NRC-PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 9 1979

MEMORANDUM FOR: D. Eisenhut, Acting Director, Division of Operating Reactors

THRU: G. Lainas, Chief, Plant Systems Branch, Division of Operating Reactors

FROM: E. Butcher, Plant Systems Branch, Division of Operating Reactors

SUBJECT: GUIDELINES FOR ENVIRONMENTAL QUALIFICATION OF CLASS IE ELECTRICAL EQUIPMENT IN OPERATING REACTORS

In recent weeks I have been involved in an extensive effort within DOR to develop guidelines for acceptable methods for environmental qualification of Class IE electrical equipment in operating reactors. As you are aware, DOR agreed to develop these guidelines by the end of September 1979 for use by IE in their reviews of licensee responses to IE Bulletin 79-01. The purpose of this memorandum is to provide a status report of our activities to date, identify the principle tasks remaining, and estimate both short term and long term manpower requirements and schedules.

1. Current Status

D. McDonald, Bill Morris (on loan from RSB since August 6, 1979) and myself are currently working full time on the guidelines. Other individuals and groups are providing assistance and input on a task basis as identified in item 2 below. A partial draft and outline has been completed (see Enclosure 1). We believe that this partial draft is significant in that is identifies the major subjects where guidance for equipment qualification can be provided in September to meet our commitment to IE.

The next step in the development process is to begin to fill the holes in the outline by applying the guidelines to an actual plant review. We have picked Palisades for this task and plan a site visit for the week of 8/20/79. The principle purpose of the visit will be to help develop the guidelines, not to complete the Palisades review. A second visit to Palisades will be required in September to enter the containment.

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It is important to note at this time that the character of the guidelines is evolving as a hybrid between a standard review plan and a regulatory guide. In those cases where it is not possible to provide simple go-no go acceptance criteria, general guidelines for plant and component specific evaluations will be provided. This should permit IE personnel reviewing the responses to IE Bulletin 79-01 to step out of their traditional role as inspectors and into the function of performing the safety evaluations required to make decisions regarding the adequacy of individual equipment qualification. This approach is necessary if we desire to minimize the number of unresolved issues returned to DOR for resolution at the conclusion of the IE reviews.

2. Principle Tasks Remaining

Following is a listing of the principle tasks remaining. The individual whose name appears in parenthesis is primarily responsible for the task. I will provide coordination and integration of these activities as part of my responsibility as the overall guidelines preparation task leader.

A. Radiation Service Conditions Inside and Outside Containment For LOCA and Steam Line Break Accidents - (Ted Quay & EEB)

In those cases where radiation service conditions are specified at less than 2×10^8 rads, it will be necessary to evaluate the adequacy of the specific dose level to which equipment is qualified. Specific factors to be considered will be identified (e.g., location of the equipment, time required to remain functional). These factors will be based primarily on the previous staff work reported in D. Eisenhut's memo to V. Stello dated April 2, 1978, Subject - Environmental Qualification of Safety Electrical Equipment-Radiation, and the NRC Staff Interim Position on Environmental Qualification of Safety Related Electrical Equipment, Draft No. 2, dated June 11, 1979. Guidelines for equipment both inside and outside containment will be provided.

B. Aging (E. Butcher & ORNL)

There are no plans at present to require that a qualified life be established for all Class IE equipment. This is consistent with R. G. 1.89. Instead a list of generic material types that are known to exhibit degradation with time due to thermal and radiation effects will be developed. The guidelines will require that a qualified life be established by the licensees for equipment using these materials. Examples identified to date include Nylons, Buna, and Teflon.

C. Temperature and Pressure Service Conditions For Steam Line Break (SLB) Accidents (E. Butcher & DSS CSB)

Following is a summary of the positions we propose to take in the guidelines with regard to service conditions for SLB accidents:

1. Equipment qualified for a LOCA environment is considered qualified for a SLB accident environment in plants with automatic spray systems not subject to disabling single component failures. This position is based on the "Best Estimate" calculation of a typical plant peak temperature and pressure and a thermal analysis of typical components inside containment.

