27
3-16-81

(1)

R-2716

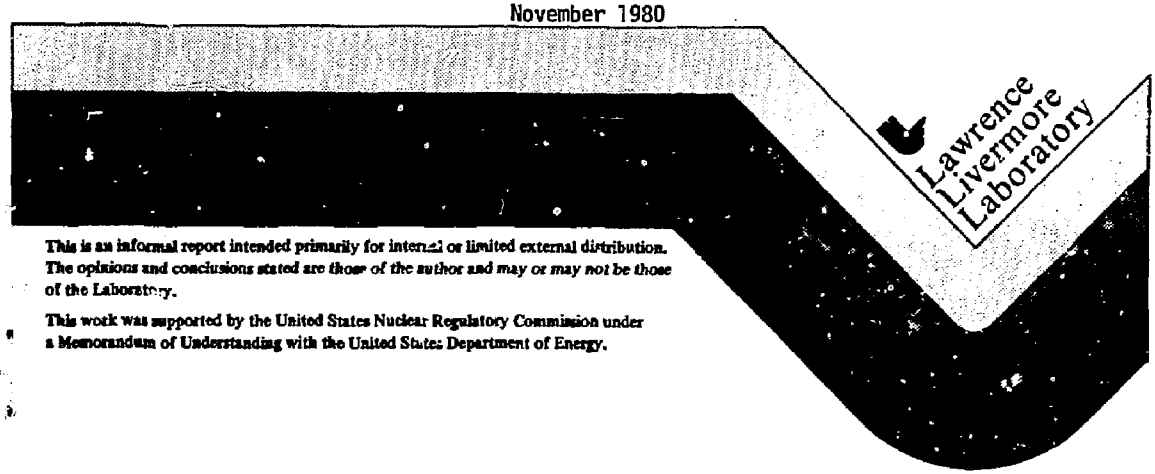
MASTER

UCID-18956

TECHNICAL EVALUATION OF THE SUSCEPTIBILITY OF SAFETY-RELATED SYSTEMS TO FLOODING CAUSED BY THE FAILURE OF NON-CATEGORY 1 SYSTEMS FOR THE YANKEE ROWE NUCLEAR POWER STATION

R. C. Epps

November 1980



This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

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.

The NRC work is funded under the authorization entitled "Electrical, Instrumentation and Control System Support", B&R 201904 031. FIN A-0231.

TABLE OF CONTENTS

Blank

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

1. INTRODUCTION

By letter to the Yankee Atomic Electric Company (YAEC) dated August 8, 1972, [Ref. 1], the U.S. Nuclear Regulatory Commission (NRC) requested YAEC to review the Yankee Rowe Nuclear Power Station to determine whether the failure of any non-Class I (seismic) equipment, particularly in the circulating water system, could result in a condition such as flooding that might adversely affect shutdown of the facility or which might be required to limit the consequences of an accident.

By letter to the NRC dated September 8, 1972, [Ref. 2] YAEC responded to the orignal NRC requirements. NRC requested additional information from YAEC by letters [Refs. 3 & 7]. YAEC responded to these requests by various letters, [Refs. 4,5,6 and 8]. In their letters YAEC identified critical areas of their plant and gave descriptions of various plant changes that they proposed, to mitigate the effects of some non-Class I system failures on safety-related equipment.

On April 12, 1973, NRC originated a memorandum which outlined the guidelines to be used in evaluating the responses from various licensees. These guidelines are provided as Appendix B to this report.

The purpose of this technical evaluation is to determine, on the basis of the information provided, whether the licensee's response and equipment/plant modifications are deemed to be adequate to mitigate the effects of flooding on safety-related equipment important to a safe shutdown of the facility.

During the period from August 1972 until November 1975, three separate reviews of the Yankee Rowe facility were conducted by Yankee Atomic Electric Company (YAEC). Initially, at the request of the U. S. Nuclear Regulatory Commission (NRC), [Ref. 1], YAEC responded [Ref. 2] in general terms stating that the circulating water system would not produce sufficient flooding to affect the operation of the engineered safety systems, nor would such an occurrence result in common mode failure of redundant safety-related equipment.

