, "Limitorque Valve Actuator Qualification for Nuclear Power Stations", prepared by Limitorque Corporation and dated 1-11-80 documents the dynamic tests used to qualify the actuator. It is based on series of tests on actuators with serial numbers SMB-00 and SMB-000 performed by Aero Nav Laboratories, Inc. and discussed in report no. 5771, "Report of Seismic Test on SMB-000-5 motor actuator for Limitorque Corporation". The standard tests were designed to insure that the motor will perform its safety-related function during a postulated seismic event. There were no anomalies mentioned in the report. The same report also contains a test program which was conducted to ensure environmental aging of the motor operator and to qualify it for the life of the plant.

Based on the above information, it is concluded that the 18" motor operated butterfly valve will be qualified for the seismic loads at the Nine Mile Point Unit 2 site.

Storage Batteries

The Storage Batteries provide emergency DC power to critical circuits including 120V MOVS and flashing power for the standby diesel generator.

The batteries are mounted on a double set of two-step steel racks which are located in the control buiding at the 261' level. The racks, which are 39' long X 3'-10" high, are bolted to channels embedded in the concrete floor. The total weight is 34,200 lbs.

The qualification of the storage batteries is shown by the tests performed at the Wyle Laboratories in Huntsville. The test report is No. 44681-2, dated October 27, 1981. Two battery racks, each containing three NCX-2550 batteries, were seismically tested along with other batteries and racks. The battery racks, with batteries installed, were attached to Wyle fabricated fixtures which were welded to the test table. This was done for both FB and SS orientations.

The specimens were subjected to 30 second duration biaxial multifrequency random motion which were amplitude controlled in one-third octave bandwidths spaced one-third octave apart over the frequency range of 1 to 40 Hz. Two simultaneous, but independent, random signals were used to produce phase incoherent horizontal and vertical motions. The required five OBE's and one SSE were produced in each test orientation.

During the first test program, a number of anomalies occurred. These included the loosening of bolts, spilled electrolyte solution and a crack in one of the other batteries involved in the test. The tests were carried out at high TRS level. Another series of tests were conducted at reduced TRS levels which still envelope the Nine Mile 2 RRS with ample margin. Table 1 is illustrative of the TRS levels for both the test series at which failures occurred as well as for the test series for which no failures occurred.

Table 1

Test Direction	ZPA(g)	Response Peak(g)	Failed/Passed
SS/V - HCA	4.7	9.6	Failed
SS/V - VCA	2.7	7.0	Failed
SS/V - HCA	1.7	5.6	Passed
SS/V - VCA	1.3	3.9	Passed

As a result of the final test series, in which the TRS levels enveloped the RRS levels but not excessively so, it was demonstrated that the batteries possessed sufficient structural and electrical integrity to withstand the required seismic environment.

For the test series, control measurements were made at the table level. Therefore, it is necessary to show that the battery racks are rigid within the frequency range of excitation.

The qualification of the array of battery racks was done by analysis. The qualification report is identified as SWEC File No. IEEE 01.520-5000C. The report is entitled, "Environmental Qualification for Class 1E Lead-Acid Storage Batteries", October 25, 1983. The analysis uses a static deflection determination to find the lowest natural frequency of the structure.

The results of the analysis show that the battery rack can be considered to be rigid since its natural frequency is above 30 Hz. However, at the time of the audit a question was raised regarding the implementation of the analytical method. On page 8, Section 6 of the qualification report, the equation for deflection uses the differences due to two static loads. This results in a higher calculated natural frequency than if a sum is used. The loads should actually be in the direction of the normal mode. The normal mode would deter-

mine whether the sum or difference should be used. For the first natural frequency, it appears that the sum should actually be used. Using the difference may actually reflect a higher mode condition. In any case, the question remains as an open issue, i.e., the sign in Y_1-Y_2 should be justified; otherwise, the analysis should be rerun using the finite element approach to show that the natural frequency is high.

Air Conditioning Unit
(2HVC*ACU3A)

The air conditioning unit is used to remove the heat gain in the remote shutdown rooms located in the Control Building. The inspected unit is capable of circulating 1500 CFM and is manufactured by American Air Filter. It is of horizontal configuration, consisting of three rectangular boxes supported on a common floor-mounted skid, and containing a filter unit, a chilled water cooling coil and a fan, respectively. The fan housing is adjacent to the coil housing. The overall dimensions of the unit are 3'-6" wide x 6'-0" long x 2'-10" high and it weighs 1747 lbs. It is located in the Control Building at elevation 275 feet.

The pertinent design requirements of the unit are given in Stone and Webster's Specifications No. NMP2-P412M, Safety Related Unit Space Coolers, Rev. 1, addendum 1, and Specification No. NMP2-P412W. Safety Related Air Cooling Coils for Unit Space Coolers, Rev. 1, addendum 1.

