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

OCTOBER 1 8 1979

Docket Nos.: 50-282
50-306

Mr. L. O. Mayer, Manager
Nuclear Support Services
Northern States Power Company
414 Nicollet Mall - 8th Floor
Minneapolis, Minnesota 55401

Dear Mr. Mayer:

SUBJECT: NRC REQUIREMENTS FOR AUXILIARY FEEDWATER SYSTEMS AT PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2

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 Westinghouse-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 Westinghouse report WCAP-9600, "Report on Small

Break Accidents for Westinghouse NSSS System." 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,

Edward F Jordan/for

Darrell G. Eisenhut, Acting Director
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Enclosures:
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ENCLOSURE 1

X.10 (W) PRAIRIE ISLAND 1 & 2

AUXILIARY FEEDWATER SYSTEM

X.10.1 System Description

X.10.1.1 Configuration and Overall Design

The auxiliary feedwater system (AFWS) is designed to supply water to the steam generators for reactor coolant system decay heat removal when the normal feedwater system is not available. It is also used for plant startups and shutdown (below the point where main feed system flow capacity is not required).

The AFWS is shown in simplified form on Figure 1. The system consists of two steam turbine-driven pumps 11 and 22, (220 gpm rated flow with 20 gpm recirculation flow each), one for each unit, capable of delivering feedwater to either or both steam generators of the same unit. There is no interconnection between the discharge line of the two turbine-driven pumps of either unit. In addition, there are two motor-driven pumps 12 and 21 (220 gpm rated flow with 20 gpm recirculation flow each), one for each unit, capable of delivering feedwater to either or both steam generators of the same unit. Referring to Figure 1 pumps 11 and 12 are normally lined up to feed the steam generators of Unit #1, pumps 21 and 22 are normally lined up to feed the steam generators of Unit #2. The two motor-driven pump discharge headers are interconnected by two normally closed

valves. By opening these valves the Unit #1 pump #12 can supply water to Unit #2 steam generators or the Unit #2 pump #21 can supply water to Unit #1 steam generators.

Normal feedwater supply to the auxiliary feedwater pumps consists of 150,000 gallon condensate storage tanks, one for Unit 1, two for Unit 2 with a common (isolable) header. A backup water supply to the pumps is provided by the cooling water system. The cooling water system consists of five pumps, 2000 gpm capacity each - three motor driven, two diesel driven. Normally two motor driven pumps are operating. Actuation of the third motor driven pump is automatic on low cooling water header pressure. If low discharge pressure persists (~75 psi) and/or AC power is lost, the diesel driven pumps are automatically started. In addition, 260 gpm of water can be supplied via the non-seismic demineralized water treatment system to the condensate storage tank(s).

The AFW system is automatically actuated. The licensee states that the steam generators would lose their ability to transfer heat in approximately 40 minutes. The valves in the AFWS lines to the steam generators are motor operated and are normally open. The steam admission valve in the steam supply line to the steam turbine is motor operated and is normally closed. Two steam supply valves, one from each steam generator, are motor operated and are normally open.

X.10.1.2 Component Design Classification

The turbine pump trains and motor pump trains (pumps, valves, motors, piping) are seismic Category I, tornado missile protected and designed to Quality Group I. Electrical equipment is designed as Class IE.

The sources of water and associated piping are classified as follows:

1. Condensate storage tank (Unit 1)
   Condensate storage tanks (Unit 2) } Type 3 (Non-seismic)
2. Cooling Water System - Seismic Category I, Tornado Missile Protected
3. Suction Piping
   from condensate storage tanks - Class 2B (non-seismic)
   from cooling water system (seismic - Category 1)
4. Demineralized water treatment system (non-seismic)

X.10.1.3 Power Sources

The motor driven pumps are supplied from the Class IE emergency buses, (Bus #16 - Train B for #12 pump, Bus 26 - Train A for #21 pump) Motor operated valve (MOV) power is from the emergency buses on a train basis. The emergency buses are capable of being powered from the diesel generators. Steam for the turbine driven pumps is supplied from each steam generator of the respective reactor unit.

The instrumentation and control power supplies are from the 120 VAC vital bus system. There are four vital buses/unit, each supplied by an inverter connected to the 480 VAC emergency bus and the 125 VDC

power system. The motor driven pump breaker controls are powered from the 125 VDC control batteries which are charged by battery chargers connected to the 480 VAC emergency buses.

X.10.1.4 Instrumentation and Control

Controls

Any of the MOV's can be controlled from either the Main Control Room or the Hot Shutdown Panel (local station).

Steam generator level is controlled by positioning the MOV's in the flow discharge lines. Level and flow indication is provided for operator information.

The valves are motor operated and fail as-is on loss of power.