On December 16, 1974, the NRC [Ref. 3] requested additional evaluation on a more detailed basis and submitted a guide for such an evaluation of the Yankee Rowe station. YAEC responded on January 20, 1975, [Ref. 4] and again on February 14, 1975, [Ref. 5] to this request. These responses identified certain areas in the facility that might be vulnerable to flooding which might affect the safety-related systems necessary for safe shutdown of the facility. YAEC also outlined certain modifications that they planned to make to their facility to mitigate the effects of any flooding due to a failure of non-Class I system component.

The NRC requested further amplifying information on October 8, 1975, [Ref. 7] in the form of five detailed questions. YAEC responded on November 25, 1975, [Ref. 8] to all questions.

The various sources of potential flooding identified by YAEC and the affected safety-related equipment, are discussed in sections 2.2 and 2.3. Sections 2.2, 2.3, and 2.4 provide an evaluation of existing protection as well as measures proposed and made by YAEC to minimize the danger of flooding of safety-related equipment.

2. EVALUATION

2.1 GENERAL CONSIDERATIONS

The Yankee Rowe Nuclear Power Station was not designed to the seismic criteria now in effect, consequently the piping systems are classified as safety-related or non-safety-related rather than by a seismic category.

All of the applicable non-safety related systems in Reference [3] were included in the licensee's investigation. The licensee has also included an analysis of the vulnerability to flooding of all Class 1E equipment required for a safe shutdown.

The worst case rupture of any piping would be that of the circulating water system which does not have flow reversing valves. The expansion joints in this system are located at ground level in the Turbine Building.

The licensee found no scenario which would result in common mode failure of redundant safety-related system equipment.

The sources of potential flooding at the Yankee Rowe plant that were analyzed were as follows:

Service Water	Drains
Condensate	Heating Boiler Condensate
Feedwater	Make-up water
Reactor Building Cooling Water	Potable water
Circulating Water	Fire Protection Water
Demineralized Water	

2.2 TURBINE BUILDING

2.2.1 Safety-Related Equipment Vulnerable to Flooding

The safety-related equipment in the Turbine Building that is of concern in a safe shutdown of the plant, are the control and instrumentation system in the Control Room and the control relays and equipment in the Switchgear Room.

2.2.2 Sources of Flooding

The main sources of flooding in the Turbine Building are the condensate, the feedwater, and the circulating water systems.

Flooding caused by failure of the circulating water line expansion joint will envelope the flooding from the condensate or feedwater lines.

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

The Turbine Building contains the Switchgear Room/Battery Rooms and the Control Room at elevated levels. The Switchgear Room elevation (1037'3") is 15 feet above the ground level of the Turbine Building and the Control Room elevation (1052'8") is 30 feet above the ground level. The Turbine Building at ground elevation (1022'8") is a large open area with three large roll-up doors to the outside, and a number of pedestrian doors opening to the outside and other areas of the plant. Major flooding resulting from failure of the circulating water piping expansion joints would be readily detected by the Turbine Room operator whose station is at the 1022' level in the Turbine Building. The flooding of non-safety related equipment at ground level in the Turbine Building would result in equipment trips, also alerting the operator. The various outside doors to the Turbine Building will fail if water builds up to three or four feet. The operator, in response to operating procedure OP-3016, "In-Plant Flooding Conditions", will open the three large overhead doors and trip the circulating pump which is the source of the flooding. These factors preclude the flooding from reaching a depth (15') where the switchgear would be threatened.

The turbine driven auxiliary feed pump is located in the auxiliary boiler room which is separated from the Turbine Hall by a closed fire door.

The water inventory in the steam generator can be maintained by the auxiliary feed pump or one of three charging pumps located in the Primary Auxiliary Building. The electric driven main feed pumps can be used as long as off-site power is available.

2.2.5 Conclusions

We conclude that the system features and administrative procedures described above are adequate to prevent flooding of safety-related equipment in the Turbine Building, necessary for a safe shutdown of the plant.

2.3 PRIMARY AUXILIARY BUILDING

2.3.1 Safety-Related Equipment Vulnerable to Flooding

The Primary Auxiliary Building contains Motor Control Center 4, which if flooded would cause failure of charging and purification pumps which are required for heat removal and long term recirculation phases of a shutdown.

