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PACIFIC GAS AND ELECTRIC COMPANY

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November 13, 1980

NEW MAILING ADDRESS
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Mr. A. Schwencer, Acting Chief
Licensing Branch No. 3
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Docket No. 50-275
Docket No. 50-323
Diablo Canyon Units 1 & 2

Dear Mr. Schwencer:

As requested in Mr. Stolz's letter dated March 3, 1980, we have reviewed our environmental qualification program for safety-related electrical equipment using NUREG-0588. "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment (Comment Issue)," as the basis for our evaluation. The following information related to our review is attached:

Attachment 1. An evaluation of the environmental qualification program for safety-related electrical equipment.

Attachment 2. A tabulation of Class IE equipment outside containment subject to high energy line break.

Attachment 3. A tabulation of Class IE equipment inside containment with potential for exposure to severe environment.

Attachment 4. A tabulation of Class IE equipment not required to operate in a severe environment.

Attachment 5. A tabulation of environmental temperature evaluations for Class IE balance-of-plant electrical equipment.

Attachment 1 provides the response to Mr. Stolz's March 3, 1980 letter requesting an evaluation of our environmental qualification program for safety-related electrical equipment.

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Attachments 2 and 3 were submitted with our letters dated January 14, 1980 and March 20, 1980, respectively, as a partial response to Mr. Stolz's letter of November 2, 1979 regarding environmental qualification of Class IE equipment. They are attached here for convenience.

Attachments 4 and 5 provide the final portion of information to be supplied by PGandE in response to Mr. Stolz's November 2, 1979 letter.

Kindly acknowledge receipt of the material listed above on the enclosed copy of this letter and return it to me in the enclosed addressed envelope.

Very truly yours,

Philip A. Crane, Jr.

Attachments
CC w/attachment: Service List

1. ESTABLISHMENT OF THE QUALIFICATION PARAMETERS FOR DESIGN BASIS EVENTS

1.1 Temperature and Pressure Conditions Inside Containment - Loss of Coolant Accident (LOCA)

(1) The time-dependent temperature and pressure, established for the design of the containment structure and found acceptable by the staff, may be used for environmental qualification of equipment.

EVALUATION

The time-dependent temperature and pressure conditions for the LOCA were established for the design of the containment structure as documented in the FSAR and were found acceptable by the staff.

Qualification tests for equipment inside containment were performed using the applicable accepted environmental conditions.

(2) Acceptable methods for calculating and establishing the containment pressure and temperature envelopes to which equipment should be qualified are summarized below. Acceptable methods for calculating mass and energy release rates are summarized in Appendix A.

EVALUATION

The methodology described in WCAP-8312A was used for calculating the LOCA mass and energy release. Appendix A to NUREG-0588 indicates this methodology is acceptable to the staff.

Pressurized Water Reactors (PWRs)

Dry Containment - Calculate LOCA containment environment using CONTEMPT-LT or equivalent industry codes. Additional guidance is provided in Standard Review Plan (SRP) Section 6.2.1.1.A, NUREG-75/087.

EVALUATION

The methods used for calculating pressure and temperature time dependent envelopes for equipment qualification were based on the COCO model described in WCAP-8327 and 8936. This method was found acceptable by the staff.

(3) In lieu of using the plant-specific containment temperature and pressure design profiles for BWR and ice condenser types of plants, the generic envelope shown in Appendix C may be used for qualification testing.

EVALUATION

Not applicable.

(4) The test profiles included in Appendix A to IEEE Std. 323-1974 should not be considered an acceptable alternative in lieu of using plant-specific containment temperature and pressure design profiles unless plant-specific analysis is provided to verify the adequacy of those profiles.

EVALUATION

Plant-specific analysis have been used for providing containment temperature and pressure profiles for equipment environmental qualification tests (see 1.1(a) and (2) above). The test profiles in Appendix A to IEEE 323-1974 were not used.

1.2 Temperature and Pressure Conditions Inside Containment - Main Steam Line Break (MSLB)

(1) Where qualification has not been completed, the environmental parameters used for equipment qualification should be calculated using a plant-specific model based on the staff-approved assumptions discussed in item 1 of Appendix B.

EVALUATION

Not applicable as qualification has been completed.

(2) Other models that are acceptable for calculating containment parameters are listed in Section 1.1(2).

EVALUATION

The model used for calculating containment parameters used the methodology in WCAP-8822 for the environmental qualification program which has been accepted by the staff. Appendix A to NUREG-0588 indicates the acceptability of WCAP-8822 for calculating the mass and energy release following main steam line break (MSLB). The methods used for calculating pressure and temperature time dependent envelopes for equipment qualification were based on the COCO model described in WCAP 8327 and 8936. This method was found acceptable by the staff.

(3) In lieu of using the plant-specific containment temperature and pressure design profiles for BWR and ice condenser plants, the generic envelope shown in Appendix C may be used.

EVALUATION

Not applicable.

(4) The test profiles included in Appendix A to IEEE Std. 323-1974 should not be considered an acceptable alternative in lieu of using plant-specific containment temperature and pressure design profiles unless plant-specific analysis is provided to verify the adequacy of those profiles.

EVALUATION

Plant-specific analyses have been used for providing containment temperature and pressure profiles for equipment environmental qualification tests. The test profiles included in Appendix A to IEEE 323-1974 were not used.

(5) Where qualification has been completed but only LOCA conditions were considered, then it must be demonstrated that the LOCA qualification conditions exceed or are equivalent to the maximum calculated MSLB conditions. The following technique is acceptable:

(a) Calculate the peak temperature from an MSLB using a model based on the staff's approval assumptions discussed in item 1 of Appendix B.

EVALUATION

The calculations of the containment temperature transient employs the methodology described in the response to item 1.2(2).

(b) Show that the peak surface temperature of the component to be qualified does not exceed the LOCA qualification temperature by the method discussed in item 2 of Appendix B.

EVALUATION

In determining component temperature, the model used, as described in WCAP-8936, estimates the component internal temperatures under qualification and the peak MSLB conditions. PGandE believes that the significant parameter to measure in qualification is the temperature attained during any transient condition of any potentially temperature sensitive internal components and not the surface temperature of the metallic enclosure.

(c) If the calculated surface temperature exceeds the qualification temperature, the staff requires that (i) additional justification be provided to demonstrate that the equipment can maintain its required functional operability if its surface temperature reaches the calculated value or (ii) requalification testing be performed with appropriate margins, or (iii) qualified physical protection be provided to assure that the surface temperature will not exceed the actual qualification temperature.

EVALUATION

In the calculations performed using the model described in WCAP-8936 (noted in item 1.2(5b), the component internal temperature under qualification conditions exceeded the estimated component internal temperatures under worst case MSLB conditions.

1.3 Effects of Chemical Spray

The effects of caustic spray should be addressed for the equipment qualification. The concentration of caustics used for qualification should be equivalent to or more severe than those used in the plant containment spray system. If the chemical composition of the caustic spray can be affected by equipment malfunctions, the most severe caustic spray environment that results from a single failure in the spray system should be assumed. See SRP Section 6.5.2 (NUREG-75/087), paragraph II, item (3) for caustic spray solution guidelines.

EVALUATION

The chemical composition of the spray used in the environmental qualification tests had a concentration of at least 1.146 weight percent boric acid and 0.17 weight percent sodium hydroxide dissolved in water. This chemical spray concentration corresponds to a pH of 8.5. The test spray meets the guidelines of SRP 6.5.2, II(e).

The containment spray system is designed such that no single failure can occur that will result in additional sodium hydroxide being added which could increase the anticipated alkalinity of the chemical spray.