The air conditioning unit has been qualified by a combination of test and analysis. The fan and coil sections are qualified by test while the pre-filter unit is qualified by analysis. Document No. AAF-NESE-714, Rev. 1, "Seismic Qualification of Safety Related Unit Space Coolers", prepared by American Air Filter, dated 7/27/83, describes the seismic test program and the accompanying correlation employed to qualify the fan and cooling sections. It contains Wyle Laboratories report no. 45076-1, Rev. A, "Seismic Simulation", dated 5/30/80, which describes the seismic tests performed on a generic, horizontally-mounted air handling unit.

The tested unit has a greater weight and size than the installed one. However, both are of similar constructuion and design. During test run 12, the unit experienced structural failure which required modifications for

successful completion of the test. The failure resulted from back out of coil mounting bolts which were 1/4" - 20 UNC x 3/4" long, Grade 5 bolts. These were replaced by identical bolts but of length 1-1/2" for the remainder of the tests. The installed unit is attached by 1/4" - 20 UNC x 1" long ASME SA-449, Grade 5 bolts. Since the installed coil is 16" high and weighs 195 lbs. compared with a tested coil of 52" high and 2691 lbs. weight, it can be concluded that the installed bolts are adequate.

The cooling coils are also qualified by analysis. A finite element computer model, utilizing STRUDL code, was used to show that the coils are rigid (least natural frequency = 192 Hz). The stresses in the critical coil sections and in the bolt attachment to the housing are within the norms established by the design codes.

A 2'-10" high by 3'-10" wide by 22" long prefilter section, not included in the tested unit, is qualified by analysis. The analysis is given in report no. NESE-714, "Seismic Qualification" prepared by American Air Filter. Analytical procedures, using the computer program STRUDL, are used to demonstrate the capability of the prefilter section to maintain its structural and functional integrity under the required seismic and operational loads. Analysis is justified because structural integrity alone determines the ability of the equipment to withstand the required loading without loss of function in the operating mode.

The design loads include dead weight, pressure and nozzle load which arise due to the effects of design pressure, thermal expansion and seismic acceleration. However, it appears that the nozzle load assumed for the qualification was not confirmed (the spec. revision for nozzle loads was dated 5/2/85 while the qualification report - based on the same nozzle loads - was dated 7/22/83 and approved by Stone and Webster on 1/22/85).

In light of what is mentioned above, the qualification of the air conditioning unit is pending the confirmation of the nozzle loads.

Air Cooling Unit
(2HUVY*UC2)

This equipment is item 25 per SWEC Spec. No. NMP2-P412W, Rev. 1. It is not a preselected SQRT item. The vendor of the equipment is American Air Filter.

The equipment is qualified by analysis. Document No. AAF-NESE-714, Rev. 1, "Seismic Qualification of Safety Related Unit Space Coolers", prepared by American Air Filter, dated 7/27/83 and reviewed by Stone and Webster Engineering Corporation, describes the structural analysis.

A finite element model is made of the equipment and applicable loads. On page 25 of the above mentioned report (bottom paragraph), it appears that in the analysis some nodes were assumed anchored although they are not really anchored in the field. This assumption might lead to unconservative results in the response of the equipment.

Based on the above observations, the qualification of the air cooling unit must be considered open till the status of the modeling of the said nodes is clarified.

Hydraulic Control Unit (HCU)
(C120D001)

The inspected Hydraulic Control Unit (model no. 761 E500 G004) is located in the Reactor Building (outside the primary containment) at elevation 261 ft. There are a total of 185 units in the plant. Each unit consists of two scram cylinders (nitrogen and water accumulator), scram valves, wiring trough and hold down hardwares. The unit is mounted vertically on the floor by means of four 1/2" diameter bolts with its back side attached to the structural frame of the building by means of steel beams at two levels. At the lower support beam there is a metal brace connecting the nitrogen and water cylinders to the unit and a structural frame which itself is attached to the primary structure by means of 2" x 2" x 3/4" angle section. The top of the nitrogen cylinder is attached to a manifold compartment by means of a bolt hanger (4" long, 3/4" diameter and made of 304 stainless steel).

The HCU is a part of the CRD system and its principal safety-related function is the successful completion of a scram function during emergency plant shutdowns. During scram the HCU permits the stored accumulator hydraulic energy to pass through the inlet scram valve and insert the control rod drive. It also allows the control rod drive return flow to discharge through the exhaust scram valve. During a seismic event, structural integrity of the HCU is to be maintained until successful completion of a scram cycle, if required.

The dynamic qualification of the installed HCU is demonstrated by tests performed on a similar HCU (model no. 767 E800 G001) during GE's phase III equipment qualification program. The tests are documented in report no. 58870, "Seismic Qualification Testing of one HCU for General Electric Company", prepared by Wyle Laboratories and dated 9-15-1983. Four anomalies were observed during the tests. The significant safety-related item is NOD

no. 2 which is concerned with the fracture of the hanger bolt holding the nitrogen cylinder during the SRV aging test. It sheared off after 3 minutes and 40 seconds elapsed time during the side-to-side test. Fifteen minutes of successful test time is required. During the Wyle test, this anomaly was resolved by adding a second cross brace at a location 10 inches below the existing HCU lower attachment brace. This structural upgrading of the unit enabled the SRV aging test to be completed successfully.

