Annual Report:

EQUIPMENT QUALIFICATION INSPECTION PROGRAM

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1. Executive Summary

During FY83, Sandia's Equipment Qualification Inspection Program (EQIP) participated in 40 NRC, RIV inspections of qualification test efforts and facilities. Ten test laboratories, eight irradiation facilities, six manufacturers which perform qualification activities, and two NSSS vendors were inspected. Several of these facilities were visited more than once.

The inspection effort resulted in many technical findings. We provide illustrative examples to highlight the issues of: Qualification Strategies, Inadequate Instrumentation, Calibration, Conflicts in Data or Analysis, Documentation, Review, Prototype Testing, and Test Plans and Procedures. Some of our technical concerns illustrate areas where additional NRC guidance may be useful. For example:

1. Frequently a manufacturer will perform more than one test on his product and/or include several specimens in a single test. Must all test results be noted in the qualification report, or may the manufacturer be selective in which test results are documented for qualification purposes? What criteria distinguishes research results from qualification test results? This issue frequently arises when a manufacturer performs a generic test in preparation for marketing of a product. When product sales are successful, the generic effort many times forms the basis for the plant-specific qualification documentation.

2. To what extent can post-accident acceleration techniques be used to compress a one-year accident requirement into a manageable experimental test? Is there a minimum accident exposure period; say 10 hrs, 15 days, or 30 days, for which a postulated accident must be simulated prior to performing acceleration techniques to simulate the remaining portion of the accident?

3. How does one establish "current state-of-the-art" qualification capabilities? Many manufacturers and test laboratories consider their test capabilities and practices to be proprietary.

4. What limits are appropriate for similarity analysis? Can another manufacturer's product be referenced in a similarity analysis? Is there a limit to size variations between two products compared in a similarity analysis?

2. Summary of Technical Findings for FY83 Activities

During FY83, Sandia consultants participated in NRC, RIV inspections to ten test laboratories, eight irradiation facilities, six manufacturers which perform qualification activities, (some of the manufacturers also provided qualification services to other companies), and two NSSS vendors. Several of these facilities were inspected more than once.

In this section some of our findings during FY83 inspection activities are summarized. The list of findings is not intended to be all inclusive. Rather, the intention is to illustrate some current industry qualification practices that might be improved by inspection efforts. We definitely do not wish to imply that these findings are applicable to all the facilities inspected during FY83. For some inspections, we only had positive findings.

Our second reason for summarizing the FY83 findings is to identify and illustrate areas where additional NRC regulations and guidance would be helpful. Many times during FY83 we had technical concerns that were difficult to justify from a regulatory standpoint. Examples are highlighted during our discussion. We start our list of findings by discussing examples of Qualification Strategies.

Qualification Strategies

1. One company announced that it did not perform qualification tests. Rather it performed research testing on its products several times to assure itself that particular products were appropriate for marketing to the nuclear industry. It then summarized relevant research results in reports that "established" qualification. The reports certified that qualification efforts were in accordance with relevant IEEE standards such as IEEE Std 323-1974. The research tests, however, were not performed according to test plans (a requirement of IEEE Std 323-1974), nor did the research test documentation satisfy the requirements of the IEEE standards. The qualification reports also did not specify how research test results were chosen for inclusion in the qualification report. After examination of research files, it was established that the company had summarized in some cases its best demonstrated performance as the equipment capability. Product specimens that had degraded earlier in the accident simulation were sometimes not mentioned when research summary qualification reports were written.

2. Another company started to qualify a product line by testing five different products in that line. By completion of the test program, four of the products had substantially degraded. A qualification report was written describing only the successful qualification of the one product that did not degrade. A second qualification report was then generated arguing that other members of the product line were qualified by similarity. The degradation observed during testing for four members of the product line was never discussed in the similarity report. Interestingly, the one product that successfully performed throughout this test had substantially degraded during previous qualification attempts. These previous efforts were never mentioned in the qualification report. The qualification test parameters had been successively changed until qualification success was achieved.

3. Demonstrating functionability of terminal blocks for one year after the start of a LOCA was the goal of another qualification effort. The test profile specified by the test plan was less than two days in length. Arrhenius techniques were employed to argue that this short test was equivalent to a one-year exposure. The elevated temperatures specified by the Arrhenius calculation resulted in a test plan profile that was superheated for the duration of the test. Hence, moisture films which would cause current leakage on the terminal blocks would evaporate in the superheated environment. In contrast, most of the postulated one-year accident exposure was at saturated or subcooled moisture environments. The actual test performed did not satisfy the test plan profile; it did include saturated steam environmental exposures.