X.10.1.4.1 AFW System Information Available to the Operator (At both remote and local stations except as noted)

1. MOV Position
2. S/G Level and pressure indication (alarm-control room only)
3. S.I. Ready Panel-abnormal valve position and AFW pump operability status-(control room only)
4. Discharge Pressure
5. Discharge Flow
6. CST Level Indication (low level alarm-control room only)

X.10.1.4.2 Initiating Signals for Automatic Operation

The following signals start the pump motors and open the steam admission control valve to the turbine of the affected unit:

1. Low-low water level in either steam generator
2. Trip of both main feedwater pumps
3. Safety injection
4. Undervoltage of both 4.16 kv normal buses (turbine driven pump only)
5. Manual

X.10.1.6 Testing

Auxiliary feed system surveillance tests are required on a monthly and refueling interval in accordance with tech spec requirements. The monthly tests involve (a) stroking MOV's and observing stem travel and (b) pump curve point check. The test is performed by shutting the appropriate pump discharge valves and recirculating back to the CST. After the test, the valves are positioned to normal lineup and all valve positions are verified.

X.10.1.7 Technical Specifications

The present limiting condition of operation (LCO) permits one unit operation with one motor-driven pump operable and either one turbine or one motor driven pump operable and if failure occurs and is not fixed in 48 hours - go to cold shutdown. Two unit operation is permitted with all four AFW pumps operable. If a failure occurs and repair is not completed within 7 days so that the four pump requirement is met, one unit must be taken to cold shutdown.

X.10.2 Reliability Evaluation Results

X.10.2.1 Dominant Failure Modes

Failure modes of the AFWS were assesssed for three types of initiating transients. The dominant failure modes for each transient type are discussed below.

It should be noted that the failure modes discussed below as dominant presume LCOs of 48 hours on all AFWS trains. Currently, the LCO allows both the turbine-driven trains to be unavailable indefinitely when only one of the two units is operating. See Recommendation GS-1.

Loss of MFW with Offsite Power Available

A dominant failure mode of the AFWS for this transient is assessed to be the blockage of flow to the two steam generators due to inadvertent closure of two manual valves in the pump discharge lines inside containment. These valves could possibly be closed prior to the AFWS demand because of, for example, a personnel error in failing to reopen them after maintenance on the AFWS. Because these valves do not have remote position indication and are located inside the containment, there could be a considerable delay in gaining access to and reopening of the valves after an AFWS demand. However, the licensee states that any inadvertent closure of these valves would be detected prior to reactor startup or at least before the reactor exceeds 2% power since (a) plant startup procedures require a valve alignment check to verify the AFWS flow path and (b) the AFWS is used during normal plant startup to maintain steam generator water level

before initiating operation of the main feedwater system after reaching 2% reactor power; thus inoperability of the AFWS would have been detected before proceeding further. See Recommendations GS-2 and GS-6.

Loss of MFW with Only Onsite AC Power Available

This transient is very similar to the transient discussed above. Additional failure modes related to the onsite AC power system were considered; however, these did not have a significant impact. As such, a dominant failure mode for the case described above (closure of two manual valves in the AFWS discharge lines inside containment) is also considered to be dominant for this transient.

Loss of MFW with Only DC Power Available

In this transient no AC power (onsite or offsite) is available, so that the AFWS is reduced to one steam-driven pump train. The dominant failure mode of this train in such a transient is assessed to be failure of the operator to open the normally closed steam-admission valve before the steam generator water level decreases to the point where it loses its ability to transfer heat. This valve is motor-operated and is normally powered from either offsite AC power or from the diesel-generators. Since neither of these power sources is available in this transient, local, manual opening of the valve would be required.

X.10.2.2 Principal Dependencies

The principal dependency found in this evaluation is the common-cause failure of all trains due to closure of the manual valves in the two AFWS discharge lines.

The second significant dependency found is the dependence on AC power to run the turbine-driven pump train of the AFWS.

Because of physical separation of the AFWS pumps, location dependencies do not appear to be significant in this plant.

The AFWS pumps require cooling from the plant cooling water system. However, since this system can be run from offsite or onsite AC power supplies, and also has separate diesel-driven pumps, this potential common cause failure does not appear to be of significance.

X.10.3 Recommendations for this Plant

The short-term recommendations (both generic, denoted by GS, and plant specific) identified in this section represent actions to improve AFW systems 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 (both generic, denoted by GL, and plant specific) 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.10.3.1 Short Term

1. Recommendation GS-1 - The Technical Specification LCO for one unit operation allows the turbine-driven pump train of that unit to be unavailable indefinitely. Consequently, the plant could not provide AFW flow in the event of loss of offsite and onsite AC power. The licensee should propose modifications to the Technical Specifications to limit the time that a turbine-driven pump train can be inoperable during single unit operation. The licensee should update the Technical Specification LCO for both one and two unit operation to conform with current standard Technical Specifications; namely 72 hours and 12 hours for the outage time limit and action time.