2. Equipment installed in plants without automatic spray systems or plants with spray systems subject to disabling single failures should be qualified for a SLB accident environment determined by a plant specific analysis using the methods or bounding curves listed in Draft No. 2 of the NRC staff Interim Position on Environmental Qualification of Safety Related Electrical Equipment, dated June 11, 1979. This position is also applicable to equipment which must be retested as a result of the bulletin reviews in general.

The Containment Systems Branch, DSS has been requested to verify that the "Best Estimate" approach remains valid and is adequately conservative for the near future. It is our understanding that TAP A-21 is nearing completion and that some information may become available shortly to justify analysis methods that would predict more realistic but still conservative calculations of SLB accident conditions. If this information becomes available by the end of August 1979 or CSB concludes that the "Best Estimate" approach as outlined above is not acceptable as a position to be included in the guidelines, they have been requested to inform us immediately. We will complete the guidelines for temperature and pressure service conditions for SLB accidents on the basis of the best information available by the first week in September 1979.

D. Systems Required For Safety (Bill Morris)

Since the type of qualification method (i.e., test, analysis, ongoing or combination) to be considered acceptable for a given item of equipment will be determined in part by the importance of the safety function of the equipment, it will be necessary to identify critical long term and short term safety functions. The basic task will be to develop general lists of systems and equipment by generic reactor type (i.e., vendor) and specify guidelines for the length of time required to function. This work will be accomplished in parallel with the work by the task force revising R. G. 1.97 and will draw heavily from their conclusions.

E. Temperature and Pressure Service Conditions Outside Containment (D. McDonald & Bill Morris)

Environments outside containment in general do not change significantly as a result of accidents inside containment. Therefore, except in very specific applications discussed below, no special requirements for environmental qualification are necessary. Since equipment outside

containment is not exposed to an elevated environmental stress resulting from a LOCA or SLB inside containment, failures are not likely to occur in two redundant systems at the same time. Any failures that might be experienced would be random and are adequately identified by normal periodic surveillance testing. Exceptions would be spaces in the vicinity of a high energy line break (HELB), and spaces associated with recirculating fluids from inside containment during long term LOCA core cooling. Equipment required to function to mitigate a HELB outside containment has previously been reviewed and will not be re-reviewed in connection with IE Bulletin 79-01. The principle task that remains for writing guidelines for outside containment equipment qualification is to identify specific types of spaces outside containment where environmental stresses could be elevated during a LOCA or SLB and result in common mode failures of safety equipment (e.g., decay heat removal pump rooms, letdown and cleanup equipment areas). An attempt will be made to establish general bounding type environments for these spaces to be included in the guidelines. It is expected that in most cases compliance with industry standards (e.g., NEMA) will be acceptable and this position will be addressed in the guidelines. Consideration will also be given to the need for the licensees to establish a program to review the surveillance testing and maintenance records to identify components nearing "end of life". This will provide assurance that components which are exhibiting aging degradation are replaced.

3. Manpower Requirements and Schedules

As noted above, at this time there are three individuals working full time on the short term task of writing the guidelines. The major tasks that remain to be accomplished for the guidelines were discussed in item 2 above. A completion date for each of these tasks is provided in Enclosure 2. These completion dates are the required completion dates to meet our commitment to produce the final guidelines in September 1979. I believe these dates can be met and will inform you immediately of any schedule problems as they arise.

With regard to manpower requirements for the long term reviews to implement the guidelines, it is extremely difficult to estimate with much certainty the time required to implement guidelines that are not yet developed. However, based on our thinking to date the following estimate could be used for preliminary planning.