4. Plant specific environmental profiles were used by one facility to generate test requirements. Transient ramp times and irradiation dose rates in excess of current state-of-the-art capabilities were specified. The facility wrote test plans specifying that testing with regard to these parameters be performed on a best effort basis for that facility. A survey of other test laboratory capabilities had not been performed (at the time of the inspection) to establish the industrial norm for current state-of-the-art qualification testing techniques.

5. One company employed another company's qualification report to argue that its product was qualified by similarity. Manufacturing process similarities and

differences between the two companies was never addressed. Interestingly, the referenced test included four test specimens, two of which failed the acceptance criteria. These failures were not reconciled.

6. An 80 conductor cable was qualified by testing single conductors only.

7. Eleven products were tested during the 1970's using a simultaneous aging and accident environmental simulation test. Ten out of the eleven products failed to satisfy the acceptance criteria. One product passed the test. Subsequent to this test, sequential testing techniques were employed by the company to establish qualification. The test engineer asserted during the NRC, RIV inspection that the test was performed for engineering information purposes only; there was no pending qualification requirement due to a purchase order, etc.; the simultaneous test was not repeated; and the company does not certify to a simultaneous test but to a sequential test.

8. Triaxial cable constructions were qualified without demonstrating or discussing the importance of electrical separation between the two concentric shields of the triaxial cable design.

9. A triaxial cable construction experienced electrical failure during several qualification type (research?) tests. Each of these tests employed a thermal aging-irradiation-steam test sequence. Thermal aging exposures of 7 days at 150°C, 29 days at 120°C, and 83 days at 110°C were successively employed during qualification attempts. Each qualification test resulted in electrical degradation. The failure mode, as described by the manufacturer: thermal expansion of the dielectric results in extrusion of the insulation through the triaxial metallic braid. During aging, the extruded dielectric is oxidized and upon cooling does not contract to its original position prior to the thermal exposure. The non-extruded dielectric, however, does contract, producing voids in the insulation. To overcome this problem, the company performed a qualification test that aged the cable insulation core before it was manufactured into a triaxial cable. After thermal aging, the metallic braids as well as jackets were manufactured and irradiation and steam exposures performed. The cable passed its specified electrical acceptance criteria and was certified as qualified. The manufacturer did not demonstrate that unaged cable (no

thermal aging nor irradiation) could not experience the previously observed failure made at the start of a LOCA environment where 171°C temperatures are postulated.

10. During a qualification test for a pressure switch (to be qualified for an out-of-containment application that might experience pressure and steam environments), the internal volume of the pressure switch was vented to the outside of the environmental pressure chamber employed for testing. This was accomplished by enclosing the pressure switch electrical interface and wiring inside metallic tubing. A pressure boundary at the interface was not fabricated. The technique is used to eliminate apparent failures caused by connection or lead wire failures. Choosing acceptable qualified interfaces and lead wires is typically the responsibility of the pressure switch user rather than the manufacturer. In this particular example, the use of metallic tubing without appropriate interface seals eliminated the possibility that leakage through the pressure switch housing would cause pressure buildup inside the switch at the backside of the pressure diaphragm and change its setpoint.

The above ten "Qualification Strategy" examples illustrate several important points for which additional NRC guidance may be useful:

1. Frequently a manufacturer will perform more than one test on his product and/or include several specimens in a single test. Must all test results be noted in the qualification report, or may the manufacturer be selective in which test results are documented for qualification purposes? What criteria distinguishes research results from qualification test results? This issue frequently arises when a manufacturer performs a generic test in preparation for marketing of a product. When product sales are successful, the generic effort many times forms the basis for the plant-specific qualification documentation.

2. To what extent can post-accident acceleration techniques be used to compress a one-year accident requirement into a manageable experimental test? Is there a minimum accident exposure period: say 10 hrs, 15 days, or 30 days, for which a postulated accident must be simulated prior to performing acceleration techniques to simulate the remaining portion of the accident?

3. How does one establish "current state-of-the-art" qualification capabilities? Many manufacturers and test laboratories consider their test capabilities and practices to be proprietary.

4. What limits are appropriate for similarity analysis? Can another manufacturer's product be referenced in a similarity analysis? Is there a limit to size variations between two products compared in a similarity analysis?

