

NUCLEAR UTILITY GROUP
ON EQUIPMENT QUALIFICATION

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December 22, 2021

VIA: U.S. Mail and email:

Thomas R. Hipschman, Chief
Reactor Inspection Branch
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: NRC Inaccurate Interpretation of General Design Criterion 4 as Expressly
Requiring Inclusion of Synergistic Effects and Aging in Design Analyses

Dear Mr. Hipschman:

The Nuclear Utility Group on Equipment Qualification (NUGEQ)¹ hereby presents a specific regulatory concern related to the scope of design analyses being dictated by the NRC's interpretation of 10 CFR 50.69² and the implementing inspection guidance³. It is the Group's perspective that the regulatory position taken by the NRC with respect to the application and consideration of synergistic effects, and aging, is inconsistent with the provisions of 10 CFR 50.49, and the application of General Design Criterion (GDC)-4, "Environmental and dynamic effects design basis."

In support of this examination of the NRC regulatory position the NUGEQ provides herewith, as Attachment 1, "Request for Reexamination and Justification of Staff Position that licensees or applicants must address environmental effects such as aging and synergisms to satisfy the provisions of General Design Criterion 4."

¹ The Group represents approximately 75% of the operating nuclear power plants in the United States. The Group was founded in 1981, as the NRC staff was evaluating and planning the ultimate promulgation of 10 CFR 50.49, "Environmental qualification of electric equipment important to safety for nuclear power plants."

² 10 C.F.R. 50.69, "Risk-informed categorization and treatment of structures, systems and components for nuclear power reactors."

³ IP 37060, "10 C.F.R. 50.69, Risk-Informed Categorization and Treatment of [SSCs]."

The NUGEQ considers this topic to be of particular importance as we are about to embark on inspections in support of licensees' implementation of their risk-informed programs, pursuant to 10 CFR 50.69.

We also request this letter and any subsequent communications be placed into the public Agencywide Documents Access and Management System. We look forward to opportunities to discuss this regulatory issue with you, at your convenience.

Respectfully,



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WAH/pan
Attachment

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Attachment 1

*Request for Reexamination and Justification of Staff
Position that licensees or applicants must address
environmental effects such as aging and synergisms to
satisfy the provisions of General Design Criterion 4.*

Request for Reexamination and Justification – Staff Position on Addressing Synergistic Effects to Satisfy GDC-4

INTRODUCTION

According to the results and recommendations of the IP 37060 Enhancement Working Group, dated July 30, 2021 (ML2118A110) “nearly 40% of power reactor sites have either adopted the provisions of 10 C.F.R. § 50.69 or have license amendment requests under NRC review to allow them to do so.” With this increase in approved license amendments, and the resultant increase in forthcoming inspection activity, the Nuclear Utility Group on Equipment Qualification (“NUGEQ” or “Group”)¹ hereby submits this request for reexamination and justification to confirm the regulatory position regarding the need for licensees to address aging and synergistic effects to comply with General Design Criterion (GDC) 4 that is included in Appendix A of IP 37060, “10 C.F.R. 50.69 Risk-Informed Categorization and Treatment of [SSCs].” This update to the inspection procedure becomes effective on January 1, 2022. With respect to GDC-4, “Environmental and dynamic effects design bases” the existing regulatory position could result in undue enforcement exposure to licensees who have implemented the § 50.69 categorization process. As currently worded, the requirement to address synergistic effects for all important to safety equipment subject to GDC-4 could also have generic implications (*i.e.*, compliance with GDC-4) for licensees who have not adopted or implemented § 50.69.

ISSUE

Specifically, IP 37060 contains the following stated position delineated in Section V.5.2 of the Statement of Considerations for 10 C.F.R. 50.69 (69 FR 68041):

“To satisfy the provisions of GDC-4 of 10 CFR part 50, Appendix A, the licensee or applicant must address environmental conditions such as temperature, pressure, humidity, chemical effects, radiation and submergence; and environmental effects such as aging and synergisms. [emphasis added]”

This statement can be interpreted to reflect the imposition of special treatment in accordance with 10 C.F.R. § 50.49(e)(7), “Synergistic Effects,” as a requirement for satisfying the provisions of GDC-4 of 10 C.F.R. § 50, Appendix A for equipment that is not subject to 10 C.F.R. § 50.49.

Such an interpretation has implications beyond the scope of 10 C.F.R. § 50.69 since it is expanding upon what a licensee or applicant must address as part of designing important to safety structures, systems and components (SSCs) to accommodate the effects of, and to be compatible with, the environmental conditions and effects associated with normal operation, maintenance, testing, and postulated accidents including loss of coolant accidents.

REQUIREMENT

10 C.F.R. § 50.49(e)(7), “Synergistic Effects,” states:

“Synergistic effects must be considered when these effects are believed to have a significant effect on equipment performance.”

