SELECTED ISSUES PROGRAM

TECHNICAL EVALUATION OF THE SUSCEPTIBILITY OF SAFETY-RELATED SYSTEMS TO FLOODING CAUSED BY THE FAILURE OF NON-CATEGORY I SYSTEMS FOR THE MAINE YANKEE ATOMIC POWER STATION

Docket No. 50-309

by

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ABSTRACT

This report documents the technical evaluation of the Maine Yankee Atomic Power Station. The purpose of this evaluation was to determine whether the failure of any non-Class I (seismic) equipment could result in a condition, such as flooding, that might adversely affect the performance of the safety-related equipment required for the safe shutdown of the facility, or to mitigate the consequences of an accident. Criteria developed by the U.S. Nuclear Regulatory Commission were used to evaluate the acceptability of the existing protection system as well as measures taken by Maine Yankee Atomic Power Company (MYAPC) to minimize the danger of flooding and to protect safety-related equipment.

Based on the information supplied, we conclude that the licensee, Maine Yankee Atomic Power Company (MYAPC), has demonstrated in its analysis that the Maine Yankee Atomic Power Station has the capacity and capability to manage and mitigate any single incident, such as flooding from a non-Class I system component or pipe, so that this flooding will not prevent a safe shutdown of the facility.

FOREWORD

This report is supplied as part of the Selected Electrical Instrumentation and Control Systems Issues (SEICSI) Program being conducted for the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, Division of Operating Reactors, by the Lawrence Livermore National Laboratory, Nuclear Systems Safety Program.

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1. INTRODUCTION

By letter to the Maine Yankee Atomic Power Company (MYAPC) dated September 27, 1972 [Ref. 1], the U.S. Nuclear Regulatory Commission (NRC) requested MYAPC to review the Maine Yankee Atomic Power Station to determine whether the failure of any non-Class I (seismic) equipment could result in a condition such as flooding that might adversely affect the safe shutdown of the facility.

By letter to the NRC dated October 20, 1972 [Ref. 2], MYAPC responded to the orignal NRC request, furnishing information on postulated failure of the service water pumps and the circulating water pumps.

On June 7, 1973, MYAPC submitted additional detailed information to the NRC [Ref. 3] which was the result of an extensive study conducted on the effects of piping failure external to the Containment Building. Proposed modifications to the system as outlined in this letter were not acceptable to the NRC.

Revised modification designs were outlined by MYAPC in their letter to the NRC dated October 19, 1973 [Ref. 4].

The NRC transmitted to MYAPC on December 17, 1974 [Ref. 5], a set of Guidelines for Protection from Flooding of Equipment Important to Safety. These guidelines expanded on the scope of MYAPC's original study and required further study of the flooding problem by MYAPC.

MYAPC responded to the NRC Guidelines by letter reports dated January 23, 1975 [Ref. 6], and February 19, 1975 [Ref. 7].

The various sources of potential flooding identified by MYAPC and the affected safety-related equipment are discussed in Sections 2.2 through 2.5.

2. EVALUATION

2.1 GENERAL CONSIDERATIONS

In the Maine Yankee Atomic Power Station, the Service Water System and the Component Cooling Water System are Category I systems. NRC Guidelines [Ref. 5] had listed these as non-Category I systems. However, MYAPC analysis has treated these water systems as non-Category I systems.

All of the non-safety related systems in Reference [5] were included in the licensee's investigation. The licensee has included an analysis of the vulnerability to flooding of all Class 1E equipment required for a safe shutdown

2.1.1 Shutdown Capability

Safe shutdown is accomplished in the following manner:

- Power rate is reduced to zero
- Decay heat is removed by opening the atmospheric vent valves
- Steam generator water is maintained by auxiliary feed pumps
- Reactor coolant system is borated
- When temperature is reduced to 350 F, and pressure is reduced to 400 psig, flow is established through the Residual Heat Removal System

2.2 STEAM VALVE ENCLOSURE AREA

2.2.1 Safety-Related Equipment Vulnerable to Flooding

The safety-related equipment in this area of concern which is required for safe shutdown of the plant, are the steam driven emergency feed pumps and cable trays holding power cables.

2.2.2 Sources of Flooding

The source of flooding in this area would be a break in the main feed water line.

2.2.3 Systems and/or Procedures to Mitigating the Effects of Flooding

The main areas of concern are the steam driven auxiliary feed pumps and electric power cables to the spray pump area exhaust fans. The failure mode considered in this area was a break in the main feed line.

A break in the main feed line to the steam generator would trip the low steam generator level and the steam driven auxiliary pumps would not be available for further use. This function is then handled by the electrically driven auxiliary feed pumps which are located in another area that is not subject to flooding. The emergency diesel generators are sized so that they have ample capacity to handle these redundant pumps in the absence of off-site power.

The power cables in this area have been rerouted from the cable trays to the underground cable vault to minimize potential flooding damage.

The analysis showed that the rupture of a main feed line will not prevent a safe plant shutdown.