Assuming a three man review team made up of a full time electrical engineer, a full time reactor/containment systems engineer, and a part time materials consultant, 4 team weeks per plant at a minimum would be required to perform a complete review. The four weeks would be broken down as follows:

1 - Team/week to study the licensees submittal and prepare for a site visit.

1 - Team/week for a site visit.

2 - Team/weeks to write an evaluation.

This schedule does not include time to resolve open issues and would produce an SER which merely identifies equipment whose qualification is in doubt based on the qualification guidelines.

Assuming approximately 70 plants to review this adds up to 280 team/weeks or 2 years to complete the reviews with three teams and 1 1/2 years to complete the reviews with four teams (including 1/2 team/week per plant for leave, holidays, etc).

Due to the extremely short schedule we are working under to complete the guidelines, the status of this activity changes almost daily. I will keep you informed regularly as the project develops.

Ed Butcher

E. Butcher
Plant Systems Branch
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cc: D. Eisenhut
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ENCLOSURE 1

E. J. BUTCHER

AUG 7 1979

GUIDELINES FOR ENVIRONMENTAL QUALIFICATION OF CLASS 1E ELECTRICAL EQUIPMENT IN OPERATING REACTORS SUBJECT TO THE REPORTING REQUIREMENTS OF 1E BULLETIN 79-01

1.0 INTRODUCTION

Discuss history of IE Bulletin 79-01 and the purpose of the guidelines. Include a statement that the guidelines are intended to be a statement of acceptable qual. methods for a particular blass of plants (i.e., early operating reactors) and that other classes of plants may be subject to different requirements i.e., DSS Interim Position on E/Q depending on their date of licensing. Include the standard caveat that alternatives will be considered on a case by case basis.)

2.0 DISCUSSION

(Discuss history of E/Q and IEEE 323. Identify principal diferences between 1971 and 1974 version of the standard and state that the 1974 version represents the bench mark used for identifying the significant factors to be considered in judging the qualification of equipment. Identify any specific E/Q issues or requirements of IEEE 323-1974 that are excluded from consideration and provide the basis).

3.0 GUIDELINES

3.1 Service Conditions

In order to determine the adequacy of the qualification of an item of equipment it is necessary to specify the environment the equipment is exposed to during normal and accident conditions. These environments are referred to as the "service conditions."

In general the service conditions previously approved by the staff and specified for the docket record in the FSAR or other licensee submittals should be considered acceptable, unless specific information is available (either from other SEP topic reviews or NRC staff reviews in general including reviews performed for latter licensing actions) to indicate that the service conditions are not representative of worst case LOCA conditions. In cases where the service conditions specified on the existing docket are not adequate a new plant specific analysis should be performed and submitted to the NRC staff for approval. Additional information in general and guidelines for establishing service conditions in such cases are provided in the following subsections.

3.1.1 Service Conditions For a LOCA

1. Temperature and Pressure - Where a new plant specific analysis is required the models and methods specified in the NRC staff Interim Position on Environmental Qualification of Safety Related Electrical Equipment, draft No. _____ dated _____ should be used. In lieu of performing a new analysis, the typical temperature and pressure service conditions in Appendix A of IEEE Std. 323-1974 are acceptable.

2. Radiation - When specifying radiation service conditions for equipment exposed to radiation during normal operation and accident conditions, the normal operating dose should be added to the dose during the course of an accident. Following are guidelines for an acceptable simplified method of specifying radiation service conditions.

   (Summarize the factors affecting equipment dose setforth in a memo from D. Eisenhut to V. Stello dated 4/2/78, s subject - Environmental Qualification of Safety Electrical Equipment - Radiation).

3. Submergence and Chemical Sprays - The preferred method of protection against the effects of submergence is to locate equipment above the water flooding level. If a water tight enclosure (including a compartment) is relief upon to protect an item of equipment from the effects of submergence or chemical sprays, the enclosure should be qualified and subject to a surveillance technical specification to assure its continued water tight integrity. Equipment exposed to chemical sprays should be qualified for the most severe chemical environment (acidic or basic) which could exist. If the chemical composition of the sprays can be affected by equipment malfunctions, the most severe environment that could result from a single active spray system component failure should be assumed when establishing service conditions for qualification.

