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U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

REGULATORY GUIDE 1.75

PHYSICAL INDEPENDENCE OF ELECTRIC SYSTEMS

A. INTRODUCTION

Section 50.55a, "Codes and Standards," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires in paragraph (h) that protection systems meet the requirements set forth in the Institute of Electrical and Electronics Engineers Standard, "Criteria for Protection Systems for Nuclear Power Generating Stations," (IEEE 279)[1]. Section 4.6 of IEEE Std 279-1971 (also designated ANSI N42.7-1972) requires, in part, that channels that provide signals for the same protective function be independent and physically separated. General Design Criterion 3, "Fire Protection," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 requires, in part, that structures, systems, and components important to safety be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires. General Design Criterion 17, "Electric Power Systems," requires, in part, that the onsite electric power supplies, including the batteries, and the onsite electric distribution system have sufficient independence to perform their safety functions assuming a single failure. General Design Criterion 21, "Protection System Reliability and Testability," requires, in part, that independence designed into protection systems be sufficient to ensure that no single failure results in loss of the protection function. This guide describes a method acceptable to the Regulatory staff of complying with IEEE Std 279-1971 and Criteria 3, 17, and 21 of Appendix A to 10 CFR Part 50 with respect to the physical independence of the circuits and electric equipment comprising or associated with the Class IE power system, the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the systems it actuates to perform their safety-related functions. This guide applies to all types of nuclear power plants.

B. DISCUSSION

Draft IEEE Standard, "Criteria for Separation of Class IE Equipment and Circuits," dated July 20, 1973, was prepared by Ad Hoc Subcommittee 6 of the Nuclear Power Engineering Committee (NPEC) of the Institute of Electrical and Electronics Engineers. The draft was subsequently modified by NPEC in August 1973 incident to the normal process of developing its technical content. The modified draft standard provided criteria for the separation of redundant Class IE equipment and circuits installed at nuclear power plants.

Inasmuch as there was an urgent need for explicit guidance in the area of physical independence of electric systems and in view of the considerable guidance already available from the modified IEEE draft standard, the Regulatory staff prepared a document entitled, "Appendix 1 to Regulatory Guide 1.75—Physical Independence of Electric Systems." This Appendix, which was essentially the modified IEEE draft standard further modified to (a) address acceptably those portions of the standard on which there was not complete agreement, (b) describe logical extensions of the standard's provisions that were acceptable to the Regulatory staff, and (c) provide clarification where necessary, was endorsed by the February 1974 version of this guide.

Subsequent to the issuance of the February 1974 version of this guide, the modified IEEE draft standard upon which the guide and its Appendix were based evolved, in the normal course of standard development, into IEEE Std 384-1974, "IEEE Trial-Use Standard Criteria for Separation of Class IE Equipment and Circuits," (also designated ANSI N41.14). IEEE Std 384-1974 has undergone balloting within Ad Hoc Subcommittee 6 and NPEC and was approved by the

[1] Copies may be obtained from the Institute of Electrical and Electronics Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.

IEEE Standards Board on February 28, 1974. This revision to the guide endorses, with certain exceptions, IEEE Std 384-1974.

The Regulatory staff does not agree with certain provisions of the trial-use standard such as those pertaining to the definition of "raceway," the routing of power cables through the cable spreading area(s) and control room, and the status of non-Class 1E circuits that are not separated from associated circuits by acceptable distance or barriers. This lack of agreement is reflected in Regulatory Positions C.1, 2, 4, 6, 7, 9, 10, and 12.

There are also several regulatory positions that are logical extensions of the Standard's provisions and reflect current Regulatory staff review practice. For example, a provision of the standard which addresses the "degree of separation commensurate with the damage potential of the hazard" does not specifically cover cable tunnels which, in the event of a fire, may not effectively separate redundant circuits or equipment. As another example, the standard requires that methods of identification distinguish between redundant Class 1E systems, associated circuits, and non-Class 1E systems. By implication, associated circuits assigned to different redundant divisions should also be identified. However, the provision is implicit. An explicit provision should be provided.

Detailed bases are included herein for those regulatory positions that are significantly at variance with the standard's provisions. The remaining regulatory positions are logical extensions, or clarifications, of the standard's provisions.

C. REGULATORY POSITION

IEEE Std 384-1974 sets forth criteria for the separation of circuits and equipment that are redundant. The determination of which circuits and equipment are redundant and the degree of redundancy required is outside the scope of this guide and the standard. The standard also sets forth criteria relating to tests and analyses for determining the flame-retardant characteristics of proposed cable installations. The criteria are acceptable provided such tests and analyses are based on realistic premises and are otherwise fully applicable to the actual cable installations.

The guidance in IEEE Std 384-1974, "IEEE Trial-Use Standard Criteria for Separation of Class 1E Equipment and Circuits," dated March 15, 1974, is generally acceptable to the Regulatory staff and provides an adequate basis for complying with IEEE Std 279-1971 and the Commission's General Criteria 3, 17, and 21 of Appendix A to 10 CFR Part 50 with respect to the physical independence of the circuits and electric equipment comprising or associated with the Class 1E power system, the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the systems it actuates to perform their safety-related functions, subject to the following:

1. Section 3, *Isolation Device*, should be supplemented as follows: "(Interrupting devices actuated only by fault current are not considered to be isolation devices within the context of this document.)"

