D/F 50-335

SEPTEMBER 2 1 1979

Docket No. 50-335

Mr. Robert E. Uhrig, Vice-President
Advanced Systems and Technology
Florida Power and Light Company
P. O. Box 529100
Miami, Florida 33152

Dear Mr. Uhrig:

SUBJECT: NRC REQUIREMENTS FOR AUXILIARY FEEDWATER SYSTEMS AT ST. LUCIE UNIT 1

The purpose of this letter is to advise you of our requirements for the auxiliary feedwater systems at the subject facility. These requirements were identified during the course of the NRR Bulletins and Orders Task Force review of operating reactors in light of the accident at Three Mile Island, Unit 2.

Enclosure 1 to this letter identifies each of the requirements applicable to the subject facility. These requirements are of two types, (1) generic requirements applicable to most Combustion Engineering-designed operating plants, and (2) plant-specific requirements applicable only to the subject facility. Enclosure 2 contains a generic request for additional information regarding auxiliary feedwater system flow requirements.

The designs and procedures of the subject facility should be evaluated against the applicable requirements specified in Enclosure 1 to determine the degree to which the facility currently conforms to these requirements. The results of this evaluation and an associated schedule and commitment for implementation of required changes or actions should be provided for NRC staff review within thirty days of receipt of this letter. Also, this schedule should indicate your date for submittal of information such as design changes, procedure changes or Technical Specification changes to be provided for staff review. You may also provide your response to the items in Enclosure 2 at that time.

In addition to the requirements identified in this letter, other requirements which may be applicable to the subject facility are expected to be generated by the Bulletins and Orders Task Force. Such requirements are those resulting from our review of the loss-of-feedwater event and the small break loss-of-coolant accident as described in the Combustion Engineering report CEN-114-P (Amendment 1-P)

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entitled, "Review of Small Break Transients in Combustion Engineering Nuclear Steam Supply Systems." Our specific concerns include systems reliability (other than the auxiliary feedwater system), analyses, guidelines and procedures for operators, and operator training.

We plan to identify, in separate correspondence, the requirements resulting from the additional items from the Bulletins and Orders Task Force review.

Sincerely,

Original signed by
Darrell G. Eisenhut

Darrell G. Eisenhut, Acting Director
Division of Operating Reactors
Office of Nuclear Reactor Regulation

Enclosures:
As stated

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cc:
Robert Lowenstein, Esquire
Lowenstein, Newman, Reis & Axelrad
1025 Connecticut Avenue, N.W.
Washington, D. C. 20036

Norman A. Coll, Esquire
McCarthy, Steel, Hector & Davis
14th Floor, First National Bank Building
Miami, Florida 33131

Mr. Jack Shreve
Office of the Public Counsel
Room 4, Holland Bldg.
Tallahassee, Florida 32304

Indian River Junior College Library
3209 Virginia Avenue
Fort Pierce, Florida 33450

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

October 17, 1979

Docket No. 50-335

Mr. Robert E. Uhrig, Vice-President
Advanced Systems and Technology
Florida Power and Light Company
P. O. Box 529100
Miami, Florida 33152

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Sincerely,

Darrell G. Eisenhut, Acting Director
Division of Operating Reactors
Office of Nuclear Reactor Regulation

Enclosures:
As stated

cc: see next page

Combustion Engineering Owners Group Representatives

Mr. G. E. Liebler, Chairman
Combustion Engineering Owners Group
Florida Power and Light Company
P. O. Box 013100
Miami, Florida 33101

Mr. Joseph K. Gasper, Vice Chairman
Combustion Engineering Owners Group
Omaha Public Power District
Fourth & Jones
Omaha, Nebraska 68108

Mr. John Garrity, Chairman
Guidelines Subgroup
Maine Yankee Atomic Power Company
Edison Drive
Augusta, Maine 04336

Mr. Robert G. Harris, Chairman
Analysis Subgroup
Northeast Utilities Service Co.
P. O. Box 270
Hartford, Connecticut 06101

Mr. David S. Van de Walle
Consumers Power Company
212 West Michigan Avenue
Jackson, Michigan 49201

