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DRAFT REGULATORY GUIDE

Contact: T. Kendzia
301-415-8155

DRAFT REGULATORY GUIDE DG-1294

(Proposed Revision 1 of Regulatory Guide 1.41, dated March 1973)

PRE-OPERATIONAL TESTING OF ONSITE ELECTRIC POWER SYSTEMS TO VERIFY PROPER LOAD GROUP ASSIGNMENTS, ELECTRICAL SEPARATION, AND REDUNDANCY

A. INTRODUCTION

This guide describes methods the U.S. Nuclear Regulatory Commission (NRC) staff considers acceptable for verifying that the as-built condition of the onsite electrical systems meet the design requirements for load group assignments, electrical separation, and redundancy. This includes the following:

- Verifying that the load group assignments, electrical separation, and redundancy meet the design requirements for onsite or temporally installed power systems that may be used to comply with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.63, "Loss of All Alternating Current Power," and 10 CFR 50.54(hh)(2).

- Verifying that the design requirements and time requirements are met for startup and alignment of electric power sources that may be required to meet the regulations in 10 CFR 50.54(hh)(2).

- Demonstrating compliance with NRC regulations on verification of electrical separation and proper assignment of redundant load groups to onsite power sources as described in Regulatory Guide (RG) 1.6, "Independence between Redundant Standby (Onsite) Power Sources and between Their Distribution Systems (Safety Guide 6)" (Ref. 1), and RG 1.32, "Criteria for Power Systems for Nuclear Power Plants" (Ref. 2).

This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position. Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value and impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; submitted through the NRC's interactive rulemaking Web page at http://www.nrc.gov; or faxed to 301-492-3446. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by [insert date - 60 days from issuance].

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC Library at http://www.nrc.gov/reading-rm/doc-collections/ and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML12228A589. The regulatory analysis may be found in ADAMS under Accession No. ML12228A591.

- Demonstrating that the time required for startup and alignment of another alternating current (ac) power source(s) and the associated equipment can be verified by testing in accordance with the requirements of 10 CFR 50.63(b)(2),

This guide applies to all types of nuclear power plants that are licensed under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," or 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 3), including new construction and initial testing of major modifications or repairs to currently licensed nuclear power plants.

The applicable design requirements are spelled out in the following:

- General Design Criteria (GDC) 1 of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 (Ref. 4), which requires, in part, that structures, systems, and components (SSCs) important to safety be tested to quality standards commensurate with the importance of the safety functions to be performed.

- GDC 17, "Electric Power Systems," which includes a requirement that an onsite electric power system and an offsite electric power system be provided to permit functioning of SSCs important to safety.

Onsite emergency power systems designed in accordance with GDC 17, RG 1.6, and RG 1.32 require electrical separation and the proper assignments of redundant load groups to the onsite power sources. For onsite or temporally installed power systems, 10 CFR 50.63 includes design requirements for load group assignments, electrical separation, and redundancy. In addition, 10 CFR 50.63(b)(2) includes a requirement that the time required for startup and alignment of the alternate ac power source(s) and the associated equipment shall be demonstrated by testing. The regulations in 10 CFR 50.54(hh)(2) require, in part, development and implementation of guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with loss of large areas of the plant caused by explosions or fire. These strategies may include onsite or temporarily installed power systems that have design requirements for load group assignments, electrical separation, and redundancy, and they may have time requirements for startup and alignment of electric power sources.

Criterion XI, "Test Control," of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 states, in part, that licensees should establish a test program to ensure that all testing required to demonstrate that SSCs will perform satisfactorily in service is identified and performed in accordance with written test procedures. The written procedures should incorporate the requirements and acceptance limits contained in applicable design documents. The regulations in 10 CFR 50.34, "Contents of Applications; Technical Information," and 10 CFR 52.79, "Contents of Applications; Technical Information in Final Safety Analysis Report," also require, in part, that the applicant include plans for pre-operational testing and initial operations in the final safety analysis report (FSAR).

Chapter 14 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Light-Water Reactor (LWR) Edition," (Ref. 5), and Regulatory Position C.I.14, "Verification Programs" of RG 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," (Ref. 6), provide guidance on information related to the initial test program (ITP) to be included in both the preliminary safety analysis report (PSAR) and the FSAR. This information enables the staff to perform its safety evaluations for construction permits, operating licenses, and combined licenses (COLs). In addition, 10 CFR 52.80(a) requires, in part, that applications for a COL include the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the

licensee shall perform. Applications also should include the acceptance criteria necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will be operated in conformity with the COL and the Commission's rules and regulations. In most cases, licensees may rely on pre-operational tests completed as part of the ITP to satisfy testing related to the inspections, tests, analyses, and acceptance criteria before fuel load.