For the Nine Mile Point Unit 2 Plant, the SRV loads are negligible (<0.2 g) because of the location of the HCU units outside the primary containment. The SRV TRS used in the Wyle test are enveloping loads obtained from several BWR plants. They are equal to about 10 g which are significantly higher than the SRV RRS for the Nine Mile Point. Because of the significant margin between the TRS and RRS at the attachment location and at the internal component location, including the nitrogen bottle hanger location, it is the judgment of this reviewer that an additional brace is not required for the HCU in this plant.

The second anomaly is concerned with the bracket holding the wiring trough assembly. The report states "During the X-Y axis of the SRV cycling fatigue aging test - 9 minutes and 40 seconds elapsed time - the bracket holding the wiring trough assembly broke on both sides." During the test, the mounting bracket was structurally upgraded by adding a plate (4" x 1/4" x 1/8") to the back side of the bracket and the test was continued successfully. GE personnel confirm that this failure has no adverse effect on the HCU safety function and conclude that the installed units at the Nine Mile Point need no additional structural upgrading. However, they recommend that the wiring trough assembly supporting bracket should be inspected regularly for signs of cracking and structural degradation especially after each upset event. This is acceptable and should be implemented by Niagara Mohawk Power in their maintenance and surveillance program.

Based on the above recommendations, we have reached the conclusion that the HCU is seismically qualified for the Nine Mile Point Unit 2 Plant.

Drywell Penetration (Flange)
(C51-J003)

The drywell penetration assembly is a 5" diameter flange with 7" long by 0.375" diameter tube on its center axis. It is part of the Neutron Monitoring System and its purpose is to maintain the pressure integrity of the containment and to support the travelling in-core probe. It is located in the Reactor Building at elevation 252.8 feet. The approximate weight of the flange is about 10 lbs. It is welded over a length of 6" to the penetration pipe of the containment and attached to guide tube unions by means of four 1/2" diameter bolts. The equipment is supplied by General Electric Company (model no. 198B6193) and there are 6 such assemblies in the plant. At the time of the walk-thru inspection the equipment was not installed in the Reactor Building.

The pertinent design requirements of the unit is described in GE Specification No. 157C4620 and Nos. 23A1931 through 23A1934.

The seismic qualification is performed by test and the document introduced during the audit is Report No. 71185, "Seismic Evaluation", prepared by Viking Laboratories and dated 1-26-73. The tested penetration flange specimen (PPD112C2398) is similar to the one supplied to NMP-2 (PPD 198B6193) except that six inches of TIP guide tubing extends on each side of the test article flange, whereas the plant flange does not have this tubing. It follows that the test is conservative. The RRS, obtained by combining seismic loads with LOCA, SRV and AP hydrodynamic loads (absolute sum of all events along each axis and SRSS combination of three axes), resulted in 1.5g.

The test specimen demonstrated no natural frequencies between 5 to 1000 Hz for each of three orthogonal directions; therefore, the assembly can be considered a rigid body and the test results independent of test frequency.

Each orthogonal axis was tested to 10 g's at 30 Hz, which can effectively be considered as covering the full frequency range because of the rigid body characteristic. The conservatism built into the RRS and the large margin between TRS and RRS, provide test conditions that exceed what would result from five upset events (OBE's) or bi-axial testing as would be required if the testing was performed to current standard.

During normal operation there is no appreciable fatigue loading or pressure loading. The accumulation of seismic activity would be the source of fatigue. The sine sweep applied to the test specimen during the resonant search required 14 minutes on each axis over a range from 5 to 1000 Hz at g levels in excess of the OBE. In addition, the fragility tests required two minutes on each axis and were performed at 30 Hz over a range 0.5 to 10.0 g's. Thus, the sine sweep plus the fragility testing enveloped the potential fatigue conditions.

The service conditions of the flange consist of zero psig normal operating pressure, 62 psig LOCA pressure and operating temperatures under 200°F while the welding neck flange and blind flange are 150 pound components with ANSI B16.5 ratings of 200 psig up to 200°F. However, a pressure controlling and monitoring system was not included in the penetration assembly.

Based on what's mentioned above, the qualification of the Drywell penetration flange at the Nine Mile Point Unit 2 Site is pending the satisfactory resolution of the following findings:

1) The equipment was not installed.
2) A pressure controlling and monitoring system was not included in the penetration assembly.
3) Periodic and post-earthquake pressure monitoring procedures were not clearly defined in light of finding number 2 above.

