U.S. NUCLEAR REGULATORY COMMISSION

REGION V

Report No. 50-344/85-26

Docket No. 50-344

License No. NPF-1

Licensee: Portland General Electric Company
121 S. W. Salmon Street
Portland, Oregon 97204

Facility Name: Trojan Nuclear Plant

Meeting Location: Region V Office, Walnut Creek, California

Meeting Conducted: August 8, 1985

Prepared by: R T Dodds
D. B. Pereira, Project Inspector

8/21/85
Date Signed

Approved by: R T Dodds
R. T. Dodds, Chief
Reactor Projects Section No. 1

8/21/85
Date Signed

Summary:

Management meeting on August 8, 1985, to examine the auxiliary feedwater system past history and reliability. The meeting was held pursuant to MC30702.

DETAILS

1. Meeting Participants

Nuclear Regulatory Commission

J. B. Martin, Regional Administrator, Region V
J. L. Crews, Senior Reactor Engineer
D. F. Kirsch, Acting Director, Division of Reactor Safety and Projects
A. E. Chaffee, Branch Chief, Reactor Projects
B. H. Faulkenberry, Deputy Regional Administrator, Region V
D. B. Pereira, Project Inspector
S. Richards, Senior Resident Inspector, Trojan
J. Singh, NRR Auxiliary Systems Branch
E. Merschoff, I.E., Vendor Inspection Branch

Portland General Electric

B. Withers, Vice President, Nuclear
C. Yundt, General Manager, Technical Functions
A. S. Cohlmeyer, Supervisor, Technical Services
C. A.Olmstead, Manager, Nuclear Quality Assurance
J. Lentsch, Manager, Nuclear Safety and Regulation Department
R. Susee, Operations Supervisor, Trojan

Bechtel Power Corporation

H. Friend, Vice President
R. Fosse, Project Engineer

2. Management Discussion

A management meeting was held on August 8, 1985, at the U. S. Nuclear Regulatory Commission's (NRC) Region V offices in Walnut Creek, California, to discuss several items of concern on Trojan's Auxiliary Feedwater (AFW) problems/reliability.

Mr. Martin opened the meeting by suggesting that the discussion follow the outline of the meeting agenda memorandum letter dated August 7, 1985, and agreed upon by the licensee and the staff. The five items agreed upon were as follows:

a. Operational History and Related Problems of AFW
b. Quality Assurance Assessment of AFW
c. Reliability of AFW System
d. Long Term Actions with Regards to AFW System
e. Safety Significance of Current Configurations and Features of AFW System

The discussion of Operational history and related problems of AFW systems was led by B. Withers and P. Yundt. The licensee presented diagrams of the AFW system, the electric auxiliary feedwater pump, and the steam supplies to the Terry Turbine (see Attachment A). The licensee discussed the AFW failure history with the statement that since plant startup in 1975 there have been 29 events where the AFW pumps failed to either start or run, out of approximately 356 system demands. In addition, there were 11 other reportable deficiencies for the auxiliary feedwater system. Eighteen of the 29 failures to start or run occurred during 1975-1976 and were associated with startup and initial design deficiencies. Three failures occurred in 1980 following an extensive outage which added TMI modifications to the plant. Of the five failure events since 1980, two were attributable to TMI modifications added to the auxiliary feedwater system without receiving adequate testing prior to placement into service. Attachement B reflects the AFW failure history.

Mr. Crews expressed concern on whether post-maintenance/modification testing covers, in a substantial manner, all the essential design features that ensure the AFW system works correctly prior to placement into service. Mr. Martin discussed the equipment operators role in the AFW reliability problems and whether their training and experience were sufficient to foresee potential problems or have the ability to correct problems.

A discussion of the Quality Assurance (QA) assessment of the AFW system was presented by C. A. Olmstead (Attachment C). Several recommendations were presented as a result of this evaluation of modifications involving AFW pumps and safety-related equipment. Some of the more important recommended actions were as follows:

a. Conduct a simultaneous auto start test of both AFW pumps following extended outages at minimum CWST level.

b. Strengthen the design change process to ensure that all necessary and relevant post installation testing have been prescribed.

c. Increase emphasis on management follow-up and coordination of identified potential problems.

d. Have the Nuclear Safety and Regulations department analyze the cause(s) for the main feed system isolation following a reactor trip and low average temperature.

A discussion of reliability of the AFW System with consideration of probability risk assessment (PRA) was presented by J. Lentsch. The three studies presented were as follows:

1. TMI Requirement, October 3, 1979 Report
2. ITI Reliability Assessment, Dec. 28, 1979, and
3. INPO Reports, October 19, 1984, December 28,1979, and March 15, 1985.

