Docket File

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

October 30, 1979

Docket Nos.: 50-315
50-316

Mr. John Dolan, Vice-President
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Indiana and Michigan Power Company
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Dear Mr. Dolan:

SUBJECT: NRC REQUIREMENTS FOR AUXILIARY FEEDWATER SYSTEMS AT DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

The purpose of this letter is to advise you of our requirements for the auxiliary feedwater systems at the Donald C. Cook Nuclear Plant, Units 1 and 2 (Cook 1 & 2). 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.

Based on our review of the auxiliary feedwater systems at Cook 1 & 2, we have identified requirements which are applicable to the current auxiliary feedwater system design. Enclosure 1 contains these requirements. These requirements are of two types, (1) generic requirements applicable to most Westinghouse-designed operating plants, and (2) plant-specific requirements applicable only to Cook 1 & 2. Enclosure 2 contains a generic request for additional information regarding auxiliary feedwater system flow requirements.

Your letter of August 9, 1979 to Mr. Harold R. Denton, Director of Nuclear Reactor Regulation, submitted Amendment No. 84 to the Cook 1 & 2 Final Safety Analysis Report. This amendment, which contains a number of proposed modifications to the auxiliary feedwater systems, is currently under staff review. The requirements contained in Enclosure 1 are based on our review of the as-built auxiliary feedwater system design at Cook 1 & 2. We recognize that you have proposed modifications to the as-built design. However, to expedite matters, we request that you evaluate the Cook 1 & 2 design and procedures against the applicable requirements specified in Enclosure 1 to determine the degree to which your facility currently conforms to these requirements. You should also indicate how this degree of conformance will be affected by the proposed design modifications contained in Amendment No. 84.

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 Cook 1 & 2 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,

Darrell G. Eisenhut, Acting Director
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Enclosures:
As stated

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ENCLOSURE 1

X.2 (W)

DONALD C. COOK UNITS 1 and 2

AUXILIARY FEEDWATER SYSTEM

X.2.1 System Description

X.2.1.1 Configuration and Overall Design

The auxiliary feedwater system (AFWS) is designed to supply water to the steam generators for reactor coolant system sensible and decay heat removal when the main feedwater system is not available. The AFWS for Cook 1 & 2 is utilized in the event of either a malfunction such as loss of offsite power, or an accident, and during certain periods of normal startup and shutdown. The AFWS is automatically actuated under certain transient and accident conditions.

The AFWS is shown in simplified form on Figure 1 attached. The AFWS, consists of a steam turbine driven pump for each unit which supplies AFW flow to 4 steam generators of its associated unit and two cross-connected motor driven pumps each of which supplies flow to 4 steam generators, two in each unit.

The motor driven and turbine driven auxiliary feed pumps of each unit normally take suction from the condensate storage tank associated with that each unit. A cross-tie line connects the condensate storage tanks and auxiliary feed pump suctions of the two units. An air-operated valve which can be controlled from the control room is provided in the cross-tie line. This valve is normally closed and will fail in the closed position. This valve can also be manually operated at a local valve station.

Each condensate storage tank has a capacity of 500,000 gallons of which 175,000 gallons are reserved by Technical Specification for AFW system use. The licensee estimates that this reserve capacity is sufficient for approximately 12 hours of operation and is adequate to bring the unit to RHR operation capability. Each condensate storage tank is located outdoors and is non-seismic Category 1 design. However, the tanks have been analyzed to show that they can withstand the operating basis earthquake (OBE). If neither condensate storage tank is available, the AFW pumps can take suction from the Essential Service Water System (ESWS) through a normally closed motor operated valve and a normally closed manual isolation valve at each auxiliary feed pump suction. The ESWS piping and valves are designed in accordance with B31.1. However, the entire ESWS system is analyzed to withstand the safe shutdown earthquake (SSE).

All manual valves located between the condensate storage tank and the AFW pumps suctions are locked in the open position.

A manual duplex strainer is installed in each auxiliary feed pump suction to prevent pump damage from debris and/or scale in the water. Also automatic backwash duplex trainers are installed in the ESWS pump discharge lines.

The motor driven AFW pumps supply two steam generators in each unit (i.e., the Unit 1 motor driven pump supplies steam generators No. 2 and No. 3 of Unit 1 and steam generators No. 1 and No. 4 of Unit 2 and the Unit 2 motor driven pump supplies steam generators No. 2 and No. 3 of Unit 2 and steam generators No. 1 and No. 4 of Unit 1.) Each of the motor driven pump supply lines to the steam generators has a normally closed motor-operated valve for flow control and isolation. On loss of power these valves fail AS-IS.