¹ The Group represents approximately 75% of the operating nuclear power plants in the United States. The Group was founded in 1981, as the NRC staff was evaluating and planning the ultimate promulgation of 10 CFR 50.49, “Environmental qualification of electric equipment important to safety for nuclear power plants.” Since its inception, the Group has been actively involved in the development and implementation of licensee EQ programs in accordance with NRC requirements and guidance. The Group most recently also was actively involved in the recent NRC DBA EQ program inspections and worked with licensees and the NRC in addressing implementation issues associated with those inspections.

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There is no regulatory requirement, other than § 50.49(e)(7), that explicitly specifies the need to consider synergisms or synergistic effects in the design of important to safety SSCs.

As a special treatment, 10 C.F.R. § 50.49 was promulgated to provide additional requirements (i.e., beyond those established by prior regulations) for that subset of electrical equipment important to safety that is credited to function during or following exposure to harsh environmental conditions resulting from design basis accidents. According to the Statement of Considerations accompanying the § 50.49 final rule (48 FR 2729 (1983)), the requirement that equipment important to safety must be able to perform its safety functions throughout its installed life is embodied in GDC-1, “Quality Standards and Records,” GDC-2, “Design bases for protection against natural phenomena,” GDC-4, “Environmental and Dynamic Effects design bases,” GDC-23, “Protection System Failure Modes,” and Appendix B, Criterion III, “Design Control,” and Criterion XI, “Test Control.” The most relevant of these aforementioned regulations with respect to environmental considerations is GDC-4, which applies to all important to safety SSCs. GDC-4 requires these SSCs to be “designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents.”

ANALYSIS

NRC Implementation of § 50.69 Expands the Previously Established Scope of Important to Safety Equipment Expected to Address Synergistic Effects to Satisfy the Provisions of GDC-4

The Staff’s position in Appendix A of IP 37060 and Section V.5.2 of the Statement of Considerations for 10 C.F.R. § 50.69 regarding the need to address synergism in order to satisfy the provisions of GDC-4 for RISC-3 equipment goes beyond the requirement in § 50.49(e)(7) based on the following:

- The position does not limit the need to consider synergisms to situations where they are believed to have a significant effect on equipment performance.
- § 50.49(e)(7) only applies to a subset of equipment subject to 10 C.F.R § 50.49. Consistent with § 50.49(k), electrical equipment qualified to the requirements of the DOR Guidelines, or NUREG-0588 Category II are not required to address synergistic effects.
- The position expands the need to consider synergisms or synergistic effects to mild environment electrical equipment, which is not subject to § 50.49.
- The position expands the need to consider synergisms or synergistic effects to mechanical equipment important to safety, which is not subject to § 50.49.

This position also does not appear to recognize that the two currently identified synergistic effects cited in Regulatory Guide (RG) 1.89, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants” are both related to type testing as an environmental qualification method. Yet the Statement of Considerations for 10 C.F.R. § 50.69 makes it clear that the NRC has removed the need for qualification testing as a special treatment to verify design capability under DBA conditions for RISC-3 SSCs. See 69 FR 68113. According to RG 1.89, Regulatory Position C.5.a, the Staff identified synergistic effects known at the time as dose rate effects and radiation and temperature sequencing effects. Both of these effects are related to radiation aging and the sequential accelerated aging simulations that are used as part of the qualification test method specified by 10 C.F.R § 50.49 and IEEE 323-1974, “IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations.” As a practical matter, licensee considerations of such known synergistic effects have not materially affected qualification test-based aging or accident qualification conclusions.

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The focus on synergistic effects for RISC-3 equipment is inconsistent with the prior regulatory scheme as well as past NRC research on the subject, especially when one considers that synergisms “barely affect[] the uncertainty of the aging process.”²

The Consideration of Synergistic Effects is a Special Treatment Specific Only to 10 C.F.R § 50.49(e)(7)

10 C.F.R § 50.49(e)(7), "Synergistic Effects," was integrated into Section 50.49 to address potential second-order effects associated with special treatment qualification test methods that used accelerated age-preconditioning followed by a simulation of accident conditions. Synergistic effect concerns were raised during the environmental qualification (EQ) rulemaking based on some research testing results which suggested that, for certain material formulations, the combined effects of the sequential application of accelerated aging conditions (e.g., thermal aging followed by radiation aging) during qualification tests might be less degrading than their simultaneous application in actual plant applications.³

Significantly, 10 C.F.R § 50.49 and associated regulatory guidance do not even require consideration of synergisms for all equipment covered by the EQ final rule. 10 C.F.R § 50.49(k) grandfathers qualification efforts previously performed in accordance with the DOR Guidelines or NUREG-0588. Synergistic effects need not be considered for any equipment that is qualified to the DOR Guidelines or Category II of NUREG-0588. This regulatory flexibility was based, in part, on a recognition that (1) "synergistic effects" is a secondary consideration that did not warrant additional licensee activities for equipment already qualified to the "DOR Guidelines" or "NUREG-0588, Category II;" and (2) other conservatisms in the qualification process, including conservatisms when defining environmental conditions, provided adequate confidence in equipment capability. In the discussion of Underlying Assumptions from Section X.E1 of NUREG-2191⁴, synergistic effects are described as example of “unquantified uncertainties” that is specific to the special treatment in § 50.49.

