

# NRE Research and/or Technical Assistance Report

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AUDIT OF PACIFIC GAS AND ELECTRIC'S DOCUMENTATION  
CONCERNING ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED  
ELECTRICAL EQUIPMENT PER NUREG-0588 FOR THE DIABLO CANYON  
NUCLEAR PLANTS

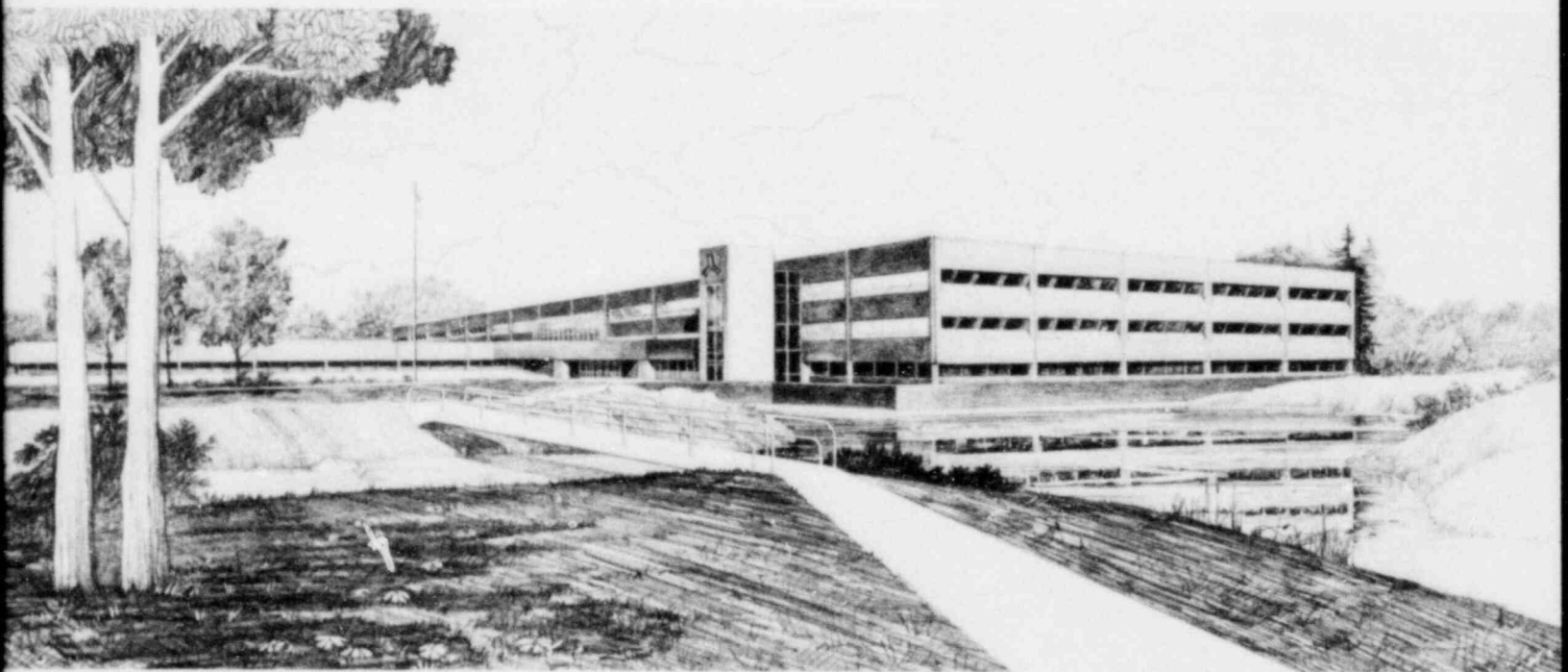
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Idaho Operations Office • Idaho National Engineering Laboratory



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## INTERIM REPORT

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## INTERIM REPORT

AUDIT OF PACIFIC GAS AND ELECTRIC'S DOCUMENTATION CONCERNING  
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT  
PER NUREG-0588 FOR THE DIABLO CANYON NUCLEAR PLANTS

Docket Nos. 50-275 and 50-323

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#### ABSTRACT

The Diablo Canyon Nuclear Plants documentation was audited to determine the environmental qualification of safety-related electrical equipment. Results of the audit are summarized in this report.