Based upon these prior studies, it was decided by PGE that further PRA studies would not serve a useful purpose at this time.

A discussion of the long term actions with regards to the AFW system was presented by P. Yundt. Bechtel Power Corporation has been selected to study the long term actions, and their scope of this work will be to review the AFW system component by component and provide recommendations for long term modifications to increase reliability. The schedule calls for Bechtel to complete the reviews of Operations and Maintenance history logs, review hardware modifications, procedural or administrative changes and provide possible hardware or procedural modifications by the end of September 1985. PGE will review and assess the Bechtel recommendations by the end of October, 1985. To the extend possible, PGE will implement the hardware and procedural modifications agreed upon during the May 1986 refueling outage.

A discussion of the safety significance of current configurations and features of the AFW system (10CFR 50.59) considerations was presented by the licensee. They stated that the 60% level limit on the condensate water storage tank (CWST) was controlled by administrative procedures. Seventeen administrative procedures were changed which included Operating Instructions, Functional Restorational Instructions, and Off-Normal Instructions. Mr. Crews commented that it would be diserable for PGE to formally notify the NRC in writing of the AFW system problems, address the matter of Technical Specifications changes, long term solution of reliability of the automatic start feature of the AFW pumps and the safety significance of 60% CWST level. Mr. Crews stated that the final fix of the AFW system and its acceptance would be based on a review and assessment by NRR.

The meeting closed by giving a synopsis of the meeting and the results and actions agreed upon. The licensee agreed to provide NRR a report concerning the safety evaluation of the CWST and administrative controls in place to maintain the CWST at 60% within 10 days. By November 1985, PGE will notify NRC of the long term modifications and procedural changes planned to be implemented to improve the reliability and operational performance of the AFW system.

The attached hand out material was provided by the licensee during the meeting.