1.4 Radiation Conditions Inside and Outside Containment

The radiation environment for qualification of equipment should be based on the normally expected radiation environment over the equipment qualified life, plus that associated with the most severe design basis accident (DBA) during or following which that equipment must remain functional. It should be assumed that the DBA related environmental conditions occur at the end of the equipment qualified life.

The sample calculations in Appendix D and the following positions provide an acceptable approach for establishing radiation limits for qualification. Additional radiation margins identified in Section 6.3.1.5 of IEEE Std. 323-1974 for qualification type testing are not required if these methods are used.

(1) The source term to be used in determining the radiation environment associated with the design basis LOCA should be taken as an instantaneous release from the fuel to the atmosphere of 100 percent of the noble gases, 50 percent of the iodines, and 1 percent of the remaining fission products. For all other non-LOCA design basis accident conditions, a source term involving an instantaneous release from the fuel to the atmosphere of 10 percent of the noble gases (except Kr-85 for which a release of 30 percent should be assumed) and 10 percent of the iodines is acceptable.

EVALUATION

The source term used for determining the radiation environment for qualification of equipment for a LOCA meet these criteria.

(2) The calculation of the radiation environment associated with design basis accidents should take into account the time dependent transport of released fission products within various regions of containment and auxiliary structures.

EVALUATION

During the qualification of equipment, there was no requirement for considering time dependancy of transport of the released fission products and no attempt was made to include this aspect into the calculation of the radiation environment to which equipment was qualified.

(3) The initial distribution of activity within the containment should be based on a mechanistically rational assumption. Hence, for compartmented containments, such as in a BWR, a large portion of the source should be assumed to be initially contained in the drywell. The assumption of uniform distribution of activity throughout the containment at time zero is not appropriate.

EVALUATION

During the qualification of equipment, there was no requirement for determining the distribution of activity mechanistically and the distribution of activity was assumed to be uniform throughout the containment at time zero. As a general rule, this method is conservative as shielding from structures and equipment is not considered with uniform distribution of activity.

(4) Effects of ESF systems, such as containment sprays and containment ventilation and filtration systems, which act to remove airborne activity and redistribute activity within containment, should be calculated using the same assumptions used in the calculation of offsite dose. See SRP Section 15.6.5 (NUREG-75/087) and the related sections referenced in the Appendices to that section.

EVALUATION

No credit was taken for removal of radioactivity from the containment atmosphere by containment sprays, filters or fission product plateout. The fission products are assumed to be distributed homogeneously throughout the containment with removal by decay only. This assumption makes the radiation dose used for equipment qualification conservative.

(5) Natural deposition (i.e., plateout) of airborne activity should be determined using a mechanistic model and best estimates for the model parameters. The assumptions of 50 percent instantaneous plateout of the iodine released from the core should not be made. Removal of iodine from surfaces by steam condensate flow or washoff by the containment spray may be assumed if such effects can be justified and quantified by analysis or experiment.

EVALUATION

Plateout was not considered in the calculation of the radiation environment.

(6) For unshielded equipment located in the containment, the gamma dose and dose rate should be equal to the dose and dose rate at the centerpoint of the containment plus the contribution from location dependent sources such as the sump water and plateout, unless it can be shown by analyses that location and shielding of the equipment reduces the dose and dose rate.

EVALUATION

Dose and dose rates to equipment was calculated as indicated in the response to items 1.4(1), (2), (3), (4), and (5).

(7) For unshielded equipment, the beta doses at the surface of the equipment should be the sum of the airborne and plateout sources. The airborne beta dose should be taken as the beta dose calculated for a point at the containment center.

EVALUATION

Qualification for the effects of beta radiation was not a requirement for Category II equipment and as a consequence was not systematically addressed as part of the original qualification program, however, all 1E instrumentation is adequately shielded from beta doses.

(8) Shielded components need be qualified only to the gamma radiation levels required, provided an analysis or test shows that the sensitive portions of the component or equipment are not exposed to beta radiation or that the effects of beta radiation heating and ionization have no deleterious effects on component performance.

EVALUATION

See response to item 1.4(7).

(9) Cables arranged in cable trays in the containment should be assumed to be exposed to half the beta radiation dose calculated for a point at the center of the containment plus the gamma ray dose calculated in accordance with Section 1.4(6). This reduction in beta dose is allowed because of the localized shielding by other cables plus the cable tray itself.

EVALUATION

See response to items 1.4(6) and 1.4(7).

(10) Paints and coatings should be assumed to be exposed to both beta and gamma rays in assessing their resistance to radiation. Plateout activity should be assumed to remain on the equipment surface unless the effects of the removal mechanisms, such as spray washoff or steam condensate flow, can be justified and quantified by analysis or experiment.

EVALUATION

See response to items 1.4(6) and 1.4(7).

(11) Components of the emergency core cooling system (ECCS) located outside containment (e.g., pumps, valves, seals and electrical equipment) should be qualified to withstand the radiation equivalent to that penetrating the containment, plus the exposure from the sump fluid using assumptions consistent with the requirements stated in Appendix K to 10 CFR Part 50.

EVALUATION

A comprehensive study has been performed to determine the radiological environment associated LOCA events in selected Plant locations outside of the containment. The results of this study will be used to evaluate the environmental qualifications of ECCS equipment located outside containment. The results of this study will be available November 15, 1980.

(12) Equipment that may be exposed to radiation doses below 10^4 rads should not be considered to be exempt from radiation qualification, unless analysis supported by test data is provided to verify that these levels will not degrade the operability of the equipment below acceptable values.

EVALUATION

The thrust of this requirement relates to in-service aging mechanisms which is addressed in item 4.

(13) The staff will accept a given component to be qualified provided it can be shown that the component has been qualified to integrated beta and gamma doses which are equal to or higher than those levels resulting from an analysis similar in nature and scope to that included in Appendix D (which uses the source term given in item (1) above), and that the component incorporates appropriate factors pertinent to the plant design and operating characteristics, as given in these general guidelines.

EVALUATION

The radiation environment discussed in the response to items 1.4(1), (2), (3), (4) and (5) was used in qualifying equipment and was accepted by the staff.

(14) When a conservative analysis has not been provided by the applicant for staff review, the staff will use the radiation environment guidelines contained in Appendix D, suitably corrected for the differences in reactor power level, type, containment size, and other appropriate factors.

EVALUATION

See response to item 1.4(13).

1.5 Environmental Conditions for Outside Containment

(1) Equipment located outside containment that could be subjected to high-energy pipe breaks should be qualified to the conditions resulting from the accident for the duration required. The techniques to calculate the environmental parameters described in Sections 1.1 through 1.4 (Category II) above should be applied.

EVALUATION

An evaluation of the effects of postulated pipe breaks outside containment was performed and reported in Appendix 3.6 of the FSAR. The environmental conditions reported in Appendix 3.6 have been accepted by the staff. Equipment outside containment has been qualified to the accident conditions identified in the evaluation of pipe breaks outside containment or to conditions which are more severe.

(2) Equipment located in general plant areas outside containment where equipment is not subjected to a design basis accident environment should be qualified to the normal and abnormal range of environmental conditions postulated to occur at the equipment location.

EVALUATION

As indicated in Table 3.11-2 of the FSAR and the correspondence of March 20, 1980 to John Stolz, equipment outside containment which is not subjected to design basis accident conditions has been qualified to the normal and abnormal conditions associated with their location within the plant.

(3) Same as Category I; or, there may be designs where a loss of the environmental support system may expose some equipment to environments that exceed the qualified limits. For these designs, appropriate monitoring devices should be provided to alert the operator that abnormal conditions exist and to permit an assessment of the conditions that occurred in order to determine if corrective action, such as replacing any affected equipment, is warranted.