RHR Heat Exchanger
(2RHS * E1A)

The RHR heat exchanger is required to provide cooling water for ECCS systems, plant shutdown needs and suppression pool cooling. It is relatively a large piece of equipment, about 30 ft. high by 4 ft. in diameter and has the appearance of a vertical cylindrical shell with semi-ellipsoidal heads. Its total weight when flooded is 58,000 lbs. There are two such pieces of equipment in the plant, both in the Reactor Auxiliary Bay Building (North and South). The inspected unit, located in the North Bay between elevation levels 175'-o" to 207'-9", is manufactured by Atlas Industrial Manufacturing company (model designation CEW, size 48"-189"). It is supported by a vertical structural steel frame at two locations along its length. At the upper support the shell is connected to the frame by support lugs with clearance of about 1/8". At the bottom support, anchor bolts (8 - 3" diameter bolts) are used for fastening. The support structural frame itself is attached to the primary structure at two elevations approximately 12 feet apart with the upper one being at the 200 ft. level.

The pertinent design specifications of the heat exchanger are described in GE document No. 21A9425AK, Rev. 6, dated 3-14-1978.

The equipment is qualified by analysis which is described in report no. E12-00022-2, "Nine Mile Point - Unit 2, RHR Heat Exchanger New Loads and Modified Support Structure Analysis Report", prepared by GE and dated 10-2-1984. A 3D finite element model of the heat exchanger and its support structure (including the inertial effect of the attached piping system) is employed to perform mode/frequency and static load analyses. The frequency analysis determined that the fundamental frequency was less than the required response spectra cutoff frequency value making it necessary to perform a dynamic analysis using the response spectrum and multimode response approach.

Seismic and hydrodynamic components of the loads were considered. The values of the RRS (for SSE, SRV and LOCA) at elevation 198 feet were used to envelope the whole range of elevations at the equipment location. In carrying out the analysis, computer codes SAP4GU4, BILRD01 and BST1F01 were used. Modes up to 137 Hz were examined and closely spaced modes were included using the double sum method. Each dynamic load was considered as a separate load case, and element responses were combined by the SRSS combination method. Static and dynamic combined forces and moments were employed to calculate the critical stresses in the equipment and its support structural frame. The report presents a table summary indicating that the stresses at all investigated locations are smaller than the corresponding allowable values.

It appears that the effect of the relative motion of the primary structure under seismic events on the critical stresses in the heat exchanger and its support structure were not addressed in the above mentioned analysis. A request was made to the A/E of the plant to provide displacement diagrams of the floor of the primary structure. From these "telex" diagrams, one can conclude that there is an out-of-phase relative displacement of at least 0.024" - 0.028" under SSE loading. This maximum lateral support displacement could induce additional significant stresses in the heat exchanger and its support structure.

Based on what is mentioned above, the qualification of the RHR heat exchanger remains open till the issue of the effect of the relative horizontal motion of the primary structure is addressed. Since the South auxiliary bay heat exchanger has higher inlet nozzle loads, it should be considered for this purpose rather than the North Bay one as the possible worst case.

HPCS Pump and Motor
(CSH *P1, E22-S003)

The high pressure core spray pump and motor assembly is used for emergency core cooling in the event of a loss-of-coolant accident or reactor isolation and failure of the isolation cooling system. The assembly consists of a 13-stage vertical pump supplied by Byron and Jackson (model 30 DX19CKXLH) and a 3050 hp GE electric motor (model 5K6357XC15A) mounted at the top. The combined length of the pump and motor is 473 inches and its overall weight is 68,000 lbs. It is mounted in a vertical position to the floor of the containment building (elevation 175 feet) by means of 24 - 2-1/2" bolts. The top of the motor is about 8 feet above the floor level and the remaining length of the assembly is housed in a concrete pump pit and supported at several locations by means of attachments to the pit's wall.

The pertinent design specifications for qualification requirements are given in GE documents:

Specification 21A1913 AB, Rev. 4 (7-11-1977) - Vertical pump

Specification 21A1944 AB, Rev. 2 (8-19-1977) - Vertically mounted motor

Code NEMA - No. MG-1 - motors and generators

The seismic qualification is done by a combination of analysis and test. Report No. E22-C01, "Nine Mile Point - Unit 2 HPCS Pump and Motor New Loads Analysis", prepared by GE (11-14-84), contains a stress analysis of the pump-motor assembly. A three-dimensional finite element model of the assembly and its support system is developed and dynamically analyzed using the response spectrum analysis method. Seismic and suppression pool hydrodynamic loads were considered. A computer code SAP4G07 was employed in the analysis

and modes up to 150 Hz were considered and the effects of closely spaced modes were included using the double sum method. Static and dynamic response forces and moments were combined and used to calculate the stresses at the critical locations. All calculated stresses were shown to be less than the allowable values. Critical locations for deflections and accelerations were also checked to evaluate operability of the assembly. The relative displacement between the shaft and throttle bushing is 0.0088" while the allowable clearance is 0.009". The close proximity between these two numbers warrants periodic surveillance to insure operability of the equipment.

A question was raised during the audit concerning the effect of the relative lateral motion between the ground and the floor support on the response of the assembly. Since the ground g-level at the Nine Mile Point site is 0.15 g and the SSE response at the elevation of the floor is about 0.16 g, it appears that the resulting stresses due to any out-of-phase relative lateral motion between the ground and the floor are insignificant.