AUXILIARY FEEDWATER SYSTEM

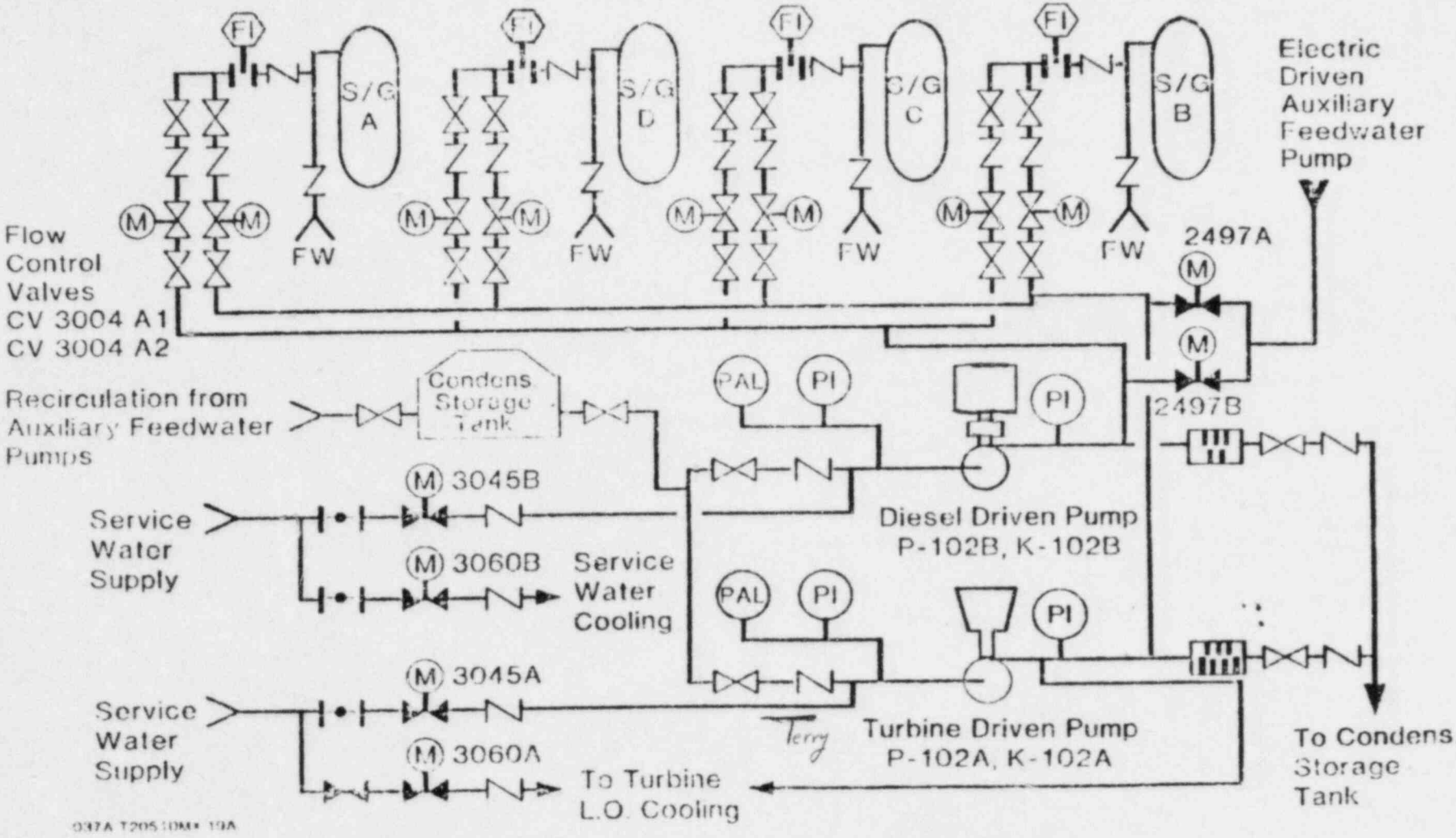

Figure 1

ELECTRIC AUXILIARY FEEDWATER PUMP

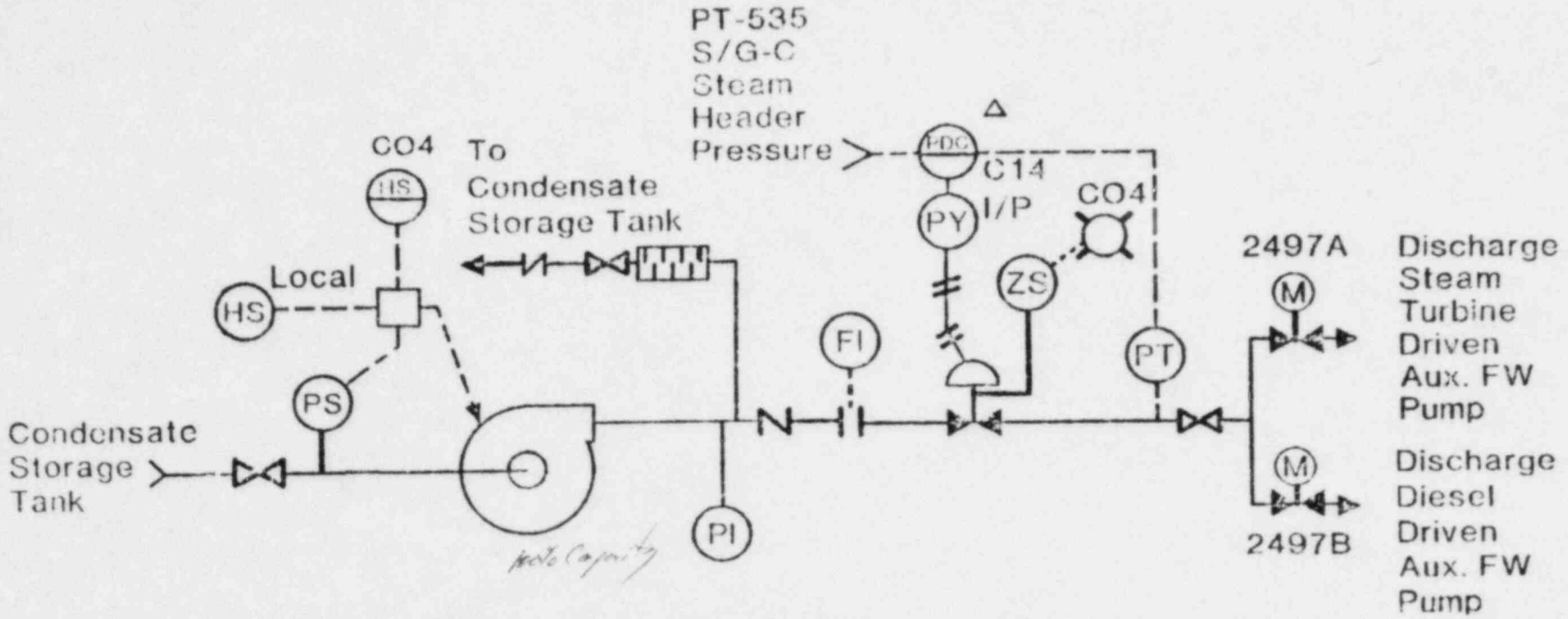

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Figure 2

Attachment A Page 2 of 2

STEAM SUPPLIES TO TERRY TURBINE

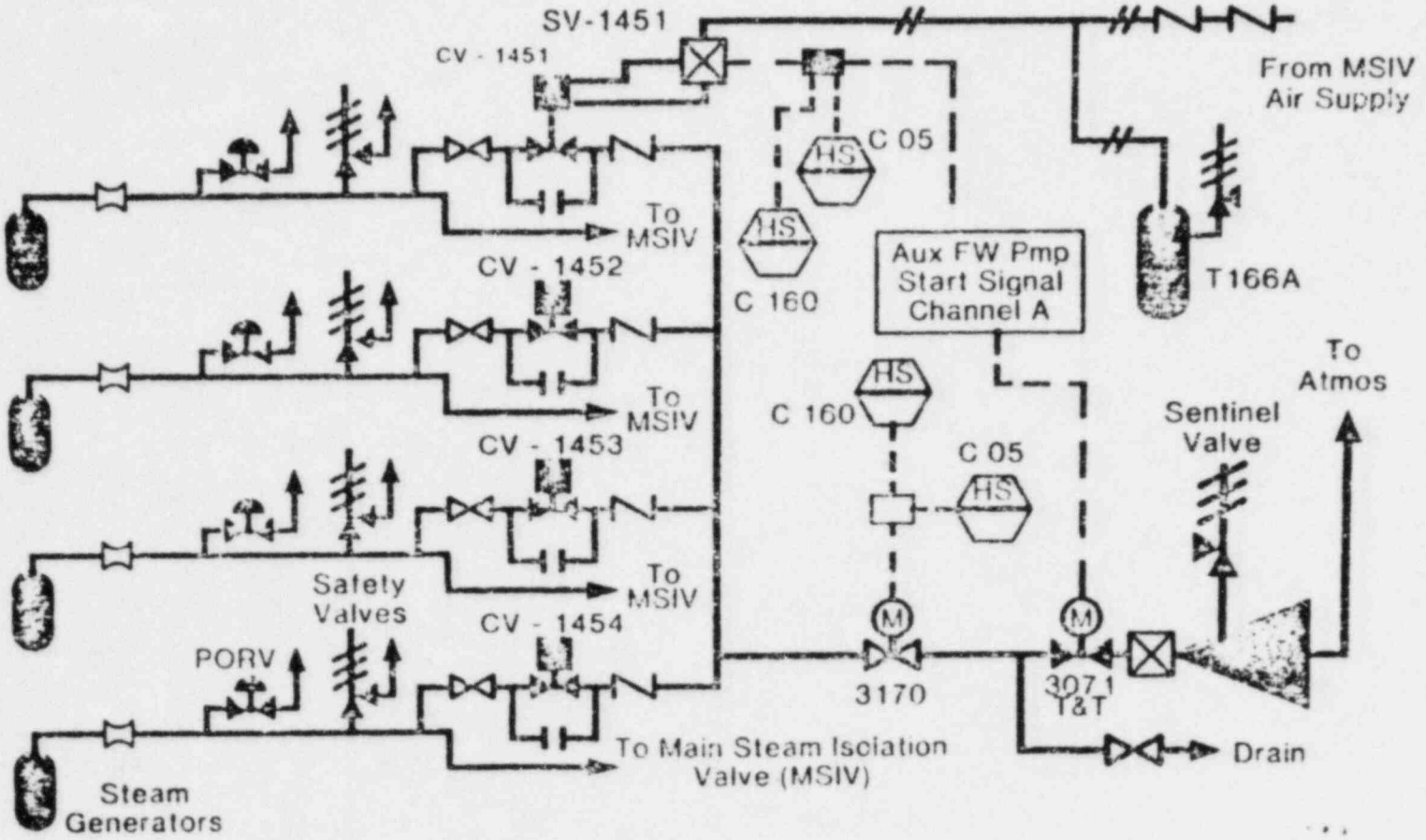


Figure 8

T20.51C-4

Attachment A
Page 3 of 3

Auxiliary Feedwater Failure History

The attached failure history time line shows that since plant startup in 1975 there have been 29 events where the auxiliary feedwater pumps failed to either start or run, out of approximately 356 system demands. In addition, there were 11 other reportable deficiencies for the auxiliary feedwater system.