The motor driven AFW pumps are sized to prevent actuation of the pressurizer safety or relief valves in the event of loss of all main feedwater supply in conjunction with loss of power to the reactor coolant pump buses. Each motor driven AFW pump has a capacity of 450 gpm with a TDH of 2714 feet. These pumps are powered from separate emergency electrical buses. The capacity of the two pumps (900 gpm) is sufficient to maintain the level in 4 steam generators above the lower limit of the wide range level indicator.

The turbine driven AFW pumps meet the same criteria as the motor driven AFW pumps except their capacity is 900 gpm with a TDH of 2714 feet.

Steam to each of the turbine driven AFW pumps is supplied from its associated Units' No. 2 and No. 3 steam generators taken upstream of the main steam isolation valves. Each of the turbine driven AFW supply lines to the steam generators has a normally open motor-operated valve for flow control and isolation.

The discharge pipe header and individual supply lines to each steam generator for the motor driven and turbine driven auxiliary feedwater pumps are designed to seismic Category 1 requirements, AEPSC quality level 4 which is equivalent to ASME Class II.

Each AFW pump is provided with an emergency leakoff line and a test line. The emergency leakoff line ensures that a minimum flow through the pump is maintained to prevent pump overheating and possible damage.

Upon automatic startup of the motor driven auxiliary feed pumps, the steam generator blowdown valves and pump test line close. The motor driven valves in the pump discharge lines to the unaffected unit remain closed while the valves to the affected unit open automatically.

A high flow rate through the motor driven or turbine driven pump causes the associated pump's motor-operated isolation valves to the steam generators to automatically close to an intermediate position. The valves may then be operated as necessary from the control room.

X.2.1.2 Component Design Classification

1. The condensate storage tanks are non-seismic but have been analyzed to withstand the OBE.

2. The suction piping and valves from the condensate storage tanks to the AFW pumps are designed to B31.1 with quality control to

the requirement of B31.7. The suction piping is analyzed to withstand the SSE.

3. The ESWS (alternate AFW supply) piping, valves and components are designed to B31.1 requirements. However, the ESWS is analyzed to withstand the SSE.

4. The turbine driven pumps and motor driven pumps are designed to seismic Category I requirements.

5. The turbine driven pump discharge header and steam generator supply lines and motor driven pump discharge header and supply lines associated with each Unit are designed to seismic Category 1, AEPSC quality level 4 which is equivalent to ASME Class II.

6. Each motor driven and turbine driven AFW pump is located in a separate seismic Category I enclosure and protected from tornado missiles.

7. Motors, cables and other electrical components required for the AFW system operation are Class 1E.

X.2.1.3 <u>Power Sources</u>

Each Unit has two class 1E power system trains A and B. Each power train contains a 250 V DC Station battery, 4 KV diesel generator and power distribution system.

Each unit's turbine driven AFW pump and associated valves are powered from power train B of its own unit.

Each motor driven AFW pump and associated support system is powered from the A power train of its associated unit.

The motor driven AFW pump discharge valves are powered from the A power train of the unit served, i.e., Unit 1 motor driven AFW pump supply valves to Unit 1 steam generators are powered from train A Unit 1; Unit 1 motor driven AFW pump supply valves to Unit 2 steam generators are powered from train A Unit 2; Unit 2 motor driven AFW pump supply valves to Unit 2 steam generators are powered from train A Unit 2; Unit 2 motor driven AFW pump supply valves to Unit 1 steam generators are powered from train A Unit 2.

The AFW system as presently installed meets redundancy requirements, however, it is dependent on both AC and DC power for automatic operation.

Intended modifications (currently in progress) to the turbine driven AFW pumps will remove the turbine driven AFW pumps AC power dependence for automatic system initiation.

X.2.1.4 Instrumentation and Controls

The instrumentation and control power is supplied form the 120 V AC vital bus system. There are four vital buses, each supplied by an inverter receiving power either from the 600 V AC Class 1E auxiliary buses or the 250 V DC power system. The motor driven pump breaker controls are powered from the Class 1E 250 V DC power system. The Class 1E station batteries are maintained at full charge by battery chargers supplied from the Class 1E auxiliary buses.