The qualification of the HPCS motor is given in General Electric's document no. NEDC-30469, "Qualification Report for ECCS motors - Nine Mile Point - Unit 2", dated December 1981. A motor similar in size and construction was seismically tested. The test was performed at an SSE loading of 3.0 g in the horizontal direction and 1.0 g in the vertical. The actual seismic accelerations at the motor bearing, were 0.956 g horizontal and 0.23 g vertical. A separate static analysis was also prepared to qualify the structural and load carrying components of the motor to a load level of 3.0 g. It is found that the induced stresses are within the specified allowable limits and the rotating and stationary components of the motor will remain unimpaired during and after being subjected to the specified seismic loading. In addition, the lowest torsional frequency of the motor is 62 Hz which is higher than the running speed of 1800 RPM.

Based on the above information, it is concluded that the design of the HPCS pump and motor qualifies it seismically for use at the Nine Mile Point Unit 2 Plant.

HPCS Motor Control Center
(2EHS*MCC201)

The high pressure core spray (HPCS) Motor Control Center (MCC) is a class 1E electrical equipment which is required to provide power to HPCS bus for both hot standby and cold shutdown. The five-bay free-standing MCC measures 100" wide x 20" deep x 90" high and weighs approximately 3 kips. It is located at 261' elevation of the Control Building. It contains various starter units, feeder units and control devices. The equipment (AC series 8000) is supplied by General Electric Company.

The equipment was inspected at the site. The MCC cabinets were bolted to the base framing channels which were in turn fillet welded to embedded steel. Some enclosure panels were found loose due to inadequate tightening of screws.

The 8000 series MCC, GE's top-of-the-line model, is qualified for use at Nine Mile Point - Unit 2 by similarity with GE's previous model, series 7700 MCC, which was generically tested on a shake table. The actual test was done at Wyle Laboratories and is described in test report no. 43757-1, dated 6/6/78. Report No. DRF-A00-01933, "Motor Control Center, Qualification Report, Nine Mile Point 2", prepared by GE company, documents the rationale used for qualification of the equipment.

The seismic testing performed on the generic 7700 series test panel consisted of resonant search testing and biaxial sine beat on random multifrequency testing in each of two test orientations. The Motor Control Center (MCC) was electrically loaded and monitored for electrical operation before, during and after the test. The MCC test panel was mounted to a Wyle-furnished mounting fixture with twelve one-half-inch diameter, grade 5 bolts. The fixture was then welded to the test table. Analysis of the specimen/test table interface fixture was performed.

Resonant search testing was then performed at approximately 0.2g's horizontally and vertically. These single-axis, low level, sine sweeps were performed from 1 to 35 Hz at a rate of one octave per minute.

The multifrequency testing subjected the MCC test panel to 40 second duration simultaneous horizontal and vertical phase-incoherent inputs of random motion consisting of frequency bandwidths spaced one-third octave apart over the frequency range of 1 to 40 Hz.

The amplitude of each one-third octave frequency bandwidth was independently adjusted. Fifteen oscillation sine beats were superimposed sequentially on the 40 second random signal at frequencies of 4, 5, 8, 2.5, 3.2 and 6.3 Hz. The resulting table motion was analyzed at 5% damping.

Five OBE tests, followed by one SSE test was performed in both the front-to-back/vertical and side-to-side/vertical orientations. A plot comparing the RRS with TRS shows that the RRS is enveloped by the TRS.

In addition, two test series were performed. The series I followed radiation, post-radiation functionals, first thermal aging and post-thermal aging functionals. Test series II followed series I, the second thermal aging test and second thermal aging functional. Test series I included 75 test runs.

Further, the MCC test panel was tested in each of three electrical conditions: 1) specimen energized, 2) specimen de-energized and 3) specimen de-energized, energized, and de-energized. During the five (5) OBE's and the SSE, it is shown that contact chatter did not exceed 2 milliseconds. At no time did the electrical state of the devices of concern experience any change.

Following the final seismic test and before the post-SSE temperature/humidity test, a functional test was performed and no problems or out-of-specification conditions were noted. It is therefore concluded that the MCC test panel passed the seismic portion of the test program.

In addition to above, a structural analysis was performed to show similarity of the 7700 series MCC and the 8000 series MCC. This analysis demonstrates the structural similarity and, therefore, extends the test data for the 7700 series MCC to the 8000 series MCC.

Based on what is mentioned above, we have reched the conclusion that the HPCS Motor Control Center is qualified pending the tightening of the screws holding the rear enclosure panels.

High Pressure Core Spray Switchgear
(2ENS*SWG102)

The high pressure core spray (HPCS) switchgear is a floor mounted cabinet consisting of seven compartments. Each compartment measures 26" wide x 81.5" deep x 90" high. It contains power breakers for the HPCS system and is considered as class 1E electrical equipment. The overall weight of the cabinet is approximately 7,500 lbs. and is located at elevation 261' of the Control Building. It is mounted on the floor by means of a combination of 1" long fillet welds at 14" centers and 0.7" diameter plug welds.