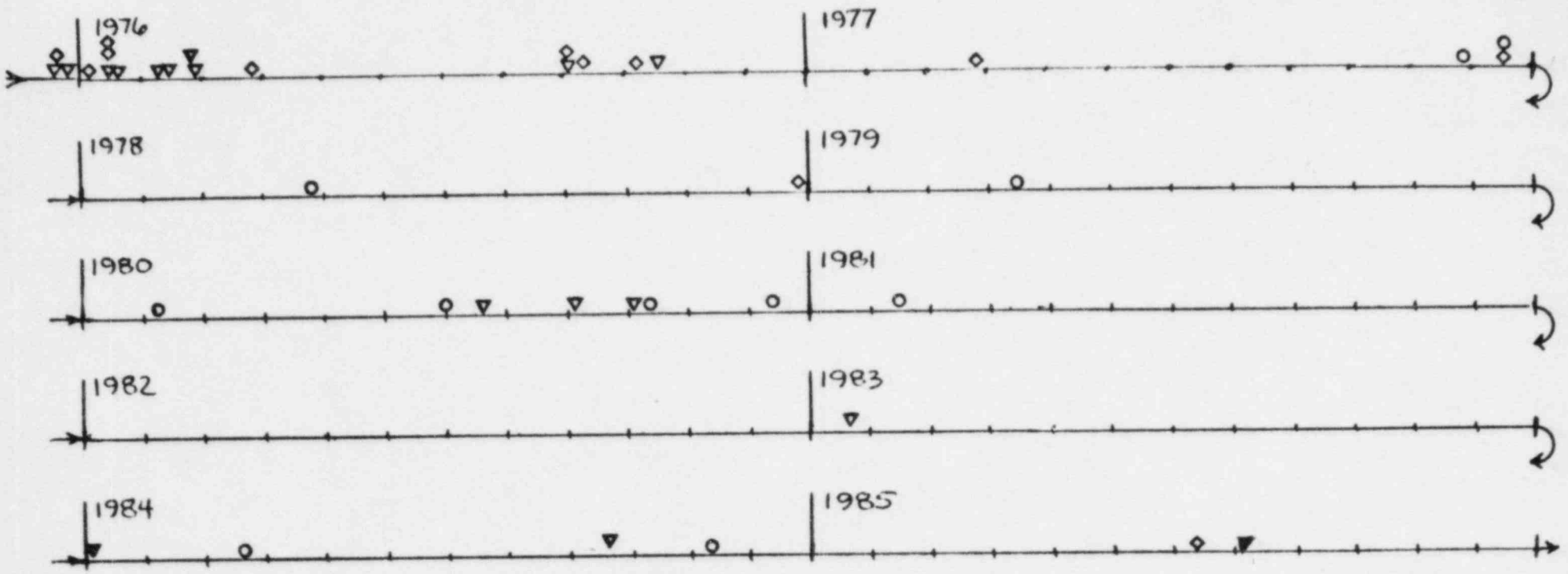
Eighteen of the 29 failures to start or run occurred during 1975-1976, associated with startup and initial design deficiencies. Three failures occurred in 1980 following an extensive outage which added TMI modifications to the plant. Of the 5 failure events since 1980, 2 are attributable to TMI modifications added to the auxiliary feedwater system without receiving adequate testing prior to placement into service.

While the reliability of the auxiliary feedwater system can probably be improved further following a comprehensive design review and improved test program, the overall system reliability that has been demonstrated since 1976 is not unreasonable.

Attachment B
Page 1 of 7

AUXILIARY FEEDWATER SYSTEM

FAILURE HISTORY TIME LINE



▼ Fail to START events	17
◇ Fail to RUN events	12
○ Associated events	11
TOTAL	40

ATTEMPTS TO START
APP. 356

Attachment 3
Page 2 of 7

AUXILIARY FEEDWATER PUMPS FAIL TO START EVENTS

EVENT DATE	LER	PUMP	DESCRIPTION
08/02/85	85-10	Diesel	Pump failed to start due to faulty potentiometer in the speed control circuit.
09/20/84	84-16	Diesel Turbine	Following a reactor trip, the turbine-driven pump started but tripped on low suction pressure after 7 minutes. The diesel pump failed to start. Low lube oil pressure time delay was set at 0 vice 25 seconds.
01/03/84	83-22	Turbine	Following scheduled maintenance, the pump failed to start remotely due to tripped overload contacts in the trip and throttle valve motor operator circuit.
01/22/83	83-02	Diesel	AFW pumps were manually shut down due to high steam generator levels. When restart was attempted, the diesel-driven pump would not start because it had locked out on low lube oil pressure.
		Turbine	The steam-driven pump started but tripped on overspeed.
10/03/80	80-20	Both	Both pumps failed to respond to an auto start signal from lo-lo steam generator level following a reactor trip. The auto start from low-low level was inadvertently disabled due to a wiring error.
09/03/80	80-18	Diesel	Pump would not start during periodic testing due to a bad cell in the starting battery.
07/20/80	80-15	Turbine	Pump would not start on a manual start signal because the trip and throttle valve did not open. The motor operator torque switch was improperly set following maintenance.
10/19/76	76-65	Turbine	Pump failed to auto start when the main feed pumps were secured during a normal reactor shutdown. The trip and throttle valve was not properly reset following the previous shutdown.
09/03/76	76-57	Diesel	Pump failed to start on low-low steam generator level after a reactor trip due to a blown fuse in the automatic start circuit.

