SEISMIC QUALIFICATION ASSESSMENT OF FOXBORO SPEC 200 EQUIPMENT FOR USE AT DONALD C. COOK NUCLEAR PLANT REPORT NO. 2985-HEI-07, Rev. 0

PO No. C-8741 Specification No. DCC-IC-500-QCN

Equipment Identification: FOXBORO SPEC 200/200 MICRO

Prepared By: Kirk R Nelson for D. N. Bauman Date: 11/17/92

Reviewed By: [signature] Date: 11/17/92

Approved By: [signature] Date: 11/20/92

The document preparer shall use this checklist to evaluate the qualification report/analysis per the following issues. Section 1 is the "Qualification Assessment/Summary." This section is a brief summary of the adequacy of the subject documents. This summary is based on the results of the answers to the questions listed in Section 2 of this document. Any additions or changes to the report(s)/analyses which are required in order to provide proper qualification should be listed in this section of this form. Approval will be subject to the open items listed in this section.

Section 2 of this form is the Report(s)/Analyses Evaluation Checklist. A "Y", "N", or "N/A" response should be given for each question listed. Each response shall be properly explained and justified, giving specific section references within the subject procedure(s).

SECTION 1 - QUALIFICATION ASSESSMENT/SUMMARY

Provide a comprehensive statement of device qualification for the parameters addressed by the report(s)/analyses. Include any clarifications, corrections, or changes necessary to provide proper device qualification per the report(s)/analyses.

Qualification of the various Foxboro components to be used in this project, are documented by Foxboro in their various equipment qualification reports identified in the Documents Reviewed. The actual seismic testing of the components is principally documented in Doc. 1.0, 1.1, 1.2, and 1.4. The remaining documents provide summary test information for specific components identified. Doc. 4.0 provides justification for the various components that were not tested, but are similar in size, shape, and function to tested components to determine adequacy based on similarity. Table 1 (attached) summarizes all the components to be used in this project and which reports are used to document their qualification. It also includes specific references to key statements in the documents and an overall summary of the qualification.

Module N-2AO-V2H is being customized for this application, and a supplemental qualification report is to be issued soon. This report will be reviewed at that time for seismic considerations, and this document will be revised to reflect that review.

In general Foxboro follows the criteria of IEEE 344 to establish a seismic qualification program that allows there components to be qualified for most nuclear facilities in the country. Therefore the Test Response Spectrum (TRS) envelopes the Required Response Spectrum (RRS) and is of a magnitude above the requirements of AEPSC specification DCC-NS-103-QCN Response Spectra for the Cook Nuclear Plant Auxiliary Building Elev. 633'-0" both OBE and SSE. The magnitudes of the acceleration are compared in the following table:

Response Spectra at 2% Damping (g)

Frequency	Cook OBE	Foxboro OBE	Cook SSE	Foxboro SSE
0.5	0.060	2.000	0.120	2.000
1.0	0.118	2.000	0.236	2.000
1.5	0.255	3.500	0.510	4.000
2.0	0.630	5.800	1.260	7.000
4.0	0.425	11.000	0.580	11.000
5.0	0.290	9.000	0.580	11.000
7.0	0.185	10.000	0.370	11.000
10.0	0.155	9.200	0.310	11.000
16.0	0.130	5.500	0.260	9.200
20.0	0.124	4.200	0.248	5.500
33.0	0.120	1.600	0.240	1.600
50.0	0.118	1.600	0.236	1.600

* Note: 2.5% Damping used for Foxboro OBE.

As it is indicated, the testing exceeded the requirements for the Cook Nuclear Plant and in some cases the actual Test Response Spectra (TRS) exceeded 100g.

All Foxboro testing was run with the vibration table moving at 45 degree angle so that equal horizontal and vertical components were obtained. Equal acceleration was used in all three directions. Additionally a balanced and an unbalanced rack configuration was tested to envelope the worst scenarios for rack loading.