EVALUATION

Class 1E equipment has either been qualified for the most severe environment based on the loss of environmental support systems or temperature monitoring of the room or area where Class 1E equipment is located is provided to indicate abnormal temperature occurrences.

The FSAR section on "Environmental Conditions Outside the Containment" identified as Section 3.11.2 describes when temperature monitoring of a room or area is required. Table 3.11-2 "Environmental Temperature Evaluations for Class 1E BOP Electrical Equipment" provides a listing of equipment and their associated environmental qualification limits and an indication as to which rooms or areas have temperature sensing and control room alarms to inform the operator when an abnormal temperature occurs in the given area.

2. QUALIFICATION METHODS

2.1 Selection of Methods

(1) Qualification methods should conform to the requirements defined in IEEE Std. 323-1971.

EVALUATION

Environmental qualification, in accordance with IEEE 323-1971, was only required for that Category II equipment that is required to perform a safety function in a severe environment.

For the remaining Category II equipment not required to operate in a severe environment, environmental qualification to IEEE 323-1971 was not required. Rather, the equipment was designed to maintain its required performance capability throughout the specified range of normal and abnormal environmental parameters. The only design basis event (DBE) testing completed on this equipment was for the seismic event since, due to the equipment location, there is no other DBE capable of producing a severe environment at the equipment location which could then potentially cause common mode failures.

While qualification for normal and abnormal environments has not been completed for this latter group of equipment in accordance with IEEE 323-1971, a performance test at ambient conditions is completed on all production units prior to shipping and, for some items of equipment, a production unit was tested at the specified maximum ambient temperature, as described in the response to item 2.3(1). While these production tests have not been performed or documented in accordance with the standards established in IEEE 323-1971, the supplier believes that these production tests, together with the design specification for the equipment, which specifies the range of normal and abnormal environmental parameters, provides sufficient assurance of equipment capability in accordance with the staff position under item 2.1(4).

(2) The choice of the methods selected is largely a matter of technical judgment and availability of information that supports the conclusions reached. Experience has shown that qualification of equipment subjected to an accident environment without test data is not adequate to demonstrate functional operability. In general, the staff will not accept analysis in lieu of test data unless (a) testing of the component is impractical due to size limitations, and (b) partial type test data is provided to support the analytical assumptions and conclusions reached.

EVALUATION

In general, most equipment required to perform a safety function in a severe environment was subjected to qualification tests to demonstrate functional operability.

(3) The environmental qualification of equipment exposed to DBA environments should conform to the following positions. The bases should be provided for the time interval required for operability of this equipment. The operability and failure criteria should be specified and the safety margin defined.

(a) Equipment that must function in order to mitigate any accident should be qualified by test to demonstrate its operability for the time required in the environmental conditions resulting from that accident.

EVALUATION

The required and demonstrated duration of the safety function time interval for equipment operability is defined for the equipment tested.

Equipment that must function to mitigate accidents was qualified by test. One of the test acceptance criteria was that the safety related function for the equipment must be demonstrated for the time required for the environmental conditions associated with the accident.

(b) Any equipment (safety related or non-safety related) that need not function in order to mitigate any accident, but that must not fail in a manner detrimental to plant safety should be qualified by test to demonstrate its capability to withstand any accident environment for the time during which it must not fail.

EVALUATION

The inclusion of non-safety related equipment is beyond the scope of the environmental qualification program undertaken.

The effects and consequences of severe environments on non-safety related equipment has been identified as a Category I item in NUREG-0585 and should be resolved as part of the TMI action plan.

PGandE will continue to monitor the industry and NRC efforts to resolve this issue.

(c) Equipment that need not function in order to mitigate any accident and whose failure in any mode in any accident environment is not detrimental to plant safety need only be qualified for its non-accident service environment.

Although actual type testing is preferred, other methods when justified may be found acceptable. The bases should be provided for concluding that such equipment is not required to function in order to mitigate any accident, and that its failure in any mode in any accident environment is not detrimental to plant safety.

EVALUATION

For safety related equipment that is located in an area where it can experience the environment resulting from an accident but is not required to perform any safety function, it has been verified that any consequential failure of such equipment, due to the resulting environment, does not prejudice the safety related functions of other equipment required for accident mitigation.

(4) For environmental qualification of equipment subject to events other than a DBA, whch result in abnormal environmental conditions, actual type testing is preferred. However, analysis or operating history, or any applicable combination thereof, coupled with partial type test data may be found acceptable, subject to the applicability and detail of information provided.

EVALUATION

As stated in the response to item 2.1(1), it is believed that production tests and, in some cases, testing at maximum ambient conditions on equipment not subjected to severe environments, described in response to item 2.3 constitute a partial type test and that these tests, together with the design specifications of this equipment provides the assurance of equipment capability.

2.2 Qualification by Test

(1) The failure criteria should be established prior to testing.

EVALUATION

Failure criteria are established before component testing.

(2) Test results should demonstrate that the equipment can perform its required function for all service conditions postulated (with margin) during its installed life.

EVALUATION

Environmental qualification testing performed to IEEE 323-1971 was limited to demonstrating the capability of equipment to perform safety related functions when subjected to the severe environments. For that equipment not required to operate in a severe environment refer to the response to item 2.1(1).

(3) The items described in Section 5.2 of IEEE Std. 323-1971 supplemented by items (4) through (12) below constitute acceptable guidelines for establishing test procedures.

EVALUATION

The response to item 2.3(3) address the aspects of compliance with Section 5.2 of IEEE 323-1971.

(4) When establishing the simulated environmental profile for qualifying equipment located inside containment, it is preferred that a single profile be used that envelopes the environmental conditions resulting from any design basis event during any mode of plant operation (e.g., a profile that envelopes the conditions produced by the main steamline break and loss-of-coolant accidents).

EVALUATION

Where possible a single profile enveloping the environmental conditions for both MSLB and LOCA for qualification of equipment is used. The exceptions to the use of a single qualification envelope for LOCA and MSLB occurs when:

(a) The equipment is only used to mitigate against one of the severe environments. In such a case, qualification has been completed to conditions enveloping the possible consequences from the single severe environment and it has been verified that failure of the equipment in any other more limiting severe environment will not prejudice any safety related function.

(b) The test conditions are found to be unacceptably conservative.

(5) Equipment should be located above flood level or protected against submergence by locating the equipment in qualified watertight enclosures. Where equipment is located in watertight enclosures, qualification by test or analysis should be used to demonstrate the adequacy of such protection. Where equipment could be submerged, it should be identified and demonstrated to be qualified by test for the duration required.

EVALUATION

All safety related equipment throughout the plant has either been qualified for submerged operation and so tested or provided with watertight enclosures that have qualified to show watertight adequacy.

The consequences of flooding in the containment to a post LOCA Level of 96' - 1" is supplied in Appendix 3.11A of the FSAR.

(6) The temperature to which equipment is qualified, when exposed to the simulated accident environment, should be defined by thermocouple readings on or as close as practical to the surface of the component being qualified.

If there were no thermocouples located near the equipment during the tests, heat transfer analysis should be used to determine the temperature at the component. (Acceptable heat transfer analysis methods are provided in Appendix B.)

EVALUATION

In performing qualification tests, the test procedures require that the external environment temperature be measured as close to the test unit surface as is practicable.

(7) Performance characteristics of equipment should be verified before, after, and periodically during testing throughout its range of required operability.

EVALUATION

Where a safety related function of the equipment requires operation during the time period the equipment is subjected to the identified environmental conditions, the equipment performance is, at a minimum, verified before, during and after the simulated event.

(8) Caustic spray should be incorporated during simulated event testing at the maximum pressure and at the temperature conditions they would occur when the onsite spray systems actuate.

