SAFETY EVALUATION REPORT

SUSCEPTIBILITY OF SAFETY-RELATED SYSTEMS TO FLOODING FROM FAILURE OF NON-CATEGORY I SYSTEMS FOR PALISADES NUCLEAR POWER PLANT

I. INTRODUCTION

By letter to the Consumers Power Company (CPC) dated September 26, 1972, the Nuclear Regulatory Commission (NRC) requested a review of the Palisades Nuclear Power Plant 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 that might adversely affect the performance of safety-related equipment required for safe shutdown of the plant or which may be required to limit the consequences of an accident. By letter dated October 26, 1972, and subsequent letters (see references of enclosure) the Consumers Power Company submitted the additional information requested by the NRC, as well as descriptions of various plant changes implemented to mitigate the eff cts of failure of some non-Category I systems on safety related equipment.

A continuing review of potential sources and consequences of flooding at the Palisades Plant was conducted by the CPC between 1972 and 1975. Initially, at the request of NRC in September 1972, the CPC reviewed several water systems as sources of flooding. Following the forwarding of more descriptive guidelines for review of flooding from failure of non-Category I systems in November 1974, the plant was again reviewed. The potential sources of flooding were described; and safety-related equipment which could be damaged by flooding were identified, and measures taken to minimize the effects of flooding and to protect safety-related equipment were reviewed.

II. EVALUATION

The enclosed technical evaluation was prepared by us by Lawrence Livermore Laboratory (EG&G) as part of our technical assistance program.

III. CONCLUSION

The consultant has reviewed the licensee's submittals for the Palisades Plant to determine if postulated failures of non-Category I (seismic) components could adversely affect the operability of safety-related equipment. The consultant's findings, with which we agree, indicate a degree of vulnerability of safety-related equipment due to postulated flooding in the auxiliary feed pump room and diesel generator room 116. The licensee is presently reviewing these two areas to determine

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the appropriate modifications to mitigate the consequences of flooding in the auxiliary feed pump room and diesel generator room 116. The licensee will be required to complete the installation of these selected modifications prior to start-up following the next scheduled refueling.

The licensee also committed to prepare operating procedures or technical specifications to require periodic surveillance of those floor drains and water tight doors required in mitigating the consequences of flooding to assure their proper operation. The licensee will be required to implement these operating procedures or technical specifications prior to March 1, 1980.

Based on our review of the consultant's technical evaluation, we have concluded that the proposed protective measures, in conjunction with existing design features, will provide a sufficient level of protection for safety-related equipment from flooding as a consequence of failure of non-Category I (seismic) sources; and, therefore, are acceptable.

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

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1. INTRODUCTION

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The purpose of this technical evaluation is to determine, on the basis of the information provided (refer to References), whether the Licensee's response and equipment/plant modifications seems to be adequate to mitigate the effects of flooding on equipment important to safety.

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2. EVALUATION OF PALISADES

2.1 INTRODUCTION

Three separate reviews of the Palisades facility were conducted by the CPC between 1972 and 1975. Initially, at the request of NRC in 1972, the CPC reviewed the circulation water system as a source of flooding [Ref. 2]. Subsequently, as a result of extensive plant modifications completed in 1974, the NRC requested that the Palisades facility be again reviewed [Ref. 4]. These modifications [Ref. 5] consisted of the following:

(1) Circulating water pumps were removed from the intake structure.

(2) Cooling towers were added.

(3) The layout of two 90-inch diameter return pipes leading from the cooling tower basins to the condenser was changed. This resulted in both pipes traveling vertically downward through the intake structure.

(4) Two dilution pumps and associated piping were added to the intake structure.

(5) Expansion joints and butterfly valves in the inlet piping to the condenser were added.

(6) Expansion joints in the discharge piping from the condenser water boxes were added.