A minimum of five (5) OBE events and one (1) SSE event were applied. In general there was no structural damage or degradation from the testing. In one test situation however, the screws and nuts that secure the hinge between the Hinge Mounting Strip and the Test Panel Mounting Plate loosened and fell off (Ref. 1.4, par. 3.b). The manufacturers drawings were since revised to specify that each of the eight nuts are to be welded to the screws after assembly. It was also observed that the hinge pin was protruding out after the test. To eliminate a potential problem the manufacturing drawings have been revised to specify that the ends of the hinge pin are to be peened over at assembly. Therefore these minor concerns have been satisfactorily addressed.

In addition to the structural integrity, the equipment was appropriately tested for performance before, during and after the seismic testing. Again all equipment meet the performance criteria with two minor exceptions. The Multi-Loop Power Supply P/N P03000CQ had an intermittent loss of output power which was discovered to be due to a fuse holder cap being loose. It was later determined that an improper type of fuse holder was used. This has since been corrected by substituting a previously qualified fuse holder. The other performance item that was identified was that the N-2AO-L2C-R(C) Contact Output Isolator chattered under the Foxboro SSE event. The module remained fully functional during the Foxboro OBE testing. Since the Cook Nuclear Plant SSE is fully enveloped by the Foxboro OBE, the module is SSE qualified for use at Donald C. Cook Nuclear Plant.

The existing AMCO instrumentation racks with the Spec 200 equipment installed in them, were qualified by analysis for AEPSC Donald C. Cook Nuclear Plant under Doc. 3.0. The racks are qualified using finite element analysis (STARDYNE) for the worst case rack configuration. The rack was evaluated as a free standing unit, however the potential impacts of multibay racks was addressed by Foxboro (Reference 1.1), and determined to have no significant detrimental effects. The maximum combined principal stresses in the rack were computed and were only 32.9% of the minimum yield strength of the A36 steel used. The anchor bolt stresses (16,898 psi) and the weld pad stresses (8,707 psi) were also within acceptable stress ranges for the materials used. The report also addressed the dynamic amplification of the input excitation and shows that the peak amplified floor response spectra is 1.25 G which is well below the Foxboro qualification mentioned previously.

DOCUMENTS REVIEWED

Doc.	Source	Document I.D.	Title	Rev.
1.0	Foxboro	QOAAA20 PART 1	Seismic Testing of SPEC 200 Current Production Model	REV. B
1.1	Foxboro	QOAAA20 APP. A	Report T9-6011	REV. A
1.2	Foxboro	QOAAA20 PART 2	Seismic Testing of N-2ES Style B Rack and Naturally Aged Rack-Mounted Modules	REV. C
1.3	Foxboro	QOAAA20 PART 3	Seismic Testing of Current Production Rack-mounted Modules	REV. B
1.4	Foxboro	QOAAA20 PART 4	Seismic Vibration Test of	REV. E
2.0	Foxboro	QOAAA37 PART 2	Seismic Vibration Test of	REV. B
3.0	NQS	REPORT 1619	Seismic Qualification of Foxboro Reactor Protection.... for AEP Cook	Rev. 1
4.0	Foxboro	QOAAAO6	Similarity of Spec 200 Rack Mounted Modules of Current Production....	Rev. F
5.0	Foxboro	QOAAB60	2AO-L2C-R Style A CS-N/SRC Current Production and Style A Naturally Aged Contact Output Isolators	Rev. B
6.0	Foxboro	QOAAB28	2AI-T2V+E Type B CS-N/SRC Current Production and Style A Naturally....	Rev. B
7.0	Foxboro	QOAAB69	Spec 200 Micro 2CCA Series Style CB Control Cards 2CDA Series Style B Display Modules and Associated Equipment	Rev. B
8.0	Foxboro	QOAAB35	2AI-I2V Style B CS-N/SRC Current Production and Style A Naturally Aged	Rev. C
9.0	Foxboro	QOAAB29	2AI-P2V Style B CS-N/SRC Resistance Converter	Rev. C
10.0	Foxboro	SI 1-01830	Custom N-2AO-L2C-R Contact Isolator with Four DPDT Relay Outputs	April '90
11.0	Foxboro	SI 1-01833	Custom Termination Modules for Spec 200 Loop Testing Applications	July '80
12.0	Foxboro	QOAAB17	2AO-VAI+P Style A CS-N-SPC Current Production and Style A Naturally Aged ...	Rev. B