EVALUATION

For that equipment located inside containment caustic spray is incorporated in the testing procedure. The characteristics of the spray are those noted in the response to item 1.3.

(9) The operability status of equipment should be monitored continuously during testing. For long-term testing, however, monitoring at discrete intervals should be justified if used.

EVALUATION

See response to item 2.2(7).

(10) Expected extremes in power supply voltage range and frequency should be applied during simulated event environmental testing.

EVALUATION

Most of the Class 1E equipment requiring environmental qualification is supplied by a stabilized power supply. Therefore the range of electrical parameters is very small and are not considered to be significant. Because of this, no variation of voltage and frequency is normally applied during equipment testing.

(11) Dust environments should be addressed when establishing qualification service conditions.

EVALUATION

Process instruments subjected to severe environment are sealed and therefore dust environment is not considered significant.

(12) Cobalt 60 is an acceptable gamma radiation source for environmental qualification.

EVALUATION

Cobalt 60 has been used to simulate the effects of gamma radiation for equipment qualification.

2.3 Test Sequence

(1) Justification of the adequacy of the test sequence selected should be provided.

EVALUATION

A. Equipment not required to operate in HELB environment

As stated in the response to item 2.1(1)b, qualification testing to IEEE 323-1971 standards was not completed. However the following performance tests were completed on production units;

1. Electronic production units were, in general, subject to a burn-in period.

2. All production units were subject to a verification test at ambient conditions. This test included verfication of all safety related functions.

3. For some equipment, a sample production unit was tested at the specific abnormal maximum ambient temperature.

4. A sample production unit was tested to verify equipment capability during a simulated seismic event.

Steps 1 and 2 verify the equipment capability to perform safety related functions under normal ambient conditions. The equipment is designed to maintain this demonstrated performance capability within the specified range of normal and abnormal environmental parameters. In some cases (step 3), testing at the specified upper temperature limit was completed to provide additional demonstration of the equipment capability to operate at abnormal extreme conditions. This information, together with the design basis event simulation (seismic) provides assurance that he equipment is capable of performing specified safety related functions under all anticipated service conditions.

B. Equipment required to operate in a HELB environment

In general, the following test sequence was employed to qualify supplier equipment;

1. All production units were subjected to a calibration and/or verification test at ambient conditions. This test included verification of all safety related functions.
2. No specific abnormal tests were completed since the severe environment envelopes the abnormal condition with ample margin.
3. A sample production unit was irradiated, using a Cobalt 60 source, to the estimated worst case gamma dose obtained from in-service operation and required accident and post-accident performance.

4. The same production unit was tested to verify equipment capability during a simulated seismic event.

5. The same production unit was tested under applicable simulated severe environment and conditions.

Completion of the above test sequence gives assurance that the equipment can perform safety related functions under normal, abnormal and design basis event conditions. The design basis event testing applies extremes of radiation, vibration (seismic), temperature, humidity and chemical spray in a conservative sequence and verifies that the unit(s) being qualified is not marginal with respect to any of these parameters. This sequence is the same as defined in IEEE 323-1974 excet for aging. The subject of margin and aging are discussed under items 3 and 4 of this document respectively.

(2) The test should simulate as closely as practicable the postulated environment.

EVALUATION

Tests for qualifying equipment provide an environment which closely simulates the postulated environment the equipment is to be subjected to or provides a more severe environment.

(3) The test procedures should conform to the guidelines described in Section 5 of IEEE Std. 323-1971.

EVALUATION

The referenced section of IEEE 323-1971 does not provide guidance elated to test procedures but rather defines the data to be established in order to demonstrate qualification by type test. Documentation requirements are provided in response to item 5(2) of this document.

(4) The staff considers that, for vital electrical equipment such as penetrations, connectors, cables, valves and motors, and transmitters located inside containment or exposed to hostile steam environments outside containment, separate effects testing for the most part is not an acceptable qualification method. The testing of such equipment should be conducted in a manner that subjects the same piece of equipment to radiation and the hostile steam environment sequentially.

EVALUATION

In the testing of 1E equipment, the test sequence included subjecting the equipment to the environment they would encounter during the postulated event they were being qualified for. The equipment was subjected to these conditions in a sequential manner.

2.4 Other Qualification Methods

Qualification by analysis or operating experience implemented, as described in IEEE Std. 323-1971 and other ancillary standards, may be found acceptable. The adequacy of these methods will be evaluated on the basis of the quality and detail of the information submitted in support of the assumptions made and the specific function and location of the equipment. These methods are most suitable for equipment where testing is precluded by physical size of the equipment being qualified. It is required that, when these methods are employed, some partial type tests on vital components of the equipment be provided in support of these methods.

EVALUATION

All safety related electrical equipment identified for environmental qualification has been qualified by testing, either specifically for Diablo Canyon or type tested by the vendor.

3. MARGINS .

(1) Quantified margins should be applied to the design parameters discussed in Section 1 to assure that the postulated accident conditions have been enveloped during testing. These margins should be applied in addition to any margins (conservatism) applied during the derivation of the specified plant parameters.

EVALUATION

IEEE 323-1971 did not require that any specific margin be included in establishing the test parameters. However, in most instances, the test environment for equipment is more severe than the postulated environment associated with accident case the equipment is being qualified for and therefore constitutes margin.

(2) The margins provided in the design will be evaluated on a case-by-case basis. Factors that should be considered in quantifying margins are (a) the environmental stress levels induced during testing, (b) the duration of the stress, (c) the number of items tested and the number of tests performed in the hostile environment, (d) the performance characteristics of the equipment while subjected to the environmental stresses, and (e) the specified function of the equipment.

EVALUATION

In qualifying equipment required to operate in a severe environment, there was no effort to include any systematic margins. Rather, margin is in qualification testing by selecting conservative qualification parameters and test sequences. Some of the areas where margin is usually implicit in the test sequence is as follows;

1. The full radiation dose, simulating the effects of in-service and high energy line break (HELB) applications, is applied in a single step prior seismic and HELB test

simulations.

2. The seismic event simulation applies significant mechanical stress to the equipment prior to the HELB simulation.

3. The single envelope normally employed for HELB simulation, not only encompasses the effects of LOCA and MSLB accidents, but a whole spectrum of break sizes and locations within these accident definitions. As a consequence, the envelope employed invariably contains significant margin with respect to the transient for any single break size and location.

4. The single HELB simulation normally employed combines the high irradiation dose associated with the LOCA with the high temperature associated with the MSLB.

(3) When the qualification envelope in Appendix C is used, the only required margins are those accounting for the inaccuracies in the test equipment. Sufficient conservatism has already been included to account for uncertainties such as production errors and errors associated with defining satisfactory performance (e.g., when only a small number of units are tested).

EVALUATION

Not applicable. Appendix C was not used to define the environmental envelopes used for qualification testing.

(4) Some equipment may be required by the design to only perform its safety function within a short time period into the event (i.e., within seconds or minutes), and, once its function is complete, subsequent failures are shown not to be detrimental to plant safety. Other equipment may not be required to perform a safety function but must not fail within a short time period into the

event, and subsequent failures are also shown not to be detrimental to plant safety. Equipment in these categories is required to remain functional in the accident environment for a period of at least 1 hour in excess of the time assumed in the accident analysis. For all other equipment (e.g., post-accident monitoring, recombiners, etc.), the 10 percent time margin identified in Section 6.3.1.5 of IEEE Std. 323-1974 may be used.