GDC-4 Does Not Explicitly Require Consideration of Aging Effects or Synergistic Effects

Neither GDC-4⁵ nor other regulations which specify the design basis for SSCs require consideration of "aging or synergistic effects" as design considerations. While GDC-4 requires compatibility with environmental conditions, it does not explicitly require consideration of "aging effects" or "synergistic effects."

Criterion 4—Environmental and dynamic effects design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance,

² Section 2.7, “Regulation,” from report prepared by S.P. Carfagno, “Electric Cable Issues Related to Equipment Qualification Research,” January 14, 1994 (ML20112A508).

³ NUREG/CR-3629, “The Effect of Thermal and Irradiation Aging Simulation Procedures on Polymer Properties,” April 1984. Additional discussions related to research with respect to synergistic effects can be found in NUREG/CR-0276, “Qualification Evaluation Testing Program, LWR Safety Research,” Quarterly Report Jan-Mar 1978 (1978), and NUREG/CR-0401, “Qualification Testing Evaluation Program, LWR Safety Research,” Quarterly Report, Apr-June 1978 (1978).

⁴ NUREG-2191, “Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report – Final Report,” July 2017.

⁵ Further, consistent with SRM SECY-92-233, the Commission approved the staff proposal “in which the staff will not apply the General Design Criteria (GDC) to plants with construction permits issued prior to May 21, 1971.”

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testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.

The perspective of “aging and synergistic effects” not being design requirements is consistent with the information provided in Section III.4.2 of the SOC for § 50.69, “Section 50.49 Environmental Qualification of Electric Equipment.” This section states: “The requirements in GDC-4 as they relate to RISC-3 and RISC-4 SSCs, the design basis requirements for these SSCs, including the environmental conditions such as temperature and pressure, remain in effect. These SSCs must continue to remain capable of performing their safety-related functions under design basis environmental conditions.” See 69 FR 68025. Thus, aging and synergistic effects are neither environmental conditions nor design requirements, but are effectively enveloped within maintenance activities outside the scope of GDC-4 to ensure Section 50.69 “reasonable confidence” is maintained over the service life of the equipment.

EQ Task Action Plan Conclusions Reject Additional Regulatory Efforts Related to Synergistic Effects

As part of the EQ Task Action Plan (EQ TAP)⁶, the NRC conducted research on a number of EQ related topics including synergistic effects. The literature review performed by Brookhaven specifically addressed the question of, “Are the effects of synergisms during aging significant enough to affect qualification results?” As described in Section 2.3 of NUREG/CR-6384, “Literature Review of Environmental Qualification of Safety-Related Electric Cables” the response to this question (C.3 at page 2-9) included the following statement:

*“Past work has shown that, in general, more severe degradation results from radiation exposures first, followed by thermal aging. However, with the perspective that preaging sequences cause only a small portion of the damage induced in a DBA simulation, **the sequence in which the preaging is performed would be inconsequential and the question should be considered moot.** Although the issue is not resolved, further work is not recommended.” (Emphasis added)*

Based on past NRC research on synergistic effects, the regulatory focus in Appendix A of IP 37060 regarding the need to consider synergistic effects is fundamentally inconsistent with the low safety significance of RISC-3 SSCs. The EQ-TAP research tested cables in the same sequence as the original qualification testing. No new information regarding synergistic effects on preaging was presented. Synergistic effects were classified as a “Resolution Category 2” issue that was unresolved by past research activities, but new research was not recommended.⁷ The closeout of EQ-TAP concluded that actions taken by the NRC and licensees since the implementation of the EQ rule and the margins inherent in the qualification process ensure an acceptable level of safety regardless of which qualification level was

⁶ The EQ TAP was established to focus on three major issues: (i) differences in EQ requirements between newer and older plants; (ii) adequacy of accelerated aging practices; (iii) programmatic review of EQ requirements to identify and resolve any other EQ concerns.

⁷ Table 1 of NUREG/CR-6384, “Literature Review of Environmental Qualification of Safety-Related Electric Cables,” Volume 2, April 1996.

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implemented.⁸ This conclusion by the NRC further supports the position that synergistic effects are a second-order effect⁹ and therefore are not significant compared to the inherent conservatism in the qualification process.