Finally, the facilities were again reviewed at the NRC's request and several questions regarding flooding of the Turbine Building were dealt with [Ref. 6, 7]. The various sources of flooding identified by the Licensee and the appropriate safety equipment are discussed in Sections 2.2 and 2.3. Section 2.4 provides an evaluation of existing protection as well as measures that were taken by CPC to minimize the danger of flooding and to protect safety-related equipment.

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2.2 SOURCES OF FLOODING

During the Licensee's three reviews of the Palisades plant, the following potential sources of flooding were identified:

(1) Circulating water system
(2) Fire protection system

2.3 SAFETY-RELATED EQUIPMENT SUBJECT TO FLOODING DAMAGE

The following safety-related systems, equipment, or locations were considered to require protection from flooding:

(1) Turbine Building and Intake Structure
(2) Service water pump motors
(3) Auxiliary feedwater pumps
(4) Emergency diesel generators
(5) Switchgear rooms
(6) Safety injection pumps
(7) Containment spray pump rooms
(8) Charging pumps
(9) Motor control centers
(10) 480-volt load center
(11) Battery room

Existing protection from flooding as well as the steps taken by the Licensee to protect the above equipment from flooding damage are discussed in Section 2.4.

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2.4 EVALUATION

2.4.1 General Considerations

The Licensee has indicated that all shutdown cooling equipment, the component cooling system, emergency diesel generators, and engineered safeguards, which are located in the Auxiliary Building, are protected from flooding by water-tight marine doors on all doorways connecting the Auxiliary Building with the Turbine Building. The spatial isolation of redundant safeguards systems in water-tight enclosures is designed to further assure that if flooding were to occur due to some local causes, a common mode failure of redundant safety-related equipment would not occur [Ref. 2].

As an added measure, two auxiliary operators are on duty each shift. One is located in the Turbine Building, and the other is in the Auxiliary Building [Ref. 16].

2.4.2 Turbine Building and Intake Structure

It was determined by the Licensee that the modified circulating water system, which is located in both the Turbine Building and the Intake Structure, should be categorized as a "moderate energy fluid system" per Branch Technical Position - MEB No. 3-1, entitled "Postulated Break and Leakage Locations in Fluid System Piping Outside Containment" [Ref. 8, 9, 5].

The actual stresses, including seismic, in the modified piping of the circulating water system were determined by the licensee [Ref. 5] to be much less than the allowable stresses for non-nuclear piping. Therefore, the postulation of any break in the circulating water system piping was not warranted and no protective measures were needed. It was concluded by the Licensee that the modifications to the circulating water system piping had not changed the flooding potential in the Intake Structure [Ref. 5]. The NRC staff has ageed with this position [Ref. 10, 11].

However, this does not preclude a rupture in an expansion joint in the piping. Therefore, an analysis was made by the Licensee of the expansion joints in the Turbine Building circulating water system piping. From this analysis, it was determined that a postulated expansion joint rupture and subsequent water leakage would result in the flooding of the condensate pump area (571'-0"), the condenser area (580'-0"), and the Turbine Building floor (590'-0") in a minimum time of 2-1/2 minutes. Two level alarms were installed in the condensate pump area to detect the rising water level. The sensors, which activate alarms in the control room, provide sufficient time after flooding begins to permit appropriate administrative action [Ref. 5].

This administrative action (or operating procedure) includes the opening of a roll-up door in the Turbine Building to limit the water build-up to a maximum of only several inches above the 590' floor. The roll-up door may be operated manually or by pushbutton-controlled motor.

The maximum water build-up has been determined by the licensee to be 2.56 feet in the Turbine Building [Ref. 7].

A break in a circulating water system piping expansion joint could also cause flooding from the Turbine Building to the Intake Structure. Door #35 between the Turbine Building and the Intake Structure is a security door and is closed and locked at all times when not in use. Leakage under this door would be drained through five floor drains and one backwash drain in the Intake Structure. We consider this adequate.

The service water pumps are located at the 593'6" level and so are in no immediate danger of flooding.

In addition, there are alarms on the turbine sump pump so that operators know if the turbine sump is flooding.