Mr. William Szymczak
Yankee Atomic Power Company
25 Research Drive
Westboro, Massachusetts 01581

Mr. J. T. Enos
Arkansas Power & Light Company
P. O. Box 551
Little Rock, Arkansas 72203

Combustion Engineering Principal Contact Listing

Mr. David Bixel
Nuclear Licensing Admiistrator
Consumers Power Company
212 West Michigan Avenue
Jackson, Michigan 49201

Mr. William Cavanaugh, III
Executive Director of Generation
and Construction
Arkansas Power & Light Company
P. O. Box 551
Little Rock, Arkansas 72203

Mr. A. E. Lundvall, Jr.
Vice-President - Supply
Baltimire Gas & Electric Company
P. . Box 1475
Baltimore, Maryland 21203

Mr. Theodore E. Short
Assistant General Manager
Omaha Public Power District
1623 Harney Street
Omaha, Nebraska 68102

Mr. Robert H. Groce
Licensing Engineer
Yankee Atomic Electric Company
20 Turnpike Road
Westboro, Massachusetts 01581

Mr. W. G. Counsil, Vice-President
Nuclear Engineering & Operations
Northeast Nuclear Energy Company
P. O. Box 270
Hartford, Connecticut 06101

Dr. Robert E. Uhrig, Vice-President
Advanced Systems & Technology
Florida Power & Light Company
P. O. Box 529100
Miami, Florida 33152

cc:
Robert Lowenstein, Esquire
Lowenstein, Newman, Reis & Axelrad
1025 Connecticut Avenue, N.W.
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ENCLOSURE 1

X.7 ST. LUCIE UNIT 1

AUXILIARY FEEDWATER SYSTEM

X.7.1 System Description

X.7.1.1 Configuration, Overall Design

A simplified flow diagram of the St. Lucie auxiliary feedwater system (AFWS) is shown in Figure 1. The AFWS consists of one full capacity turbine-driven pump (500 gpm @ 1200 psi) and two half capacity (250 gpm @ 1200 psi) motor-driven pumps. One turbine pump or both motor driven pumps are required to adequately remove decay heat. The turbine-driven pump supplies feedwater to two steam generators (SG) by means of two separate lines each with its own motor operated control valve. Each motor-driven pump normally supplies feedwater to one steam generator. A cross connection with two remote manual normally closed isolation valves is provided to enable the routing of feed flow of the two motor driven pumps to either steam generator. The AFWS is manually started from the control room. The AFW system can supply water to the SG(s), assuming a single active component failure with loss of offsite or onsite power. The licensee states that the AFWS is capable of cooling the plant down to the condition where the shutdown cooling system can be used to continue the safe plant shutdown process.

The primary water supply of the AFWS is maintained in a 250,000 gal.

seismic Category 1 condensate storage tank (CST) connected to the pumps' suction by redundant lines with locked open manual valves. A minimum of 168,000 gal. is reserved strictly for the AFWS by administrative control. The reserved water inventory is sufficient to maintain the plant at hot standby condition for 8 hours following a reactor trip, and subsequently cool the plant down to the shutdown cooling system cut-in temperature.

Low water level in the CST will alarm and annunciate in the main control room. The AFW pump suctions are connected only to the CST. Additional water may be supplied either from the SG Blowdown Monitor Storage Tank or the city water tanks via the CST as shown in Figure 1. Supplying water from these alternate sources requires considerable operator action and is estimated to take 3 hours to accomplish.

X.7.1.2 Components - Design, Classification

All components of the AFWS, including the primary water supply, are designed to seismic Category 1 requirements.

X.7.1.3 Power Sources

The steam turbine driven pump uses steam from the main steam lines taken upstream of each main steam isolation valve (MSIV) and exhausts to the atmosphere. The steam is supplied via an AC powered motor operated valve (MOV) from each steam generator. These valves are normally closed and fail as-is. Downstream of these valves there is a single

steam supply header with a DC powered MOV which is normally closed and fails as-is. The two motor driven pumps are powered from the Division A and B emergency diesel generators respectively in case of a loss of normal AC power.

