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 FACIL: 50-275 Diablo Canyon Nuclear Power Plant, Unit 1, Pacific Ga 05000275
 50-323 Diablo Canyon Nuclear Power Plant, Unit 2, Pacific Ga 05000323

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SUBJECT: Forwards comparison of NUREG-0611 recommendations for auxiliary feedwater sys to design &/or operation of facility sys.

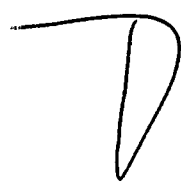
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THE UNIVERSITY OF CHICAGO
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RESEARCH REPORT
NO. 1000

BY
J. H. GOLDSTEIN

Submitted in partial fulfillment of the requirements for the Ph.D. degree
in the Department of Chemistry
by
J. H. GOLDSTEIN
Chicago, Illinois
1954

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Mr. John F. Stolz, Chief
Light Water Reactors Branch No. 1
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Docket No. 50-275
Docket No. 50-323
Diablo Canyon Units 1 and 2

Dear Mr. Stolz:

Pacific Gas and Electric Company was represented at an NRC meeting held on November 30, 1979, in Bethesda, Maryland. At this meeting, several applicants with near-term OL plants were advised of the results of the NRC's Review of the Auxiliary Feedwater Systems (AFWS) of 33 operating units. Sixteen specific NRC recommendations for improved AFWS reliability were discussed. We have considered the recommendations relative to the Diablo Canyon facility.

Attached for your information are the results of our study entitled "Comparison of NUREG-0611 Recommendations for Auxiliary Feedwater Systems (AFWS) to the Design and/or Operation of the Diablo Canyon Auxiliary Feedwater System."

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it to me in the enclosed addressed envelope.

Very truly yours,

Philip A. Crane, Jr.

Attachment (40)

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Comparison of NUREG-0611 Recommendations for Auxiliary Feedwater Systems (AFWS) To the Design and/or Operation of the Diablo Canyon Auxiliary Feedwater System

1. Recommendation GS-1: The licensee should propose modifications to the Specifications to limit the time that one AFW system pump and its associated flow train and essential instrumentation can be inoperable. The outage time limit and subsequent action time should be as required in current Standard Technical Specifications; i.e., 72 hours and 12 hours, respectively.

Response: The Diablo Canyon AFWS design consists of two trains powered by vital busses and one train powered by the steam supply system.

Draft Diablo Canyon Technical Specification 3.7.1.2. requires that all three (3) trains of Auxiliary Feedwater be operable, including instrumentation, during power operation, start-up, and hot standby modes. The time limit for one train of AFW inoperable is 72 hours. Subsequent actions required in the event of continued inoperability of one train is; be in at least hot standby within the next six (6) hours and be in at least hot shutdown within the following six (6) hours.

2. Recommendation GS-2: The licensee should lock open single valves or multiple valves in series in the AFW system pump suction piping and lock open other single valves or multiple valves in series that could interrupt all AFW flow. Monthly inspections should be performed to verify that these valves are locked and in the open position. These inspections should be proposed for incorporation into the surveillance requirements of the plant Technical Specifications. See Recommendation GL-2 for the longer-term resolution of this concern.

Response: There is one, normally open, manual valve in the common suction piping of the Diablo Canyon AFW pumps. This valve will be locked, sealed, or otherwise secured in the open position whenever the plant is in a power operation, start-up, or hot shutdown mode. A proposed Technical Specification revision will require that correct valve alignment is verified monthly.

3. Recommendation GS-3: The licensee has stated that it throttles AFW system flow to avoid water hammer. The licensee should re-examine the practice of throttling AFW system flow to avoid water hammer.

The licensee should verify that the AFW system will supply on demand sufficient initial flow to the necessary steam generators to assure adequate decay heat removal following loss of main feedwater flow and a reactor trip from 100% power. In cases where this reevaluation results in an increase in initial AFW system flow, the licensee should provide sufficient information to demonstrate that the required initial AFW system flow will not result in plant damage due to water hammer.



Response: The Diablo Canyon steam generators were modified in January, 1976 to preclude the occurrence of feedwater line waterhammer events. The modifications consisted of retrofitting the feedwater spargers with "J-tubes." Tests at operating plants have demonstrated that the "J-tubes" modification does, in fact, preclude waterhammer events.

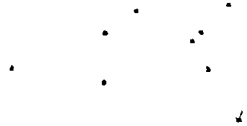
The Diablo Canyon AFWS control valves will be full open at the start of any event requiring the automatic initiation of the AFWS. Plant operating procedures require that the valves remain unthrottled until the steam generator water levels are recovered at which time the control valves will be throttled, either automatically or manually, as required to maintain the steam generator water levels. The AFWS control valves are also automatically throttled to limit flow to depressurized steam generator. This feature protects against destructive runoff of the motor driven AFW pumps.

4. Recommendation GS-4: Emergency Procedures for transferring to alternate sources of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operators when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

- (1) The case in which the primary water supply is not initially available. The procedures for this case should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated; and,
- (2) The case in which the primary water supply is being depleted. The procedure for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply.

