



REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

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INITIAL STARTUP TEST PROGRAM TO DEMONSTRATE REMOTE SHUTDOWN CAPABILITY FOR WATER-COOLED NUCLEAR POWER PLANTS

A. INTRODUCTION

This guide describes an initial startup test program acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) for demonstrating hot shutdown capability and the potential for cold shutdown from outside the control room. This guide is applicable to water-cooled nuclear power plants.

Title 10, of the *Code of Federal Regulations*, Part 50, “Domestic Licensing of Production and Utilization Facilities” (10 CFR Part 50) (Ref. 1), and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 2), 10 CFR 50.34, “Contents of Applications; Technical Information,” and 10 CFR 52.79, “Contents of Application; Technical Information in Final Safety Analysis Report,” require, in part, that an applicant for a license to operate a production or utilization facility provide a safety analysis report that includes the principal design criteria for the proposed facility. The introduction to Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50 states that these principal design criteria are to establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components (SSCs) important to safety (i.e., SSCs that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public).

General Design Criterion (GDC) 1, “Quality Standards and Records,” of Appendix A to 10 CFR Part 50, requires that structures, systems, and components important to safety be tested to quality standards commensurate with the importance of the safety functions to be performed.

The NRC issues regulatory guides to describe and make available to the public methods that the NRC staff considers acceptable for use in implementing specific parts of the agency’s regulations, techniques that the staff uses in evaluating specific problems or postulated accidents, and data that the staff needs in reviewing applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public.

Regulatory guides are issued in 10 broad divisions – 1, Power Reactors; 2, Research and Test Reactors; 3, Fuels and Materials Facilities; 4, Environmental and Siting; 5, Materials and Plant Protection; 6, Products; 7, Transportation; 8, Occupational Health; 9, Antitrust and Financial Review; and 10, General.

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Quality Assurance (QA) Criterion XI, “Test Control,” of Appendix B, “Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,” to 10 CFR Part 50 requires that a program be established to ensure that all testing necessary to demonstrate that SSCs will perform satisfactorily in service be identified and conducted. GDC 19, “Control Room,” of Appendix A to 10 CFR Part 50 requires that equipment at appropriate locations outside the control room be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

Regulatory Guide 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants” (Ref. 3), describes a method acceptable to the NRC staff for complying with its regulations with regard to preoperational and initial startup testing of nuclear power plant SSCs. Part of Regulatory Guide 1.68 states that both of the requirements of GDC 19 should be demonstrated as part of the initial startup test program.

The NRC issues regulatory guides 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. Regulatory guides are not substitutes for regulations, and compliance with them is not required.

This regulatory guide 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.

B. DISCUSSION

Background

The staff has identified the need for additional guidance on the startup test program and the role of additional personnel in the control room during testing. The startup test program should include a demonstration of both of the requirements of GDC 19 (i.e., the ability of equipment outside the control room to (1) safely shut down the reactor, bring it to a hot shutdown condition, and maintain the unit in a safe condition during the hot shutdown, and (2) bring the reactor to a cold shutdown condition).

The ability to bring the reactor to a cold shutdown from outside the control room is of considerable importance, since demonstration of this capability lends the added assurance that, in the event a fire or other event causes the control room to become unusable for an indeterminate length of time, no danger to the health and safety of the public would result from the potential loss of controlled residual heat removal capability. Although the likelihood of large-scale control room damage from any postulated event is considered to be very small, the “defense-in-depth” concept practiced in the design, testing, and inspection of nuclear power plants (specifically, in the case of remote shutdown capability, as set forth in GDC 19) mandates that licensees take all practical steps to ensure that the plant can be maintained in a safe condition at all times, even in the event of highly unlikely, but foreseeable, incidents.

The role of additional personnel in the control room during testing is discussed in Regulatory Position 3 below. The staff has determined that licensees should perform the test with the minimum of personnel required to be at the reactor unit at any one time. The number of personnel in the control room

may exceed the minimum shift complement, as specified in 10 CFR 50.54(m), and the personnel in excess of the minimum requirements may be present during the demonstration, provided that during the demonstration the additional personnel perform only nonsafety-related activities that would not be required during an actual emergency shutdown

Additional Guidance

The NRC staff has concluded that additional guidance should be provided regarding the scope of testing, the documentation of procedures, and the reporting of test results pertaining to the demonstration of remote shutdown capability. The purpose of the guidance is threefold:

1. demonstrate that the design of the plant is adequate to meet the requirements of GDC 19,
2. demonstrate that the procedures to be used in performing the shutdown from outside the control room are sufficiently clear and comprehensive and that the operating personnel are familiar with their application, and
3. demonstrate that the number of personnel available to conduct the shutdown operation is sufficient to perform the many actions required by the procedure in a timely, coordinated manner.

C. REGULATORY POSITION

The regulations in GDC 19 and QA Criterion XI of Appendix B to 10 CFR Part 50 require licensees of water-cooled nuclear power plants to develop and conduct a test program to demonstrate remote shutdown capability for each unit. The test program should contain the following elements:

1. Objectives
 - a. Verify that the nuclear power plant can be safely shut down from outside the control room.
 - b. Verify that the nuclear power plant can be maintained in a hot shutdown condition from outside the control room.
 - c. Verify that the nuclear power plant can be safely cooled from hot shutdown to cold shutdown conditions from outside the control room.
2. Prerequisites
 - a. Approved operating procedures for performing a remote shutdown should be available, including approved procedures for conducting the test.
 - b. Communications should exist between the control room observers and the remote shutdown locations.
 - c. The authority and responsibility of the control room observers should be established and documented in the test procedure. Licensees should make provisions for the following:
 - (1) Assume control of the plant if an emergency or unsafe condition develops during the testing that cannot be managed by the shutdown crew.