EVALUATION

In general, equipment required to operate in a severe environment is qualified to perform its safety function over a considerable period of time (weeks/months). Because this period is somewhat speculative, there was no inclusion of any systematic margin on the specified duration of the safety function. For equipment which has a short duration operating requirement, we believe that the arbitrary application of an additional one hour time requirement in excess of the calculated worst case time required to perform the safety function as derived from accident analysis is unreasonable. However, statements in NUREG-0675, Supplement No. 9, "Safety Evaluation Report related to the operation of Diablo Canyon Nuclear Power Station Units 1 and 2," require that PGandE replace, prior to the second refueling, those transmitters which do not meet the one hour margin requirement. PGandE will comply with this requirement.

4. AGING

(1) Qualification programs that are committed to conform to the requirements of IEEE Std. 382-1972 (for valve operators) and IEEE Std. 334-1971 (for motors) should consider the effects of aging. For this equipment, the Category I positions of Section 4 are applicable.

EVALUATION

No requirement relating to aging was required for Category II equipment during the time the equipment was being qualified.

(2) For other equipment, the qualification programs should address aging only to the extent that equipment that is composed, in part, of materials susceptible to aging effects should be identified, and a schedule for periodically replacing the equipment and/or materials should be established. During individual case reviews, the staff will require that the effects of aging be accounted for on selected equipment if operating experience or testing indicates that the equipment may exhibit deleterious aging mechanisms.

EVALUATION

Analysis has been used to identify the susceptability of 1E equipment to aging. This analysis was used to qualify the equipment only by exception where the analysis showed the equipment was not susceptable to aging in the time frame associated with the plant lifetime or to provide an indication as to when the equipment should be replaced to avoid the effects of aging. PGandE has initiated a study which will determine the qualified life of all 1E equipment subject to severe environment. PGandE will also establish a maintenance/replacement program to maintain or replace equipment subject to aging. It is estimated the study will be completed by December 1980.

5. QUALIFICATION DOCUMENTATION

(1) The staff endorses the requirements stated in IEEE Std. 323-1974 that, "The qualification documentation shall verify that each type of electrical equipment is qualified for its application and meets its specified performance requirements. The basis of qualification shall be explained to show the relationship of all facets of proof needed to support adequacy of the complete equipment. Data used to demonstrate the qualification of the equipment shall be pertinent to the application and organized in an auditable form."

EVALUATION

Qualification documentation exists for each type of equipment qualified. The documentation includes both the information relating to the pertinent qualification requirements and the data resulting from the testing.

(2) The guidelines for documentation in IEEE Std. 323-1971 when fully implemented are acceptable. The documentation should include sufficient information to address the required information identified in Appendix E. A certificate of conformance by itself is not acceptable unless it is accompanied by test data and information on the qualification program.

EVALUATION

Qualification reports for equipment qualified to operate in a severe environment, in general, meet the requirements of Section 5 to IEEE 323-1971 by providing as a minimum, the following essential information:

- safety related functional requirements to be demonstrated
- range of applicable environmental parameters to be considered
- identification of the test unit
- description of the test facility and monitoring instrumentation
- description of test unit mounting and interfaces
- summary of the test procedures
- summary of the test results

CLASS IE EQUIPMENT OUTSIDE CONTAINMENT SUBJECT TO HIGH ENERGY LINE BREAK

Equipment Function	Location	Manufacturer	Model No. or Identification No.	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
1. Electrical Cables	Various	Raychem	Flamtrol	212°F for 300 sec. then 200°F 100% RH	-	Note 1	540°F for 72 hrs.	-	-	N/A	N/A	N/A	N/A	Raychem Test Report EM1030 9-24-74 (Test)
		Okonite	EPR/ Okolon (Hypalon)	212°F for 300 sec. then 200°F 100% RH	-	Note 1	540°F for 48 hours	-	-	N/A	N/A	N/A	N/A	Okonite Test Report 10-14-74 (Test)
2. Feedwater flow sensors	Area FW El. 85' Area GW El. 105'	Fischer & Porter	10B2496 PBBA	212°F for 300 sec. then 200°F 100% RH	-	Note 1	295°F 63 psig 100% RH	-	-	Trip 5 Min. Post DBE 4 months	127 Min.	±10% for ≤5 min. 5 min. to 4 mo. ±25%	+17% -3.5%	WCAP 7410-L (Test)
3. Main steam line pressure sensors	Area FW El. 85' Area GW El. 120'	Fischer & Porter	50EP1041BCX	212°F for 300 sec. then 200°F 100% RH	-	Note 1	294°F 60 psig 100% RH	-	-	Trip 5 min. Post DBE 4 months	127 min.	±10% for ≤5 min. 5 min. to 4 mo. ±25%	+6% -1%	WCAP 7410-L (Test)
4. Auxiliary feedwater isolation valve motor operators	Area FE El. 111 Area GE El. 118	Limitorque	SMC-04	212°F for 300 sec. then 200°F 100% RH	-	Note 1	250°F 25 psig	-	-	Operate	Operated	N/A	N/A	Limitorque Test Report HC003 and attached Limitorque letter

[illegible]

CLASS IE EQUIPMENT INSIDE CONTAINMENT WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
1. P & ΔP Transmitters														
a) Pressurizer pressure	Containment El. 122'	Rosemount	1152	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in Water 8.8 pH	5.5x10^7 Gamma	350°F 60 psig 0% RH 316°F 70 psig 100% RH Fig. 7&8	-	5x10^6 Gamma	Trip-5 min.	50 Hr. Post DBE	0.5%	0.5%	Rosemount Report 117415 (test)
b) Pressurizer level	Containment El. 96'	Barton	764 (Lot 1)	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water 8.8 pH	5.5x10^7 Gamma	LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric acid and 0.17 wt. % N_AOH dissolved in water	LOCA 5x10^7 Gamma SLB 1.13 x 10^5 Gamma	Trip 5 min. monitor 4 mo.	4 months Post-DBE	Trip +10% -∞ monitor ±25%	0 to 5 <5% max. error 5 min. to 4 mo. 17%	NS-TMA-1950 Anderson to Stolz NS-TMA-2120 Anderson to Stolz (Test)
c) Containment sump level	Containment El. 98'	Barton	764 (Lot 1)	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water 8.8 pH	5.5x10^7 Gamma	LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 Thru 3-22	1.14 wt. % Boric acid and 0.17 wt. % N_AOH dissolved in water	LOCA 5x10^7 Gamma SLB 1.13 x 10^5 Gamma	Trip 5 min. monitor 4 mo.	4 months Post-DBE	Trip +10% -∞ monitor ±25%	0 to 5 <5% max. error 5 min. to 4 mo. 17%	NS-TMA-1950 Anderson to Stolz NS-TMA-2120 Anderson to Stolz (Test)

CLASS IE EQUIPMENT INSIDE CONTAINMENT
WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
d) RCS wide range pressure	Containment El. 96'	Barton	763 (Lot 1)	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water 8.8 pH	$5.5x10^7$ Gamma	LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric acid and 0.17 wt. % N_AOH dissolved in water	LOCA $5x10^7$ Gamma SLB 1.13×10^5 Gamma	Trip 5 min. monitor 4 mo.	4 months Post-DBE	±10%	<±10%	NS-TMA-1950 Anderson to Stolz NS-TMA-2120 Anderson To Stolz (Test)
e) Steam Gen. level (narrow)	Containment El. 122	Barton	764 (Lot 1)	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water 8.8 pH	$5.5x10^7$ Gamma	LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric acid and 0.17 wt. % N_AOH dissolved in water	LOCA $5x10^7$ Gamma SLB 1.13×10^5 Gamma	Trip 5 min. monitor 4 mo.	4 months Post-DBE	Trip +10% -∞ monitor ±25%	0 to 5 min. <5% Max. error 5 min. to 4 mo. 17%	NS-TMA-1950 Anderson to Stolz NS-TMA-2120 Anderson to Stolz (Test)
f) Steam flow	Containment El. 122	Rosemount	1152	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water 8.8 pH	$5.5x10^7$ Gamma	350°F 60 psig 0% RH 316°F 70 psig 100% RH Fig. 7&8	-	$5x10^6$ Gamma	Trip 5 min.	>50 hr. Post DBE	0.5%	0.5%	Rosemount Report 117415 (Test)
g) Containment pressure sensor	Containment El. 104-109	Barton	351	344°F 47 psig 100% RH	Boric acid N_AOH dissolved in water [illegible]	$5.5x10^7$ Gamma	>320°F Fig. 5-3 & 6.3 66 psig 100% RH	1.140 wt. % boric acid and 0.17 wt. % N_AOH dissolved	$1.8x10^7$ Gamma	Trip 5 min. monitor 4 mo.	4 months post DBE	1.5% trip 4% monitor	+.5% -2.06%	WCAP 9157 (Test)

