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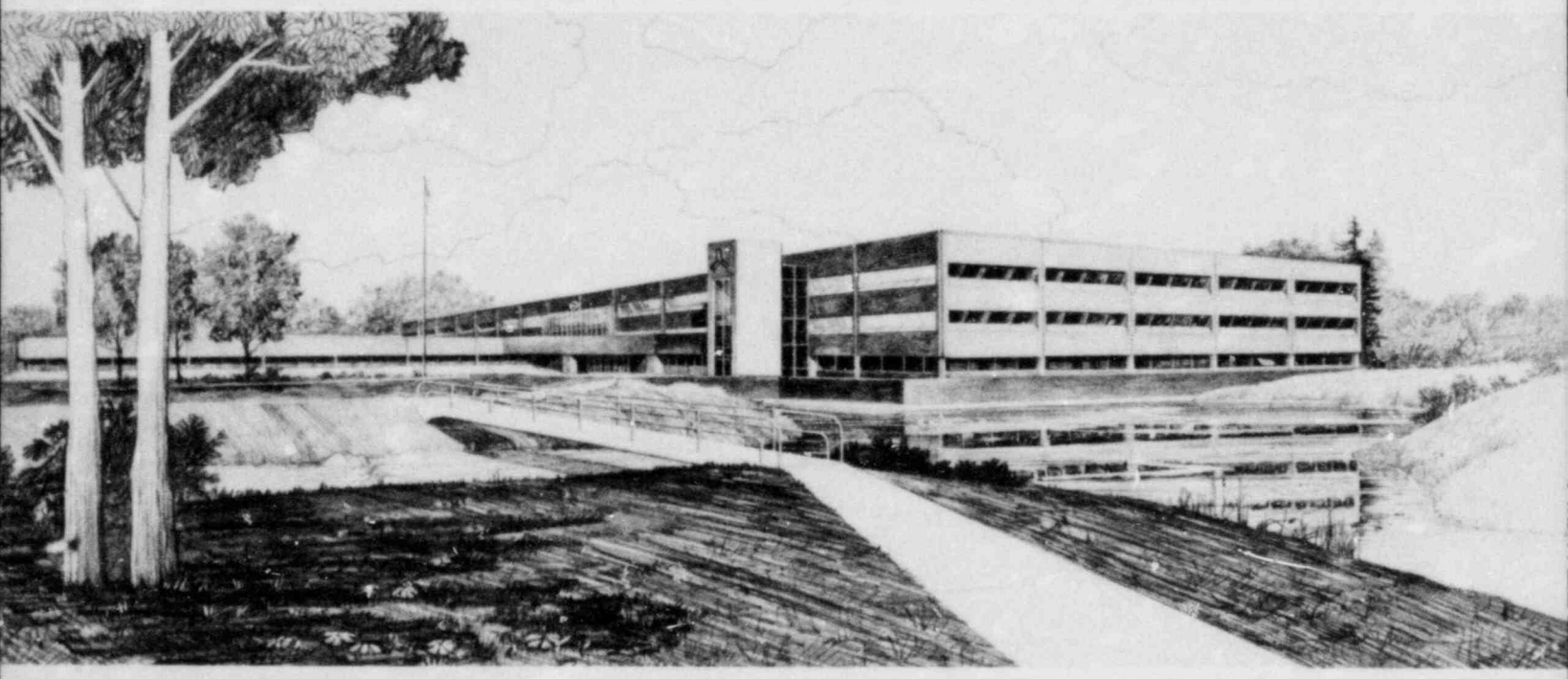
SYSTEMATIC EVALUATION PROGRAM, TOPIC VI-7.A.3

ECCS ACTUATION SYSTEM, HADDAM NECK

R. VanderBeek

Idaho National Engineering Laboratory
Operated by the U.S. Department of Energy



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R. VanderBeek

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R. F. Scholl, Jr., Division of Licensing

EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

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SYSTEMATIC EVALUATION PROGRAM

TOPIC VI-7.A.3
ECCS ACTUATION SYSTEM

HADDAM NECK

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R. VanderBeek
Reliability and Statistics Branch
Engineering Analysis Division
EG&G Idaho, Inc.