13.0	Foxboro	QOAAB15	2AI-C2L Style A CS-N/SRC Current Production and Style A Naturally Aged ...	Rev. C
14.0	Foxboro	QOAAB14	2AX+DP10 Style C CS-N/SRC Power Distribution Module	Rev. C
15.0	Foxboro	85-1182A	Evaluation of (21) 2CCA Style A Spec 200 Micro Control Cards	Nov.'85
16.0	Foxboro	QOAAB34	2AO-L2C-R Style A (ECEP 8389) CS-N/SRC Current Production Contact Output Isolators	Rev. E
17.0	Foxboro	QOAAB61	Spec 200 System Cable and N-2ES, Style B, Rack Wiring and Cabling	Rev. B
18.0	Foxboro	QOAAB58	2ANV-D and P Style A CS-N/SRC Current Production and 2ANV-D and P Style A Naturally Aged Nest	Rev. A

ADDITIONAL REFERENCES

Doc.	Source	Document I.D.	Title	Rev.
1.0	Foxboro	QOAAA01	Program for Class IE Qualification for Spec 200 Instrumentation Equipment	Rev. A
2.0	Foxboro	QOAAA04 PART 1	Seismic Vibration Test Procedure N-2ES Style B Rack Current Production Model Rack Mounted Modules	Rev. D
		QOAAA04 PART 2	Seismic Vibration Test Procedure N-2ES Style B Rack Naturally Aged Rack Mounted Modules	Rev. B
		QOAAA04 PART 3	Seismic Vibration Test Procedure Current Production Rack Mounted Modules	Rev. B
		QOAAA04 PART 4	Seismic Vibration Test Procedure Current Production Rack Mounted Modules...	Rev. B
3.0	Foxboro	QOAAA05	Nuclear Class IE Qualification Spec 200 Rack-Mounted Modules by Similarity to Type Tested Modules...	Rev. J

4.0	Foxboro	QOAAA40	Type Test Program Class IE Qualification...	Rev. B
5.0	Foxboro	QOAAB01	Class IE Qualification Spec 200 Instrumentation Equipment to Generic Service Conditions	Rev. A

SECTION 2 - REPORT(S)/ANALYSES EVALUATION CHECKLIST

GENERAL QUALIFICATION ISSUES

1. *Does the report/analysis properly identify the test specimens used, and the components, systems, or structures which are qualified based on the results.*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, and by similarity under Doc. 4.0, the test reports clearly identify each item tested. Item numbers from the tests are included in Table 1.

Doc. 3.0 references the Drawing Y300272-AEP (Rev. 5) and the Foxboro/Harding & Smith drawings 92F12687-SC-2101 Sheets 1 through 4 (Rev. 1) as the basis for this qualification. These drawings describe the structural configuration of the Foxboro Racks.

2. *Were the same specimens used throughout the testing process?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the same specimens were used throughout the specific test that was being run. There are several different tests that were run for different configurations to provide assurance that the location in the rack or the loading on the rack would not be detrimental to performance. For these different cases, different specimens was used.

This question is not applicable to Doc. 3.0.

3. *Does the report address the testing of the proper components for qualification? (Identical components or adequate similarity proved?)*

Y[x] N[ ] N/A[ ]

Doc. 4.0 was the primary document used to substantiate the similarity of several modules of the Spec 200 Foxboro equipment. This also established similarity with naturally aged components which were retrieved from field situations for testing. This document focused on the similarity of physical construction , function, components, and materials to prove adequate similarity.

The Doc. 3.0 report models the racks as defined by the drawings and envelopes any combination of configuration or multibay to a limit of 7 racks.

4. *Were the applicable interactions with other equipment properly simulated?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, complete rack set ups were utilized to simulate actual installation configuration. This included various combinations of loading in nests as well as balanced and unbalanced rack configurations. Therefore, applicable interactions within the racks were simulated adequately.

For Doc. 3.0 the applicable interactions are the multiple racks which is adequately addressed by Foxboro qualifications Doc. 1.1.