CLASS IE EQUIPMENT INSIDE CONTAINMENT
WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
2. Resistance temperature detector														
a) Reactor coolant system temp.	Containment El. 107-117	Sostman	11834 B-1	344°F 47 psig 100% RH	Boric acid NaOH dissolved in water 8.8 pH	$6.5x10^7$ Gamma	>320 °F see Fig. 5-3 and 6.3 66 psig 100% RH	1.146 wt. % boric acid and 0.17 wt. % NaOH dissolved in H_2O	$1x10^8$ Gamma	30 sec. Post-SLB	40 yr. life over 30 sec. Post-SLB	±.2%	±.2%	WCAP 9157 (Test)

CLASS IE EQUIPMENT INSIDE CONTAINMENT
WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
3. Stem mounted limit switches	Various	NAMCO	EA 180	344°F 47 psig 100% RH	Boric acid N_AOH Dissolved in water 8.8 pH	$6.5x10^7$ Gamma	LOCA 340°F 70 psig	Boric acid N_AOH $N_{A2}S_2O_3$ Dissolved in water 10-11 pH	$204x10^6$ Gamma	Maintain open contact	Maintained open contact	N/A	N/A	Acme Cleveland Report - 3/3/78 (Test)
4. Solenoid valves														
a) Post accident solenoid valves	Various	ASCO	NP8321A5E	344°F 47 psig 100% RH	Boric acid N_AOH Dissolved in water 8.8 pH	$5.5x10^7$ Gamma	346°F 110 psig	3000 ppm Boric acid .064M $N_{A2}S_2O_3$ & N_AOH in water 9.5 - 10.5 pH	$200x10^6$	Operate	Operated	N/A	N/A	Asco Test Report AQS21678/TR Rev.A (Test)
b) Containment isolation solenoid valves	Various	ASCO	8300 8302 8316* 8321*	344°F 47 psig 100% RH	Boric acid N_AOH Dissolved in water 8.8 pH	$5.5x10^7$ Gamma	-	-	-	Fail properly	Failed properly	N/A	N/A	NS-CE-755 C. Eicheldinger to D. B. Vassallo (Analysis)
5. Valve motor operators	Various	Limitorque	SMB-0,00,000	344°F 47 psig 100% RH	Boric acid N_AOH Dissolved in water 8.8 pH	$5.5x10^7$ Gamma	340°F 78 psi 100% RH	Boric acid $N_{a2}S_2O_3$ Dissolved in water 10.5 pH	$2.04x10^8$ Gamma	Operate	Operated	N/A	N/A	Limitorque Test Reports #600456 & #600376 (Test)

*Special valves with all elastic parts replaced with stainless steel or brass parts to withstand higher temperatures.

**CLASS IE EQUIPMENT INSIDE CONTAINMENT
WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT**

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
6. Containment fan cooler motors	Containment El. 140	Westinghouse	300/100 h.p.	344°F 47 psig 100% RH	Boric acid NAOH dissolved in water 8.8 pH	5.5×10^7 Gamma	324°F 80 psig 100% RH	Boric acid & NAOH 9.5 pH	2×10^8 Gamma	1 yr. post -DBA	Per IEEE 324 thermally aged to simulate end of life conditions (40 yr. life)	N/A	N/A	WCAP 7829 letters PGandE to NRC 1-19-78 and 2-10-78 (Test)
7. Electrical penetrations	Contain- El. 120-135	General Electric	NS02/03/04	344°F 47 psig 100% RH	Boric acid NAOH dissolved in water 8.8 pH	5.5×10^7 Gamma	340°F 103 psig 100%	NAOH/ H_3BO_3 pH > 10	5×10^7 Gamma	N/A	N/A	N/A	N/A	G.E. Series 100 Test Report Letter-G.E. to Allison NRC - 11/6/78
8. Electrical cables	Various	Continental	Silicon/Silicon	344°F 47 psig 100% RH	Boric acid NAOH dissolved in water 8.8 pH	5.5×10^7 Gamma		PENDING		N/A	N/A	N/A	N/A	
		Boston	Silicon/Hypalon	344°F 47 psig 100% RH	Boric acid NAOH dissolved in water 8.8 pH	5.5×10^7 Gamma	340°F 70 psig 100%	NAOH/ H_3BO_3 pH > 9	1.8×10^8 Gamma	N/A	N/A	N/A	N/A	Boston I.W. Test Report 9273 (Test)

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CLASS IE EQUIPMENT INSIDE CONTAINMENT
WITH POTENTIAL FOR EXPOSURE TO SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
		Raychem	Stilan	344°F 47 psig 100% RH	Boric acid NaOH dissolved in water 8.8 pH	5.5×10^7 Gamma	357° 70 psig 100%	NaOH H_3BO_3 pH $9.5 < 11$	2×10^8 Gamma	N/A	N/A	N/A	N/A	Franklin Inst. Test Report F-C4033-2 Jan. 1975 (Test)
		Okonite	Tefzel	344°F 47 psig 100 RH	Boric acid NaOH dissolved in water 8.8 pH	5.5×10^7 Gamma	346°F 113 psig 100%	NaOH H_3BO_3 pH > 10	2×10^8 Gamma	N/A	N/A	N/A	N/A	Dupont Test Report IEEE 383-1974 (Test)
		Boston	Silicon glass braid/ Kapton/ Hypalon	344°F 47 psig 100% RH	Boric acid NaOH dissolved in water 8.8 pH	5.5×10^7 Gamma	392°F 50 psig 100%	NaOH H_3BO_3 pH > 9	1.8×10^8 Gamma	N/A	N/A	N/A	N/A	PGandE Engr'g Research Test Report and Boston I.W. Test Rep. 9273 (Test)
9. Electrical Terminations		Raychem	Sealed splice	344°F 47 psig 100% RH	Boric acid NaOH dissolved in water 8.8 pH	5.5×10^7 Gamma	357°F 70 psig 100%	NaOH H_3BO_3 pH $9.5 < 11$	2×10^8 Gamma	N/A	N/A	N/A	N/A	Franklin Instit. Report F-C4033-3 (1-75) (Test)