In addition to the "Qualification Strategy" findings, there were many implementation, design control, and test control findings during the FY83 inspections. A few examples are summarized below for each of the categories: Inadequate Instrumentation, Calibration, Conflicts in Data or Analysis, Documentation, Review, Prototype Testing, and Test Plans and Procedures:

Inadequate Instrumentation:

1. One manufacturer employed a 7-day circular chart to monitor simulated LOCA temperature profiles. This instrumentation lacked resolution to demonstrate compliance with steam ramp times specified by customer specifications. This manufacturer also did not have instrumentation to monitor the chemical spray flow rate and pH nor equipment to monitor the electrical energizing and functionability of the product being qualified by testing.

2. A manufacturer employed thermal aging ovens for qualification testing but did not have instrumentation to continuously monitor the oven temperatures.

3. During qualification of a temperature sensor element, the accuracy of the element was monitored during the accident irradiation exposure. (An acceptance criteria was established in the test plan for this measurement.) The thermocouple junction of the temperature element was enclosed during manufacture inside a vented stainless steel tube. In a radiation environment the tube will heat to a higher temperature than the surrounding ambient air, possibly leading to inaccurate (and unacceptable) temperature readings for the temperature element. During this qualification test, a reference thermocouple was employed to monitor the ambient air environment. This thermocouple was also enclosed by a stainless steel tube which in this case was unvented.

Hence its temperature readings were higher than the measurements generated from the "qualification" specimen. The reference thermocouple device chosen for this application was inappropriate.

Calibration:

1. One irradiation facility had no procedures for calibration of equipment. The QA manual did not require calibration to standards traceable to the National Bureau of Standards. There was no provision in the QA manual for handling equipment subsequently found out of calibration. This facility also did not have any requirements for maintaining records of calibration.

2. A manufacturer listed in a qualification report that a temperature controller had a range of 100-400°F and an accuracy of ± 1%. During qualification tests, the controller was used to monitor temperatures above 400°F. During a previous test, the controller was shown to be out of calibration by 20-30°F for temperatures between 300 and 340°F. The controller was not recalibrated prior to subsequent tests.

Conflicts in Data or Analysis:

1. Inspection of a company yielded several examples of "conflicts in data," including:

   a. Several examples where steam profile ramp times were reported in test qualification reports as achieved in shorter times than actually accomplished. For example, one report includes a figure illustrating that a 100°F to 440°F ramp was achieved in 10 seconds. In contrast, the test file notes indicated that 3 minutes were required to heat from 300°F to 420°F.

   b. A qualification report indicated that product specimens were thermally aged prior to irradiation and steam exposures. The test data file indicates that these specimens were never thermally aged. The file also indicates that these specimens functionally failed 24 hours into LOCA testing. Post-test measurements were satisfactory. The qualification report never mentions the test failure.

Documentation

1. A qualification report for one manufacturer was written in 1981 based on experimental data obtained in 1976. The data file did not include a listing of test equipment nor of calibration. The report contained data sheets from an unknown source which were unsigned. The report stated that the samples were irradiated at 1 Mrd/hr but the irradiation certificate stated that the average dose rate was 0.55 Mrd/hr. This irradiation certificate is dated 1979, but the qualification data file implies testing was performed in 1976. A second qualification report for the same company was in narrative form and contained no list of test apparatus and equipment. The irradiation certificate of compliance was not auditably linked to this qualification effort. It covered 43 test specimens but there was no positive identification to the six samples used for the qualification effort covered by the report.

2. A test plan required that certain measurements be performed for engineering information only. Raw test data indicates there was a failure during these measurements. This failure to meet test plan requirements was not documented in the qualification report. The data and related files contained no evaluation and justification for the exclusion of this data from the test report. An internal company memo which was made available indicated that the manager of quality testing had been instructed to remove this data from the test report.

3. One facility experienced several deviations and anomalies during a qualification test program. These included broken subcomponents, subcomponent operational failures, and replacement of subcomponents during qualification testing. No nonconformance or deviation reports were generated (as required by the facility's QA program) to document these events. A final test report was not written; the qualification effort was stopped and redefined as a research activity.

4. A facility decided to reorient a product during testing and to readjust the setpoints. No nonconformance or deviation reports were found by the inspectors in the project file. During the same test program, gaskets for a second product were replaced with new similar gaskets provided by the test sponsor. Again, no nonconformance or deviation reports were generated.

Review

1. A facility's test plan was reviewed for adequacy by a staff member other than the author. The test plan indicated that the author employed the Arrhenius method to calculate thermal aging requirements. In actuality, the Arrhenius technique had not been employed. Nor had all the subcomponents susceptible to thermal aging been identified in the aging analysis. The reviewer did not note these discrepancies. The facility manager indicated that the reviewer was not technically qualified to evaluate aging analysis data for this qualification report.