The equipment (designation 7.2 KV-1200A-500MVA) is supplied by General Electric Company. The pertinent design requirements are described in GE specification no. 21A9300 AS, Rev. 1.

It is qualified by test and the methodology is described in Wyle Laboratories report no. 43639-1, "Qualification Report, Metalclad Switchgear Equipment", dated 11/30/77. The report has been reviewed by GE company. The switchgear was subjected to a seismic simulation test program required by General Electric's Nuclear Energy Division.

As a result of problems encountered during the test program, several structural modifications were made as stated in paragraph 6.4.1 of the above mentioned Wyle report, and are described in a letter from E.J. Dugan (GE Switchgear Business Department) to L.R. Thornberry (Wyle Labs) dated 11/17/77. In essence, the letter described the redesign of the switchgear door latches and door jambs to eliminate cracking of door hinges that occured during the seismic testing. In addition, paragraph 6.7.1 and Table IV of the same report indicate that electrical monitoring chatter, change of state, target indications, and spurious breaker tripping operations were encountered during the testing. The qualification package reviewed during the audit contains

another letter from E.M. Fitzgerald (GE Switchgear Business Department) to W.G. Woodward (GE EUSD, San Francisco), dated 2/8/78. This letter elaborates the argument used to close out all the concerns regarding the anomalies experienced during testing of the subject specimen and also addresses justification for additional modification to the test program. GE concludes their rationale for qualifying the equipment by invoking the degree of conservatism built into the test program as compared to the requirement of the Nine Mile Point - Unit 2 Site.

Based upon the site inspection and review of the qualification documents we have reached the conclusion that in order to qualify the HPCS switchgear the applicant must address the following concerns:

1) During the seventh test run (Wyle report 43639-1, pg. 15) a breaker tripping occurred. The report relates the anomaly to a weld stud and mentions that the cover was removed for the remaining tests.

(a) It is to be demonstrated that similar tripping would not occur.

(b) It is to be established that test results obtained by removal of the cover are applicable to the switchgear with cover.

2) Present one-to-one correlation between the anomalies observed during the test and the modifications made to preclude recurrence of similar problems.

3) Effectiveness of filling up bolt holes with plug weld in lieu of using mounting bolts is questionable.

Instrument Racks with G.E. Relays

The qualification review covered two different kinds of instrument racks. The first is identified as H22-P028 and the second is H22-P005.

The H22-P028 is a relay rack which is used to protect the high pressure core spray diesel generator from faults external to the generator. The relays protect against an overload on the generator and act as a secondary backup for an internal generator fault.

In appearance, the H22-P028 is a closed panel which measures 36"Wx36"Dx 84"H. The panel tiedown is accomplished by 12-1/2" bolts which engage slotted openings at the front and rear edges of the panel. It weighs about 600 lbs. and is located in the Control Building at the ground level (261'). The relays used in this panel are high current, 3 phase AC power relays and include high-speed differential relays, loss of excitation relays, time overcurrent relays, instantaneous voltage relays and other DC relays which are used to detect faults in the AC relays.

All of the relays, with the exception of the generator differential relay, are blocked from tripping the diesel generator during an accident condition. Hence, some relay chatter for all protective relays is acceptable from a system point of view, with the exception of the generator differential relay. In all cases, however, structural integrity and electrical integrity must be maintained.

The H22-P028 was qualified by test. The rack was mounted to the vibration table in the same way that it is mounted at the field site. The relays were tested in their energized and de-energized states for excessive chatter and for maintaining effective operability during seismic events. Two types of tests were performed.

The first test was a slow sine sweep from 3 Hz to 60 Hz to determine the natural frequencies and transmissibilities. These tests were run in all three orthogonal directions. The second set of tests were biaxial random (vertical and horizontal) with signals to the actuator both in phase and 180 degrees out of phase. The test spectra were significantly higher than the required response spectra.

It is concluded that the qualification documents show that the relay rack H22-P028 is qualified for the dynamic environment at the Nine Mile Point Unit 2 Nuclear Plant.

The test was actually done to qualify the H22-P028 rack for the Clinton Nuclear Power Plant. The test showed that the H22-P028 panel, with the normal configuration of relays, cannot withstand the seismic motions of either an SSE or an OBE.

The tests revealed that the following relays had intermittent 10 MS chatter "failures" as a result of the seismic excitation. These include Types CCH, GGP, CFD, IAV, IJCV, IAC and PJV. Of these relays, only the CFD is a differential relay, for which a 10 MS intermittent chatter is not acceptable. The CFD type was therefore replaced by an upgraded PVD-Type. The test report results contained in the document GEZ-6675, dated 5/20/80 show that the PVD-Type differential relay was seismically qualified to a ZPA level of 3.0 g, which is much higher than the level required at the panel input location at Nine Mile. For the H22-P028 rack at the Nine Mile Unit 2 Plant, the differential relay (PVD-Type) was also relocated to the bottom of the rack where the seismic level is even less severe.