5. *Did the test parameters properly envelope the required environments for the components?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the table provided in Section 1 above shows that the RRS enveloped the specific requirements for the Cook Nuclear Plant Control Room in the Auxiliary Building at elevation 633'.

In Doc. 3.0 the analysis was properly based on the required response spectra for Cook Nuclear Plant Auxiliary Building Floor Elev. 633' amplified by the maximum dynamic amplification possible.

6. *Was the acceptance criteria properly chosen to demonstrate qualification?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the acceptance criteria included both physical and functional ruggedness. By visually inspecting the components after the testing the physical durability of the components under seismic events was determined. Also, by functionally operating the equipment before, during and after the seismic testing the functional adequacy was proven.

In Doc. 3.0, the acceptance criteria is based on the allowable stresses of the components considered. For the steel frame members of the rack the report appropriately concluded that the maximum stress of 32.9% of minimum yield stress is acceptable. It also concluded that the bolt stress of 16,989 psi is satisfactory for any grade steel material. Also, the weld stress was deemed acceptable at 8,707 psi with normal minimum weld stress of 60,000 psi.

7. *Was equipment performance data recorded before, during and after the test to demonstrate qualified operation and functionality?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the components were functionally operated before , during and after the seismic testing to prove functional operability. Simplified diagrams of the various functional setups for the equipment are included in the test reports to provide information on how functionality was demonstrated.

The test report also documents such things as output shifts, calibration changes, and proper function for the various components.

This question is not applicable to Doc. 3.0.

8. *Were the test methods in general accordance with the test procedure and purchase specifications?*

Y[x] N[ ] N/A[ ]

The purchase specifications applicable to this evaluation is AEPSC Specification DCC-IC-500-QCN and Attachments 15.9, 15.14, 15.15, 15.16, and 15.17.

For the components shown in the qualification matrix Table 1, the entire test program was done in accordance with IEEE 323-1974 and IEEE 344-1975 which is the general basis for the purchase specifications listed above. Industry standards for seismic testing and reporting were met.

For Doc. 3.0, paragraph 4.1 of Att. 15.9 describes the requirements for Qualification by Analysis. This report is in accordance with the requirements by analyzing a "simple" component to model (the rack) and applying three equal earthquake components (two horizontal and one vertical) simultaneously.

9. *Were proper margin/safety factors applied to the test parameters per industry standards?*

Y[x] N[ ] N/A[ ]

The industry standard for margins of safety applied during seismic testing is to add a 10% margin to the required response spectra (RRS). For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, based on the table in section 1 above, this margin was adequately maintained for Cook specifically. In the actual test results of Doc. 1.1, there were a few cases were the TRS did not quite envelope the RRS in the higher frequencies however the deviation was adequately addressed in the report and is not at all significant to the Cook Nuclear Plant due to the magnitude of the test RRS compared with the Cook Nuclear Plant RRS.

For Doc. 3.0 no special margins or safety factors were required which is appropriate.

10. *Can qualification of the equipment be clearly determined based on this report/analysis?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix Table 1, the qualification is clearly demonstrated by the documents referenced.

The qualification of the rack can clearly be determined from review of Doc. 3.0.

11. Were test sequences, logic and protocol acceptable?

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, the appropriate sequence of OBE testing and SSE testing was followed.

This question is not applicable to Doc. 3.0.

12. Was the testing performed in general accordance with IEEE Standards 323 and 344 per Reference 7.1?

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix Table 1, the entire test program was done in accordance with IEEE 323-1974 and IEEE 344-1975.

In the case of Doc. 3.0 an adequate seismic analysis methodology was used in compliance with the requirements of IEEE 344 was used.

13. Are the analyses, logic, graphics, formulas, equations, and mathematics understandable and valid?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the documents included graphic representations of each components functional test setup, graphs of the various response spectra, pictures of various test setups, and diagrams of the various loading configurations. All these graphics were understandable and useful. There were little or no formulas, equations or mathematics in the test report documents.

For Doc. 3.0, the analysis utilizes standard design engineering methodology to analyze the base welds and determine the properties of the elements used in the computer analysis. The computer analysis is also a standard finite element program used in dynamic analysis.