X.7.1.4 Instrumentation and Controls

X.7.1.4.1 Controls

The control of auxiliary feedwater flow and steam generator water level is accomplished from the control room by remote manually operated control valves. A local control station is provided to facilitate plant shutdown if the control room is not accessible. All manually operated valves in the AFWS are locked open. The motor operated valves will fail in the "as-is" position.

X.7.1.4.2 Information Available to Operator

The important information available to the operator includes AFW discharge header flow, AFW discharge header pressure, CST level, steam generator level, steam pressure to steam driven AFW pump, and control valve position indication.

Additional information available is listed in the following instrument list:

Auxiliary Feedwater Parameters Available on RTGB 102. Vertical Section

1. Aux Feedwater Flow, Header 'A' FI-09-2A
2. Aux Feedwater Flow, Header 'B' FI-09-2B

3. Aux Feedwater Flow, Header 'C' FI-09-2C
4. Aux Feedwater Press. Header 'A' PI-09-8A
5. Aux Feedwater Press. Header 'B' PI-09-8B
6. Aux Feedwater Press. Header 'C' PI-09-8C
7. Steam Press. to Aux Feedpump 'C' PI-08-5
8. Condensate Storage Tank Level LIS-12-11
9. Aux Feed Pump '1A' Amperes
10. Aux Feed Pump '1B' Amperes

Auxiliary Feedwater Parameters on RTGB 102-Horizontal Section

1. AFW Pump 1A disch steam generator (SG) 1A MV-09-9 Switch and valve position lights.
2. AFW pump 1B disch to SG 1B MV-09-10 - switch and valve position lights.
3. AFW pump 1C disch to SG 1A MV-09-11 - switch and valve position lights.
4. AFW pump 1C Disch to SG 1B MV-09-12 - switch and valve position lights.
5. AFW pump 1A disch to SG 1B MV-09-13 - switch and valve position lights. (crossconnect valve)
6. AFW 1B disch to SG 1A MV-09-14 - switch and valve position lights. (crossconnect valve)
7. Start and stop switches for 1A, 1B and 1C Aux Feed Pumps and indicator lights.
8. 1C Aux Feed Pump speed controller and speed indicator.

9. 1C Aux Feed Pump steam inlet from 1A main steam line, MV-08-14 indicator lights.
10. 1C Aux Feed Pump steam inlet from 1B main steam line MV-08-13 indicator lights.
11. 1C Aux Feed Pump steam inlet MV-08-3 indicator lights.

X.7.1.4.3 Initiating Signals for Automatic Operation

The St. Lucie AFWS is a manually started system. In the event of a loss of main feedwater pumps or offsite power, followed by reactor trip the licensee estimates that the operator has approximately 13 minutes in which to start the AFW pump and open the AFW flow control valves to the steam generators to prevent the steam generators from boiling dry.

X.7.1.5 Testing

Each month the motor operated feed water valves are cycled from closed to full open to closed, after which each pump is started and operated at least 15 minutes. Specified minimum discharge pressure is verified while the pumps are operating. No manual valve lineup changes are required for this testing. Condensate storage tank level is verified at or above minimum at least once per 12 hours.

X.7.1.6 Technical Specifications

1. The two motor driven AFW pumps and the steam turbine driven AFW pump are all required to be operable when the reactor coolant system is above 325°F, the maximum operating temperature of the shutdown cooling system.

2. If any one pump is inoperable, it must be returned to operable status within 72 hours or the plant must be placed in hot standby within 12 hours.

3. If two or more pumps are inoperable, the plant must be in hot standby within 1 hour and in cold shutdown within 30 hours unless at least one pump is returned to operation and the unit is back under 2 above using the time intervals of the initial discovery.

4. The CST is required to have minimum volume of 116,000 gallons when the RCS temperature is above 325°F. If the volume is below minimum it must be restored within 4 hours or the plant must be in hot standby within the next 6 hours and in cold shutdown within the following 30 hours.