The second panel, H22-P005, is an open rack which measures 72"Wx30"Dx 84"H and weighs 1500 lbs. The panel houses pressure transmitters which monitor reactor water level and pressure conditions.

The H22-P005 is qualified by a test of a similar panel. The actual panels tested were Perry production units with calibration stations. These panels are identified as representative of local instrument units. The tests were generic in scope. They enveloped both the seismic levels as well as the equipment fragility at several plants, including the Nine Mile Plant. The particular type of instrumentation housed by the panel at Nine Mile Unit 2 was tested on the generic panel.

The actual test was performed at the Wyle Laboratories, Huntsville, Alabama. Their report is Wyle Test Report 45353-1, dated October 20, 1980. For the test, the panel was secured to the vibration table as closely as possible to an actual installation. The panel piping was pressurized and monitored during the seismic testing to assure pressure integrity of the instruments and plumbing. Prior to, during and after vibration exposure, the instruments were functionally monitored.

The vibration testing included a low level resonance search to determine transmissibilities and natural frequencies. The tests were run in all three orthogonal axes. These tests were followed by a series of ten OBE and two SSE random, multifrequency, thirty second duration, simultaneous horizontal and vertical, phase-coherent bandwidths spaced one-sixth octave apart. The tests were performed over the frequency band up to 100 Hz, which was required to envelop the generic RRS.

During the tests, anomalies occurred with the Rosemount type 1151 transmitters. The outputs of these transmitters showed variations that exceeded the acceptance criterion. The anomaly was worse when the transmitters were exposed to a vibration environment perpendicular to the plane of the sensing diaphragm.

As a result of the anomaly, the Rosemount 1151's were replaced with Rosemount 1153 transmitters which were seismically and environmentally qualified under the Phase 3 environmental qualification program. The replacement was authorized by the issuance of a G.E. Field Disposition Instruction (FDI-TWBR), dated November 16, 1984.

It is therefore concluded that the H22-P005 panel is qualified for the dynamic environment at the Nine Mile Unit 2 Plant.

HPCS Transformer

The HPCS Transformer is part of the high pressure core spray electrical supply system. The purpose of the transformer is to step down the line voltage from 4160V to 600 volts for the operation of various safety related equipment.

The transformer is located in the Control and Diesel Generator Building. It is a large unit that weighs about 3350 lbs. and measures 50"Wx54"Hx30"D.

The seismic qualification is shown by the test results of a similar sytem. The test was performed at the Wyle Laboratories located in Norco, California and is documented in Wyle Test Report No. 54428, entitled, "Seismic Testing of HPCS Transformer for Elma Engineering", dated September 12, 1975.

For the seimsic tests, the transformer was bolted to a steel mounting plate which was welded to the test table. The transformer was oriented in its normal upright position. A functional test was performed while the transformer was subjected to the seismic excitation. The functional test consisted of powering the secondary windings and monitoring the line voltage appearing at the primary winding terminals. Voltages were measured both before and after the seismic testing. Only a single phase line voltage in the primary was monitored during seismic testing.

The seismic testing was done with biaxial, phase incoherent random motions. The portion of the RRS that could not be enveloped with purely random motion was accomplished with superimposed 20 oscillations per beat sine beats injected over a specific frequency range spaced one-third octave apart.

The results of the test showed that the transformer was capable of withstanding the required seismic excitation without structural or functional malfunction. There were only minor differences between the voltage values before and after seismic testing. These were within the accuracy tolerance of the instrumentation being used.

The transformer that was tested was an ELMA Model 317, S/W 372602 unit. The transformer that is actually installed at 9 Mile is an ELMA Model 451, S/N 473201. Both are structurally the same. Both are designed for a primary voltage of 4160 volts. Only the secondary voltages are different. The tested secondary was 480V as compared to the 600V for the Model 451 which is installed at the 9 Mile Plant.

On the basis of their similar structure, the two transfomers are considered to be dynamically similar. The 600V HPCS transformer is therefore qualified for the seismic environment at the 9 Mile, Unit 2 Plant.

Audit Equipment Table

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
NSSS-1	C12-D001	Hydraulic Control Unit. The unit consists of two cylinders, (accumulator and nitrogen), scram valves, wiring trough and hold-down hardware.	It provides the stored accumulator energy to insert the control rod drive during emergency shutdown.			Qualified	
NSSS-2	C51-J003	Drywell Penetration Flange	It maintains pressure integrity of the containment and supports the traveling in-core probe.	1. The equipment was not installed. 2. A pressure controlling and monitoring system was not included in the penetration assembly. 3. Periodic and post-earthquake pressure monitoring procedures were not clearly defined in light of finding number 2 above.	Pending	Open	
NSSS-3	2RHS*E1A (E12-B001)	RHR Heat Exchanger. A vertical cylindrical shell (4 ft in diameter and about 25 ft long) with its structural support system.	The RHR heat exchanger is used to provide cooling for the reactor during shutdown, for suppression pool cooling and for condensing reactor steam on hot standby.	Stresses due to the relative horizontal deflections of the primary structure (south reactor auxiliary bay) were not addressed in the dynamic analysis of the RHR heat exchanger.	Pending	Open	