CLASS 1E EQUIPMENT NOT REQUIRED
TO OPERATE IN A SEVERE ENVIRONMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model No. or Identification No.	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of span)	Accuracy Demonstrated (% of span)	Qualification Reference and Methods
Reactor coolant flow transmitters	Containment El. 96'	Fischer & Porter	10D2496 PBBA	120°F	N/A	4x10⁴ Rad	212°F for 300 sec.	N/A	4x10⁴ Rad	Not Required in Accident	127 min.	±.5%	+17% -3.5%	WCAP 7410L (Test)
Containment pressure transmitters	Area GE-GW Elev. 109'	ITT Barton	332	111°F	N/A	N/A	288°F	N/A	N/A	120 days post DBE	2 hr.	±.5%	5%	WCAP 7410L (Test)
Refueling water storage tank level	Area J El. 115'	ITT Barton	368	111°F	N/A	N/A	200°F	N/A	N/A	120 days post DBE	N/A	±.5%	1%	Manufacturers rating
		ITT Barton	368/224	111°F	N/A	N/A	200°F	N/A	N/A	120 days Post DBE	N/A	±.5%	1%	Manufacturers rating
		Fischer & Porter	13D2496BBA/95	111°F	N/A	N/A	212°F	N/A	N/A	120 days Post DBE	N/A	±.5%	.5%	Manufacturers rating
Turbine first stage pressure transmitters	Turbine Building El. 104'	Fischer & Porter	50EP1041BCX	111°F	N/A	N/A	294°F 60 psig	N/A	N/A	Trip 5 min	127 min.	±.5%	+6% -1%	WCAP 7410L (Test)
Residual heat removal discharge flow trans-	Aux. bldg. Elev. 61'	ITT Barton	288A	111°F	N/A	N/A	200°F	N/A	N/A	120 days Post DBE	N/A	±1%	1%	Manufacturers rating

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

Identification	Location	Ventilation[1] System Type	Normal[2] Temperature Extremes °F Min. / Max.	Maximum[3] Temperature Extremes °F Min. / Max.	Equipment Rating (°F) Min. / Max.	Proposed[8] Temperature Monitoring	Reference Standard/Comments Electrical Equipment
Electric Storage Batteries	Aux. Bldg. Area H - 115' El.	a	60°F / 95°F	35°F / 125°F[13]	60°F, 77°F, 90°F[5] (Avg.)	Yes	Manufacturer's Rating IEEE-STD-450, IEEE-STD-484
Battery Chargers	Aux. Bldg. Area H - 115' El.	b	(14) 82°F / 110°F	(15) 70°F / 110°F	33°F / 104°F	Yes	NEMA ICS, Section 1-108.01
125/250 VDC Switchgear and Motor Control Center	Aux. Bldg. Area H - 115' El.	b	(14) 82°F / 110-F	(15) 70°F / 110°F	32°F / 104°F	Yes	NEMA AB1, Molded Case CKT BKRS NEMA IC1, Industrial Control NEC 1969, NEMA PB1, Panelboards
125 VAC Instrumentation Power Distr. Panelboards	Aux. Bldg. Area H - 115' El.	b	(14) 82°F / 110°F	(15) 70°F / 110°F	32°F / 104°F	Yes	NEMA AB1, Section 2.04
125 VDC Lighting Power Panelboards	Aux. Bldg. Area H - 100' El.	a	55°F / 110°F	(16) 45°F / 110°F	32°F / 104°F	Yes	NEMA AB1, Section 2.04
	Turb. Bldg. Area 119' El.	b	(17) 35°F / 90°F	(17) 35°F / 90°F	32°F/ 104°F	No	NEMA AB1, Section 2.04
Main Annunciator	Aux. Bldg. Area H - 128' El.	a	55°F / 110°F	(16) 45°F / (18) 120°F	32°F / 120°F	No	Manufacturer's Rating
Hot Shutdown Panel	Aux. Bldg. Area H - 100' El.	b	(21a) 54°F / (21b) 94°F	(21a) 54°F / (21b) 94°F	32°F / 104°C	Yes	ANSI C19.3, Section 3-2.3
Main Control Board: Electrical Instruments Electronic Instruments Control Device	Aux. Bldg. Area H - 140' El.	c	75°F / 78°F	(20) 54°F / 78°F	32°F / 104°F	No	NEMA SG-5-1959, ASA Std. C1-1963 ANSI C19.3, Section 3-2.3 Mfrs. Stds. NEMA IC1 - 1965, IPCEA Std. S-61-402
4KV Switchgear	Turb. Bldg. Area A - 119' E.	d	50°F / 105°F	(11a) 50°F / See Note (11b)	32°F / 104°F	Yes	ANSI C37.20 (1974) Section 3.1
480V Vital Load Center	Aux. Bldg. Area H - 100' El.	b	(14) 82°F / 110°F	(15) 70°F / 110°F	32°F / 104°F	Yes	ANSI C37.20 (1974) Section 3.1 ANSI C19.7, ANSI C89.2
Inverters	Aux. Bldg. Area H - 115' El.	b	(14) 82°F / 110°F	(15) 70°F / 110°F	32°F / 104°F	Yes	Manufacturer's Rating

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

Identification	Location	Ventilation System Type (1)	Normal (2) Temperature Extremes °F Min. / Max.	Maximum (3) Temperature Extremes °F Min. / Max.	Equipment Rating (°F) Min. / Max.	Proposed (8) Temperature Monitoring	Reference Standard/Comments Electrical Equipment
Diesel Engine:	Turb. Bldg. 85' El.	d	62°F / 120°F (10)	35°F / 120°F (6, 10)	/ 120°F	Yes	Engine-Mfrs. Rating
Engine Controls			62°F / 120°F	35°F / 120°F	-4°F / 131°F		Controls - ANSI C89.2 (See Note 19)
Electric Generator			62°F / 120°F	35°F / 120°F	-4°F / 131°F		Generator - MG-2
Gen. Excitation Equip.			62°F / 120°F	35°F / 120°F	-4°F / 131°F		Gen. Excitation Equip. - Mfrs. Std.
Ventilation Relay Panels	Aux. Bldg. Area H - 128' El.	a	55°F / 110°F	(16) 45°F / 120°F (18)	32°F / 120°F	No	NEMA IC3
Ventilation Logic Panel	Aux. Bldg. Area H - 140' El.	c	75°F / 78°F	(20) 54°F / 78°F	32°F / 120°F	No	Manufacturer's Rating
Vital Relay Board	Turb. Bldg. Area A - 119' El.	d	50°F / 105°F	(11a) 50°F / See Note (11b)	-4°F / 104°F	Yes	NEMA IC1 Mfrs. Stds.
Fire pp motor	Aux. Bldg., Area J El. 115', Col. 15 & U	b	65°F / 110°F	35°F / 110°F	50°F / 104°F	Yes	NEMA MG-2 - 3.07 Note (7)
Boric Acid Trans. pp motors	Aux. Bldg., Area K El. 100', Col. 16.8 Bet. U & T	b	65°F / 110°F	35°F / 110°F (12)	50°F / 104°F	Yes	NEMA MG-2 - 3.07 Note (7)
Aux. F.W. pp motors	Aux. Bldg., Area J El. 100', Col. 15 & T	b	65°F / 110°F	35°F / 110°F	50°F / 104°F	Yes	NEMA MG-2 - 3.07 Note (7)
Aux. Salt W. pp motors	Intake Structure El. 7'0"	d	48°F / 103°F	35°F / See Note (4)	50°F / 104°F	No	NEMA MG-2 - 3.07 Have Sp. Htrs. in motor
Comp. Cooling W. pp motors	Aux. Bldg., Area K El. 73', Col. 16 & K	b	65°F / 110°F	35°F / 110°F	50°F / 112°F	No	NEMA MG-2 - 3.07 Note (7). Have Sp. Htrs. in motor
Local Starters	Various	b	65°F / 110°F	35°F / 110°F	32°F / 104°F	No	ANSI C19.7.

NOTES:

(1) Air conditioning and ventilation systems:
- a. Normally powered single train ventilation system
- b. Class IE redundant ventilation system.
- c. Class IE redundant air conditioning system
- d. Class IE single train ventilation system (each ventilation train is serving related redundant Class IE equipment).

