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

October 11, 1979

Docket No.: 50-213

Mr. D. C. Switzer, President
Connecticut Yankee Atomic Power Company
P. O. Box 270
Hartford, Connecticut 06101

Dear Mr. Switzer:

SUBJECT: NRC REQUIREMENTS FOR AUXILIARY FEEDWATER SYSTEMS AT HADDAM NECK NUCLEAR POWER PLANT

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

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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
Division of Operating Reactors
Office of Nuclear Reactor Regulation

Enclosures:
As stated

cc w/enclosures:
Day, Berry & Howard
Counselors at Law
One Constitution Plaza
Hartford, Connecticut 06103

Superintendent
Haddam Neck Plant
RFD #1
Post Office Box 127E
East Hampton, Connecticut 06424

Mr. James R. Himmelwright
Northeast Utilities Service Company
P. O. Box 270
Hartford, Connecticut 06101

Russell Library
119 Broad Street
Middletown, Connecticut 06457

ENCLOSURE 1

X.5 (W) HADDAM NECK

AUXILIARY FEEDWATER SYSTEM

X.5.1 System Description

X.5.1. Configuration Overall Design

Figure 1 is a simplified flow diagram of the Haddam Neck auxiliary feedwater system (AFWS). The AFWS consists of two steam turbine driven pumps* which take water through a common underground header from the demineralized water storage tank and inject it into four steam generators via main feedwater piping. The pumps discharge to a common header which supplies water via either of two possible parallel flow paths. One path feeds to the bypass line around the main feed regulating valves in the turbine building. By using the bypass line, the main feedwater bypass control valve can be used to regulate flow to the steam generators individually. The other flow path supplies water from the discharge header through a motor operated valve to the main feedwater piping downstream of the feedwater check valve inside containment.

Steam to the turbine driven pumps is taken from all four steam generators upstream of the main steam isolation valves from a common header.

*The licensee indicated that it plans addition of a motor driven AFWS pump.

The header is normally split in such a manner that two steam generators supply one turbine pump while the other two steam generators supply the remaining turbine pump.

The system has no automatic initiation capability and relies on manual initiation from the control room for all conditions. However, on loss of control air, for whatever reason, the turbine driven pumps would start due to the fail-open feature of steam inlet valves and deliver AFW through the main feedwater bypass control valves which also fail open on loss of air.

No electrical power is necessary to operate these valves because the controls at the panel mechanically initiate or remove control air. (Control air passes through panel via copper tubing.)

The primary source of water is from the demineralized water storage tank (Minimum capacity 50,000 gallons by Technical Specifications) which is always lined up to the pump suction header via locked open manually operated valves. The secondary source of water is the primary water storage tank (Minimum volume of 80,000 gallons by Technical Specifications) which must be transferred to the demineralized water storage tank before use. As a backup to these sources, the recycle water storage tank (100,000 gallons) is normally always available and also must be transferred to the demineralized water storage tank before use. Long term sources of makeup water include

the water treatment system using a well pump, the well pump without use of the water treatment system and a diesel driven fire protection system pump. All water sources must eventually come via the demineralized water storage tank.

X.5.1.2 Components Design Classification

The seismic design and safety classification of components for the Haddam Neck plant are being reviewed as part of the Systematic Evaluation Program. The safety classification and seismic design requirements for the plant as compared to today's requirements are too detailed and complex to provide a meaningful explanation in this report. Refer to the details available as part of SEP for this information. The overall design of the auxiliary feedwater system, including the demineralized water storage tank and primary water storage tank,are considered to be seismic Category I based on the Licensee's standards. The adequacy of these seismic criteria are also being evaluated as part of SEP.

X.5 1.3 Power Sources

No electric power sources are directly used for valve operation or turbine pump startup to use the main feedwater bypass control valve flow path. To use the alternate flow path directly to the feedwater inlet piping at the steam generators, a single motor operated valve, powered from a vital bus is used.

Compressed air is used to operate the steam inlet valves and the main feedwater bypass line control valves. These valves are opened or closed at the control panel by controls that are essentially control valves that control the air pressure from the compressed air header to the valve operators. All valves fail in the open position upon loss of air pressure. The compressed air system includes three air compressors and three air receivers for control air. All of the compressors can be powered by the diesel generators.