2.2.4 Conclusions

We conclude that the system features in the Steam Valve Enclosure Area are adequate to mitigate the effects of a rupture of a non-Category I pipe or component on safety-related equipment required for a safe plant shutdown.

2.3 TURBINE BUILDING

2.3.1 Safety-Related Equipment Vulnerable to Flooding

The safety-related equipment involved in the Turbine Building would be the emergency diesel generators, the component cooling pumps, the underground cable trenches in the diesel generator rooms, the Control Room, the 4160 V and the 480 V switchgear and the battery rooms.

2.3.2 Sources of Flooding

The sources of flooding which are of concern in the Turbine Building, are the main feed water line and the condensate line, and the circulating water line.

2.3.3 Systems and/or Measures to Mitigate the Effects of Flooding

A rupture of any of the high volume water pipes such as a feed or condensate line could result in flooding of the ground floor of the Turbine Building. The analysis showed that there are sufficient openings in this building to offer ample avenues of egress for this flooding. Any flooding condition would be detected early and corrective action taken by the auxiliary operator stationed in this building. There is also a guard post just outside the main door to the Turbine Building and the guard stationed there can provide early detection and notification to the Control Room of any flooding condition in this building. The analysis did identify a problem area in which water could enter and fill the underground cable trench in the diesel generator rooms. The licensee has constructed curbs in front of the entrance to each diesel generator room to prevent water from the Turbine Building floor (Elev. 21') from entering the diesel generator rooms.

Breaks in the condensate or feed lines in this area would result in an interrupt to the steam generator feed and would result in a plant trip due to a low water level in the steam generator, a condition which is alarmed in the Control Room. Safe shutdown in accomplished as outlined in 2.2.3 above, by utilizing the electrical auxilialry feed pumps.

The safety-related 4160 V and 480 V switchgear, and the batteries and battery charging equipment are all located at the 45' level which is well above any conceivable flooding from the floor level in the Turbine Building which is at elevation 21'.

The licensee, however, did not include in his submittals an analysis of flooding of safety-related equipment in the Turbine Building (Elev. 21') resulting from a failure of a circulating water line or expansion joint.

2.3.4 Conclusions

We conclude that the system features the Turbine Building are adequate to mitigate the effects of flooding due to a rupture of the feed water or condensate piping in this area. However, the evaluation of flooding

of safety-related equipment in the Turbine Building is incomplete, and cannot be completed until we receive the licensee's analysis identified above in section 2.3.3.

2.4 PRIMARY AUXILIARY BUILDING

2.4.1 Safety-Related Equipment Vulnerable to Flooding

The equipment in the Primary Auxiliary Building, (PAB), which would be used for safe shutdown and which would be subject to the effects of flooding are the high pressure safety injection pumps (charging pumps) and the emergency shutdown panel.

2.4.2 Sources of Flooding

The sources of flooding in the PAB are the charging lines from each charging pump. There is also a fluid line feeding the Heise gauge on the emergency shutdown panel.

2.4.3 Systems and/or Measures to Mitigate the Effects of Flooding

Each charging pump in the PAB is in a separate compartment. Each pump is subject to the environmental effects of a postulated break in that compartment only. Should a charging pump be taken out of service for any reason, its function is replaced by valving in an installed spare pump provided for this purpose.

The emergency shutdown panel is located at elevation 11' in the basement of the PAB which is constructed with floor drains which flow to the building sump. If a rupture occured in a non-Category 1 system on any floor of the PAB, the water would collect in the sump. An alarm in the sump would alert the operators in the Conrtrol Room and corrective action would be initiated. The accumulation of water to any appreciable depth is highly unlikely due to the large floor area of the building and the existence of the alarm system. The tubing feeding the Heise gauge on the emergency shutdown panel is de-energized during normal operations by closing the root valve at the sampling line. Under normal operations there should be no fluid damage to the emergency shutdown panel from this source.

2.4.4 Conclusions

We conclude that the systems as described in the Primary Auxiliary Building are adequate to prevent damage to any safety-related equipment which might be caused by flooding due to a rupture of a non-Category I pipe or component.

2.5 CIRCULATING WATER PUMP HOUSE

2.5.1 Safety-Related Equipment Vulnerable to Flooding

The service water pumps which are required for a safe shutdown are located in the Circulating Water Pump House.

2.5.2 Sources of Flooding

The source of flooding in the Circulating Water Pump House would be a rupture of a circulating water pipe which could cause flooding of the service water pump motors.

2.5.3 Systems and/or Measures to Mitigate the Effects of Flooding

The Circulating Water System is located at elevation 7'0" in this building. To prevent the flooding of the service water pump motors which might result from a break in a circulating water system pipe, a reinforced concrete wall was constructed from elevation 7' to elevation 14' which extends the full length of the Circulating Water Pump House.

The licensee has also installed redundant, multi-level alarm switches on the circulating water pump side of the concrete wall which will alert the Control Room operators of a flooding incident and automatically trip the circulating water pumps when the water level reaches a depth of ten inches.

2.5.4 Conclusions

We conclude that the measures taken by the licensee are adequate to protect the service water pump motors which are required for a safe shutdown of the plant.