The Environmental Design Provisions of GDC-4 Described in Section 3.11 of NUREG-0800 Does Not Specify the Need to Consider Synergistic Effects

Section 3.11 of NUREG-0800¹⁰ contains guidance related to compliance of mechanical equipment in harsh environments as well as electrical and mechanical equipment in mild environments with the environmental design provisions of GDC-4. For mechanical equipment located in a harsh environment, compliance with the environmental design provisions of GDC-4 is “generally achieved by demonstrating that the non-metallic parts/components are suitable for the postulated design basis environmental conditions.” For electrical and mechanical devices located in mild environments, compliance with the environmental design provisions of GDC-4 is “generally achieved and demonstrated by proper incorporation of all relevant environmental conditions into the design process, including the equipment specification.” This is further supported by Section 3.11 of NUREG-0800 at page 3.11-10, which states in part:

“For electrical and mechanical equipment located in a mild environment, ... [a] well-supported maintenance/surveillance program, in conjunction with a good preventive maintenance program, is sufficient to ensure that equipment that meets the design/purchase specifications is qualified for the designed life. Compliance with 10 C.F.R. 50.65, “Requirements for monitoring the effectiveness of maintenance at nuclear power plants,” and associated guidance in Regulatory Guide 1.160 are sufficient to provide reasonable assurance that environmental considerations established during design are reviewed every refueling outage and maintained on a continuing basis to ensure that the qualified design life has not been reduced by thermal, radiation, and/or cyclic degradation resulting from unanticipated operational occurrences or service conditions.”

This guidance in Section 3.11 of NUREG-0800 clearly differentiates between design provisions of GDC-4 and maintenance activities aimed at preserving functional capability over the installed life of safety related electrical and mechanical equipment. The specific guidance of Section 3.11 related to GDC-4 for electrical and mechanical equipment located in mild environment areas as well as mechanical equipment located in harsh areas does not specify the need to consider synergistic effects.

CONCLUSION

The Staff’s position in Appendix A of IP 37060 and Section V.5.2 of the SOC § 50.69 creates an explicit obligation to satisfy GDC-4 related to aging and synergisms that does not exist for equipment that is not subject to the requirements of 10 C.F.R. § 50.49. No existing design basis requirements applicable to all important to safety SSCs outside of the special treatment requirements of 10 C.F.R. § 50.49 explicitly requires consideration of aging and synergistic effects. Additionally, electrical equipment that is

⁸ Report on the Status of the Environmental Qualification Task Action Plan (WITS Item 9300107), dated November 15, 1996.

⁹ Section 3.3, “Aging,” from report prepared by S.P. Carfagno, “Electric Cable Issues Related to Equipment Qualification Research,” January 14, 1994 (ML20112A508).

¹⁰ NUREG-0800, Chapter 3.11, “Environmental Qualification of Mechanical and Electrical Equipment,” Revision 3, March 2007.

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environmentally qualified to the requirements of the DOR Guidelines (Enclosure 4 to IEB 79-01B)¹¹ or NUREG-0588 Category II¹² requirements are not required to address synergisms or synergistic effects. Electrical equipment qualified to the requirements of § 50.49 is only required to address synergistic effects when these effects are believed to have a significant effect on equipment performance. Indeed, this staff interpretation and direction under § 50.69 and the inspection procedure results in a higher regulatory hurdle for RISC-3 equipment drawn from 10 CFR 50.49, than for non-RISC-3 electrical equipment that remains subject to 10 CFR 50.49.

In addition, while GDC-4 requires compatibility with environmental conditions, it does not explicitly require consideration of "aging effects" or "synergistic effects." It is our opinion that neither GDC-4 nor other regulations that specify the design basis for SSCs require consideration of "aging or synergistic effects" as design considerations except as provided for specific equipment subject to § 50.49(e)(7). Therefore, the current wording in Appendix A of IP 37060, which aligns with Section V.5.2 of SOC § 50.69, could result in undue enforcement exposure premised on new and incorrect regulatory requirements for licensees who have implemented the § 50.69 categorization process. This requirement also has generic implications (*i.e.*, compliance with new interpretations of GDC 4) for licensees who have not adopted or implemented § 50.69.

For the foregoing reasons, NUGEQ requests confirmation that there is no regulatory requirement for licensees to address synergistic effects to satisfy the requirements of GDC-4 for important to safety SSCs that are not subject to the special treatment requirements of 10 C.F.R. § 50.49(e)(7). In the event that the Staff feels that synergistic effects do need to be addressed to satisfy the requirements of GDC-4, the Group requests that the NRC provide a documented evaluation with a detailed basis for such a regulatory position.

¹¹ Section 5.2.4 of the Division of Operating Reactor (DOR) Guidelines, "Guidelines for Evaluating Qualification of Class 1E Electrical Equipment in Operating Reactors," Enclosure 4 to NRC IEB 79-01B.

¹² Section 4(3) of NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Revision 1, July 1981.