EVENT DATE	LER	PUMP	DESCRIPTION
02/29/76	76-17	Both	Following an auto start signal after a reactor trip, turbine trip and steam generator low-low level signal, both pumps apparently started and immediately tripped on overspeed.
02/27/76	76-16	Turbine	Pump started but immediately tripped on overspeed in three attempts. Apparent design deficiency in not providing control oil to the governor during the initial phases of cold starts.
02/17/76	76-15	Turbine	Pump failed to start during testing because of stem binding in the motor-operated trip and throttle valve.
02/09/76	76-19	Diesel	When started automatically in auto speed control, the pump tripped on overspeed due to changes in engine conditions (oil and "ater temperatures) since the previous governor alignment.
01/23/76	76-12	Diesel	Pump failed to start on first attempt due to a low lube oil pressure before the pump reached operating speed. A 24-second time delay was added to the low lube oil pressure circuit.
01/16/76	76-06	Both	A lifted lead to allow steam generator blowdown with the main feed pumps tripped disabled the main feed pump trip auto start signal to the AFW pumps. One pump was manually started.
12/24/75	76-04	Diesel	Following a planned reactor trip, the diesel pump failed to auto start after the main feed pumps were tripped. The fuel racks had not been reset following the previous shutdown.
12/19/75	76-01	Diesel	Operator attempted to start the diesel-driven pump after experiencing difficulty in controlling the speed of the turbine-driven pump. The diesel pump failed to start due to improper sequence of switch operations following the previous shutdown.

AUXILIARY FEEDWATER PUMPS
FAIL TO RUN EVENTS

EVENT DATE	LER	PUMP	DESCRIPTION
07/20/85	85-09	Both	Pumps tripped on low suction pressure.
08/20/83	83-12	Diesel	Following a reactor trip and AFW pump auto start, the pump tripped on overspeed.
12/28/78	78-28	Diesel	Pump was running to maintain steam generator level in Mode 3 when a fitting on the 3/8-inch fuel line ruptured.
12/17/77	77-45	Diesel	The pump was manually started in Mode 3 but immediately tripped on overspeed due to an out of adjustment microswitch in the speed sensing circuit.
03/24/77	77-06	Diesel	Both pumps were running in Mode 2 when the diesel pump tripped due to a broken crankshaft.
10/05/76	76-60	Turbine	While being tested after maintenance (bearing inspection), the pump tripped on overspeed due to a failure in the governor speed sensor circuit.
09/02/76 and 09/09/76	76-56	Diesel	In Mode 1 on September 2, and in Mode 2 on September 9, the pump tripped on high jacket water temperature. A loose spring in the temperature switch caused a faulty setpoint calibration.
03/28/76	76-24	Diesel	Both pumps were started manually. The diesel engine ran for approximately 30 seconds but tripped on overspeed when the idle hold was removed. The cause was faulty governor design resulting in a variable overspeed governor setpoint.
02/14/76	76-14	Turbine	The pump was idling on recirc in Mode 2 with feedwater supplied by the diesel pump. The turbine-driven pump tripped on overspeed due to circuit failures in the governor.
02/14/76	76-13	Diesel	In Mode 2, the diesel driver tripped on high cooling water temperature. The water temperature switch was improperly set at 154°F.

Attachment B
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EVENT DATE	LER	PUMP	DESCRIPTION
01/04/76	76-05	Diesel	Pump tripped on overspeed due to an electrical connection in the speed governor circuit that had vibrated loose.
12/19/75	76-02	Turbine	Pump was secured due to severely oscillating discharge pressure and impulse pressure. Turbine journal and thrust bearings were damaged due to a broken shaft in the AFP lube oil pump.

ASSOCIATED LERS (NOT INVOLVING FAIL TO START/RUN)