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ABSTRACT

This SEP Technical Evaluation, for the Haddam Neck Plant, reviews the scope and frequency of periodic testing of the Emergency Core Cooling System and compares the required testing against current licensing criteria.

FOREWORD

This report is supplied as part of the "Electrical, Instrumentation, and Control Systems Support for the Systematic Evaluation Program (II)" being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by EG&G Idao, Inc., Reliability and Statistics Branch.

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1.0 INTRODUCTION

The objective of this review is to determine if all Emergency Core Cooling System (ECCS) components, including pumps and valves, are included in component and system tests, if the scope and frequency of periodic testing are identified, and if the test program meets current licensing criteria. The systems included in the ECCS are the High Pressure Safety Injection System, the Charging System, and the Low Pressure Safety Injection (Core Deluge) System.[1]

2.0 CRITERIA

General Design Criterion 37 (GDC 37), "Testing of Emergency Core Cooling Systems," requires that:

> The ECCS shall be designed to permit appropriate periodic pressure and functional testing to assure the operability of the system as a whole and to verify, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.[2]

Branch Technical Position ICSB 25, "Guidance for the Interpretation of GDC 37 for Testing the Operability of the Emergency Core Cooling System as a whole," states that:

All ECCS pumps should be included in the system te[illegible]

Regulatory Guide 1.22, "Periodic Testing of the Protection System Actuation Functions," states, in Section D.1.a, that:

> The periodic tests should duplicate, as closely as practicable, the performance that is required of the actuation devices in the event of an accident.[4]

Standard Review Plan, Section 7.1, Appendix B, "Guidance for Evaluation of Conformance to IEEE STD 279" states, in Section 11, that:

> Periodic testing should duplicate, as closely as practical, the overall performance required of the protection system. The test should confirm operability of both the automatic and manual circuitry. The capability should be provided to permit testing during power operation. When this capability can only be achieved by overlapping tests, the test scheme must be such that the tests do, in fact, overlap from one test segment to another.[5]

Regulatory Guide 1.22 states, in Section D.4, that:

> Where actuated equipment is not tested during reactor operation, it should be shown that:
>
> 1. There is no practical system design that would permit operation of the actuated equipment without adversely affecting the safety or operability of the plant.
>
> 2. The probability that the protection system will fail to initiate the operation of the actuated equipment is, and can be maintained, acceptably low without testing the actuated equipment during reactor operation.
>
> 3. The actuated equipment can be routinely tested when the reactor is shut down.[4]

3.0 HIGH PRESSURE SAFETY INJECTION SYSTEM

3.1 Description

The High Pressure Safety Injection System is designed to automatically actuate the injection of borated water from the refueling water storage tank into the four reactor coolant loops.

Operation of the High Pressure Safety Injection System is initiated automatically by an actuation signal generated as a result of two out of three low pressurizer pressure signals. The system may also be actuated manually from the main control room. To prevent automatic operation while the reactor is cold and depressurized, the actuation signal is blocked manually when reactor coolant system pressure is below 1,700 psig. The signal is unblocked automatically when reactor coolant system pressure rises above 1,700 psig.

The safety injection signal starts all pumps and actuates all valves in the High Pressure Injection System. Within 10 seconds after the initiation signal is generated, the two safety injection pumps can deliver borated refueling water at full rated flow to a header supplying four independent injection lines, one to the cold leg of each loop.

3.2 Evaluation

The Haddam Neck Technical Specifications require testing and surveillance for the High Pressure Injection System as follows:

a. Testing and Surveillance During Refueling Shutdown

1. During each refueling shutdown, a test signal is applied to initiate a loss of normal AC power to each of the Emergency Power Systems while a coincident signal initiates the operation of the High Pressure Safety Injection System.