We consider these measures adequate to mitigate the consequences of flooding in this area.

2.4.3 Auxiliary Feedwater Pumps

The auxiliary feedwater pump room is located in the Turbine Building at the 571-foot elevation. The room contains the electric as well as the steam-driven auxiliary feedwater pumps and is protected from external flooding sources by a water-tight door and water-tight seals around all room penetrations.

* However, due to piping and other such hardware within the room, there exists a danger of the room flooding from internal sources. Such flooding to a depth of 6 inches did occur in August, 1978 [Ref. 12], and caused the room to be reviewed in light of the possibility of damaging the two pumps. Leakage from an operating pump as well as plugged and inadequate drains contributed to the problem. An NRC review of the room revealed that [Ref. 13, 14, 15]:

(1) The single entrance to the room was equipped with a water-tight door which was normally closed.

(2) The room drains appeared to be inadequate for accommodating all possible pipe breaks in the room.

(3) No automatic level alarms existed in the room to advise operating personnel that the room was flooding.

(4) The room was checked once per shift by security personnel.

To date, Palisades personnel have taken the following actions [Ref. 16]:

(1) The packing was replaced on both of the auxiliary feedwater pumps, and a float-type check valve in the drain line was repaired.

(2) An annual preventive maintenance schedule to clean and check all the check valves has been developed.

(3) The room continues to be checked by an operator once per shift.

*Edited by NRC

The Licensee is presently reviewing this problem to determine a permanent solution. Once this determination is made, the Licensee will submit the design to the NRC staff for review. The resolution of this problem will be reported in subsequent evaluations.

2.4.4 Diesel Generator Rooms

The two diesel generator rooms (rooms 116 and 116B) are located side by side at the 590-foot level of the Reactor Building. Fire system piping as well as other water-carrying piping systems pass through the rooms and are capable of breaking and exposing the diesel generators to the danger of flooding. Both rooms have 6-inch dams located in the doorways which lead from the rooms to a common vestibule. The doors leading from these rooms to the vestibule have a 1/16-inch gap along the bottom through which water can leak into the vestibule. Room 116 has one door leading to the vestibule; room 116B has a door leading not only into the vestibule but also into the adjacent 1-C, 2400-volt switchgear room (room 116A). Both this room and the switchgear room are designed to drain into a corridor through a switchgear room door. Drains in the corridor will carry the water into a sump. The door from the diesel generator room to the switchgear room as well as the door from the switchgear room to the corridor both have large (1-inch) gaps through which water would drain. Other doors leading out from the vestibule, room 116, and room 116A are water-tight [Ref. 17].

Maximum flooding would occur if a fire system line broke in any one of the three rooms. Worst-case flooding would occur in diesel generator room 116. The water level would rise approximately 0.1 feet per minute providing the operator with about 30 minutes in which to discover the flooding and correct it. Room 116 is checked by the auxiliary operator at least once per shift and sometimes as often as every two hours. Two alarms can result from a break in the fire line. Either one of these could alert the operator, although it is possible to have a moderate fire main break *without triggering the alarms. A small leak in the fire main, the capacity of which does not exceed the output of the "ancillary" fire pump would preclude detection because the fire main pressure would be maintained.

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*Edited by NRC

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Because of the potential danger of undetected flooding in room 116, the Licensee is presently reviewing this problem to determine a permanent solution. Once this determination is made, the Licensee will submit the design to the NRC staff for review. The resolution of this problem will be reported in subsequent evaluations.

2.4.5 2400-Volt Switchgear Rooms

All doors between the 2400-volt switchgear rooms and the Turbine Building have full bulkhead doors which prevent water from entering the rooms. All other remaining doors are standard [Ref. 18].

Worst-case flooding, which would occur from a break in the 6-inch fire system piping in the 1-C switchgear room (room 116A), can be handled by the gap under the door leading to the corridors and the corridor drains. The 1-D switchgear room, located at the 607-foot, 6-inch elevation of the Reactor Building, is also subject to flooding. Worst-case flooding would occur from a break in the 6-inch fire main. The 1-D switchgear room, however, contains two 3-inch drains. We consider these measures adequate to mitigate the consequences of flooding.