2.3.2 Sources of Flooding

Sources of flooding in the Primary Auxiliary Building are service water, component cooling water, demineralized water, heating system and condensate which are routed through the lower level of the building. A rupture of any of these systems, which resulted in a water depth in excess of one foot, could flood out Motor Control Center 4 and prevent operation of the charging and purification pumps which are needed for heat removal and post LOCA recirculation.

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

The Licensee has provided sufficient openings at the ground level in this building to prevent flooding of the motor control center due to any anticipated event. An opening 5' wide by 1' high was made at the bottom of the double door in the north wall. Three additional openings 1' by 1' were provided at ground level along the north wall. The licensee has also provided redundant level switches in the floor sump of the Primary Auxiliary Building which initiate alarms in the Control Room to alert the operators of any flooding at this location.

2.3.4 Conclusions

We conclude that the above described features in the Primary Auxiliary Building and the licensee's adminstrative procedures are adequate to mitigate the effects of flooding of the safety-related equipment required for a safe shutdown of the plant.

2.4 DIESEL GENERATOR BUILDING

2.4.1 Safety-Related Equipment Vulnerable to the Effects of Flooding

The Diesel Generator Building contains the three diesel generators and Emergency Buses 1, 2, and 3 which are required in the event of a loss of offsite power. Also located in this building is the safety injection system which is required for both a safe shutdown and a design basis accident (LOCA).

2.4.2 Sources of Flooding

No non-safety related piping of any size passes through this building; however, there is a connecting door between this building and the Primary Auxiliary Building which could present a possible source of flooding.

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

The potential flooding source in the Diesel Generator Building was through a door between this bulding and the Primary Auxiliary Building. The licensee has provided gasketing around the door between these two buildings to prevent any flow of water from the Primary Auxiliary Building into the Diesel Generator Building. This door is normally kept closed. Alarms are provided to warn the operator in the Control Room when this door is open for more than 15 seconds.

2.4.4 Conclusions

We conclude that the licensee's corrective measures are adequate to protect the safety-related equipment, located in the Diesel Generator Building, from the effects of flooding.

2.5 CIRCULATING WATER PUMP HOUSE

2.5.1 Safety-Related Equipment Vulnerable to the Effects of Flooding

The Circulating Water Pump House contains the circulating water pumps, the service water pumps, the fire water pumps, and their associated piping. Flooding from a rupture in this area might damage the fire system, or service water pumps so that they would not be available for use.

2.5.2 Sources of Flooding

Sources of flooding are the piping and fittings of the water systems listed above.

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

The drain sump in the Circulating Water Pump House is alarmed in the Control Room to alert the operators of any flooding condition in this area that might affect the service water system. Either of two methods can be employed to remove decay heat and reduce the main coolant temperature and pressure to ambient. The first method is a feed and bleed operation using the Charging and Volume Control system located in the PAB, and the Service Water system which is located in the Circulating Water pump house. In the alternate mode, heat can be removed from the primary system by venting the steam generator to atmosphere. Water inventory can be maintained by one of three pumping systems; the steam driven auxiliary feed pump, one of the three charging pumps, or the main feed system if off site power is available. Because there is an alternate method for removing decay heat and cooling the plant, the service water system is not required for a safe shutdown.

2.5.4 Conclusions

We conclude that the system of alarms in the Circulating Water Pump House is adequate to alert the operators of impending flooding conditions that might occur in this area. The licensee's analysis also shows that any flooding in this area would not inhibit the capability to the plant of accomplish a safe shutdown.

2.6 WASTE DISPOSAL BUILDING

2.6.1 Safety-Related Equipment Vulnerable to the Effects of Flooding

The Waste Disposal Building contains no equipment required to shut down the plant or any fluid systems of any capacity for flooding.

2.6.2 Sources of Flooding

The Waste Disposal Building contains piping for the Fire Water system which could cause some flooding

2.6.3 Systems and/or Measures to Mitigate Effects of Flooding

The Waste Disposal Building is almost continuously manned and it is located at one of the higher elevations of the plant. Any flood water would be quickly detected and would easily drain away by the operator opening one of the four outside doors.