Response: Emergency procedures are being revised. The revised procedures will incorporate the guidelines of the Westinghouse Owners Group Task Force on Emergency Procedures. The revised procedures will include the operator actions required to align secondary water sources for the case where the primary water source is initially not available and the case where the primary water source is being depleted. The revised procedures will be made available for NRC review.

5. Recommendation GS-5: The as-built plant should be capable of providing the required AFW flow for at least two hours from one AFW pump train independent of any alternative current power source. If manual AFW system initiation or flow control is required following a complete loss of alternating current power, emergency procedures should be established for manually initiating and controlling the system under these conditions. Since the water for cooling of the lube oil for the turbine-driven pump bearings may be dependent on alternating current power, design or procedural changes shall be made to eliminate this dependency as soon as practicable. Until this is done, the emergency procedures should provide for an individual to be stationed at the turbine-driven pump in the event of the loss of all alternating current power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in an on-off mode until alternating current power is restored. Adequate lighting powered by direct current power sources and communications at local stations should also be provided if manual initiation and control of the AFW system is needed. (See Recommendation GL-3 for the longer-term resolution of this concern.)



Response: The Diablo Canyon AFWS will be modified at or prior to the first refueling such that one train of AFW is capable of delivering the required flow independent of off-site and on-site AC power. This train will consist of a steam-driven AFW pump that delivers flow to all four steam generators, a steam supply stop valve powered from a vital DC bus (station batteries), automatic AFWS actuation instrumentation powered from a vital instrument AC bus, and steam generator level and AFW flow indication instrumentation powered from a vital instrument AC bus.

In the event of a loss of on-site AC power, the vital instrument AC busses are powered from the station batteries through an inverter.

The steam turbine-driven AFW pump has no dependence on AC power. Bearing lube oil cooling water is taken from the pump discharge. Appropriate AFWS operating procedures will be prepared for loss of off-site and on-site AC power.

6. Recommendation GS-6: The licensee should confirm flow path availability of an AFW system flow train that has been out of service to perform periodic testing or maintenance as follows:

(1) Procedures should be implemented to require an operator to determine that the AFW system valves are properly aligned and a second operator to independently verify that the valves are properly aligned.

(2) The licensee should propose Technical Specifications to assure that prior to plant start-up following an extended cold shutdown, a flow test would be performed to verify the normal flow path from the primary AFW system water source to the steam generators. The flow test should be conducted with AFW system valves in the normal alignment.

Response: The Diablo Canyon AFWS periodic testing and maintenance procedures include requirements to return the system valves to their proper alignment subsequent to the testing or maintenance activity. Presently they do not include requirements for an independent verification by a second operator.

The Diablo Canyon design requires the AFWS to function during plant start-up from cold shutdown conditions. Flow path availability from the primary water source to the steam generators is thus demonstrated during the normal course of plant start-up.

7. Recommendation GS-7: The licensee should verify that the automatic start AFW system signals and associated circuitry are safety-grade. If this cannot be verified, the AFW system automatic initiation system should be modified in the short-term to meet the functional requirements listed below. For the longer term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements as indicated in Recommendation GL-5.

(1) The design should provide for the automatic initiation of the auxiliary feedwater system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of auxiliary feedwater system function.



- (3) Testability of the initiation signals and circuits shall be a feature of the design.
- (4) The initiation signals and circuits should be powered from the emergency buses.
- (5) Manual capability to initiate the auxiliary feedwater system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.
- (6) The alternating current motor-driven pumps and valves in the auxiliary feedwater system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.
- (7) The automatic initiation signals and circuits shall be designed so that their failure will not result in the loss of manual capability to initiate the AFW system from the control room.

Response: The Diablo Canyon Auxiliary Feedwater System presently meets all of the listed functional requirements. The required automatic AFW actuation signals and associated circuitry are safety grade.

8. Recommendation GS-8: The licensee should install a system to automatically initiate AFW system flow. This system need not be safety-grade; however, in the short-term, it should meet the criteria listed below, which are similar to Item 2.k.7a of NUREG-0578. For the longer term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements as indicated in Recommendation GL-2.
 - (1) The design should provide for the automatic initiation of the auxiliary feedwater system flow.
 - (2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of auxiliary feedwater system function.
 - (3) Testability of the initiating signals and circuits should be a feature of the design.
 - (4) The initiating signals and circuits should be powered from the emergency buses.
 - (5) Manual capability to initiate the auxiliary feedwater system from the control room should be retained and should be implemented so that a single failure in the manual circuits will not result in the loss of system function.
 - (6) The alternating current motor-driven pumps and valves in the auxiliary feedwater system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.



(7) The automatic initiation signals and circuits should be designed so that their failure will not result in the loss of manual capability to initiate the AFW system from the control room.

Response: The Diablo Canyon Auxiliary Feedwater System presently meets all of the listed functional requirements. The required automatic AFW actuation signals and associated circuitry are safety grade.