- (2) Perform nonsafety-related activities that would not be required during an actual remote shutdown. These could include the protection of nonsafety-related equipment from mechanical damage during the transient and the placement of equipment into shutdown status when no longer required. Licensees should have previously defined and evaluated such activities to ensure that, if they were not performed during an actual remote shutdown, safe shutdown of the plant could still be achieved. Any additional activities should be recorded and reviewed following the test to assess their impact on the validity of the total test performance. Individuals in addition to those comprising the minimum shift crew described in Regulatory Position 3 may carry out these activities.
- d. Licensees should have completed preoperational testing of plant instrumentation, controls, and systems to be used at remote shutdown locations. This preoperational testing should include verification that all systems to be used during shutdown operation from outside the control room are operable in the manner in which they would be used during the operation (i.e., control from remote stations, manual operation, use of available power supplies) and that communication could be established and maintained among the personnel who will be performing the shutdown operation. In addition, if applicable to the plant design, licensees should verify that it is not possible to control transferred components from the control room after control of these components has been established at the remote shutdown locations. Licensees can verify much of this in conjunction with other tests, such as preoperational tests on individual systems or components. Once successfully completed, these verification tests need not be repeated.

3. Hot Shutdown Demonstration Procedure

Licensees should initiate the test from a location outside the control room with the reactor at a moderate power level (10–25 percent), sufficiently high that plant systems are in their normal configuration with the turbine generator in operation. Licensees should perform the test with the minimum of personnel required to be at the reactor unit at any one time (i.e., the minimum number of reactor operators and senior reactor operators onsite per shift, as required by 10 CFR 50.54(m) and the minimum complement of personnel who are not licensed operators, as required by unit technical specifications). Data obtained at locations outside the control room should verify:

- a. that the plant has achieved hot shutdown status, and
- b. that the plant can be maintained under stable hot shutdown conditions for at least 30 minutes.

During the demonstration, licensees should use only that equipment for which credit would be taken in performing an actual remote shutdown. Personnel in excess of the minimum requirements may be present during the demonstration, provided that during the demonstration the additional personnel perform only nonsafety-related activities that would not be required during an actual emergency shutdown

4. Cold Shutdown Demonstration Procedure

Licensees do not need to demonstrate cold shutdown capability immediately following the test to achieve and maintain a safe hot shutdown from outside the control room. Rather, licensees may combine this cooldown portion of the test with another startup test requiring the reactor to be cooled down, as long

as the procedures and acceptance criteria for the combined test meet all the elements of each individual test.

The licensee should demonstrate the plant's cold shutdown capability by partially cooling down the plant from the hot shutdown condition using controls and instrumentation located outside the control room. This cooldown demonstration may use additional personnel who could be made available to the unit before the time when the cooldown would have to be initiated. Each licensee should establish the number and level of such personnel in the remote shutdown procedure. The test should demonstrate that:

- a. The reactor coolant temperature and pressure can be lowered sufficiently to permit the operation of the core decay heat removal system that is to be ultimately used to place the reactor in a refueling shutdown mode. (This demonstration should be performed with adequate steam pressure available to perform this test and avoid damaging equipment (e.g., Safety Relief Valves)).
- b. Operation of this decay heat removal system can be initiated and controlled.
- c. A heat transfer path to the ultimate heat sink can be established.
- d. The reactor coolant temperature can be reduced approximately 28 degrees Celsius (50 degrees Fahrenheit) using this decay heat removal system, at a rate that would not exceed technical specification limits. This cooldown test should show that the potential exists to achieve cold shutdown from outside the control room.

During the demonstration, the licensee should use only that equipment for which credit would be taken to perform an actual remote shutdown. Personnel in excess of the minimum requirements may be present during the demonstration, provided that during the demonstration the additional personnel perform only nonsafety-related activities that would not be required during an actual emergency shutdown

5. Reporting

The licensee should retain the testing procedures and results from the hot and cold shutdown demonstration as part of the plant's historical record. In addition, the historical record should include a summary of the testing in a startup report, consistent with (Ref. 3). This summary should include the following information:

- a. a description of the method and objectives for each test;
- b. a comparison of applicable test data with the related acceptance criteria, including the systems' responses to major plant transients (such as reactor scram and turbine trip);
- c. a description of all design- and construction-related deficiencies discovered during testing, system modifications, the corrective actions required to correct those deficiencies, and the schedule for implementing these modifications and corrective actions, unless previously reported to the NRC;
- d. justification for the acceptance of systems or components that are not in conformance with design predictions or performance requirements; and
- e. conclusions regarding system or component adequacy.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

In some cases, applicants or licensees may propose or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations for license applications, license amendment applications, and amendment requests.

REFERENCES¹

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, DC
2. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC
3. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC

¹ Publicly available NRC published documents such as Regulations, Regulatory Guides, NUREGs, and Generic Letters listed herein are available electronically through the Electronic Reading room on the NRC's public Web site at: <http://www.nrc.gov/reading-rm/doc-collections/>. Copies are also available for inspection or copying for a fee from 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.