#### FOREWORD

This report is supplied as part of the "Equipment Qualification Case Reviews," being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Engineering, Equipment Qualification Branch by EG&G Idaho, Inc.

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1.0 INTRODUCTION

On August 31 through September 3, 1981, a team comprised of representatives of the Reliability and Statistics Branch of EG&G Idaho, Inc. and NRC staff conducted an audit of the environmental qualification files for safety-related electrical equipment at the Diablo Canyon Nuclear Plants. The work effort involved a 100% audit of the licensee's central files. Areas of general concern were discussed during a separate meeting and were not involved in this audit. The attached Appendix A contains reviews of the equipment files audited by EG&G representatives.

2.0 EVALUATION

The audit indicated that six equipment items are unqualified and will be replaced, seven equipment items are incomplete and require additional analysis, testing, or other documentation, nine equipment items are exempt, and twenty-four equipment items are qualified and have complete files. Pacific Gas and Electric (PG&E) has indicated that all of this equipment will be included in a surveillance program. Qualification of some of the equipment will be maintained by following replacement schedules for materials which are susceptible to aging degradation.

3.0 CONCLUSIONS

As a result of the audit, it is concluded that PG&E has an adequate environmental qualification program in accordance with NUREG-0588.

4.0 REFERENCES

1. Units 1 and 2, Diablo Canyon Site, Pacific Gas and Electric Company, Environmental Qualification Report, Revision 1.
2. Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment, NUREG-0588.
3. IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations, IEEE Std. 323-1974.

APPENDIX A  
SUMMARIES OF CENTRAL FILE REVIEWS

Item: H. E. Sostman Co. RTDs

Models 11834B-1 Narrow Range  
11901B-1 Wide Range

IH4

The Sostman RTDs are used in the containment to monitor the Reactor Coolant System loop hot and cold legs for reactor trip and safety injection initiation signals. The wide range RTD is also used for post-accident monitoring. The bounding environmental parameters are temperature (344°F), pressure (47 psig), humidity (100%), chemical spray (boric acid and sodium hydroxide at a pH of 8.8), and radiation ( $10^8$  Rads narrow range,  $>10^8$  Rads wide range). The required operability time under the DBE is 5 minutes for the narrow range and 120 days for the wide range.

The documentation file includes a worksheet, a component evaluation report, environment profiles, purchasing documents, supporting documents such as radiation analyses, chemical analyses, and temperature variation acceptance analyses, and two WCAP reports, 9157 and 9745.

The test performed for qualification met the requirements for pressure, humidity, and chemical spray composition. The spray pH was 8.5 rather than 8.8 but was considered acceptable because the exposed materials have been shown to be resistant to attack in this range of pH and with this short duration of spray. The maximum temperature achieved was 332°F but is acceptable since the 344-degree peak lasts less than one minute, and the component surface temperature is not expected to rise to near peak temperature in this short time period. The  $10^8$  Rads exposure is sufficient for the narrow range instrument, but due to a recent change in wide range operability requirements is insufficient for the wide range. No pre-aging of this component has been done.

This item is not considered qualified by PG&E. The narrow range instrument will have an aging study done to complete its qualification. The wide range instrument will be replaced by the first refueling shutdown. Justification for interim operation is provided.

Item: Asco Solenoid Valves

Models NP 831655V, NP8316E35V  
NP 831655E, 2084483F

IH6

These NP-series solenoid valves are used throughout containment. The limiting environmental parameters are 272°F (LOCA), 344°F (MSLB), 47 psig, 100% relative humidity, 24 hours of boric acid-sodium hydroxide spray at 8.8 pH, and  $3.6 \times 10^7$  Rads total integrated dose. The required operating time under the harsh environment is 30 days.

The documentation provided in the file includes a component evaluation report, bases for the required parameters, aging and beta analyses, and Isomedix Test Report AQS 21678/TR, Revision A.