X.7.2 Reliability Evaluation Results

X.7.2.1 Dominant Failure Modes

The St. Lucie Unit 1 AFWS consists of two subsystems, i.e, one subsystem of two one-half capacity motor-driven pumps and another subsystem of a single full capacity turbine-driven pump. Either subsystem, when delivering its pumping capacity to at least one steam generator can provide for adequate decay heat removal for the three loss of main feedwater events considered.

The following failure modes were found to dominate the demand unavailability of the St. Lucie AFWS:

- Loss of feedwater (LOFW) with offsite AC available

  Failure to manually actuate the St. Lucie Unit 1 AFWS, was assessed to be the dominant failure mode and this fault contribution to the overall AFWS unavailability is estimated to be approximately 80 percent.

- LOFW with only onsite AC available

  St. Lucie Unit 1 uses a swing tie bus ("AB") that furnishes AC power to valves in the steam turbine driven portion of the AFWS. This bus is interlocked to prevent tie to more than one emergency diesel generator (EDG) simultaneously. The "AB" bus is normally tied to the "A" EDG. Thus, the limiting EDG failure would be failure of the "A" EDG. This failure requires human action to transfer bus "AB" to the available "B" EDG. The impact of this human action on the overall AFWS was assessed and found not to significantly alter the above results. Thus, failure to manually actuate AFWS remains the common dominant failure mode identified.

- LOFW with only DC available

  For this event, the St. Lucie Unit 1 AFWS design requires a plant operator to proceed to the local valve stations for the steam turbine driven train of the AFWS and open four AC motor

operated valves (2 steam and 2 water) that are normally closed. The licensee assessment of accessibility and the opening times indicate that this operation could be successfully accomplished by two men in about 5 minutes and one man in about 10 minutes. Human failure to open these valves has been assessed as the dominant fault contributor (~60%) for this event.

X.7.2.2. Principal Dependencies

The principal dependencies identified were those associated with human actions required to actuate the St. Lucie Unit 1 AFWS for the above three events.

X.7.3 Recommendations for this Plant

The short-term recommendations identified in this section represent actions to improve AFW system reliability that should be implemented by January 1, 1980, or as soon thereafter as is practicable. In general, they involve upgrading of Technical Specifications or establishing procedures to avoid or mitigate potential system or operator failures. The long-term recommendations identified in this section involve system design evaluations and/or modifications to improve AFW system reliability and represent actions that should be implemented by January 1, 1981, or as soon thereafter as is practicable.

X.7.3.1 Short-Term Recommendations

1. 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 operator when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:

   - 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,

   - 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.

2. Recommendation GS-5 - The plant should be capable of providing the required AFW flow for at least two hours from one AFW pump train independent of any alternating 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 sources 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.)

3. 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:

   - 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.
   - The licensee should propose Technical Specifications to assure that prior to plant startup 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 their normal alignment.

4. Recommendation GS-8 - The licensee should install a system to automatically initiate AFW system flow. For the short term, this system need not be safety-grade; however, it should meet the criteria listed below, which are similar to Item 2.1.7a 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-1.

   - The design should provide for the automatic initiation of the auxiliary feedwater system flow.
   - 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.
   - Testability of the initiating signals and circuits should be a feature of the design.
   - The initiating signals and circuits should be powered from the emergency buses.
   - 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.

- 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.
- 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.

X.7.3.2 Additional Short-Term Recommendations

The following additional short-term recommendations resulted from the staff's Lesson Learned Task Force review and the Bulletins and Orders Task Force review of AFW systems at Babcock & Wilcox-designed operating plants subsequent to our review of the AFW system designs at W- and C-E-designed operating plants. They have not been examined for specific applicability to this facility.

1. Recommendation - The licensee should provide redundant level indications 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.

2. 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.

3. 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 auxiliary feedwater flow to each steam generator shall be provided in the control room.
>
> The auxiliary feedwater flow instrument channels shall be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the auxiliary feedwater system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9."

4. Recommendation - Licensees with plants which require local manual realignment of valves to conduct periodic tests on one AFW system train, and there is 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 train from the test mode to its operational alignment.