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, including the manual valves V12 and V25 inside containment. 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.

3. 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:

   - 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.

4. 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 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 bearing 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.)

5. 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.

6. Recommendation GS-7 - The licensee should verify that the automatic start AFW 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.

- 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 initiation signals and circuits shall be a feature of the design.
- The initiation 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 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.

X.10.3.2 Additional Short-Term Recommendations

The following additional short-term recommendations resulted from the staff's Lessons Learned Task Force review and the Bulletin 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 a low level alarm 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.10.3.3 Long Term

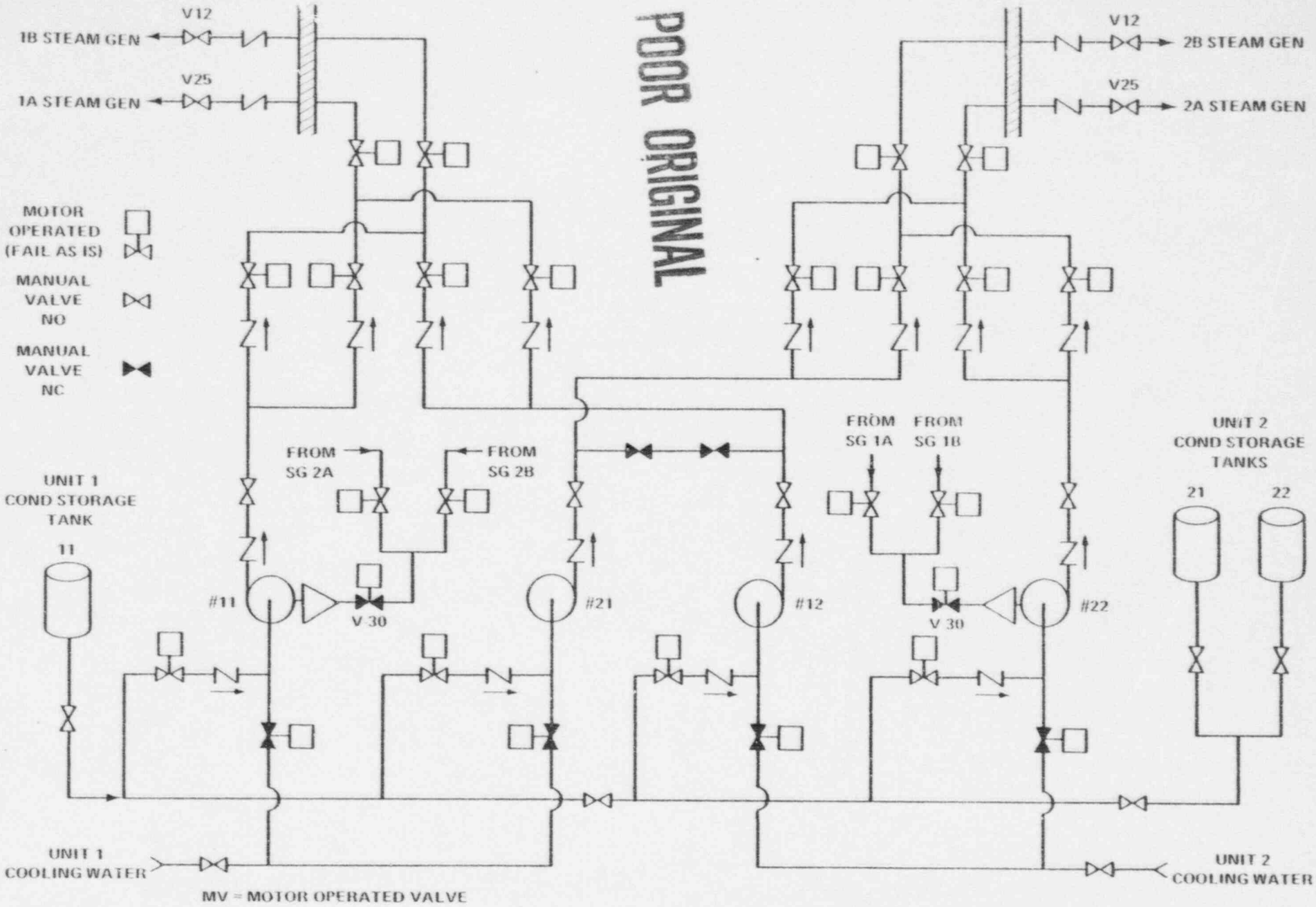
Long-term recommendations for improving the system are as follows:

1. 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.

2. 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 pump is necessary following a seismic event or a tornado. The time available before pump damage, the alarms and indications available for 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 suctions to the alternate safety-grade source of water, automatic pump trip on low suction pressure or upgrading the normal source of water to meet seismic Category I tornado protection requirements.

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



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Auxiliary Feedwater System
Prairie Island
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.