EVENT DATE	LER	PUMP	DESCRIPTION
11/09/84	85-01	Both	Incomplete seismic qualification of AFW control valve control elements.
03/20/84	84-05	Both	Auto start signals disabled while running PICT; B train out of service for maintenance.
12/15/81	81-32	Diesel	QA audit determined that diesel AFW pump day tank level verification had been deleted from a POT.
12/12/80	81-01	Turbine	Discovered a blown fuse in the control power circuit for the vent supply fan to the pump room.
10/11/80	80-24	Diesel	While troubleshooting a steam generator sample valves problem, discovered a blown fuse in the automatic start circuit.
07/01/80	80-12	Turbine	Engineering walkdown identified three missing seismic pipe restraints on a steam drain line.
02/07/80	80-02	Diesel	Routine inspection identified a broken flexible jacket cooling water hose.
04/15/79	79-06	Diesel	Routine inspection identified a crack in a fuel line fitting, apparently caused by vibration.
04/26/78	78-16	Turbine	Routine inspection identified a missing seismic restraint on the steam supply line.
12/17/77	77-46	Turbine	The pump was manually tripped when it was no longer needed in Mode 3. A faulty limit switch in the overspeed circuit prevented placing the pump in standby to be ready for auto start.
11/27/77	77-43	Diesel	The feedwater isolation valve between the diesel pump and the B steam generator failed in the open position.

ARA/3kal
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Attachment B
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8-40-265

INTER-OFFICE COMMUNICATION

PORTLAND GENERAL ELECTRIC COMPANY

Date August 7, 1985
CAO-30-85

To W. S. Orser

From C. A. Olmstead

Subject Results of QA Evaluation of Testing Requirements Associated with AFW Pumps and Safety-Related Modifications Completed during the 1985 Refueling Outage

As a result of previous low suction pressure problems with the safety-related AFW pumps and a recent trip of both pumps on July 20, 1985, you requested the QA organization to independently evaluate the adequacy of testing requirements in the following areas:

- Modifications involving the AFW pumps;
- Modifications involving safety-related equipment completed during the 1985 refueling outage;
- History of AFW pump low suction pressure problems.

The following summarizes the results of our evaluation.

To perform our evaluation, completed as-built documentation was reviewed to verify that adequate functional tests were specified to assure satisfactory system operation.

It was also verified that adequate time was available for personnel to review the Detailed Construction Package (DCP) for implementing plant modifications and provide adequate test requirements. The average time between DCP issuance by Nuclear Plant Engineering (NPE) and Plant Supervisory review of the associated Maintenance Request was 1-1/2 months.

Modifications Involving AFW Pumps and Safety-Related Equipment

Although testing appeared to be adequate, a number of items were identified as weaknesses in the overall test program. These items are listed below for consideration by PGE management:

1. Nuclear Division and plant procedures do not adequately assign the responsibility for providing test requirements to one specific group or organization within PGE. During our review of Maintenance Requests associated with modifications, it was noted that test procedures were specified by NPE and subsequently changed by plant engineers and the cognizant work supervisor involved in the modification process.

Attachment C
Page 1 of 5

2. Nuclear Division and plant procedures do not describe adequate test controls:

   a. A formalized method for determining test requirements is not provided for those individuals tasked with this responsibility.

   b. Test procedures were noted as being changed on Maintenance Requests without documented evidence that the originator agreed with the change.

   c. Numerous field changes were noted as being made to modifications without documented evidence of formal evaluations of their effects on test requirements.

3. Plant procedure AO-3-9 (Maintenance Requests) does not differentiate between the type of test responsibilities and controls required for normal maintenance or system modifications. AO-3-9 describes test responsibilities and controls for the cognizant work group supervisor but does not address engineering responsibilities in this area.

On the basis of these identified weaknesses, the following recommendations are made by the QA organization to improve controls within the test program:

1. NDP 200-1 (Design Change Control) should be revised to clearly identify the specific organization responsible for establishing test requirements.

2. NDP 200-1 should provide a more definitive/formal test program, including detailed instructions for determining test requirements for modifications and maintenance activities.

3. AO-3-9 (Maintenance Request) should be revised to differentiate test responsibilities and controls for normal maintenance and modifications.

4. Plant personnel should be reminded of the importance of identifying potential plant problems by using the "Request for Evaluation" (RFE) System. Through discussions with Operations and Maintenance personnel it was implied that various problems were previously identified regarding the AFW system over a long period for which no corrective actions were taken. From our review of "Plant Problem Reports" and RFE reports, there was no evidence that this was the case.

5. The proposed Maintenance and Reliability Program which establishes the system engineering concept is encouraged. It is believed that this would be a positive step toward improving the existing process of identifying functional test requirements for repaired or modified equipment/systems. In the majority of cases it appears that only two persons from plant

engineering are involved in the review of modifications for establishing adequate test requirements. These two individuals must have knowledge of all plant disciplines as well as adequate time to perform a satisfactory review.

History of AFW Pump Low Suction Pressure Problems

The final portion of this report details a history of AFW pump low suction pressure trip problems that occurred since 1979. From the results of our review in this area, it was determined that NPE and plant personnel were aware of the need for testing of both AFW pumps on autostart in 1980. At that time, it was decided to not test both AFW pumps simultaneously. This appeared to be a conscientious decision made by management based on engineering judgement and economic restraints.