X.7.3.3 Long-Term Recommendations

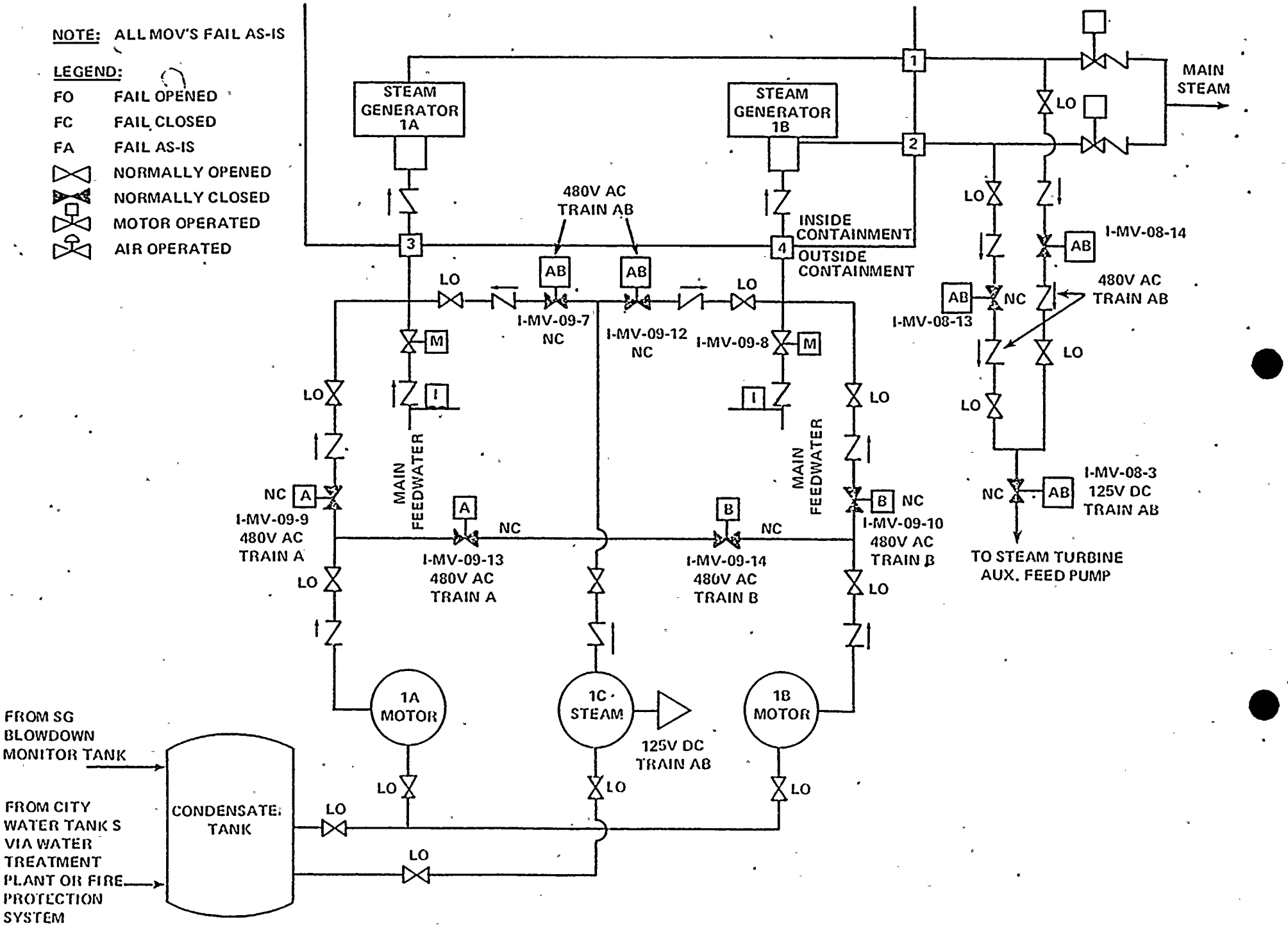
Long-term recommendations for improving the system are as follows:

1. Recommendation - GL-1 - Licensees with plants having a manual starting AFW system, 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.

2. 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 2 hours. Conversion of direct current power to alternating current is acceptable.