14. Are the variables identified?

Y[ ] N[ ] N/A[x]

This question is not applicable.

15. Are uncommon or simplified formulas, equations, and mathematical procedures explained and bases documented?

Y[x] N[ ] N/A[ ]

There were little or no formulas, equations or mathematics in the test report documents (Doc. 1.0,.1.1, 1.2, & 1.4). Therefore everything is adequately explained and documented.

As noted in response to question 13 above, for Doc. 3.0, the formulas are industry standard and are essentially self explanatory.

16. Are calculations numerically correct with units shown?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, this question is not applicable.

For Doc. 3.0, the calculations are correct, however units are not clearly spelled out. Based on similar past experience, the units utilized can be concluded to be pounds and inches throughout the document.

17. Are assumptions and judgments reasonable and acceptable with bases explained and documented?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, assumptions and judgments are limited. The main assumption deals with the acceptability of the TRS despite the fact that it does not totally envelope the Foxboro generic RRS. Their acceptance based on the magnitude of the spectrum used is reasonable.

In Doc. 4.0, there are numerous judgments made of acceptability by similarity. The basis for these decisions on similarity are clearly documented and reasonable. The document goes into great detail to compare the size, shape, and function of the component to support the similarity statements.

For Doc. 3.0 the judgments are made in comparing the determined stresses with the knowledge that steel materials were used to determine that the stresses are within acceptable levels. The resulting judgments are reasonable.

18. Have inputs been correctly selected, referenced, interpreted, and used?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, reference documents and other input information are appropriate and acceptable.

For Doc. 3.0 the inputs are derived from AEPSC specification DCC-IC-500-QCN and the drawings for the racks previously mentioned in question 1. Also, information from the Foxboro qualification testing reports were accurately utilized to perform the evaluation.

19. Are outputs and conclusions correct and justified?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the outputs and conclusions are correct and justified based on the results of the testing that was done.

For Doc. 3.0, the results are summarized in section 3.0 of the report. These conclusions are

correct and are adequately justified as indicated by the stresses documented in response to question 28 below. The final summary conclusion is "operability of the safety related Foxboro equipment is established". This is appropriate based on the documentation in the entire report.

20. Did the tested configuration appropriately match the to be installed configuration?

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix Table 1, complete rack set ups were utilized to simulate actual installation configuration. This included various combinations of loading in nests as well as balanced and unbalanced rack configurations. Therefore, applicable configuration was simulated adequately by the combinations tested.

For Doc. 3.0, the analyzed configuration envelopes the to be installed configuration in all areas including loading conditions of the rack (worst case rack fully loaded plus a test panel assembly occupying locations 3 and 4). The issue of multibay bay interconnected racks was also addressed to envelope any configuration.

SEISMIC QUALIFICATION ISSUES

21. Is component seismic classification identified?

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, the test report clearly documented the components as class 1E.

For Doc. 3.0 the component is not specifically identified as a Class I item however, it is implied through the use of the DBE response spectra for the qualification.

22. Were physical interactions/spatial conflicts with other items considered?

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, complete rack set ups were utilized to simulate actual installation configuration. This included various combinations of loading in nests as well as balanced and unbalanced rack configurations. Therefore, applicable interactions within the racks were simulated adequately. This also allowed for spatial considerations of the specific components as they would be installed.

For Doc. 3.0 the rack was evaluated as a free standing unit.. The report recognizes "that multibay interconnected racks, as employed in this application can introduce detrimental dynamic snaking or whipping modes"; however, "this multibay interconnection condition has been evaluated and shown to produce no significant detrimental effects to and including multibay strings of seven racks long." Thus the physical conflicts were adequately considered and addressed.

23. *Did the equipment performance meet the acceptance criteria before, during and after each OBE and DBE/SSE event?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix Table 1, the equipment was appropriately tested for performance before, during and after the OBE and SSE seismic testing. All equipment meet the performance criteria with one minor exception. The Multi-Loop Power Supply P/N P03000CQ had an intermittent loss of output power which was discovered to be due to a fuse holder cap being loose. It was later determined that an improper type of fuse holder was used. This has since been corrected by substituting a previously qualified fuse holder. One performance item was identified for the N-2AO-L2C-R(C) Contact Output Isolator which chattered under the Foxboro SSE event. These isolators are qualified to the OBE levels. Since the Cook SSE levels are fully enveloped by the Foxboro OBE levels, the isolator is qualified for Cook for the SSE events.