A history of the AFW events and our recommendations are noted below for management information and consideration:

1. 8/30/79 - The RDC 79-063 Design Review Report identified a deficiency. It stated that measurements should be taken at the suction of both AFW pumps during different modes of operation.

2. 4/21/80 - A meeting was held between Trojan and Generation Engineering staff members. Various solutions to prevent pumps tripping on low suction pressure during auto start were discussed. Difficulties in testing during auto start also were discussed.

3. 5/7/80 - Memorandum SRC-995-80M from Generation Engineering to Trojan General Manager stated that testing by auto starting both AFW pumps would not be done. Reasons given were "the difficult plant conditions required and the severe transient which could be imposed upon the plant".

   Translation - It's too hard.

4. 8/7/80 - A memorandum from PRB Chairman (and approved by plant General Manager) to Generation Engineering requested evaluation of either replacing the existing line with a larger Seismic I qualified pipe or installing a second parallel condensate feed line.

5. 9/10/80 - In memorandum JWL-383-80M, the Manager, GLAD, responded to the PRB Chairman's memorandum. The memorandum stated that the low pressure suction trip and the throttling of each AFW pump discharge to 650 GPM upon startup was adequate. The memorandum also stated that the "Operational Test Program should demonstrate that the trip system installed functions properly under the full range of anticipated plant conditions."

6. 10/23/80 - An NRC letter provided the Safety Evaluation Review for the Trojan AFW System. It contained a requirement to "verify the ability of each safety grade AFW pump to feed all four steam generators following an extended plant outage." PGE did not interpret this to require a simultaneous auto start of both pumps.

7. 9/23/84 - During a PRB meeting, the Plant QA Supervisor asked if both AFW pumps should be started simultaneously for testing the functioning of the low suction pressure trips. The answer was no. The emphasis was placed on testing the operation of the low suction pressure instrumentation. No action or follow up to this question was evident in subsequent data reviewed.

Summary

1. The low suction pressure trips were installed to protect the AFW pumps in case of a seismic caused rupture of the suction line or the Condensate Storage Tank or any blockage of the suction line. The net result has been:

   a. A degradation in the reliability of the pumps.

   b. A requirement for operator action following an auto start to adjust the AFW flow.

2. The AFW pumps were never tested under simultaneous auto start conditions and varying CST levels until July 1985.

Recommendations

1. Conduct a simultaneous auto start test of both AFW pumps following extended outages at minimum CST level.

2. Strengthen the design change process to ensure that all necessary and relevant post installation testing is prescribed. A specific management review of the testing requirements contained in the DCP should be performed.

3. Increase emphasis on management follow-up and coordination of identified potential problems. As noted above, there was ample evidence prior to the July 20, 1985 event that testing of the AFW system may have been inadequate. Additionally, there is evidence that management reviews sometimes took the most expeditious or economical approach to solving problems without sound safety basis.

In conjunction with our evaluation, a concern was raised regarding the reason for Main Feed System isolation following a reactor trip and Lo Tavg. The basis for our concern is described below with a recommendation for NSRD action in this area.

Main Feed System Isolation

Isolation of the main feed system occurs during all reactor trips. The isolation happens when Tavg reaches 564° F as the plant cools due to control rod insertion and supply of feed water to the steam generators. The primary operational concern during this time is to restore level indication in at least one steam generator to the narrow range. The plant temperature is expected to stabilize at the no-load Tavg of 557° F. In practice, the steam generator fill is started with the main feed pumps and completed with AFW pumps. During the plant trip on July 20, 1985, the P-2500 computer data shows that plant temperature stabilized at 554° F about seven minutes after the trip. This sequence of events produces the following results:

1. Reactor plant temperature drop is not impeded in its progress from full load to no load Tavg.

2. The AFW system is challenged by each reactor trip - regardless of reason for the trip.

3. The feed and condensate systems experience a severe water hammer. Operators routinely depart the area upon announcement of a reactor trip.

Recommendation

NSRD review the reasons for the main feed system isolation following a reactor trip and Lo Tavg. It should be determined if the reasons are still valid in light of current plant operating practices and the undesirable consequences of the feed system isolation. Consideration should also be given to reducing challenges to the ESF equipment when the non-ESF AFW pump is available.

JLD/CHB:mih

c: TNOB Members
R. W. Griebe
F. H. Lamoureaux
J. W. Lentsch
W. S. Orser
R. L. Steele
T. D. Walt
B. D. Withers
C. P. Yundt
P. A. McMillan
NQAD File (Review, 8/85)

QARID No. 7.3.2.15 T

Attachment C
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