X.2.1.3.1 Controls

Controls for the AFW pumps and their associated valves are located in the control room of the unit with which the pump is associated, and are duplicated at the hot shutdown panel and other unit control panels.

a) FMO-211, -221, 231, and -241 (Unit 1) or (Unit 2) are the Steam generator supply valves from the turbine driven auxiliary feed pump (TDAFP). These 4-inch motor operated (Globe type) valves are normally open, but each may be closed by the control room operator in the event of a feedwater or steam line break at the steam generator with which it is associated. They also may be throttled to regulate steam generator level. In the event of a steam line break and rapid depressurization of a steam generator, or upon detection of a high flow at the TDAFP, these valves are automatically driven to an intermediate position to prevent pump runout. On loss of power, the above valves fail AS-IS.

b) FMO-212, -222, -232 and -242 (Unit 1) or (Unit 2) are the steam generator supply valves from the motor-driven auxiliary feed pumps (MDAFP). These 4-inch motor operated (Globe type) valves are normally closed and are opened and/or throttled as described in (a) above. These valves open automatically, as a result of any of the signals which require MDAFP start for that unit. The steam generator supply valves in the other unit will get a signal to close. On loss of power, these valves fail AS-IS.

c) WMO-753, and -754 are the essential service water (EWS) supply valves to the turbine driven and motor-driven auxiliary feed pumps. These 4-inch motor operated (Butterfly type) valves are normally closed, and except for testing under closely controlled conditions, are opened by the control room operator only if water is unavailable from the condensate storage tanks. In addition to the above normally closed MOVs, the ESW supply to the AFW pumps contains normally closed, manually operated, butterfly valves ESW-109, -115, -145 and -240. These valves must be locally opened in the event ESW is required. Operation of these valves can be achieved in less than 10 minutes. On loss of power, the motor operated valves fail AS-IS.

d) MCM-221 and -231 are the steam supply isolation valves to auxiliary feed pump turbines. These 4-inch motor operated gate valves are normally open, allowing steam pressure to be available up to the trip and throttle (T&T) valve at each turbine. The motor operated steam isolation valves MCM-221 and -231 can be opened or closed from the control room and on loss of power they fail AS-IS. The T&T valve opens automatically when the turbine driven AFW pump receives a start signal; however, it is AC-powered and fails AS-IS.

e) FRV-257 and -258 are the emergency leakoff valves for motor-driven and turbine driven auxiliary feed pumps. The valves are 1-inch, air operated diaphragm, globe type, normally open and spring actuated to fail open on loss of air pressure. The valves are automatically modulated (open or closed) when feedwater flow rate to the steam generators or through the test line is below or above the required minimum pump leakoff flow rate setpoint.

f) CRV-51 is the condensate storage tank cross-tie valve. This 8-inch, air operated diaphragm, globe type, valve is normally closed and is spring actuated to fail closed on loss of air pressure. The valve connects Unit 1 and Unit 2 Condensate storage tanks. This valve is opened by energizing a solenoid valve in the air supply line. Controls for remote operation of this valve are located in the control room. Power to energize the solenoid valve is supplied from the normal station AC power supply.

Opening this valve and manually realigning others in the AFW systems pump suctions permits the AFW systems of both Units to draw condensate from one tank in the event the other tank is not available.

X.2.1.4.2 Information Available to the Operator

The following is information available to the operator on the Main Control Board or on the Hot Shutdown Panel:

1. Flow, gpm to each steam generator
2. Steam generator levels
3. Breaker position (motor driven pump)
4. Motor current and voltage (motor driven pump)
5. Motor operated valve status lights from limit switches
6. Steam pressure to auxiliary feed turbine (as steam generator pressure)
7. Pump discharge pressure
8. Condensate storage tank level
9. Turbine driven auxiliary feed pump speed control
10. Operational alarms and annunciations shown on the attached Table A and B

X.2.1.4.3 Initiation Signals for Automatic Operation

The turbine driven and motor driven auxiliary feedwater pump start signals are listed below.

A. Turbine Driven

The following signals in one unit will start that unit's turbine driven auxiliary feed pump:

(1) Low-Low level in any 2 of 4 steam generators (possible loss feedwater or steam line break)

(2) Reactor coolant pumps bus undervoltage (anticipation of loss of offsite power)

(3) Manually

B. Motor Driven

The following signals in either unit will start both motor driven auxiliary feedwater pumps:

(1) Low-Low level in any steam generator (possible loss of feedwater or main steam line break)

(2) Trip of main feed pumps in either unit

(3) Any safety injection signal derived from Reactor Protection System and/or containment pressure - High at 1.2 psi.

(4) Loss of offsite power* (Pump is sequenced ON when emergency diesel generator is energizing safeguards bus)

(5) Manually

*Note

There is a delay of <60 seconds in starting the motor driven pump. The reason for this delay is to limit the loads during emergency diesel generator loading.