2. Verification is made that the diesel generator and its associated pumps have started in the proper sequence and that the high pressure safety injection pumps attain a required discharge head of 1400 psig. The test is considered satisfactory by the licensee if the control board indication and visual observations indicate all components have operated and sequenced properly.

b. Testing and Surveillance During Reactor Operation

1. Each of the high pressure safety injection pumps are individually test run in recirculation on a monthly basis.

2. All safety injection valves are cycled under "no flow" conditions during cold shutdown conditions.

3. If one of the high pressure safety injection pumps is out of service, the remaining pump shall be tested within two hours and at subsequent intervals of not greater than 72 hours.

4. During normal operating periods, manual tests are conducted to demonstrate operability. The tests are performed on the same time intervals as described in Sections 3.2.b.1, 3.2.b.2, and 3.2.b.3.[6]

The High Pressure Safety Injection System is not tested from the automatic and manual actuation devices through to the establishment of flow through the safety injection header during reactor operation, as specified by Standard Review Plan Section 7.1, Appendix B, Section 11. Because actuation of the High Pressure Safety Injection System would result in the injection of borated water into the reactor, hampering operation, compliance for testing the system during reactor operation is deemed impractical. The present testing of the High Pressure Safety Injection System does conform to the testing criteria of Regulatory Guide 1.22 and GDC 37.

4.0 CHARGING SYSTEM

4.1 Description

The Charging System is designed to automatically actuate the injection of borated water from the refueling water storage tank into the reactor coolant system.

Operation of the Charging System is initiated automatically when the High Pressure Safety Injection System is actuated and offsite power is available. Upon receiving the initiating signal the suction of the two centrifugal charging pumps is automatically transferred from the Volume Control Tank to the Refueling Water Storage Tank and borated water is delivered through the charging lines to the cold leg of loop 2. The charging pump may be manually started on emergency power if offsite power is not available. Injection of borated water will continue until the condition for recirculation flow is established, at which time the operator will terminate the injection of borated water and begin recirculation flow.

4.2 Evaluation

The Haddam Neck Technical Specifications require testing and surveillance of the Charging System as follows:

a. Testing and Surveillance During Refueling Shutdown

1. During each refueling shutdown, a test signal is applied to initiate a loss of normal AC power to each of the emergency power systems while a coincident signal initiates the operation of the Charging System.

2. Verification is made that the diesel generator and its associated pumps have started in the proper sequence and that the charging pumps attain a required discharge head of 2150 psig. The test is considered satisfactory by the

licensee if control board indication and visual observations indicate all components have operated and sequenced properly.

b. Testing and Surveillance During Reactor Operation

1. Each of the charging pumps are individually tested on a monthly basis.

2. All valves associated with the Charging System, except the valves on the discharge side of the charging line to loop 2 cold leg, are cycled under "no flow" conditions on a monthly basis. The valves on the discharge side of the charging line to loop 2 cold leg are cycled on a quarterly basis.[6]

3. During normal operating periods, a manual test is conducted to demonstrate operability. The test is performed on a time interval in accordance with sections 4.2.b.1 and 4.2.b.2 above using written procedures.[6]

The Charging System is not tested from the automatic actuation devices through to the establishment of flow to loop 2 line during reactor operation, as specified by Standard Review Plan Section 7.1, Appendix B, Section 11. Because actuation of the Charging System would result in the injection of borated water into the reactor, hampering operation, compliance for testing the system during reactor operation is deemed impractical. The present testing of the charging system does conform to the testing criteria of Regulatory Guide 1.22 and GDC 37.

5. LOW PRESSURE SAFETY INJECTION SYSTEM (CORE DELUGE)

5.1 Description

The Core Deluge System is designed to inject large quantities of borated water directly into the reactor vessel if reactor coolant pressure drops substantially as a result of a loss of coolant incident. The water,

pumped into the reactor vessel through four spare control rod mechanism housings and internal piping, is discharged directly over the reactor core.