For Doc. 3.0 , the equipment was analyzed using the DBE response spectra (2% damping) imposed in three axes simultaneously and a static case was also applied to account for higher mode contributions and general conservatism. The resulting stresses were 32.9% of the minimum yield strength of the steel. Therefore the racks performance is based on acceptable stress levels.

24. *Did the number and duration of OBE and DBE/SSE events incorporated into the testing meet the requirements of Reference 7.1?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, A minimum of five (5) OBE events and one (1) SSE event were applied. It was not noted in the test reports that the duration of each test was 30 sec. or greater, however, it is indicated the test was in compliance with IEEE 344-1975 which has that requirement.

For Doc. 3.0 this section is not applicable since the qualification was done by analysis versus testing.

25. *Did the testing envelope the necessary OBE and DBE/SSE response spectra that define the seismic input at the mounting/support?*

Y[x] N[ ] N/A[ ]

As indicated in section 1 above, for the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the Test Response Spectrum (TRS) envelopes the Required Response Spectrum (RRS) and is of a magnitude above the requirements of AEPSC specification DCC-NS-103-QCN Response Spectra for the Cook Nuclear Plant Auxiliary Building Elev. 633'-0" both OBE and SSE.

For Doc. 3.0, the analysis was based on the DBE response spectra for the Cook Nuclear Plant Auxiliary Building Floor Elev. 633 at 2% damping. This is the appropriate spectra for these racks which are to be mounted in the Control Room.

26. *Was information necessary to assess or include amplification and dynamic response incorporated into the test?*

Y[x] N[ ] N/A[ ]

For the components qualified by the testing of Doc. 1.1, section 4.0 documents the review of the magnitude and amplification of the individual rack configurations at the various locations of accelerometers located on the test racks. Based on this assessment, it can be determined that amplification and dynamic response affects are considered.

For Doc. 3.0, paragraph 3.4 indicated that "the computed amplification is 2.401." This amplification factor was in turn applied to the input floor response spectra at all frequencies greater than 80% of the lowest natural frequency in the horizontal axis. The peak of the amplified floor response spectra is 1.25 G which is well below the acceleration to which the Foxboro equipment has been qualified which is greater than 20 G's.

27. *Was information necessary to assess or include mounting/support, weight and non-seismic loads incorporated into the test?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, the test racks were bolted to the floor with (6) hex head 1/2-20 bolts per SAE J429 grade 8 with flat head washers. The current rack mounting installation is comparable to this test configuration. As far as weight an non-seismic loads are concerned, the effects of vertical gravity loads existed during the test and there are no other significant loads that must be considered.

For Doc. 3.0, a static case was include to account for higher mode contributions and general conservatism. This resulted in static accelerations of .233 G in each horizontal axis and 1.233 G in the vertical axis. (paragraph. 2.0). Paragraph 3.3 of the report provides the results of the analysis on the Anchor Bolts and Floor Welds. It indicates that the bolt stresses were 16,989 psi which is satisfactory in any grade of steel material. Also, the worst case stress on the pad weld is 8,707 psi which is acceptable.

28. *Was information necessary to assess or include physical/structural strength been incorporated into the test report?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, the extensive testing proved the structural integrity of the components. With a few minor problems noted in section 1 above all components showed adequate physical/structural strength.

For Doc. 3.0, the analysis quantitatively compares the stress results with the allowable of the materials involved. For the rack itself, the maximum combined principal stress is 32.9% of the minimum material yield strength for A36 steel which is used. As stated in question 27 above, the bolt stresses were 16,989 psi which is acceptable while the weld stresses were 8,707 psi which is acceptable.

29. *Did the method used assess the postulated failure modes and associated critical characteristics?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, a minimum of five (5) OBE events and one (1) SSE event were applied to assess the principal failure mode of seismic. In addition, a balanced and unbalanced rack configuration was tested to envelope the worst case conditions of rack loading.