X.2.1.5 Testing

The AFW system and components are tested in accordance with Technical Specification requirements. The frequency of periodic testing of the pumps is 31 days. In addition, the particular system is tested in accordance with the Technical Specification after performing system maintenance. The systems are also tested using the pump recirculation lines test lines with various plant parameters noted (as called out by ASME Section XI). The instrumentation systems are checked in accordance with the technical specifications, on a per shift, monthly or refueling time frame basis.

FRV-255 and -256 are test valves for the motor and turbine-driven auxiliary feed pumps. These normally closed, 3-inch, air-operated, globe type valves are capable of passing approximately the design flow rates for each pump and are used to performance test the pumps on a periodic basis. The valves are diaphragm, spring close type and on loss of air pressure they fail closed. Operating air to each test valve is controlled by a solenoid valve installed in the air supply line. Should test valves FRV-255 and -256 be left in the open position, an automatic start of the auxiliary feed pumps will automatically close the valves.

X.2.1.6 Technical Specifications

A review of the technical specifications indicated that these specifications cover limitng conditions of operation (LCO) and periodic surveillance testing consistent with current standard technical specifications.

X.2.2 Reliability Evaluation

X.2.2.1 Dominant Failure Modes

The D. C. Cook auxiliary feedwater system was analyzed to determine the dominant failure modes under three transient conditions:

(a) LOFW with offsite power available

(b) LOFW with onsite power available

(c) LOFW with only DC power available

Results of the analysis are summarized below.

LOFW with Offsite Power Available

No significant failure modes were identified in the analysis. No significant single or double failures were noted. The most dominant failure modes appear to be triple failures involving maintenance in one of the pumps trains and independent failures in the other.

LOFW with Onsite Power Available

The system was analyzed to determine if the dominant failure modes would be significantly different given loss of offsite power. As in the previous case, the dominant failure modes would appear to involve three independent failures. The most dominant mode would involve maintenance of one pump train and hardware failures in another, and failure of the diesel powering the third.

LOFW with Only DC Power Available

Assuming loss of all AC power, the turbine-driven train must be manually actuated by locally opening the turbine-driven AFW pump trip and throttle valve. Assuming that this action is performed, the system should operate successfully, unless failures were to occur in this train or maintenance was being performed at the time of loss of power. The dominant failure modes for this case appear to be:

(a) operator fails to manually open the steam admission valve;

(b) turbine train unavailable due to maintenance.

It should be noted that the licensee is installing the capability to open the steam admission valves by use of a DC source.

X.2.2.2 Dependencies

No locational or environmental dependencies were identified which could cause common-mode failures of the system. The four pumps for the station are located in separate rooms equipped with adequate drains and protected against pipe whip and missiles. In addition, no common dependencies on AC or DC power were identified.

X.2.3 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 system realiability 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.2.3.1 <u>Short Term</u>

1. <u>Recommendation GS-2</u> - 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.

2. <u>Recommendation GS-4</u> - 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.

3. Recommendation GS-5 - Modifications currently are being implemented to make the turbine driven trains independent of any alternating current power source. The following recommendation should be met in the interim. 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 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 operate 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.)

4. 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:
   - Procedure 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.

5. 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.2.3.2 <u>Additional Short-Term Recommendations</u>

The following additional short-term recommendations resulted from the staff's Lessons Learned Task Force 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 a low level alarm in the control room for the AFW system primary water supply to allow the operator 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 which are identical to Item 2.1.7.b of NUREG-0578:

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

The auxiliary feedwater flow instrument channels should 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 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.2.3.3 Long Term

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

1. Recommendation - GL-3 - The licensee is currently performing modifications to make the turbine driven train independent of A-C power sources. The following recommendation should be met when these modifications are complete. At least one AFW system pump and its associated flow path and essential instrumentation