The review of the file shows that similar valves were exposed to an environment that equaled or exceeded the parameters listed above. There were two anomalies in the test that involved test installation hardware. The file stated that PG&E uses qualified Conax connectors and therefore



will not have these problems. The aging analysis shows a qualified life of 11.4 years.

These valves are considered qualified by PG&E and will have the age sensitive elastomers replaced at ten year intervals. The reviewer considers this file complete.

Item: Valcor Solenoid Valve, Model V526-5295-36

IH9

The Valcor valves are used inside and outside containment for post-LOCA sampling. The limiting environmental parameters are 344°F (MSLB), 272°F (LOCA), 47 psig, 100% relative humidity, 8.8 pH boric acid-sodium hydroxide spray, and  $5.3 \times 10^7$  Rads (total integrated dose). The required operating time under a harsh environment is one year.

The documentation provided in the file includes a component evaluation report; bases for the required parameters; aging, operability, and beta radiation evaluations; and Valcor qualification test report number QR52600-5940-2.

The review of the file shows that a solenoid valve with identical electrical components was exposed to an environment that equaled or exceeded the parameters listed above with the exception of post-accident operability time. The test lasted for 31 days rather than 1 year but was extended by analysis to 2.48 years. Accelerated aging analysis indicates a lifetime of 57.53 years. This aging analysis included the statement that Arrhenius extension is a relative measure and is not meant to be an absolute value for solenoid life.

The change in qualified life from 2.4 years during the previous audit of this file to 57.53 years during this audit was stated to be a misinterpretation of an aging analysis that had been performed for a different plant where these solenoids are normally energized. This analysis should never have been applied to the Diablo Canyon Plant. The test report evaluation of greater than 40 years was backed up by an independent evaluation showing 57.53 years.

The reviewer considers this file complete and assurance is provided that the plant surveillance program will reveal any new degradation that present aging analysis methods do not reveal.

Asco Solenoid Valves Models 831655 and 8321A5

IH10

These non-NP series Asco solenoid valves are used in containment for the control of containment isolation valves. The limiting environmental parameters are 272°F (LOCA), 344°F (MSLB), 47 psig, 100% relative humidity, 24 hours of boric acid-sodium hydroxide spray at 8.8 pH, and  $5.34 \times 10^7$  Rads total integrated dose. The valves are assumed to submerge. There is no operating time in the harsh environment as the valves are required only to fail to the proper position.

The documentation provided in the file include a component evaluation report, bases for the required parameters, aging and beta analyses, a failure analysis on the valves, and Isomedix Test Report No. AQS 21678/TR, Revision A.

The review of the file shows that similar valves were exposed to an environment that equaled or exceeded the above parameters with the exception of submergence. The lack of submergence testing is justified by the fact that ingress of water would simply cause electrical failure which would produce the proper positioning of the valve. The failure analysis verified this. Similarity is demonstrated due to the fact that the installed valves have had their plastic internals replaced with brass and stainless steel, which makes them electrically identical. The aging analysis shows a qualified life of 11.4 years.

These valves are considered qualified by PG&E and will have the age sensitive elastomers replaced at ten year intervals. The reviewer considers this file complete.

Item: Asco Non-NP Solenoid Valves Outside Containment

IH17

These valves are used outside containment for containment isolation. They are pilots for valves which will not be re-opened after isolation. PG&E has exempted these valves from qualification and has shown proper justification. This justification includes failure analysis, effect of failure on the system, and fault analysis for interface with other safety devices.

The reviewer considers this file complete.

Item: Okonite EPR/Hypalon Cable

EH2

This Okonite cable is used outside containment in low voltage and control applications. In areas of harsh environment the cable is installed in conduit, junction boxes, and termination boxes. The limiting environmental parameters are 300°F, 9.26 psig, 100% relative humidity, and  $6.7 \times 10^7$  Rads total integrated dose. The cable must function under the harsh environment for one year.

The documentation provided in the file includes a component evaluation report, bases for the required parameters, and a Wyle engineering report that evaluates and includes two Okonite reports.