Doc. 3.0 provides the analysis for the racks and assesses them for failure due to dynamic amplification of the structure. The analysis considered one worst case rack fully loaded plus a test panel assembly occupying locations 3 and 4. This configuration conservatively envelopes all rack conditions. The maximum combined principal stresses in the rack were compute for the dynamic response spectra excitation and for the static amplification of the ZPA plus vertical dead weight. This addresses the failure potential for the worst case conditions.

30. *As applicable, has dynamic analysis performed on electrical components, systems, structures, been performed in accordance with the mathematical principles and procedures as required by Reference 7.1?*

Y[x] N[ ] N/A[ ]

For the components shown in the qualification matrix, this question is not applicable.

For Doc. 3.0, the analysis has been performed in accordance with the principals and procedures of NEP 2.2. The qualification was accomplished by finite element analysis using the STARDYNE series of structural analysis programs. These programs are an industry standard for such qualification.

31. *For seismic analyses and testing, are computer programs, software, and firmware in accordance with NEP 2.6 and GP's 2.6, 3.7, 4.4, and 15.5?*

Y[x] N[ ] N/A[ ]

For the Foxboro components qualified by testing under Doc. 1.0,1.1, 1.2, & 1.4, this question is not applicable.

For Doc. 3.0, the analysis was done on STARDYNE Rel. 3.5 by General Microelectronics Corp. This software is controlled under the QA program of NQS.

TEMPERATURE/HUMIDITY QUALIFICATION ISSUES

Questions 32 through 43 are not applicable to the Seismic test Reports and Analysis.

TEST ANOMALIES

List all anomalies, resolutions, and justifications below. If open items remain for justification of anomaly resolution, please indicate in the explanation.

In one test situation, the screws and nuts that secure the hinge between the Hinge Mounting Strip and the Test Panel Mounting Plate loosened and fell off (Ref. 1.4, par. 3.b). The manufacturers drawings were since revised to specify that each of the eight nuts are to be welded to the screws after assembly. It was also observed that the hinge pin was protruding out after the test. To eliminate a potential problem the manufacturing drawings have been revised to specify that the ends of the hinge pin are to be penned over at assembly. Therefore these minor concerns have been addressed.

The Multi-Loop Power Supply P/N P03000CQ had an intermittent loss of output power which was discovered to be due to a fuse holder cap being loose (Ref. 1.4, par. 3.c). It was later determined that an improper type of fuse holder was used. This has since been corrected by substituting a previously qualified fuse holder. One other performance item was identified for the N-2AO-L2C-R(C) Contact Output Isolator which chattered under the Foxboro SSE event. These isolators are only fully qualified to the Foxboro OBE levels. This item was determined not to be a concern for Donald C. Cook since the Foxboro OBE far exceeds the required Cook SSE values. (Ref. 1.0, par. 4).

In Doc. 1.1, it was noted that the TRS levels achieved were somewhat lower than the Foxboro target generic values of the RRS; however, the response spectra achieved were deemed to represent conservative qualification levels from the standpoint that they envelope most of the control room floor response spectra in the United States.