RG 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," (Ref. 7), describes a method acceptable to the staff for complying with the Commission's regulations with regard to pre-operational testing of nuclear power plant SSCs that perform functions important to safety. This guide describes initial plant testing acceptable to the staff for onsite electrical power systems, including temporarily installed systems or components to meet station blackout or events related to loss of large areas of the plant caused by explosions or fire. Although this guide is applicable to all LWRs licensed under 10 CFR Parts 50 and 52, certain aspects may not be completely applicable to specific nuclear power plant designs based on individual license reviews.

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. RGs are not substitutes for regulations, and compliance with them is not required.

This RG contains information collection requirements covered by 10 CFR Part 50 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number. The NRC has determined that this RG is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808). However, OMB has not found it to be a major rule as designated by the Congressional Review Act.

B. DISCUSSION

Reason for Change

The NRC developed RG 1.41 to provide guidance on pre-operational testing of onsite electrical power systems important to safety for load group assignments, electrical separation, and redundancy. The agency first issued the guide in 1973, and it has not been revised despite multiple revisions to the regulations. Since 1973, the Commission has amended its regulations for loss of all alternating current power (station blackout) and loss of large areas of the plant caused by explosions or fire. The NRC also has established a new combined (construction and operating) licensing process under 10 CFR Part 52. This RG is being revised for three reasons: (1) to expand the scope of the guide to encompass pre-operational tests for the electrical power systems used to meet station blackout and loss of large areas of the plant caused by explosions or fire, (2) to expand the scope of the guide to encompass testing the ability to meet time requirements for startup and alignment for use of electric power sources used to meet the station blackout and loss of large areas of the plant caused by explosions or fire, and (3) to update the guide references and address facilities licensed under 10 CFR Part 52.

Background

An onsite electric power system designed in accordance with RG 1.6 and RG 1.32 will consist of redundant power sources and load groups that are independent of each other. RG 1.32 endorses the

Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 308-2001, "IEEE Standard Criteria for Class IE Power Systems for Nuclear Generating Stations," (Ref. 8). Section 5.2.2.4 of IEEE Std. 308-2001 states: "Auxiliary devices required for the operation of equipment associated with a load group shall be supplied from a related bus section to prevent the loss of electric power in one load group from causing the loss of equipment function in another load group." The staff's believes that independence among redundant onsite power sources and their load groups should be designed to ensure that the successful operation of any power source and its load group is not affected by the partial or complete failure of any other power source and its load group.

The staff holds the position that, since the reliability of an onsite safety related power system is predicated on the existence of this independence, licensees should perform a suitable pre-operational test to detect any lack of independence. As a minimum, a suitable test should ensure that each redundant onsite power source and its load group can function without any dependence upon any other redundant load group or portion thereof.

The requirements in 10 CFR 50.63 state, in part, that each light-water-cooled nuclear power plant must be able to withstand and recover from a station blackout of a specified duration. The requirements in 10 CFR 50.54(hh)(2) state that each licensee shall develop and implement guidance and strategies intended to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities under the circumstances associated with the loss of large areas of the plant caused by explosions or fire. These strategies may use equipment that is not safety related (see RG 1.155, "Station Blackout" (Ref. 9)) and may not be permanently installed. The independence among these power sources and their load groups should be such that the successful operation of any power source and its load group is not precluded by the partial or complete failure of any other power source and its load group, unless interdependence is analyzed and found acceptable by the staff. To verify that these strategies can be successfully implemented, the as-built construction should be tested to ensure that it meets the design requirements for load group assignments, electrical separation, and redundancy. This RG does not address the validation of the acceptability of interdependence in accordance with the design.

The requirements in 10 CFR 50.63(c)(2) state, in part, that the time required for startup and alignment of the alternate power source(s) and equipment, must be demonstrated by test. The regulations in 10 CFR 50.54(hh)(2) require strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities, which may have time requirements for startup and alignment of the alternate power source(s). If the analysis for the strategies required by 10 CFR 50.54(hh)(2) has a time requirement for startup and alignment of the alternate power source(s), then the requirement should be demonstrated by testing, as required in 10 CFR 50.63.

Harmonization with International Standards

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment. IAEA safety guides present international good practices and increasingly reflect best practices to help users who strive to achieve high levels of safety. Pertinent to this RG, IAEA Safety Guide NS-G-1.8, "Design of Emergency Power Systems for Nuclear Power Plants" (Ref. 10), issued August 2004, addresses design considerations for the performance requirements, design reliability, and in-service inspection of emergency power systems for nuclear power plants. While this guide does not endorse NS-G-1.8, it does incorporate similar pre-operational testing guidelines and is consistent with the basic safety principles provided in IAEA Safety Guide NS-G-1.8.