Prototype Testing

1. A company issued a qualification report for one of its products. The test samples were produced prior to the company finalizing its production materials and processes. For example, part of the test specimen production was performed by another manufacturer because of "problems." A material used in the construction of the product was changed after production of the qualification test specimens. Four months after the production of qualification specimens, manufacturing status reports indicate that some steps of the production process to date have not been satisfactory.

Test Plans and Procedures

1. At one facility, a nonconformance report describing test anomalies was generated three months prior to the approval of the governing test procedures.

3. FY83 Activities

During FY83, the Equipment Qualification Inspection (EQIP) Program participated in 40 NRC, RIV inspections of qualification test efforts and facilities. Each inspection typically involved a Sandia staff member participating as a technical consultant during a week long inspection effort. For four of these inspections, NRC employed two Sandia consultants rather than one. Two inspections were also combined into a one-week effort. Hence, EQIP's FY83 activities involved 43 person-weeks of "on-the-road" inspection support. In contrast, FY82 activities involved eleven inspection trips. Table 1 summarizes the inspection activities performed during FY83.

In addition to the 40 inspection trips, Sandia personnel participated in several additional EQIP activities. These included: technical reviews at Sandia of four qualification test plans; participation in three EQIP program reviews with NRC, RIV staff; preparation of a NRC Form 1.89 for the EQIP Program; periodic preparation of program status reports, and attendance at a seismic seminar.

Table 1
Sandia Consultation During NRC, RIV Inspections FY83

Date	Company	Sandia Participant
October 19-21	Acton Environmental Testing Corporation	J. Letz
October 25-29	Wyle Labs, Huntsville	L. Bustard
November 15-19	Isomedix	J. Benson
November 29-December 3	Southwest Research	J. Benson
November 29-December 3	Limitorque	L. Bustard
December 13-16	Georgia Tech	J. Benson
January 10-14	NTS, Saugus, CA	J. Benson
January 17-21	Wyle Labs, Norco	E. Minor
January 24-28	NTS, Hartwood, VA	J. Benson
January 24-28	Westinghouse, Forest Hills	L. Bustard
February 7-10	GE, San Jose	L. Bustard
February 14-18	Bailey Controls	J. Benson
February 22-25	Conax Corporation	E. Minor
February 28-March 4	BIW Cable Systems	J. Benson
March 29-April 1	Wyle Labs, Huntsville	E. Salazar
April 4-7	Neutron Products	J. Benson
April 11-15	Westinghouse, AESD	E. Salazar
April 18-21	East-West Technology	J. Letz
April 18-20	GE, San Jose	J. Benson
April 25-29	Franklin	L. Bustard
May 3-4	International Nutronics	E. Salazar

Table 1 (cont.)
Sandia Consultation During NRC, RIV Inspections

Date	Company	Sandia Participant
May 4-5	Radiation Sterilizers	J. Benson
May 24-27	Radiation Technology	E. Salazar
June 6-10	Rockbestos	L. Bustard
June 13-17	Farewell & Hendricks	B. Bader
June 13-17	Process Technology	J. Letz
June 20-24	Rockbestos	L. Bustard/ J. Benson
June 27- July 1	Wyle, Huntsville	E. Salazar
June 27- July 1	Acton Labs	F. Thome
July 19-20	Nuclear Qualification Services (NQS)	J. Benson
July 26-27	Westinghouse, Forest Hills	J. Benson
August 8-12	Wyle, Huntsville	E. Salazar
August 14-17	Rockbestos	L. Bustard
August 22-24	Radiation Dynamics	B. Bader
August 24-26	Farewell & Hendricks	B. Bader
August 29- September 2	BIW Cable Systems	L. Bustard/ J. Benson
August 29- September 2	Westinghouse NTD	E. Salazar
September 19-23	Westinghouse, Canada	E. Salazar
September 19-23	GE, Valley Forge	P. Bennett/ L. Bustard
September 26-30	GE, San Jose	P. Bennett/ L. Bustard

4. Financial Information

Table 2 summarizes EQIP's costs for FY83. These costs are estimates based on Sandia's Cost-Budget Report. Travel costs do not fully reflect FY83's actual costs because of billing delays. All figures are rounded to the nearest 1K. Actual costs are provided by invoices sent to NRC by DOE.