3.1.2 Steam Line Break Accident

1. Equipment required to function in a steam line break environment must be qualified for the high temperature that could result. In some cases this temperature may be higher than that resulting from a LOCA and should be specified by a plant specific analysis.

   (If possible, acceptable models for the plant specific analyses will be provided.)

2. Where equipment qualification has been completed but only LOCA conditions were considered it may not be necessary to requalify equipment if it can be shown that due to the thermal capacity of the equipment and the short duration of the steam line break accident high temperature spike the

actual equipment surface temperaturedoes not rise above the LOCA condition temperature it was qualified for. Guidelines for calculating the peak temperature conditions resulting from a steam line break and the associated peak surface temperature of individual components are provided in Appendix A. In General, this method is only suitable where the duration of the high temperature condition is very short due to the automatic actuation of a containment spray system.

3. Due to the uncertainties in analysis assumptions regarding the possibility of fuel damage during a main steam line break accident, radiation conditions during this accident should be considered the same as for a LOCA.

3.1.3 Service Conditions Outside Containment

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3.1.4 Aging

(In general the expected approach on aging will be not to require consideration of aging across the board for all equipment. Only equipment composed of materials known to age will be backfitted with a requirement to establish a qualified lift. An example of such materials would be plastics, lubricants, and various types of cable insulation. Cognizant groups within the staff, e.g., MTEB, RES, IE and ICSB, will be asked to contribute to the list. Also assistance will be sought from contract organizations.)

3.2 Qualification Methods

The qualification methods described in IEEE Std. 323-1974 (i.e., type testing, operating experience, analysis, or combination (on-going)) are the preferred qualification methods when implemented in accordance with the guidelines in this section. Specific provisions of the standard not amplified or modified are acceptable as stated in the standard.

The choice of qualification method employed for a particular application of equipment is largely a matter of technical judgment based on such factors as : (1) the severity of the service environment; (2) the structural and material complexity of the equipment; and (3) the degree of certainty required in the qualification procedure (i.e., the safety importance of the equipment function). Guidelines for selection of qualification methods acceptable for specific applications are provided for each method discussed below.

3.2.1 Qualification by Type Testing

1. Applicability - Type testing is the preferred method of qualification for equipment exposed to accident environments. Other qualification methods along are not considered adequate for the specific applications listed below unless justified on a case by case basis by such factors as diversity in qualification methods for redundant components, diversity in design between redundant components, or passive nature of component function (e.g., values that need not change positon).

   a. Equipment exposed to an accident environment which must function to mitigate the consequences of an accident which if left unmitigated, could result in a breach of containment or a disruption of the normal core geometry should be qualified by type testing.

   b. Equipment exposed to an accident environment that need not function to mitigate the consequences of the accident but whose failure could prevent mitigation or result in a breach of containment or a disruption of the normal core geometry should be qualified by type testing to withstand the accident environment for the length of time it must not fail.

2. Test Conditions (Service Conditions) - Test conditions should be established by adding appropriate margins (see item 3 below) to the service conditions established in accordance with Section 3.1 above.