The AFW pumps have a self-contained lube oil pumping system (shaft driven) but require service water to cool the lube oil. The service water is supplied on a continuous basis to the lube oil coolers (one service water train to each pump). However, the pumps will start and operate for an unspecified time without cooling water. Subsequent to this review, the licensee indicated it is presently in the process of modifying the AFW system to eliminate the need for service water for the AFW turbine driven pump lube oil coolers. The modification will provide a self-contained bearing oil cooling system for each AFW pump. Water will be drawn from the pump first stage discharge and will circulate through all necessary pump and turbine pump and turbine bearings and will return to the AFW pump suction.

X.5.1.4 Instrumentations and Controls (In Control Room)

X.5.1.4.1 Controls

Steam generator level is controlled manually from the control room by varying turbine speed or throttling the feedwater bypass control valve or a combination of both. When the alternate path to the steam generators is used through the motor operated valve directly to the feedwater piping inside containment, level is controlled by turbine speed control.

Controls for the valves to initiate the auxiliary feedwater system through either of the two flow paths are located in the control room. The controls for the normal flow path through the feedwater bypass line are independent of electrical power.

X.5.1.4.2 Information Available to the Operator

I. Alarms

1. Demineralized water storage tank low level
2. Control air system low pressure alarm
3. Discharge header high temperature alarm (indicates backflow from main feedwater system to discharge header via leaky check valve)
4. Hi/Lo steam generator level alarms

II. Indication

1. Electrical position indication for motor operated isolation valve in an alternate flow path
2. Output pressure of controllers to bypass flow control valves and turbine inlet valves (indirect indication of valve position and turbine speed)
3. Steam pressure at inlet to turbines
4. Discharge pressure from pumps
5. Steam generator level
6. Demineralized water storage tank level and temperature

X.5.1.4.3 Initiating Signals for Automatic Control

Not applicable - manual AFWS initiation

X.5.1.5 Testing

The auxiliary feedwater pumps, steam inlet valves, and controls are tested monthly by isolating pump discharge and starting pump from the control room and checking discharge pressure. This same test is performed following return of system to operation after maintenance. A flow test of the auxiliary feedwater pumps is performed annually.

Valve position is verified monthly and the active valves are cycled quarterly. All valves, active and manual, are cycled annually and the stroke times of the active valves verified.

The controls for all valves are used during valve testing for control operability check.

Technical Specifications

The reactor shall not be critical (except for determination of "just critical" rod position and low power tests at or below 10 percent of full power) unless the following conditions are met:

1. One steam driven auxiliary feedwater pump available
2. A minimum of 50,000 gallons in the demineralizer water storage tank and an additional 80,000 gallons in the primary water storage tank.
3. System piping and valves directly associated with the above components operable.

Licensee is planning to convert to standard Technical Specifications and communications with NRC have been started in this regard. In a letter dated June 1, 1979 in response to Bulletin 79-06A, the licensee submitted a license amendment request proposing more comprehensive technical specifications to further assure the availability of the AFW system. The proposed changes include a requirement that both AFW pumps be operable when the reactor is critical and a provision that limits the time that one AFW pump train can be inoperable. The proposed change is currently under staff review.

X.5.2 Reliability Analysis

X.5.2.1 Dominant Failure Modes

LOFW with Offsite Power Available

The principal dominant failure modes include two single failures associated with human failure. One is a human failure to restore to open, following a maintenance action, the suction line valve from the demineralized storage water tank. The second is the human failure to initiate the AFWS upon evidence of need. The latter contributor is reduced to some extent due to recent NRC Bulletin 79-06A for operator personnel specifically dedicated for AFWS initiation.

Other dominant failure modes include failure to reopen valves in both of two systems, and long term allowable maintenance in one pump system combined with hardware or human failure associated with the other pump system.

LOFW with Loss of Offsite Power

Same as above.

LOFW with Loss of Offsite and Onsite AC

The dominant failure is loss of both pumps due to lack of lube oil cooling from loss of all AC.

X.5.2.2 Interdependencies

The principal interdependencies noted are the common valve in the storage tank line and the AC dependence for cooling of the steam driven pumps.