2.4.6 Safety Injection Pump and Containment Spray Pump Rooms

The two adjacent safety injection pump rooms are located at the 570-foot level of the Reactor Building. Both rooms contain the low pressure and the high pressure safety injection pumps as well as the containment spray pumps.

Each pump room contains a sump for water accumulation in the event of flooding. The sumps contain pumps for pumping out the water. In addition, each room is equipped with a level alarm which sounds in the control room when the water level reaches three feet in the sump [Ref. 18].

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One pump room is isolated from the other by bulkhead doors. The sump pumps and level alarms serve to mitigate potential damage should flooding occur, and we consider this acceptable.

2.4.7 Charging Pumps

The charging pumps are located on 12-inch steel structures at the 590-foot level of the Reactor Building. There is a volume control tank located in an adjacent area. In the event of a rupture, the normal volume of this tank (2,600 gallons) can flood the charging pump area which, however, is equipped with 4-inch floor drains leading to the waste tank [Ref. 18]. With the pump elevation and the drains, we consider these measures adequate in mitigating the damage to the charging pumps.

2.4.8 Motor Control Centers and 480-Volt Load Center

The redundant engineered safeguards motor control centers, MCC no. 1 and MCC no. 2, are located together in the cable spreading room at the 607-foot, 6-inch elevation of the Reactor Building. Power for these motor control centers is supplied from the 480-volt load center buses (No. 11 and 12) [Ref. 18, 19]. The motor control centers are mounted on concrete pads 3 to 4 inches above the floor.

A potential source of flooding in the cable spreading room is a 6-inch fire system main. A rupture in this line would result in water flowing across the floor and under the door. Immediately outside the door is a hallway, leading to stairs which lead down to the next level of the building. Drains in the hallway are designed to drain away any water, and the stairway would carry away the excess [Ref. 18]. We consider these measures adequate to mitigate the damage to the motor control centers from flooding.

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2.4.9 Battery Room

The battery room is adjacent to the cable spreading room at the 607-foot, 6-inch elevation of the Reactor Building. The battery room door opens directly into the cable spreading room. The battery room contains no potential sources of flooding [Ref. 18]. Any flooding in this portion of the Reactor Building would be due to the sources discussed in Section 2.4.8, above, and would flow down the hallway and the stairs. We consider these measures adequate to mitigate the danger of flooding.

3. CONCLUSIONS

The Palisades Nuclear Power Plant is designed so as to mitigate or prevent the potential damage cuased by flooding of equipment important to the safety and/or the safe shutdown of the facility, with the exception of the items discussed below.

First, it is recommended that procedures or technical specifications be developed by the Licensee to require periodic surveillance of those drains and water-tight doors throughout the facility that are required to mitigate the consequences of flooding to ensure that they will function as designed.

Secondly, it was recommended, and the Licensee has agreed, to review the design of the auxiliary feedwater pump room (located at the 571-foot elevation of the Turbine Building) and diesel generator room 116 (located at the 590-foot elevation of the Reactor Building). This review will determine what safety-grade design modifications must be made to mitigate the problems of flooding in these two rooms and subesequent damage to the auxiliary feedwater pumps and the diesel generator, respectively. The resolution of these two problems will be reported in subsequent evaluations.

It is concluded that, with the exception of the auxiliary feedwater pump room and the diesel generator room, the "NRC Guidelines for Protection from Flooding of Equipment Important to Safety" (Appendix A) have been satisfied.

APPENDICES

APPENDIX A:
NRC GUIDELINES FOR PROTECTION FROM FLOODING OF EQUIPMENT IMPORTANT TO SAFETY

Licensees are required to investigate their facilities or 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.

Further 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 systems. The seals shall be designed for the SSE, including seismically indicated wave action of water inside the affected compartments 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

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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

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