3. Margins - *(Specific positions regarding the quantity of margin required for each of the factors discussed in Section 6.3.1.5 of IEEE Std. 323-1974 will be provided.)*

4. Test Sequence - *(Current thinking is that the test sequence is not critical but that the service conditions should be applied to the same test specimen i.e., separate effects testing is not acceptable).*

5. Test Specimen Aging - *(Specific aging methods which are acceptable based on the information available to date, i.e., "state of the art", will be specified. As noted in section 3.1.4 above, only certain materials will be subject to an aging requirement. Therefore, the aging methods specified will be restricted to those required for specific materials).*

6. Other Type Testing Guidelines

   a. Equipment Mounting and Seals - The equipment mounting and electrical or mechanical seals during the type test hould be represented of the actual installation for the test to be considered conclusive.

   b. Functional Testing - Operational modes tested should be representative of the actual application requirements. Components which operate normally energized in the plant should be normally energized during the test for the test to be considered conclusive.

   c. --
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3.2.2 Qualification By Analysis (Mathematical Analysis)

IEEE Std. 323-1974 defines analysis as - "A process of mathematical or other logical reasoning that leads from stated premised to the conclusion concerning specific capabilities of equipment and its adequacy for a particular application." The guidance in this section is applicable only to analysis by mathematic reasoning. Analysis by logical reasoning which considers test data, operating experience and mathematic models is discussed as qualification by a combination of methods in Section 3.2.3 below.

1. Applicability - Qualification by mathematical analysis alone is not acceptable for safety related equipment that must function in an accident environment.

2. Verification of Mathematical Models - Mathematic models used for equipment qualification must be verified by comparison of measurable phenomenon (e.g., material elongation) predicted by the models to actual test data for materials arranged in a configuration similar to that of the actual equipment to that of the actual equipment to be qualified.

3. Combination of Single Varible Analyses - The results of separate calculations considering single environmental factors (e.g., temperature, pressure, radiation) should not be arbitrarily conbined without accounting for the possible interaction between the effects of separate factors. In general, these effects are too complex to be accounted for with mathematical models and some testing is required.

3.2.3 Qualification by a Combination of Methods (Analysis by Logical Reasoning)

1. Applicability - Qualification by a combination of methods is considered universally acceptable for all types of electrical equipment. In the case of certain applications discussed in Section 3.2.1 the combination of methods must include type testing.

2. Examples of Qualification by a Combination of Methods

   Following are specific examples of qualification procedures using a combination of methods in a manner that is considered acceptable.

   a.

   b.

   c. etc.

   (These examples may be difficult to set forth with enough specificity to be useful, but there should be many available from our past reviews in connection with the UCS petition high energy line breaks outside containment, and 10 CFR 50.46).

3. Other General Guidelines

   a.

   b.

   c. etc.

3.2.4 Qualification by Operating Experience

1. Applicability - Qualification by operating experience is the preferred method of qualification for equipment located outside containment not exposed to accident environments.

2. Verification of Operating History - Equipment should not be considered qualified by operating history if documentation is not available to verify that the same piece of equipment was in service for the entire qualification period.

3. --

4. etc.

3.2.5 On-Going Qualification

4.0 General Qualification Guidelines

1. Documentation - Complete and auditable records must be available for qualification by any of the methods described in Section 3.0 above to be considered valid. These records should describe the qualification method in sufficient detail to verify that the guidelines in Section 3.0 above have been satisfied. A simple vendor certification of qualification or compliance with a design specification should not be considered adequate unless it identifies the basis for the certification (i.e., a test report or analysis document).

2. Failure Criteria - A component that fails during a qualification test, even in the safety function mode, should not be considered qualified by test.

3. Non-Safety Related Components - Components located inside containment with no active safety function but with failure modes that could adversely affect safety should not be considered exempt from qualification requirements (see also Section 3.2.1 Item 1 above.).

TASK SCHEDULE

TASK	DRAFT COMPLETION DATE
a. Radiation Service Conditions Inside and Outside Containment LOCA and Steam Line Break Accidents (Ted Quay, EEB)	8/17/79
b. Aging (E. Butcher, ORNL)	9/4/79
c. Temperature and Pressure Service Conditions For Steam Line Break Accidents (E. Butcher, DSS CSB)	9/7/79
d. Systems Required For Safety (Bill Morris)	8/31/79
e. Temperature and Pressure Service Conditions Outside Containment (Dan McDonald)	8/17/79