C. STAFF REGULATORY GUIDANCE

As part of the initial pre-operational testing program, the onsite ac and direct current (dc) electrical power systems should be tested, as described below, to verify that the as-built construction meets the design requirements for load group assignments, electrical separation, and redundancy. The onsite ac and dc electrical power systems may include temporarily installed power systems used for station blackout and events that result in loss of large areas of the plant caused by explosions or fire (10 CFR 50.54(hh)(2)). Additionally, after major modification or repair to any of these systems, licensees should perform testing similar to the initial pre-operational testing.

1. Testing of the onsite ac and dc electrical power systems should be performed for load group assignments, electrical separation, and redundancy after construction of the SSCs associated with these systems is complete. This testing is used to verify that the as-built condition meets the design requirements.

2. The test program for the onsite ac and dc electrical power systems and associated equipment should include the applicable prerequisite checks, verifications, and tests provided in RG 1.68.

3. For the onsite electric power systems designed in accordance with RG 1.6 and 1.32, testing should proceed as follows to verify the existence of independence among redundant onsite in-power sources and their load groups.

    3.1 The plant electric power distribution system, not necessarily including the switchyard and the startup and auxiliary transformers, should be isolated from the offsite transmission network. Preferably, this isolation should be completed by direct actuation of the undervoltage-sensing relays within the onsite system.

    3.2 Under the conditions of 3.1 above, the onsite electric power system should be functionally tested successively in the various possible combinations of power sources and load groups, with all dc and ac power sources for one load group at a time completely disconnected. Each test should include injection of simulated accident signals, startup of the onsite power source(s) and load group(s) under test, sequencing of loads, and the functional performance of the loads. Each test should be of sufficient duration to achieve stable operating conditions and, thus, permit the onset and detection of adverse conditions, which could result from improper assignment of loads (e.g., the lack of forced cooling of a vital device).

    3.3 For those functions not tested at the design limiting conditions (i.e., cooling tested during low temperature conditions, motor loading simulated by resistive loading, etc.), engineering analysis should be used to verify that the testing results meet the design requirements.

    3.4 During each test, the onsite dc and ac buses, related loads not under test, and connections to off-site power should be monitored to verify electrical separation. One method is to verify the absence of voltage at these buses and loads.

4. For the onsite and temporarily installed electric power systems used to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities for station blackout or events that result in loss of large areas of the plant caused by explosions or fire (10 CFR 50.54(hh)(2)), testing should proceed as follows to verify that the design requirements are met. The as-built

SSCs should be tested to ensure that the design requirements for load group assignments, electrical separation, and redundancy are met.

4.1 The plant electric power distribution system should be placed in the most limiting design condition that would exist because of a station blackout or beyond-design-basis events (BDBE) for each particular SSC being tested. For example, the station blackout could have all ac power buses de-energized and only the dc power specified (by design) available. Another BDBE example would for certain areas of the station to be considered totally unavailable for use.

4.2 Under the conditions of 4.1 above, the onsite and temporarily installed electric power systems should be functionally tested successively in the various possible combinations of power sources and load groups, with all dc and onsite ac power sources for one load group at a time completely disconnected, or in the design limiting condition if not completely disconnected. Each test should start from the design limiting condition (including simulated accident signals, if appropriate), startup of the onsite or temporary power source(s) and load group(s) under test, sequencing of loads, and the functional performance of the loads. Each test should be of sufficient duration to achieve stable operating conditions and, thus, permit the onset and detection of adverse conditions that could result from improper assignment of loads (e.g., the lack of forced cooling of a vital device).

4.3 For those functions not tested at the design limiting conditions (i.e., cooling tested during low temperature conditions, motor loading simulated by resistive loading, etc.), engineering analysis should be used to verify the testing results meet the design requirements.

4.4 During each test, the onsite dc and ac buses, related loads not under test, and connections to offsite power should be monitored to verify electrical separation. One method is to verify the absence of voltage at these buses and loads.

5. For the onsite and temporarily installed electric power systems used for station blackout or events that result in loss of large areas of the plant caused by explosions or fire (10 CFR 50.54(hh)(2)), that have time requirements for startup and alignment of the alternate power source(s), the ability to meet the time requirements should be verified. This test may be performed in conjunction with verifying that the design requirements are met in item 4 above.

5.1 The plant electric power distribution system should be placed in the most limiting design condition that would exist because of a station blackout or BDBE for each particular SSC being tested. For example, the station blackout would have all ac power buses de-energized and only the dc power specified (by design) available. Another BDBE example would be for certain areas of the station to be considered totally unavailable for use.