Table 2
Estimated Fiscal Year 1983 Costs

I.	Direct Manpower (man months of charged effort)	27.6
II.	Directed Loaded Labor Costs	235K
	Material and Services	4K
	Computer (ADP Support)	---
	Purchases	3K
	Travel	35K
	Total	277K

Table 3 summarizes EQIP's projected costs for FY84. These projected costs are estimates only. Some variations in program level of effort may be required because of industry scheduling, significant changes in qualification technology, or significant unanticipated trends in industry and research test results.

Table 3
Projected Fiscal Year 1984 Costs

I.	Direct Manpower (man months of effort)	42.0
II.	Direct Loaded Labor Costs	392K
	Material and Services	---
	Computer (ADP Support)	---
	Purchases	12K
	Travel	65K
	Total	469K

DISCUSSION OF SANDIA ITEMS

Executive Summary (Page 3)

Items 1-4 of this section are addressed in another section of the annual report.

Qualification Strategies (Page 4)

Items 1, 2 and 7 pertain to SNL Concern 2B on page 6 of the enclosure to SECY 83-457C, i.e., "Type testing reporting does not ensure full reporting of all test results". The NRC response is on page 7. (Inspection Report Nos. 99900283/83-02, 99900277/83-02, 99900277/83-04 and 99900921/83-02)

Item 3 is addressed under the category of "Qualification Methodologies Have Shortcomings", on pages 2 and 3 (bullet No. 5) of the enclosure to SECY 83-457C, i.e., "Under what circumstances is the Arrlenius methodology for accelerated thermal aging valid?" The NRC response is on page 4. (Inspection Report Nos. 99900902/82-08 and 99900902/83-01)

Item 4 is an unresolved and open issue at one facility. (Inspection Report Nos. 99900911/83-01 and 99900911/83-03)

Item 5 is addressed in Inspection Report No. 99900283/83-02.

Item 6 was a finding in a recent Rockbestos inspection which will be addressed in the company's response to the RIV inspection report (No. 99900277/83-04). In general, 10 CFR 50.49 allows the qualification of a multi condutor cable by testing a single conductor cable, however, analysis must be provided by the licensee/applicant and addressed on a case-by-case basis.

Item 8 is addressed under the category of "Design Bases (Acceptance Criteria) Have Shortcomings", on page 6 of the enclosure to SECY 83-457C. [SNL Concern 2.A.(b).] The NRC response is on page 7. (Inspection Report No. 99900277/83-02)

Item 9 pertains to a Rockbestos inspection finding referred to on page 8 of the enclosure to SECY 83-457C. The NRC response is on page 8. (Inspection Report No. 99900277/83-01).

Item 10 is addressed under the category of "Design Bases (Acceptance Criteria) Have Shortcomings", on page 6 of the enclosure to SECY 83-457C. [SNL Concern 2.A.(c).]

Points Requiring Additional NRC Guidance (Page 7) (Executive Summary Items)

Item 1 is SNL concern 2B on page 6 of the enclosure to SECY 83-457C, i.e., "Type testing reporting does not ensure full reporting of all test results". The NRC response is on page 7.

Item 2 is addressed under the category of "Qualification Methodologies Have Shortcomings", on pages 2 and 3 (bullet No. 5) of the enclosure to SECY 83-457C, i.e., "Under what conditions is the Arrlenius methodology for accelerated thermal aging valid?" The NRC response is on page 4.

Item 3 does not constitute an NRC concern. The staff position is that if a testing facility deviates from a test plan or procedure, justification must be provided by the licensee/applicant.

Item 4 raises questions that are addressed by current regulations and standards which allow qualification by similarity analysis. In all cases, justification must be provided by the licensee/applicant. In addition, due to the variety of equipment designs and types, it is not practical to provide generic guidance to cover all possibilities which must be dealt with on a case-by-case basis.

The remaining items of the report constitute inspection findings in the categories indicated, each of which was identified in the inspection report indicated below and in some cases were highlighted in I&E information notices. In all cases, the inspection findings involve followup and closeout by the Vendor Program Branch.

Inadequate Instrumentation

1. Report No. 99900277/83-01
2. Report No. 99900283/83-01
3. Report No. 99900911/83-03

Calibration

1. Report No. 99900903/83-01
2. Report No. 99900277/83-01 and 99900277/83-02

Conflicts in Data or Analysis

1.a. Report No. 99900277/83-02
1.b. Report No. 99900277/83-02

Documentation

1. Report No. 99900277/83-02
2. Report No. 99900277/83-02
3. Report No. 99900904/82-07
4. Report No. 99900921/83-01

Review

1. Report No. 99900921/83-01

Prototype Testing

1. Report No. 99900921/83-02

Test Plans and Procedures

1. Report No. 99900921/83-01