The Core Deluge System is a completely independent backup system for core cooling, used in the event of large reactor coolant system ruptures. The system's path of access, mode of cooling water delivery, and design characteristics are such as to assure core cladding immersion in steam and cascading water so that core damage and metal-water reactions are minimized. Performance of the Core Deluge System is based on operation of one of two low pressure safety injection pumps with or without normal auxiliary power sources. The residual heat removal pumps can also be used to provide water via the core deluge after reactor coolant system pressure is reduced to below 145 psig[6] and also as a containment spray for post-incident containment pressure control if desired.

Operation of the Core Deluge System is initiated automatically by an actuation signal generated as a result of two out of three low pressurizer pressure signals. The system may also be actuated manually from the main control room. To prevent automatic operation while the reactor is cold and depressurized, the actuation signal is blocked manually when reactor coolant system pressure is below 1,700 psig. The signal is unblocked automatically when reactor coolant system pressure rises above 1,700 psig.

5.2 Evaluation

The Haddam Neck Technical Specifications require testing and surveillance of the Low Pressure Safety Injection System (Core Deluge) as follows:

a. Testing and Surveillance During Refueling Shutdown

1. During each refueling shutdown, a test signal is applied to initiate a loss of normal AC power to each of the emergency power systems while a coincident signal initiates the operation of the Low Pressure Safety Injection System.

2. Verification is made that the diesel generator and its associated pumps have started in the proper sequence and that the low pressure safety injection pumps attain a required discharge head of 295 psig. The test is considered satisfactory by the licensee if control board indication and visual observations indicate all components have operated and sequenced properly.

b. Testing and Surveillance During Reactor Operation

1. Each of the low pressure safety injection pumps are individually test run on recirculation on a monthly basis.

2. All low pressure safety injection valves are cycled under "no flow" conditions during cold shutdown conditions.[6]

3. If one of the low pressure safety injection pumps is out of service, the remaining pump shall be tested within two hours and at subsequent intervals of not greater than 72 hours.

4. During normal operating periods, a manual test is conducted to demonstrate operability. The test is performed in accordance with Sections 5.2.b.1, 5.2.b.2, and 5.2.b.3 above and with written procedures.[6]

The Low Pressure Safety Injection System is not tested from the manual and automatic actuation devices through to the establishment of flow to the discharge lines during reactor operation as specified by Standard Review Plan Section 7.1, Appendix B, Section 11. Other than the exception above the present testing of the Low Pressure Safety Injection System does conform to the testing criteria of Regulatory Guide 1.22 and GDC 37.

6.0 SUMMARY

The following has been determined pertaining to the testing and testability of the Haddam Neck ECCS:

1. Because system testing from manual or automatic devices to establishment of flow during reactor operation cannot be accomplished due to system design pressure, and since such testing would cause injection of borated water into the reactor, testing of the High Pressure Safety Injection and Charging Systems during reactor operation is deemed impractical.

2. The present testing of the ECCS conforms to the current testing criteria of Regulatory Guide 1.22 and GDC 37.

It is left to the NRC Staff to determine whether operating experience at Haddam Neck establishes that noncompliance to Standard Review Plan Section 7.2, Appendix B, Section 11, assures a low probability of system failure.

7.0 REFERENCES

1. Haddam Neck Plant Facility Description and Safety Analysis (FSAR), Revised through April 1, 1977, Volume 1, Section 5.2.7, Emergency Core Cooling System.

2. General Design Criterion 37, "Testing of Emergency Core Cooling System," of Appendix A, "General Design Criteria for Nuclear Power Plants," 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities.

3. Branch Technical Position ICSB 25, "Guidance for the Interpretation of GDC 37 for Testing the Operability of the Emergency Core Cooling System as a Whole."

4. Regulatory Guide 1.22, Periodic Testing of the Protection System Actuation Functions.

5. Nuclear Regulatory Commission Standard Review Plan, Section 7.1, Appendix B, "Guidance for Evaluation of Conformance to IEEE STD 279."

6. Connecticut Yankee Atomic Power Company letter, W. G. Counsil to NRC, D. M. Crutchfield, "Haddam Neck Plant SEP Topic VI-7.A.3 ECCS Actuation System," dated April 14, 1982.