Basis: Logical extension of the Standard's provisions. The standard defines "isolation device" in terms of preventing malfunctions in one section of a circuit from causing unacceptable influences in other sections of the circuit or other circuits. Under the postulated conditions of a loss-of-coolant accident, loss of offsite power, and a cable tray fire, the proximity of circuits energized from redundant Class 1E power sources could lead to concurrent high fault currents (e.g. short to ground) which, in turn, threaten the redundant main circuit breakers. Also, the susceptibility of non-Class 1E loads energized from redundant Class 1E power sources to design basis event (e.g., seismic events) could similarly threaten the redundant main circuit breakers. Tripping of the main circuit breakers would cause the loss of emergency power to redundant "divisions" of equipment. It is recognized that proper breaker or fuse coordination would preclude such an event. However, because the main breakers are in series with the fault and could experience momentary currents above their setpoints, it is prudent to preclude the use of interrupting devices actuated only by fault current as acceptable devices for isolating non-Class 1E circuits from Class 1E or Associated circuits.

Breakers that trip on receipt of a signal other than one derived from the fault current or its effects (e.g., an accident signal) are *acceptable since the downstream circuits would already be isolated from their respective power sources under accident conditions and could pose no threat to these sources.*

2. Section 3, *Raceway*: Interlocked armor enclosing cable should not be construed as a "raceway".

Basis: There is no precedent or other known valid reason for considering such cable to be a "raceway" This regulatory position is consistent with current industry practice including the provisions of the National Electric Code.

3. Section 4.3 should be supplemented as follows: "In general, locating redundant circuits and equipment in separate safety class structures affords a greater degree of assurance that a single event will not affect redundant systems. This method of separation should be used whenever practicable and where its use does not conflict with other safety objectives."

4. Associated circuits installed in accordance with Section 4.5(1) should be subject to all requirements placed on Class 1E circuits such as cable derating, environmental qualification, flame retardance, splicing restrictions, and raceway fill unless it can be demonstrated that the absence of such requirements could not significantly reduce the availability of the Class 1E circuits.

Basis: This is a logical extension of the standard's provisions. The specified minimum acceptable separation distances for raceways carrying Class IE circuits are predicated on assumptions related to flame retardance, cable derating, etc. The placement of cables of lesser qualification in these raceways would nullify these assumptions.

5. The "Note" following Section 4.5 should be supplemented as follows: "This exemption is limited and does not extend to other requirements such as those of General Design Criterion 17."

6. Analyses performed in accordance with Sections 4.5(3), 4.6.2, and 5.1.1.2 should be submitted as part of the Safety Analysis Report and should identify those circuits installed in accordance with these sections.

Basis: Extension of Regulatory Guide 1.70 to provide the information needed in order for the staff to independently verify conformance to the standard.

7. Non-Class IE instrumentation and control circuits should not be exempted from the provisions of Section 4.6.2.

Basis: There is no firm technical basis for an unrestricted exemption of these circuits. Exemptions should be justified by analysis.

8. Section 5.1.1.1 should not be construed to imply that adequate separation of redundant circuits can be achieved within a confined space such as a cable tunnel that is effectively unventilated.

9. Section 5.1.1.3 should be supplemented as follows: "(4) Cable splices in raceways should be prohibited."

Basis: Splices have been identified as the initiating cause of several fires in raceways. Even where the separation distance is adequate to prevent a fire in the raceways of one division from affecting cables in a redundant division, all practicable means should be used to prevent the occurrence of a fire. This position against splices in raceways is therefore prudent. Splices are not, by themselves, unacceptable. If they exist, the resulting design should be justified by analyses. The analyses should be submitted as part of the Safety Analysis Report.

10. Section 5.1.2, the phrase "at a sufficient number of points" should be understood to mean at intervals not to exceed 5 ft throughout the entire cable length. Also the preferred method of marking cable is color coding.

Basis: This is a logical extension of the standard's provisions. A 5 ft maximum marking distance is considered necessary to facilitate visual verification that the cable installation is in conformance with separation criteria.

11. Section 5.1.2 should be supplemented as follows: "The method of identification used should be simple and should preclude the need to consult any reference material to distinguish between Class IE and Non-Class IE circuits, between Non-Class IE circuits associated with different redundant Class-IE systems, and between redundant Class IE systems."

12. Pending issuance of other acceptable criteria, those portions of Section 5.1.3 (exclusive of the NOTE following the second paragraph) that permit the routing of power cables through the cable spreading area(s) and, by implication, the control room, should not be construed as acceptable. Also, Section 5.1.3 should be supplemented as follows: "Where feasible, redundant cable spreading areas should be utilized."

Basis: This is a prudent specific interpretation of the standard's provisions in the absence of specific guidance. The Regulatory staff recognizes that subsequent investigation may prove that this approach is too conservative; however, in the absence of supporting evidence to the contrary, this conservative approach is desirable.

The use of redundant cable spreading areas is a logical extension of the standard's provisions (ref. Section 5.1.1.1).

13. No significance should be attached to the different tray widths illustrated in Figure 2.

14. Section 5.2.1 should be supplemented as follows: "And should have independent air supplies."

15. Where ventilation is required, the separate safety class structures required by Section 5.3.1 should be served by independent ventilation systems.

16. The first paragraph of Section 5.7 should be augmented as follows: "The separation requirements of 5.6 apply to instrumentation cabinets."

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the Regulatory staff's plans for utilizing this regulatory guide.

This guide reflects current regulatory practice. Therefore, except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, this guide will be used by the Regulatory staff in evaluating all construction permit applications for which the issue date of the Safety Evaluation Report is February 1, 1974, or after.