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PREOPERATIONAL AND INITIAL STARTUP TESTING OF FEEDWATER AND CONDENSATE SYSTEMS FOR BOILING WATER REACTOR POWER PLANTS

A. INTRODUCTION

General Design Criterion 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that nuclear power plant structures, systems, and components important to safety be tested to quality standards commensurate with the importance of the safety functions to be performed.

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 test program be established to ensure identification and performance of all testing required to demonstrate that structures, systems, and components will perform satisfactorily in service.

Regulatory Guide 1.68, "Preoperational and Initial Startup Test Programs for Water-Cooled Power Reactors," identifies tests acceptable to the NRC staff for preoperational and startup testing of nuclear power plant structures, systems, and components. Tests for boiling water reactor (BWR) power conversion systems are described in Regulatory Guide 1.68 to provide assurance that these systems will perform as designed and to aid in minimizing the probability of system malfunctions during subsequent plant operations. This guide describes in more detail the type and nature of BWR feedwater and condensate system tests that are acceptable to the staff.

B. DISCUSSION

In 1972 the AEC investigated eight abnormal occurrences at five different BWR power plants which involved inadvertent release of significant amounts of primary coolant into primary containment through main steam line safety and relief valves. The study[1] revealed that the ability to automatically control reactor vessel water level within acceptable bounds during anticipated transients was less than satisfactory.

There have also been abnormal occurrences associated with feedwater systems at operating nuclear power plants that resulted from excessive vibration of system components and piping. These operating problems could have been identified by thorough testing during the initial test program.

After considering the experience to date, the NRC staff has concluded that guidance should be provided regarding the preoperational and initial startup testing identified in Regulatory Guide 1.68 for the BWR feedwater and condensate system.

This guide addresses both preoperational and initial plant startup phases of the testing of BWR power plant feedwater and condensate systems.

Preoperational testing is conducted prior to fuel loading to determine component operability and performance and to verify proper system installation. While as much of this type of testing as practicable should be accomplished during this phase, the ability to conduct system-level testing and component testing at power is limited by the unavailability of reactor power. Thus, these tests should be completed as part of the initial plant startup test program.

Tests that were satisfactorily completed during preoperational testing need not be repeated.

[1] "Evaluation of Primary Coolant Release from Operating Boiling Water Reactors," WASH-1260/LK; copies may be obtained from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22151.

C. REGULATORY POSITION

Comprehensive preoperational and initial startup testing programs on the feedwater and condensate systems of boiling water reactors should be performed to provide assurance that these systems will accomplish the required functions under normal operational and transient conditions as stated in the safety analysis report.

1. Preoperational Testing

The preoperational phase of the initial test program should include at least tests and measurements to verify the following:

a. Operability of pumps utilized to provide feedwater flow (condensate, condensate booster, and feedwater pumps). Tests should confirm that the pumps satisfy all performance requirements, including required head, flow rate, suction head, and overspeed characteristics.

b. Operability and correct setpoints of permissive and prohibit interlocks in the starting and shutdown controls for the pump drivers.

c. Proper operation of controls used for manual and automatic starting and stopping of the pump drivers.

d. Operability of valves utilized for adjusting the feedwater flow rate. Tests should verify proper response of valves for the design operating range and correct operation of protective features such as thermal overload devices and undervoltage sensing devices incorporated in the design of valve operators and associated control circuitry.

e. Operability of sensors and associated instrumentation that provide inputs to the feedwater control system. Tests should verify stable and accurate outputs in response to test signals.

f. Operability of the feedwater control system. Tests should verify the proper response of individual components in the control system (including programmers, summers, and signal modifiers) and the overall response of the control system, including the final control element. Tests should also verify that the overall response of the control system to simulated limiting malfunctions in the control system and to simulated plant transients such as main steam line isolation valve closure at full flow conditions and turbine trip without bypass at full flow conditions is in accordance with performance requirements for the control system.

g. Proper operation of instrumentation and alarms utilized to monitor the performance of the systems.

2. Startup Testing

The startup phase of the initial test program should include at least tests and measurements to verify the following:

a. Operability of the feedwater system at low reactor power ($\leq$15% reactor power).

b. Proper response of the feedwater control system in the manual mode of control. Tests should verify that the system can be operated in the manual mode and that transfer to the automatic mode can be accomplished in accordance with design requirements ($\leq$15% reactor power).

c. The stability and response characteristics of the automatic control system are in accordance with performance requirements for normal plant operation (15% to 100% reactor power).

d. The stability and response characteristics of the the automatic control system following plant transients are in accordance with system performance requirements. Tests should verify that the acceptance criteria for maximum and minimum water levels in the reactor vessel are not exceeded as a result of plant transients, such as turbine trip and main steam isolation valve closure, with the control system in the automatic mode of control (15% to 100% reactor power).

e. The response of the feedwater system is in accordance with performance requirements following loss of a feedwater pump (100% reactor power).

f. Vibration levels for system components and piping are within predetermined limits.

g. Piping movements during heatup and steady-state and transient operation are within predetermined limits.

h. Adequate margins exist between system variables and setpoints of instruments monitoring these variables to prevent spurious actuation or loss of system pumps and motor-operated valves.

i. The feedwater system performs properly using the condensate storage tank.

j. The feedwater system performs properly with alternative electric power sources.

3. Reports and Records

The preoperational testing results should be documented in a report and retained as part of the plant historical record. A summary of the startup testing

should be included in a startup report as discussed in Regulatory Guide 1.16, "Reporting of Operating Information." These summary reports should include:

a. A description of the test method and objectives for each test.

b. A comparison of test data with the acceptance criteria, including the response of the system to major plant transients such as scram and turbine trip.

c. Deficiencies relating to design and construction found during conduct of the test.

d. System modification and corrective actions required and the schedule for their implementation.

e. Justification for acceptance of systems or components not in conformance with design predictions or performance requirements.

f. Conclusions regarding system adequacy.

D. IMPLEMENTATION

This section provides information to applicants and licensees regarding the NRC 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, the method described herein will be used in the evaluation of operating license or construction permit applications for which the issue date of the Safety Evaluation Report (SER) is August 15, 1976, or after.

The staff will continue to evaluate applications for which the issue date of the SER is prior to August 15, 1976, on the basis of Regulatory Guide 1.68.