X.5.3 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 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 (both generic, denoted by GL, and plant-specific) 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.5.3.1 Short Term

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

*As discussed in Section 5.15 the licensee has proposed Technical Specification modifications for AFW system which are currently under review by the staff.

2. Recommendation GS-2 - The licensee should lock open single valves or multiple valves in series in the AFW system pump suction piping and lock open other single valves or multiple valves in series that could interrupt all AFW flow. Monthly inspections should be performed to verify that these valves are locked and in the open position. These inspections should be incorporated 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 bearings may be dependent on alternating current power, design or procedural changes shall be made to eliminate this dependency as soon as practicable.* Until this is done, the emergency procedures should provide for an individual to be stationed at the turbine-driven pump in the event of the loss of all alternating current power to monitor pump bearing and/or lube oil temperatures. If necessary, this operator would operate the turbine-driven pump in an on-off mode until alternating current power is restored. Adequate lighting powered by direct current power sources and communications at local stations should also be provided if manual initiation and control of the AFW system is needed.

* As noted in Section 5.1.3, the licensee is proceeding with AFW system modifications to provide cooling of the turbine driven AFW pump lube oil which is independent of alternating current power.

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:

   - 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.

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

7. Recommendation -

a. According to Haddam Neck surveillance procedure No. 5.1-13, the monthly operational check of the auxiliary feedwater pumps is currently performed by closing a manual valve in the common discharge header of both pumps, isolating the normal flow path of the auxiliary feedwater system. A parallel flow path is available by manual operation from the control room through motor operated valve MOV-35. The

monthly pump test should be performed by isolating the pumps individually such that one pump is always available for normal AFW system operation. When the system is converted to automatic operation, then the existing procedure will have to be changed to individual pump isolation tests to allow automatic initiation.

b. According to Haddam Neck surveillance procedure No. 5.1-14, the annual flow capacity test of the AFW pumps is currently performed either at power or in hot standby. During the test temporary piping is connected to a valved flange in the common discharge header to divert flow away from the normal flow paths and direct it to the yard sewers via the temporary piping. This diverts flow from both AFW pumps while the isolation valve in the flange connection is open. This test should not be conducted when the plant is at power since both AFW pumps' availability is affected.

X.5.3.2 Additional Short-Term Recommendations

The following additional short-term recommendations resulted from the staff's Lessons 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 which are 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 a local manual realignment of valves to conduct periodic tests on one AFW system train and which have only one remaining AFW train available for operation, should propose Technical Specifications to provide that a dedicated individual who is in communication with the control room be stationed at the manual valves. Upon instruction from the control room, this operator would re-align the valves in the AFW system train from the test mode to its operational alignment.

X.5.3.3 Long Term

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

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

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

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

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

3. Recommendation - There is a common crossconnect line with no isolation valves between the two parallel flow paths on the S/G's. A break in this section cannot be isolated in the present design and the total system would be unavailable. It is recommended that some modifications be made (such as isolation valves) to provide isolation when necessary and assure a means of supplying AFW flow following isolation of such a break. The licensee has begun design plans to add a motor driven pump to the system. The licensee should introduce the flow from this third pump in such a manner that a break in this crossconnect

line will not result in the loss of all pumps. Also the licensee should 1) install the third pump with appropriate valves in the pump discharge line connections to meet the high energy line break criteria in SRP 10.4.9 and Branch Technical Position ASB 10-1; namely, to maintain the capability to supply the required AFW flow to the steam generators with a postulated pipe break anywhere in the AFW pump discharge lines plus a single active failure, 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.