3. CONCLUSIONS

Based on information supplied by the licensee, we conclude that MYAPC has demonstrated in their analysis that the Maine Yankee Atomic Power Station, excluding the Turbine Building, has the capacity and capability to manage and mitigate any single incident, such as flooding from a non-Class I system component or pipe, so that flooding will not prevent the safe shutdown of the plant.

The licensee has further shown in the analysis for those areas addressed, that no single failure would result in common mode failure of redundant safety-related equipment.

We recommend that the NRC require the licensee to submit its analysis of flooding of safety-related equipment in the Turbine Building resulting from failure of the circulating water piping or expansion joint in this area. The receipt of this analysis is required to enable us to complete the evaluation for flooding of safelty-related equipment/systems at the Maine Yankee Atomic Power Station.

4. REFERENCES

1. U.S. Nuclear Regulatory Commission (NRC) letter to Maine Yankee Atomic Power Company (MYAPC), dated September 27, 1972.

2. MYAPC letter to NRC dated October 20, 1972.

3. MKYAPC letter to NRC dated June 7, 1973.

4. MYAPC letter to NRC dated October 19, 1973.

5. NRC letter to Yankee Atomic Electric Company dated December 17, 1974.

6. MYAPC letter to NRC dated January 23, 1975.

7. MYAPC letter to NRC dated February 19, 1975.

UNITED STATES
ATOMIC ENERGY COMMISSION
Washington, D.C. 20545

Docket No. 50-309 September 27, 1972

Maine Yankee Atomic Power Company
ATTN: Mr. William H. Dunham
President
9 Green Street
August, Maine 04330

Gentlemen:

A failure of an expansion bellows in the circulating water line which serves the main condenser recently occurred at Quad-Cities Unit 1. The resultant flooding caused degradation of some safety related equipment.

You are requested to review Maine Yankee Atomic Power Station to determine whether the failure of any non-Category I (seismic) equipment, particularly in the circulating water system and fire protection system, could result in a condition, such as flooding or the release of chemicals, that might potentially adversely affect the performance of safety-related equipment required for safe shutdown of the facility, or to limit the consequences of an accident.

The integrity of barriers to protect critical equipment from potentially damaging conditions should be assumed only when the barrier has been specifically designed for such conditions. If your review determines that safety-related equipment could be adversely affected, provide your plans and schedules for corrective action.

Please submit your response within 30 days of receipt of this letter.

Sincerely,

R. C. DeYoung
Assistant Director for
Pressurized Water Reactors
Directorate of Licensing

cc: Mr. Lawrence E. Minnick
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APPENDIX B

NRC GUIDELINES
FOR PROTECTION FROM FLOODING OF EQUIPMENT IMPORTANT TO SAFETY

Licensees are required to investigate their facilites to review their designs to assure that equipment important to safety will not be damaged by flooding due to rupture of a non-Class I system component or pipe such that engineered safety features will not perform their design function. No single incident of a non-Class I system component or pipe failure shall prevent safe shutdown of the facility.

Review of responses to the letters should assure that the plants meet the following guidelines:

1. Separation for redundancy - single failures of non-Class I system components or pipes shall not result in loss of a system important to safety. Redundant safety equipment shall be separated and protected to assure operability in the event a non-Class I system or component fails.

2. Access doors and alarms - watertight barriers for protection from flooding of equipment important to safety shall have all access doors or hatches fitted with reliable switches and circuits that provide an alarm in the control room when the access is open.

3. Sealed water passages - passages or piping and other penetrations through walls of a room containing equipment important to safety shall be sealed against water leakage from any postulated failure of non-Class I water system. The seals shall be designed for the SSE, including seismically induced wave action of water inside the affected compartment during the SSE.

4. Class I watertight structures - walls, doors, panels, or other compartment closures designed to protect equipment important to safety from damage due to flooding from a non-Class I system rupture shall be designed for the SSE, including seismically induced wave action of water inside the affected compartment during the SSE.

5. Water level alarms and trips - rooms containing non-Class I system components and pipes whose rupture could result in flood damage to equipment important to safety shall have level alarms and pump trips (where necessary) that alarm in the control room and limit flooding to within the design flood volume. Redundance of switches is required. Critical pump (i.e. high volume flow, such as condenser circulating water pumps) trip circuits should meet IEEE 279 criteria.

6. Class I equipment should be located or protected such that rupture of a non-Class I system connected to a tower containing water or body of water (river, lake, etc.) will not result in failure of the equipment from flooding.

7. The safety analysis shall consider simultaneous loss of offsite power with the rupture of a non-Class I system component or pipe.

The licensees' responses should include a listing of the non-Class I systems considered in their analysis. These should include at least the following systems:

Firewater	Demineralized Water
Service Water	Drains
Condensate	Heating Boiler Condensate
Feedwater	Condenser Circulating Water
Reactor Building Cooling Water	Makeup
Turbine Building Cooling Water	Potable Water

If the licensee indentifies deficiencies, he should describe interim and final corrective action to be taken and provide a schedule for completion of any required modifications. All corrective action should be completed as expeditiously as is practicable.