The review of the file shows that the cable was exposed to an environment that was at least as severe as that shown above. The test only ran for 101 days but was extended by analysis to greater than 365 days. Pre-aging was not done on the sample that was irradiated and LOCA tested. However, another sample, with EPR insulation only and no jacket, was pre-aged before being subjected to a similar test for 130 days. The aging analysis indicates 56.2 years qualified life.

PG&E considers this cable qualified and subject only to standard on-going surveillance. The reviewer considers the file complete.

Item: ITI Exane II DAC-02A-AKP Cable

EH7

This cable is used for low voltage signal application inside containment. This cable is installed in conduit and in steel junction and termination boxes. The limiting environmental conditions are 272°F LOCA, 344°F MSLB, 47 psig, 100% relative humidity, 24 hours of boric acid-sodium hydroxide spray with 8.8 pH, and  $4.67 \times 10^7$  Rads total integrated dose. The cables must function in the harsh environment for 120 days.

The documentation provided in the file includes a component evaluation report, bases for the required parameters, aging and operability analyses, and Isomedix test report number 375-03.

The review of the file shows that an Exane II cable was exposed to conditions in excess of those listed above. The exposure was only for 30 days but the operability extension analysis calculates operability at greater than 120 days. The aging analysis indicates a qualified life of greater than 40 years.

PG&E considers this cable qualified and subject only to standard on-going surveillance. The reviewer considers the file complete.

Item: Okonite EPR-Neoprene 5KV Cable

EH16

This Okonite 5KV cable is used outside containment in medium voltage power applications. In areas of harsh environment the cable is installed in conduit, junction boxes, and termination boxes. The limiting environmental conditions are 300°F, 9.26 psig, 100% relative humidity, and  $6.7 \times 10^7$  Rads total integrated dose. The cables must function under the harsh environment for one year.

The documentation provided in the file includes a component evaluation report, bases for the required parameters, and two Okonite engineering reports.

The review of the file shows that the cable was exposed to an environment that was at least as severe as that shown above. The test only ran for 101 days but was extended by analysis to greater than 365 days. Pre-aging was not done on the sample that was irradiated and LOCA tested. However, another sample, with EPR insulation only and no jacket, was pre-aged before being subjected to a similar test for 100 days. The aging analysis indicates 56.2 years qualified life.

PG&E considers this cable qualified and subject only to standard on-going surveillance. The reviewer considers the file complete.

Item: Barton Pressure Sensor Model 351

1H-3

The Barton 351 pressure sensor is used to sense containment pressure. The associated transmitter, located out of containment, fulfills both a trip function and a monitoring function. Bounding environmental qualification parameters are identified as pressure (47 psig), temperature (344°F), relative humidity (100%), chemical spray (8.8 pH, boric acid and sodium hydroxide), and radiation ( $3.67 \times 10^7$  Rads). The operability requirements are 120 days for monitoring and a five minute trip function. The sensors are located above flood elevation. Aging requirements of 40 years were specified.

The documentation file includes a work sheet, a component evaluation report, environmental profiles, various Westinghouse reports, and supporting analysis.

The audit of the environmental qualification documentation revealed that while the basic test report was based on a water fill, adequate documentation was available on a change to oil fill to justify interim operation until a new complete test report based on oil fill is available.

The qualification test temperature exceeded the main steam line break temperature with a margin of 56°F and a pressure margin of 19 psig was identified. The radiation qualification of the oil fill was  $1.8 \times 10^9$  Rads, whereas the specification was  $3.67 \times 10^7$  Rads. The aging analysis supported the claim for 40 years qualified lifetime.

Item: Containment Fan Cooler Motors Westinghouse Model No. 588-5-5 CSP 1H5

This previously audited item had only one deficiency, that of post accident operability time. Documentation was now available to support the claim of one year post accident operability. In essence, the analysis showed that the environment surrounding the degradable portions of the fan cooler motor is not harsh with the exception of radiation. The motor was irradiated to  $2 \times 10^8$  Rads prior to the design basis event test, which provides an acceptable margin of  $1.5 \times 10^7$  Rads.

The test results showed that, due to total enclosure and heat exchanger cooling, the temperature at the motor windings and bearings would be essentially normal during post-accident conditions.