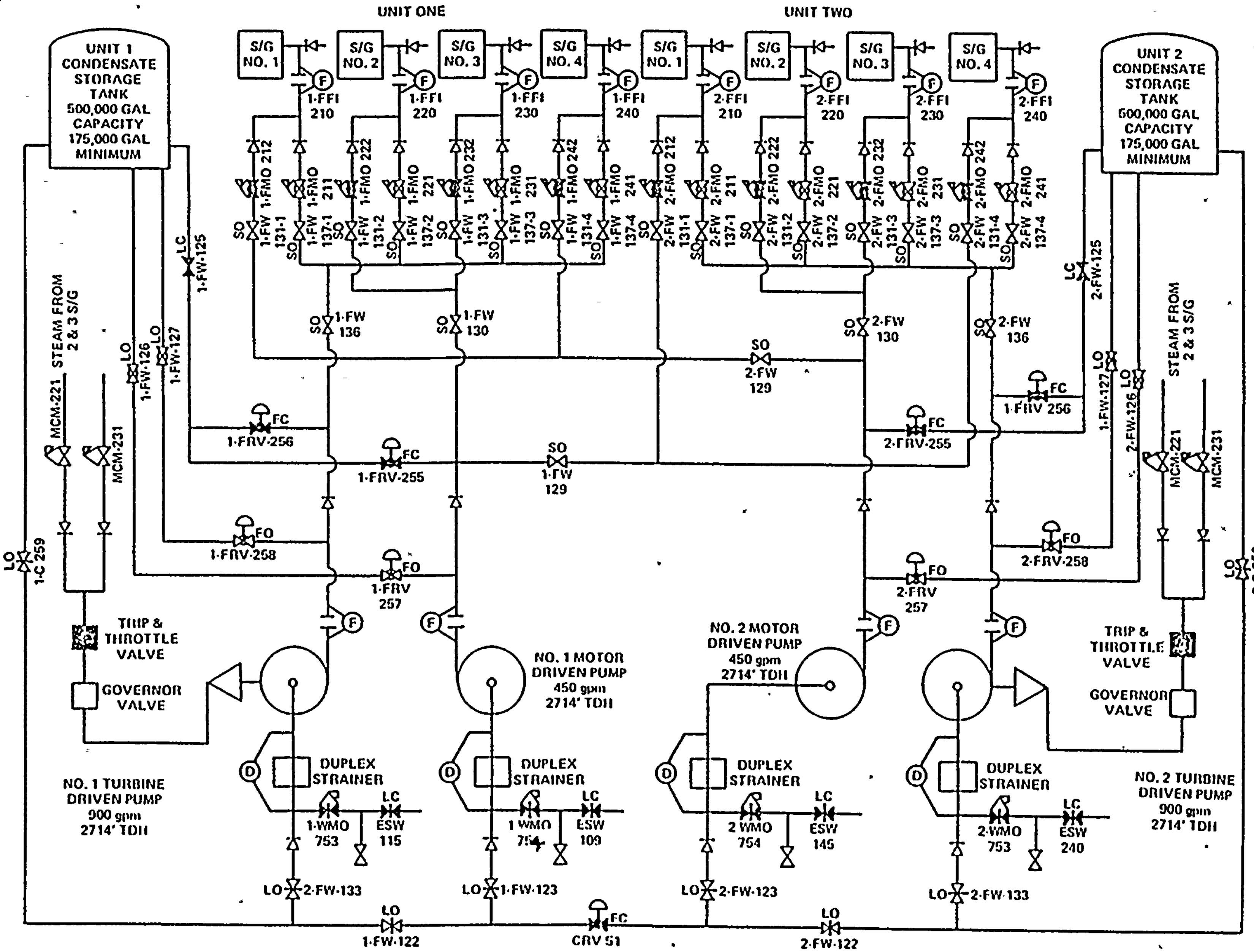
should automatically initiate AFW system flow and be capable of being operated independently of any alternating current power source for at least two hours. Conversion of direct current power to alternating current is acceptable.

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 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 suctions 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.

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

NOTE:
LEGEND SEE PAGE 2

FIGURE 1
(PAGE 1 OF 2)



Auxiliary Feedwater System
D.C. Cook
Figure 1 (Sheet 1 of 2)

LEGEND:

 = MOTOR OPERATED GLOBE VALVE – OPEN

 = MOTOR OPERATED GLOBE VALVE – CLOSED

 = MOTOR OPERATED BUTTERFLY VALVE – OPEN

 = MOTOR OPERATED BUTTERFLY VALVE – CLOSED

 = MOTOR OPERATED GATE VALVE – OPEN

 = MOTOR OPERATED GATE VALVE – CLOSED

 = MANUAL GATE VALVE – OPEN

 = MANUAL GATE VALVE – CLOSED

 = MANUAL GLOBE VALVE – OPEN

 = MANUAL GLOBE VALVE – CLOSED

 = MANUAL BUTTERFLY VALVE – OPEN

 = MANUAL BUTTERFLY VALVE – CLOSED

 = CHECK VALVE

FO = FAILS OPEN

FC = FAILS CLOSED

LO = LOCKED OPEN (LOCK AND KEY)

LC = LOCKED CLOSED (LOCK AND KEY)

SO = SEALED OPEN (DETENT)

Auxiliary Feedwater System
D.C. Cook
Figure 1 (Sheet 2 of 2)

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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