5.2 For the test, all equipment should be in the normal condition (i.e., installed if permanently installed, or in storage if a piece of equipment is only temporarily installed). For items that stored remotely from the nuclear site, the item can be at the nuclear site as long as the time to move the item from the normal storage position to the nuclear site is determined by analysis and simulated in the test.

5.3 Under the conditions of 5.1 and 5.2 above, following the nuclear site procedures that would be used in the event, install (if a temporarily installed piece of equipment), startup, and align the alternate power source(s) and the SSCs used for maintaining or restoring core cooling, containment, and spent fuel pool (SFP) cooling capabilities. The actual placing in service of the flow paths for maintaining or restore core cooling, containment, and SFP cooling capabilities may be simulated. Verify the time to perform the actions to meet the design requirements.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information about the NRC's plans for using this RG. In addition, it describes how the staff complies with the Backfit Rule (10 CFR 50.109, "Backfitting") and any applicable finality provisions in 10 CFR Part 52.

Use by Applicants and Licensees

Applicants and licensees may voluntarily[2] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this RG may be deemed acceptable if they provide sufficient basis and information for the staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this RG for actions that do not require NRC review and approval, such as changes to a facility design under 10 CFR 50.59, "Changes, Tests and Experiments." Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues. The NRC is not imposing this RG upon current licensees, but they may voluntarily choose to use it.

If a licensee believes that the NRC is either using this RG or requesting or requiring the licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, "Backfitting Guidelines," and NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection."

Use by NRC Staff

During regulatory discussions on plant-specific operational issues, the staff may discuss various actions with licensees, consistent with staff positions in this RG, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions ordinarily would not be considered backfitting, even if prior versions of this RG are part of the licensing basis of the facility. However, unless this RG is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this RG constitutes a violation.

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[1] In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52. The term "applicants" refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52 and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

[2] In this section, "voluntary" and "voluntarily" mean that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

If an existing licensee voluntarily seeks a license amendment or change and (1) the staff's consideration of the request involves a regulatory issue directly relevant to this new or revised RG, and (2) the specific subject matter of this RG is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this RG or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

The staff does not intend or approve any imposition or backfitting of the guidance in this RG. The staff does not expect any existing licensee to use or commit to using the guidance in this RG, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this RG to resolve a generic regulatory issue. The staff does not expect or plan to initiate NRC regulatory action that would require the use of this RG. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the RG, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this RG, generic communication, or promulgation of a rule requiring the use of this RG without further backfit consideration.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

REFERENCES[3]

1. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide 1.6, "Independence between Redundant Standby (Onsite) Power Sources and between Their Distribution Systems (Safety Guide 6)," NRC, Washington, DC.

2. NRC, Regulatory Guide 1.32, "Criteria for Power Systems for Nuclear Power Plants," NRC, Washington, DC.

3. U.S. *Code of Federal Regulations* (CFR), Title 10, Energy, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

4. *CFR*, Title 10, Energy, Part 50, "Domestic Licensing of Production and Utilization Facilities."

5. NRC, Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition," NRC, Washington, DC.

6. NRC, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," NRC, Washington, DC.

7. NRC, Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," NRC, Washington, DC.

8. Institute of Electrical and Electronics Engineers (IEEE) Standard 308-2001, "IEEE Standard Criteria for Class IE Power Systems for Nuclear Generating Stations," March 2002, IEEE, Piscataway, NJ.[4]

9. NRC, Regulatory Guide 1.155, "Station Blackout," NRC, Washington, DC.

10. International Atomic Energy Agency (IAEA), Safety Guide No. NS-G-1.8, "Design of Emergency Power Systems for Nuclear Power Plants," August 2004, IAEA, Vienna, Austria.[5]

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[3] Publicly available documents from the U.S. Nuclear Regulatory Commission (NRC) are available electronically through the NRC Library on the NRC's public Web site at http://www.nrc.gov/reading-rm/doc-collections/. The documents also can be viewed online for free or printed for a fee in the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or 800-397-4209; fax 301-415-3548; and e-mail pdr.resource@nrc.gov.

[4] Copies of Institute of Electrical and Electronics Engineers (IEEE) documents can be purchased from the Institute of Electrical and Electronics Engineers Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855 or through IEEE's public Web site at http://www.ieee.org/publications_standards/index.html.

[5] Copies of International Atomic Energy Agency (IAEA) documents may be obtained through the organization's Web site at http://www.iaea.org or by writing to the International Atomic Energy Agency, P.O. Box 100, Wagramer Strasse 5, A-1400, Vienna, Austria. Telephone +431-2600-0, fax +4312600-7, or e-mail at Official.Mail@IAEA.org.