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

NOTES: (Continued)

(2) The normal temperature extremes for a given area of the plant are based on the following conditions:
   a. All heating systems (normally powered) are operational.
   b. All ventilation and air conditioning systems are operational.
   c. All equipment in those areas served by ventilation and air conditioning systems are operating at design maximum capacity.
   d. The maximum temperatures listed for all ventilation systems include a 5°F margin conditions.
   e. No credit is taken for the cooling effect from the concrete mass of the building structure.

(3) The maximum temperature extremes for a given area of the plant are based on the following conditions:
   a. Those areas served by normally powered single train ventilation systems or Class IE powered single train ventilation systems have lost powered ventilation in those areas.
   b. Those areas served by Class IE redundant ventilation and air conditioning systems have lost one train of ventilation and air conditioning in those areas.
   c. The maximum temperature listed are based on all equipment in those areas served by the ventilation and air conditioning systems, operating at design maximum capacity.
   d. The maximum temperatures listed for all ventilation systems include a 5°F margin of safety and do not reflect long term temperature conditions.
   e. All heating systems (normally powered) are nonoperational. The minimum temperatures listed consider the heat generated by the equipment that is normally running. In those cases where normally operated equipment is not found in a given area, the minimum temperature tabulated by Ashrae has been listed. See recommended outdoor design temperatures for Southern Calif. Ashrae, Third Edition.
   f. No credit is taken for the cooling effect (at maximum temperature) or heating effect (at minimum temperatures) from the concrete mass of the building structure for operational systems.

(4) If a ventilation fan fails while its related pump motor is in operation, the room ambient temperature will rise at a rate of approximately 28°F/minute until the pump trips out or is shut off. A failure of a pump or a ventilation fan complies with single failure criteria. An alarm is provided to indicate loss of flow.

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

NOTES: (Continued)

(5) Effect of ambient air temperature on electric storage batteries:

a. There are no clearly defined temperature limits for batteries operated in a normal environment such as exists at this plant location. The batteries will produce rated output when their temperature is 77°F or greater, and will have a life of 20 years with an annual average temperature not exceeding 80°F. The annual mean temperature in the battery rooms is 63°F, well within the life guarantee.

b. Below 77°F, the capacity of the batteries will be less than their rated value. At 80% of their original capacity and at minimum room temperatures of 60°F the batteries still have adequate output to perform their safety function.

c. For the higher temperatures which may occur infrequently during the year, battery life will be affected. An analysis is given below.

d. The relative life of a battery at different ambient air temperatures may be expressed by this equation:

$$\log \frac{L_1}{L_2} = K \left(\frac{1}{T_1} - \frac{1}{T_2} \right) \quad \text{(Modified Arrhenius Equation)}$$

where L_1 and L_2 are the life expectancies at absolute temperatures T_1 and T_2. When T_1 and T_2 are in degrees Fahrenheit absolute and the Logarithm is to base 10, K is approximately 6250 for these batteries.

e. Ambient Conditions:

Outdoor Temperatures (from ASHRAE)			Battery Room Air Temperature °F (95°F Max.)
Time Intervals		Temperature Exceeded	
% of 4 Summer Months	Hrs/Yr.	°F	
1	29	85	90
2½	73	82	87
5	146	78	83

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

NOTES: (Continued)

(5) (Cont) f. Life for above temperatures:

Temperature Range - °F	Time Hrs/Yr.	Life at Max. Temperature, Yrs.	Fractional Loss of Life over 20-year period	
			%	Months
90 - 95	29	8.37	.008	1.92
87 - 90	44	10.60	.0095	2.27
83 - 87	73	12.24	.0136	3.26
Totals	146		.0311 = 3.11%	7.45

Normal loss of life in months for these periods is about 4 months.

g. The 3½ months increase loss of life incurred during the above warm periods over a period of 20 years is more than offset by the increase in life gained when the ambient is below 77°F. The life expectancy at the mean temperature of 63°F is approximately 39 years.

Ref: "Accelerated Life Testing of Stationary Batteries," by E. Willihnganz, Electrochemical Techology, Vol. 6, No. G-10 Sept-Oct 1968.

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

NOTES: (Continued)

(6) Diesel Generator:
a. The diesel generators have keep-warm heaters for lube oil and jacket water to guarantee starting in the 90°F to 120°F ambient temperature range. Alarms at 185°F. Heaters shutdown at 195°F. Lube oil alarms below 90°F room temperature. High alarm picks up at 120°F, drops out at 115°F.

(7) The worst case condition, indoor ambient temperatures could exceed 104°F for 73 hours per year and would not exceed 110°F. The 73 hours would not be continuous but would occur only for a few hours on a given day.

(8) The area ambient temperature monitors in the locations identified in the table will alarm to inform the operator when an abnormal temperature is occurring in the given area, and periodic covering of temperature will commence. Operator action will include an investigation as to the cause of the high temperature condition and the initiation of portable emergency ventilation or, in case where running machinery in a given space is not required, shut down nonessential machinery to reduce ambient air temperature.

(9) The minimum temperature listed is based on the following:

a. The outside ambient temperature is fixed at 35°F and the control room is in Mode I, introducing 20% outside air.

b. The only heat produced within the control room complex is from emergency lighting 800W, annunciators 5000W, control board 15,000W and nuclear instrumentation 5000W. Total 25,800W or 88,000 BTU/HR.

c. All duct heaters are nonoperable.

d. The heat required to hold the control room complex at 70°F. with an outside ambient of 35° with no internal load while in Mode I is 161,800 BTU/HR.

(10) Based on 90°F outside air and a 30°F temperature rise.

(11) System is designed for a 15°F Rise. If a ventilation fan fails while its related 4KV switchgear is in operation, the room ambient temperature will rise at a rate of approximately 4°F/minute until the equipment trips out or is shut off. Each redundant set of switchgear has its own ventilation system; therefore, the system still meets single failure criteria.

(12) Located in open area of Auxiliary Bldg., by large hatch openings in floor and ceiling.

a. The limited amount of heat from these motors will be dissipated into the building and the building ventilation system.

b. 1 motor on for 24 hr/day @ 1.4 BHP, or 1005 BTU/HR normal load. Second motor maximum 1 hr/day at 7.5 BHP increases heat generated to 4,430 BTU for that hour.

ENVIRONMENTAL TEMPERATURE EVALUATIONS FOR CLASS 1E BOP ELECTRICAL EQUIPMENT

NOTES: (Continued)

(13) Maximum room temperature without ventilation will rise to 120°F in the battery room.

(14) 82°F is the temperature at which the first redundant fan is started on low speed.

(15) 70°F is the lowest temperature the low speed of either redundant fan can be set to start.

(16) Equipment operating at half capacity or, 10°F rise above outside ambient temperature of 35°F.

(17) 35°F air being supplied into this room.

(18) Maximum room temperature without ventilation will continue to rise until a maximum temperature of 120°F in area H - 128' El.

(19) Added D.C. equipment standards are: UL Files, E22575, 508 and E19223 Vol. I, Section 6
CSA File 15734
ANSI C33.76 - 1971, C37.90 - 1971

(20) The minimum temperature listed is based on the following:

(a) The outside ambient temperature is fixed at 35°F and the Control Room is in Mode I, introducing 20% outside air.

(b) The only credit for heat produced within the Control Room Complex is from emergency lighting 800 watts, annunciator lights 5000 watts, control board 15,000 watts, and nuclear instrumentation 5000 watts, for a total of 25,800 watts or 88,000 BTU per hour. Heating credit for heat produced by the P250 computer 9500 watts, the Solid State Protection System 2700 watts, and the Relay Logic panel are not included in the 54°F minimum temperature extreme.

(c) All duct heaters are non-operable.

(21) Air temperature rise in Hot Shutdown Panel Area:

(a) 50° outside air +4° Rise = 54°F

(b) 90° outside air +4° Rise = 94°F

[illegible]