Audit Equipment Table (Cont'd)

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
NSSS-4	2CSH*P1 (E22-C001)	HPCS pump and motor. A 13-stage vertical pump with a 3050 HP motor on top.	It is used for emergency cooling (in the event of a LOCA or reactor isolation and failure of the isolation cooling system).			Qualified	
NSSS-5	2EHS*MCC201 (E22-S002)	High Pressure Core Spray (HPCS) Motor Control Center. A five-bay free-standing floor-mounted cabinet.	It provides power to HPCS bus.	Rear enclosure panel screws were loose.	Pending	Open	
NSSS-6	2ENS*SWG102 (E22-S004)	High Pressure Core Spray (HPCS) Switchgear. A seven compartment free-standing floor-mounted cabinet.	The switchgear contains power breakers for HPCS system.	1. The seventh test run (ref. Wyle Rpt. 43639-1, p. 15) results in a breaker tripping. The report relates the anomaly to a weld stud and mentions that the cover was removed for the remaining tests. a) It is to be demonstrated that similar tripping would not occur. b) It is to be established that test results obtained by removal of the cover are applicable to the switchgear with cover.	Pending	Open	

Audit Equipment Table (Cont'd)

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
NSSS-6 (cont'd)				2. A number of other anomalies was observed during the test. GE letters dated 11-17-77 and 2-8-78 mention some modifications performed on the switchgear. However, one-to-one correlation between the anomalies and the modifications made to preclude recurrence of similar problems is still missing. 3. Effectiveness of filling up bolt holes with plug weld in lieu of using mounting bolts is questionable.			
NSSS-7	a)H22-P028 E22B-K35	Instrument Rack, Relays	The relays are used to protect the high pressure core spray diesel generator for faults external to the generator. They also protect against overload on the generator and act as secondary backup for an internal generator fault.			Qualified	

Audit Equipment Table (Cont'd)

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
NSSS-7 (cont'd)	b)H22-P005	Instrument Rack, Pressure Transmitters	The pressure transmitters monitor reactor vessel water level and drywell pressure and provide signals to trip relays for the initiation of high pressure core spray			Qualified	
NSSS-8	2EJS*X2 E22-5003	HPCS Transformer	Part of High Pressure Core Spray electrical power supply system. The transformer steps down the live voltage from 4160 V to 600 V.			Qualified	
BOP-1	2CMS*PNL66A	Hydrogen/oxygen gas analyzer panel. A floor mounted cabinet containing mechanical subassemblies and electrical devices.	It is required to monitor the percentage of hydrogen and oxygen in the containment atmosphere.	Confirm that the mounting means of the subassemblies and electrical devices to the installed panel are equivalent to those used in the seismic tests.	Pending	Open	
BOP-2	2CES*PNL405	Remote Shutdown Panel (RPS)	The RSP provides redundancy to the Control Room controls in that it can shut down the reactor in case the Control Room is uninhabitable.	The qualification document for the panel structure was presented but that for the devices housed by the structure was not available.	Pending	Open	

Audit Equipment Table (Cont'd)

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
BOP-5	2EGS*EG1	Diesel Generator. A 122-ton huge floor-mounted generator.	In case of off-site power loss, the generator supplies emergency power to safety-related equipment.	1. No justification was provided for acceptability of the anomalies observed during testing of various devices. 2. The nozzle loads assumed for analysis of the engine mounted system was not confirmed. 3. The use of loose shim plates in mounting the generator skid was not justified.	Pending	Open	
BOP-6	2SWP*MOV30A	Motor Operated Valve	The motor operated valve is used to control the flow of service water in the north intake system.			Qualified	
BOP-7	2SWP*P1A	Service Water Pump. A horizontal centrifugal pump with a 600 hp motor.	This pump is required to provide cooling water to safety-related equipment.	The motor hold-down bolts do not have the necessary nuts and might become loose due to vibration of the motor and seismic loads.	Pending	Open	

Audit Equipment Table (Cont'd)

SQRT ID No.	Applicant ID No.	Equipment Name and Description	Safety Function	Findings	Resolution	Status	Remarks
BOP-8	2RHS*MOV9A	18" - 300# Butterfly Valve with Limitorque Actuator. The assembly is pipe mounted.	This valve remains open during normal operation. It provides a flow path to the RHR heat exchanger for reactor shutdown, suppression pool and containment spray.			Qualified	
BOP-9	2BYS*BAT2A	Storage Batteries	The storage batteries provide emergency DC power to critical circuits including 125 V MOVs and flashing power for the standby diesel generator.	On page 8, Section 6 of SWEC Report IEEE - 01.520-5000C, the equation for deflection used the difference due to two loads. This results in a higher natural frequency than if a sum is used, and actually gives a higher mode case. The sign in y_1-y_2 should be justified. Otherwise the analysis should be rerun using finite elements to show that the natural frequency is high.	Pending	Open	