2.6.4 Conclusions

We conclude that the systems and/or measures described by the licensee are adequate to mitigate the effects of any flooding in the Waste Disposal Building and that any flooding in this area would not inhibit the capability of the plant to accomplish a safe shutdown.

The areas described in the above sections comprise all of the areas which either contain operating fluid systems, or safety-related equipment which would be required for a safe plant shutdown.

3. CONCLUSIONS

Based on the information supplied by the licensee, we conclude that YAEC has demonstrated in its analysis that the Yankee Nuclear 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 flooding will not prevent the safe shutdown of the facility.

The licensee has further shown in the analysis that no single failure can cause flooding which would result in common mode failure of redundant safety-related equipment.

We conclude that YAEC has met all of the requirements of the NRC and that its analysis of the potential flooding conditions and the corrective measures taken at the Yankee Rowe Nuclear Power Station are acceptable.

4.0 REFERENCES

[1] Letter from the U.S. Nuclear Regulatory Commission (NRC) to Yankee Atomic Company (YAEC) dated August 8, 1972

[2] Letter from YAEC to NRC dated September 8, 1972

[3] Letter from NRC to YAEC dated December 16, 1974

[4] Letter from YAEC to NRC dated January 20, 1975

[5] Letter from YAEC to NRC dated February 14, 1975

[6] Letter from YAEC to NRC dated June 4, 1975

[7] Letter from NRC to YAEC dated October 8, 1975

[8] Letter from YAEC to NRC dated November 25, 1975

APPENDIX A

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

Docket No. 50-29 August 8, 1972

Yankee Atomic Electric Company
ATTN: Mr. Donald E. Vandenburgh
Vice President
20 Turnpike Road
Westboro, MA 01581

Gentlemen:

FLOODING OF CRITICAL EQUIPMENT

A failure of an expansion bellows in the circulating water line which serves the main condenser recently occured at Quad-Cities Unit 1. The resultant flooding caused degradation of some of the engineered safety features. Interim corrective action has been taken and more permanent corrective measures are planned at Quad-Cities 1 and 2 to prevent recurrence. A copy of the abnormal occurence report filed by Commonwealth Edison for this event is enclosed.

You are requested to review your facilities to determine (1) whether failure of any equipment which does not meet the criteria of Class I seismic construction, particularly the circulating water system, could cause flooding sufficient to adversely affect the performance of engineered safety systems, and (2) whether failure of any equipment could cause flooding such that common mode failure of redundant safety related equipment would result. The integrity of barriers to protect critical equipment from flood waters should be assumed only when the barrier meets the seismic requirements of Class I structures. If your review determines that engineered safety features could be so affected, provide your plans and schedule for corrective action together with the justification for continued operation of your facility pending completion of the corrective action.

The results of your review are requested within sixty days. This information should be provided with one signed orignal and thirty-nine additional copies.

Sincerely,

Donald J. Skovholt
Assistant Director
for Operating Reactors
Directorate of Licensing

Enclosure: CE ltr dtd 6/17/72

cc to:
C. Duane Blinn, Esquire
Day, Berry & Howard
Counselors at Law
1 Constitution Plaza
Hartford, Connecticut 06103

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.

APPENDIX C

UN-DOCKETED REFERENCE MATERIALS

9-10-80

Sent vie TELECOPY to:

John Burdoin, NRC, Washington, D.C.

QUESTIONS FOR YANKEE ROWE PLANT ON FLOODING

1. In the Primary Auxiliary Building (PAB), have the water level alarms been installed in the sumps as outlined in Yankee Atomic Electric Company (YAEC) response letter of January 20, 1975?

2. In the PAB, have new openings in the sides of the building been provided as outlined in YAEC response of February 14, 1975?

3. In the PAB, is the door between the PAB and the Diesel Generator Building (DGB) gasketed to protect against flooding from the PAB as outlined in YAEC response letter of February 14, 1975?

4. Is the door in item 3 above, alarmed in the Control Room?

5. In the PAB, how high would water have to be to reach the 480v MCC4 panel to disable the LP & HP injection pumps?
   Is it possible for water to reach that height now?

6. How high would the water have to go to disable the diesel generators in the DGB?
   Is it possible for water to reach that height now?