TABLE 1

FOXBORO EQUIPMENT QUALIFICATION MATRIX

Equipment Qualified	Type Test Report	Seismic Test Report	Item No. or Similar Comp.	Significant Pages/para.	Summary of Qualification
N-2AI-C2L	Q0AAB15	Q0AAA20-1	1	Pg. 13/5.1.1	This component was tested both with a production module and a naturally aged module and both maintained their structural integrity and performance throughout the test
N-2AI-H2V N-2AI-I2V	Q0AAA06 QOAAB35	 Q0AAA20-2 Q0AAA20-1	N-2AI-I2V 20 3	Pg. 17/4.2 Pg.11/4.1.2 Pg.13/5.1.2 Pg.18/5.2.2	Component is qualified by similarity. The operation/configuration is the same. This component was tested both with a production module and a naturally aged module and both maintained their structural integrity and performance throughout the test.
N-2AI-P2V(C) N-2AI-P2V N-2AI-T2V	1-01878 Q0AAB29 Q0AAB28	Q0AAA20-1 Q0AAA06 Q0AAA20-1 Q0AAA20-1	N-2AI-P2V N-2AI-T2V 12B 2A	 Pg. 23/4.4 Pg. 22/5.3.2;1/2.1 Pg. 21/5.2.7; 1/2.1	Component is qualified by similarity. The operation/configuration is the same. Component is qualified as part of 2AO-VAI+P; which meet both structural and performance criteria. Component is qualified as part of 2AI-T2V+E; which meet both structural and performance criteria throughout the test.
N-2AX+VE N-2AX+P(C) N-2AX+P	Q0AAA06 1-01833 QOAAB21	Q0AAA20-1 Q0AAA20-1 QOAAA20-1	N-2AX+P N-2AX+P 12B	Pg. 66 /4.18; Pg. 4 Pg. 22/5.3.2;Pg.1/2.1	Component is qualified by similarity. The operation/configuration is the same. The only difference is that a test monitor jack has been added. Components meet both structural and performance criteria throughout the test.
N-2CCA-S	QOAAB69	QOAAA20-4	5	Pg. 14/4.6	The Control Card was tested and demonstrated its ability to perform its functions when subjected to the seismic excitations of the Foxboro RRS.
N-2CCA-D	QOAAB69	Q0AAA20-4	6	Pg. 12/4.5	The Control Card was tested and demonstrated its ability to perform its functions when subjected to the seismic excitations of the Foxboro RRS.
N-2AO-L2C-R(C) N-2AO-L2C-R	Q0AAA06 Q0AAB60 QOAAB34	Q0AAA20-1 Q0AAA20-1	N-2AO-L2C-R	Pg. 17/5.2.1;Pg. 20/5.2.5; Pg. 9/4.	Component is qualified by similarity; This component chattered during seismic test under Foxboro SSE test levels, but operated properly during OBE testing. Therefore, these Isolators are qualified to the Foxboro OBE levels which envelope the required Cook SSE levels.
N-2AO-V2H(C) N-2AO-V2H	* Q0AAA06	* Q0AAA20-1	N-2AO-V2H N-2AO-VAI	Pg. 27/4.6	This component is qualified by similarity to the 2AO-VAI since they are identical in function except for the output signal is proportional. This module is being customized and a supplemental qualification report is to be issued soon. When the new qualification report is issued, it will then be reviewed.
N-2AO-VAI	Q0AAB17	Q0AAA20-1 Q0AAA20-2		Pg. 27/5.4.2; Pg. 11/4. Pg. 14/4.1.6	Three isolation tests were performed on this to assure that this component will provide proper isolation during a seismic event. Both current production and naturally aged units were tested and all meet performance criteria.
N-2AX+DP11	Q0AAB69	Q0AAA20-4	7	Pg. 15/4.7	Component was tested, however no readings were taken during testing.

N-2AX+DP10-E N-2AX+DP10	Q0AAB06 Q0AAB14	Q0AAA20-1	N-2AX+DP10 37	Pg. 43/4.11 Pg. 17/5.1.9	Component was used to supply power to the nests; since no loss of power was experienced performance criteria was met. Structural Integrity was maintained.
N-2ANU-DM	Q0AAB69 QOAAB58	Q0AAA20-4	7 or 16	Pg. 18/5.1.b	Structural integrity maintained. Electrical continuity, through functioning modules, was maintained before, during and after seismic tests.
P0300CQ	Q0AAA20-4	Q0AAA20-4	8	Pg. 6 & Pg. 16/4.8	During one SSE test this power supply intermittently failed, but it was determined to be a fuseholder cap. An improper fuseholder had been used which has been corrected and the component is qualified for both structural integrity and perf.
Wiring	QOAAB61	QOAAA20-1,2		Pg. 6/IV-B	Wiring, cables, terminals, and connectors as installed in the N-2ES Rack properly functioned during testing.
N-2ARPS05-A6	Q0AAA37-3	Q0AAA37-2	1	Pg. 2/3.	Test results indicate that this unit maintained its structural integrity and operated properly during and after seismic exposure.

* This module is to be customized and a supplemental qualification report issued. This assessment will be updated once the results of the new report are evaluated.