Item: Electro-Hydraulic Actuator ITT General Controls  
Model NH92K6002E2L80

1H-14

The electro-hydraulic actuator is located outside containment and is used for auxiliary feedwater pump runout control. The limiting environmental qualification parameters are identified as operating time (1 year), temperature (209° HELB), relative humidity (100%), and radiation ( $1.14 \times 10^6$  Rads).

The documentation file included a component evaluation report, many ITT General Controls reports, and telexed copies of parts of Gulf Report No. RTC12494. Also included was documentation establishing the required parameters.

The audit of the environmental qualification documentation revealed that the test item was exposed to the above required conditions with adequate margin with the exception of aging, which is considered an open item by the applicant, and radiation, which has a documentation problem only.

The applicant is addressing the aging problem and will update the component evaluation report as soon as this is complete. An interim aging qualification of two years is adequately justified.

The applicant has telexed copies of paragraph 3.1 and 3.2 of Gulf Report No. RTC12494, which address the radiation-caused failure of the motor capacitor and support the qualification claim. This remains an open item until receipt and review of the complete test report. Justification for interim operation is considered adequate.

Previous concerns about actuator response due to radiation-caused oil off-gassing were addressed adequately, showing that specified radiation levels would not fail the actuator.

Another previous concern about the failure of the fail-safe function was addressed adequately by operational analysis. The fail-safe function is not required as no safe position exists during actuator operation.

Item: Barton Indicating Switch Model No. 288A

IH-27

This differential pressure switch controls a miniflow valve which routes RHR pump discharge flow to pump suction. Its location does not expose it to any harsh environment with the exception of radiation. The radiation qualification specification is  $1.7 \times 10^5$  Rads (TID), and the specified post-accident operating time is one year.

The documentation file includes a work sheet, a component evaluation report, a radiation shielding review, and ITT Test Report No. R3-288A-1.

The radiation qualification test exceeded the required exposure with a margin of  $2.8 \times 10^6$  Rads. Aging qualification is still an open item pending analysis and materials investigation. Adequate justification for interim operation was provided.

Item: Boston Cable, Silicone/Hypalon Model No. 8993-H-007  
8992-H-005

EH-5

The silicone/hypalon 5 and 7 conductor cable is used for low voltage power and control applications inside containment at all elevations. The cable is installed in steel conduit inside containment. Bounding environmental qualification parameters are identified as temperature (LOCA-272°F, MSLB-344°F), pressure (47 psig), 100% relative humidity, chemical spray (8.8 pH, boric acid and sodium hydroxide), and radiation ( $4.67 \times 10^7$  Rads). A 120-day post-accident operability time and an aging requirement of 40 years was specified.

The documentation file included a worksheet, a component evaluation report, bases for the required parameters, and Boston reports No. 73J020

and 75J093. An audit of the environmental qualification documentation confirmed that the test specimens were exposed to test conditions that exceeded those listed above by an acceptable margin except for MSLB temperature and post-accident operating time, both of which were extended by analysis. The aging qualification was done by Arrhenius analysis and indicates a lifetime in excess of 40 years with adequate margin.

PG&E considers this cable qualified and subject only to standard surveillance. It is concluded that the cable is qualified.

Item: Westinghouse CC and RHR Pump Motors

EH-14

Centrifugal Charging Pumps

Frame 5808-Z

Model HSDP

Residual Heat Removal Pumps

Frame 5010P24

Model VSWI

These are drive motors for the centrifugal charging pumps and the residual heat removal pumps. The location is outside containment in the auxiliary building. Bounding environmental parameters are identified as 90°F temperature (maximum ambient), a 365-day post-accident operability time, gamma radiation ( $6.78 \times 10^6$  Rads), and a 40-year qualified lifetime.

The documentation in the file included a worksheet, a component evaluation report, bases for the required parameters, and a main test report.

The documentation confirmed that the motors identified are qualified to the above limiting environmental parameters. Due to the size of these motors, separate effects testing was the most prevalent test method. Adequate margin was demonstrated and these motors are considered qualified.