9. Recommendation: The licensee should provide redundant level indication and low level alarms in the control room for the AFW system primary water supply to allow the operator to anticipate the need to make up water or transfer to an alternate water supply and prevent a low pump suction pressure condition from occurring. The low level alarm setpoint should allow at least 20 minutes for operator action, assuming that the largest capacity AFW pump is operating.

Response: The primary water source for the Diablo Canyon Auxiliary Feedwater System is the Condensate Storage Tank (CST). CST level indication is available locally at the tank, at the remote hot shutdown panel, and in the control room. The level indication instrument channels presently are neither redundant nor safety-grade. They are, however, seismically qualified. They will be upgraded to be redundant and safety grade.

A CST Low-Low Level Alarm is annunciated in the control room. The alarm setpoint would presently give the plant operator 16 minutes notice of the need to transfer the AFWS to a secondary water source. The Low-Low Level Alarm setpoint will be changed to give the operator 20 minutes of AFW pump running time before the secondary water source must be cut-in. The Low-Low Alarm instrument circuit is safety-grade.

10. Recommendation: The licensee should perform a 72-hour endurance test on all AFW system pumps, if such a test or continuous period of operation has not been accomplished to date. Following the 72-hour pump run, the pumps should be shut down and cooled down and then restarted and run for one hour. Test acceptance criteria should include demonstrating that the pumps remain within design limits with respect to bearing/bearing oil temperatures and vibration and that pump room ambient conditions (temperature, humidity) do not exceed environmental qualification limits for safety-related equipment in the room.

Response: An endurance test of the Diablo Canyon AFWS will be performed prior to start-up. The endurance test procedures and acceptance criteria will be made available to the NRC for comment prior to the performance of the test.

11. Recommendation: The licensee should implement the following requirements as specified by Item 2.1.7.b on Page A-32 of NUREG-0578:

Safety-grade indication of AFW flow to each steam generator should be provided in the control room.



The AFW flow instrument channels should be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the AFW system set forth in the Auxiliary Systems Branch Technical Position 10-1 of The Standard Review Plan, Section 10.4.9.

Response: The Diablo Canyon AFWS design includes indication of AFW flow to each steam generator in the control room and at the remote hot shutdown panel. The instrument channels are safety-grade and powered from diverse emergency vital buses.

12. Recommendation: Licensees with plants which local manual realignment of valves to conduct periodic test on one AFW system train, and which have only one remaining AFW train available for operation should propose Technical Specifications to provide that a dedicated individual who is in communication with the control room be stationed at the manual valves. Upon instruction from the control room, this operator would realign the valves in the AFW system from the test mode to its operational alignment.

Response: The Diablo Canyon AFWS design includes three trains. This recommendation, therefore, is not applicable. It should be noted, however, that periodic test of the Diablo Canyon AFWS will not require local manual realignment of valves. The required valve realignment is accomplished from the control room. System realignment from the test mode to the normal AFWS operational mode is available from the control room.

13. Recommendation GL-1: For plants with a manual starting AFW system, the licensee should install a system to automatically initiate the AFW system flow. This system and associated automatic initiation signals should be designed and installed to meet safety-grade requirements. Manual AFW system start and control capability should be retained with manual start serving as backup to automatic AFW system initiation.

Response: See comparison to Recommendation 8 (GS-8).

14. Recommendation GL-2: Licensees with plant designs in which all (primary and alternate) water supplies to the AFW systems pass through valves in a single flow path, should install redundant parallel flow paths (piping and valves).

Licensees with plant designs in which the primary AFW system water supply passes through valves in a single flow path, but alternate AFW system water supplies connect to the AFW system pump suction piping downstream of the above valve(s), should install redundant valves parallel to the above valve(s) or provide automatic opening of the valve(s) from the alternate water supply upon low pump suction pressure modification of the plant.

The licensee should propose Technical Specifications to incorporate appropriate periodic inspections to verify the valve positions into the surveillance requirements.

Response: The common supply from the primary water source to the AFWS pumps contains one normally open valve. The alternate water source for the AFW pumps connects downstream of this valve.



See response to Recommendation GS-2 for additional information.

15. Recommendation GL-3: At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any alternating current power source for at least two hours. Conversion of direct current power to alternating current is acceptable.

Response: See response to Recommendation GS-5.

16. Recommendation GL-4: Licensees having plants with unprotected normal AFW system water supplies should evaluate the design of their AFW systems to determine if automatic protection of the pumps is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available to the control room operator, and the time necessary for assessing the problem and taking action should be considered in determining whether operator action can be relied on to prevent pump damage. Consideration should be given to providing pump protection by means such as automatic switchover of the pump suction to the alternate safety-grade source of water, automatic pump trips on low suction pressure or upgrading the normal source of water to meet seismic Category I and tornado protection requirements.

Response: The primary water source for the AFWS is Seismic Category I. The primary water source has been evaluated for the potential for damage due to tornado.

17. Recommendation GL-5: The licensee should upgrade the AFW system automatic initiation signals and circuits to meet safety-grade requirements.

Response: See response to Recommendation GS-7.