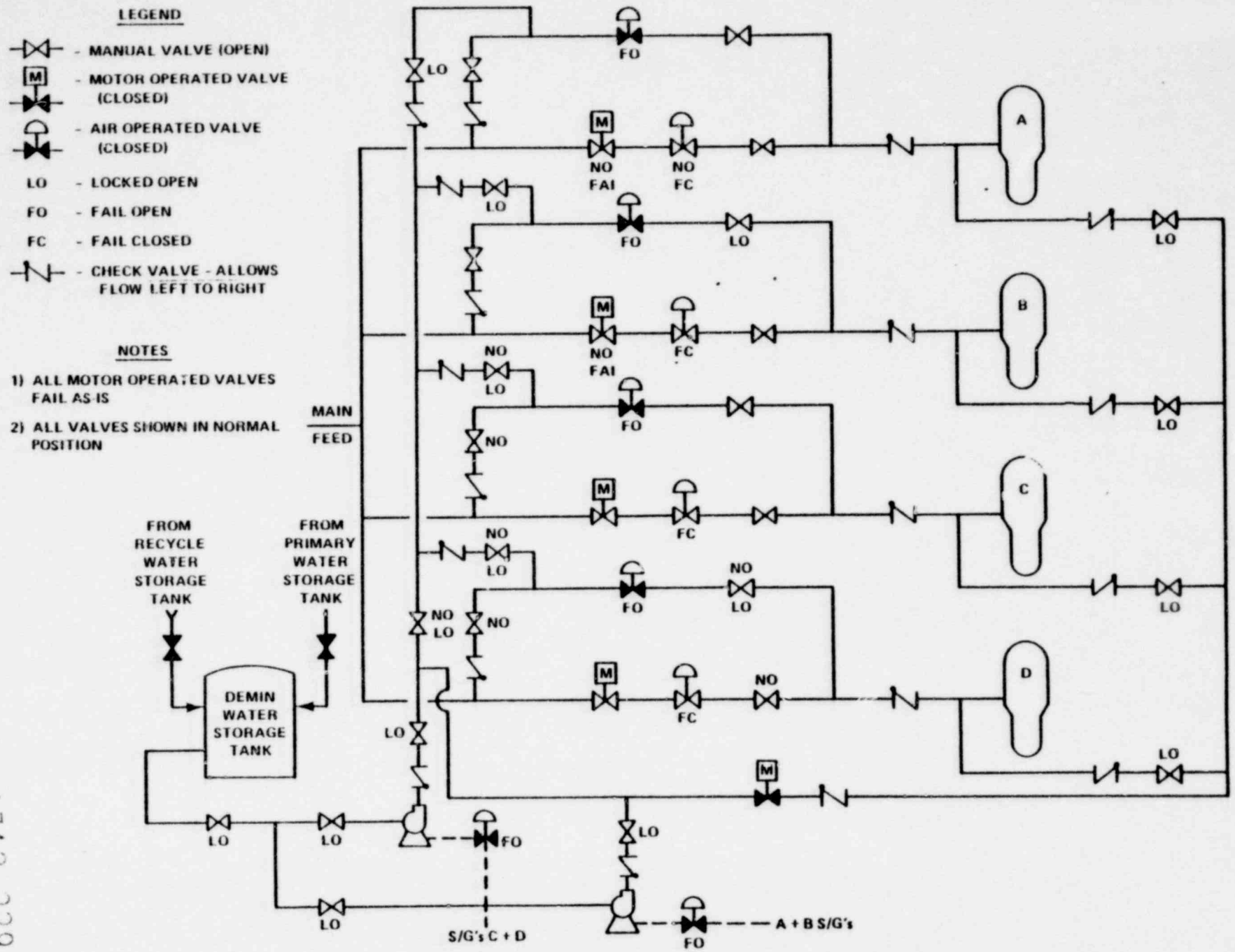
4. The AFW system itself is not designed to withstand a passive failure at all points within the system. A pipe break in a normally pressurized portion of the AFW system can be isolated by operation of manual valves outside the control room. An alternate flow path to all four S/G's would be available following such isolation. The motor driven main feedwater pumps may also be available in this event since no transient should result to cause a loss of non-vital power. For the same reasons, the main feed pumps may also be available following a break in any portion of the AFW system that is not normally pressurized even though the AFW system could be disabled. Further review, including the main feedwater system and time available for operator action, should be conducted to determine if this design has protection equivalent to today's requirements (pipe break

and single active failure). This review is being conducted as a part of Systematic Evaluation Program (SEP).

5. The Systematic Evaluation Program (SEP) will re-evaluate the plant with regard to

   a. internally and externally generated missiles, pipe whip and jet impingement quality and seismic design requirements earthquakes, tornadoes, floods and failure of nonessential systems

   b. the possible need for automatic termination of feedwater flow to a depressurized steam generator and providing flow to the intact steam generator(s). This is accomplished by the control room operator.



Auxiliary Feedwater System
Haddam Neck
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 that require AFW for mitigation

   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.