3. Recommendation - The present method of supplying water from the alternate water sources to the CST for the AFWS requires considerable operator action and is estimated to take approximately three hours to accomplish. The licensee should modify the design to provide means to supply water to the AFWS from the alternate sources within one-half hour or less.

4. Recommendation - The St. Lucie plant needs one full capacity train of AFW flow (2 motor-driven or 1 turbine-driven AFW pump) for safe plant shutdown. This AFWS design does not meet the high energy line break criteria in SRP 10.4.9 and Branch Technical Position 10-1; namely that the AFWS should maintain the capability to supply the required AFW flow to the steam generator(s) assuming a pipe break anywhere in the AFW pump discharge lines plus a single active failure. The licensee should (1) complete an evaluation assuming such an event and determine any AFW system modifications or procedures necessary to maintain the required AFW flow to the steam generator(s), or (2) describe how the plant can be brought to a safe shutdown condition by use of other available systems following such a postulated event.



Auxiliary Feedwater System
St. Lucie, Unit 1
Figure 1

ENCLOSURE 2

Basis for Auxiliary Feedwater
System Flow Requirements

As a result of recent staff reviews of operating plant Auxiliary Feedwater Systems (AFWS), the staff concludes that the design bases and criteria provided by licensees for establishing AFWS requirements for flow to the steam generator(s) to assure adequate removal of reactor decay heat are not well defined or documented.

We require that you provide the following AFWS flow design basis information as applicable to the design basis transients and accident conditions for your plant.

1. a. Identify the plant transient and accident conditions considered in establishing AFWS flow requirements, including the following events:

   1) Loss of Main Feed (LMFW)
   2) LMFW w/loss of offsite AC power
   3) LMFW w/loss of onsite and offsite AC power
   4) Plant cooldown
   5) Turbine trip with and without bypass
   6) Main steam isolation valve closure
   7) Main feed line break
   8) Main steam line break
   9) Small break LOCA
   10) Other transient or accident conditions not listed above

   b. Describe the plant protection acceptance criteria and corresponding technical bases used for each initiating event identified above. The acceptance criteria should address plant limits such as:

- Maximum RCS pressure (PORV or safety valve actuation)
- Fuel temperature or damage limits (DNB, PCT, maximum fuel central temperature)
- RCS cooling rate limit to avoid excessive coolant shrinkage
- Minimum steam generator level to assure sufficient steam generator heat transfer surface to remove decay heat and/or cool down the primary system.

2. Describe the analyses and assumptions and corresponding technical justification used with plant condition considered in 1.a. above including:

   a. Maximum reactor power (including instrument error allowance) at the time of the initiating transient or accident.

   b. Time delay from initiating event to reactor trip.

   c. Plant parameter(s) which initiates AFWS flow and time delay between initiating event and introduction of AFWS flow into steam generator(s).

   d. Minimum steam generator water level when initiating event occurs.

   e. Initial steam generator water inventory and depletion rate before and after AFWS flow commences - identify reactor decay heat rate used.

f. Maximum pressure at which steam is released from steam generator(s) and against which the AFW pump must develop sufficient head.

g. Minimum number of steam generators that must receive AFW flow; e.g. 1 out of 2?, 2 out of 4?

h. RC flow condition - continued operation of RC pumps or natural circulation.

i. Maximum AFW inlet temperature.

j. Following a postulated steam or feed line break, time delay assumed to isolate break and direct AFW flow to intact steam generator(s). AFW pump flow capacity allowance to accommodate the time delay and maintain minimum steam generator water level. Also identify credit taken for primary system heat removal due to blowdown.

k. Volume and maximum temperature of water in main feed lines between steam generator(s) and AFWS connection to main feed line.

l. Operating condition of steam generator normal blowdown following initiating event.

m. Primary and secondary system water and metal sensible heat used for cooldown and AFW flow sizing.

n. Time at hot standby and time to cooldown RCS to RHR system cut in temperature to size AFW water source inventory.

3. Verify that the AFW pumps in your plant will supply the necessary flow to the steam generator(s) as determined by items 1 and 2 above considering a single failure. Identify the margin in sizing the pump flow to allow for pump recirculation flow, seal leakage and pump wear.

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