TERA

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

September 28, 1979

Docket No.: 50-338

Mr. W. L. Proffitt
Senior Vice-President - Power
Virginia Electric and Power Company
P. O. Box 26666
Richmond, Virginia 23261

Dear Mr. Proffitt:

SUBJECT: NRC REQUIREMENTS FOR AUXILIARY FEEDWATER SYSTEMS AT NORTH ANNA POWER STATION, UNIT 1

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

Enclosure 1 to this letter identifies each of the requirements applicable to the subject facility. These requirements are of two types, (1) generic requirements applicable to most 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

7910260283

1212 268

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,

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

Enclosures:
As Stated

cc: Mr. Anthony Gambardella
Office of the Attorney General
11 South 12th Street - Room 308
Richmond, Virginia 23219

Richard M. Foster, Esquire
1230 A Pearl Street
Denver, Colorado 80203

Michael W. Maupin, Esquire
Hunton, Williams, Gay and Gibson
P. O. Box 1535
Richmond, Virginia 23212

Mrs. June Allen
412 Owens Drive
Huntsville, Alabama 35801

Mr. James Torson
501 Leroy
Socorro, New Mexico 87801

Mrs. Margaret Dietrich
Route 2, Box 568
Gordonsville, Virginia 22042

Ellyn R. Weiss, Esquire
Sheldon, Harmon, Roisman and Weiss
1725 I Street, N.W., Suite 506
Washington, D. C. 20006

Mr. James C. Dunstan
State Corporation Commission
Commonwealth of Virginia
Blandon Building
Richmond, Virginia 23209

Mr. A. D. Johnson, Chairman
Board of Supervisors of Louisa County
Trevillians, Virginia 23170

Mr. Michael S. Kidd
U. S. Nuclear Regulatory Commission
P. O. Box 128
Spotsylvania, Virginia 22553

Director, Technical Assessment Divisic
Office of Radiation Programs (AW-459)
U. S. Environmental Protection Agency
Crystal Mall #2
Arlington, Virginia 20460

U. S. Environmental Protection Agency
Region III Office
ATTN: EIS COORDINATOR
Curtis Building
6th and Walnut Streets
Philadelphia, Pennsylvania 19106

Alderman Library
Manuscripts Department
University of Virginia
Charlottesville, Virginia 22901

Mr. Edward Kube
Board of Supervisors
Louisa County Courthouse
P. O. Box 27
Louisa, Virginia 23093

Mr. J. B. Jackson, Jr.
Commonwealth of Virginia
Council on the Environment
903 Ninth Street Office Building
Richmond, Virginia 23129

Mr. Paul W. Purdom
Environmental Studies Institute
Drexel University
32nd and Chestnut Streets
Philadelphia, Pennsylvania 19104

1212 270

cc: Alan S. Rosenthal, Esquire
Atomic Safety and Licensing Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Michael C. Farrar, Esquire
Atomic Safety and Licensing Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. John H. Buck
Atomic Safety and Licensing Appeal Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ENCLOSURE 1

X.9 (W)

NORTH ANNA UNIT 1

AUXILIARY FEEDWATER SYSTEM

X.9.1 System Description

X.9.1.1 Configuration and Overall Design

The auxiliary feedwater system (AFWS) is designed to supply water to the steam generators (SG) for reactor coolant system sensible and decay heat removal when the normal feedwater system is not available. The AFWS can be utilized during certain periods of normal startup and shutdowns, in the event of malfunctions such as loss of main feed-water flow, loss of offsite power and also in the event of an accident. The AFW system is automatically initiated upon receipt of the following signals: low steam generator level, safety injection, loss of offsite power, and main feed pump trip.

The AFWS is shown in simplified form in Figure 1 attached. The system consists of two motor driven pumps (3A, 3B), and one steam driven turbine pump (2). Each motor driven pump has a design flow of 350 gpm, the turbine driven pump has a design flow of 700 gpm but is orfice limited to 350 gpm when pumping in the normal lineup to SG-A. Taps from each main steam line at a point upstream of the main steam isolation valves provide the source of steam to the turbine. The motor driven pumps are connected to separate emergency power buses

1212 272

(Class 1E). Normally the pumps take suction from the 110,000 gallon emergency condensate storage tank. This provides 8 hours of operation for decay heat removal. The emergency condensate storage tank is designed to seismic Category I requirements and is protected from tornado missiles. An additional supply of 300,000 gallons is available from a non-seismic condensate make-up storage tank. In addition to the 300,000 gallon supply, an unlimited supply of water is available from the seismic Category I service water and fire protection systems which are supplied from Lake Anna and the spray cooling pond, which is seismic Category I designed.

Referring to Figure 1, each pump is lined up normally to a specific steam generator; pump 3B to SG B, 3A to SG C and 2 to SG A. The pumps can be aligned to other steam generators in the event of line breaks, pump failures, etc., by positioning the manual control valves to suit. AFW flow to steam generator C is normally remote manually controlled by an air operated valve. AFW flow to steam generators A and B is similarly manually controlled by an AC motor operated valve in each supply line. In the event of loss of offsite and onsite AC power, realignment of manual valves is necessary to supply AFW flow to all steam generators from the turbine-driven pump. The instrument air supply system, for the air operated AFW flow control valves, includes a 16.7 cu. ft. accumulator tank charged to 100 psig. This capacity is sufficient to operate the air operated valve(s) from 30 minutes to 8 hours depending on frequency of valve adjustment.

X.9.1.2 Component Design Classification

The turbine pump train and motor pump trains (110,000 gallon tank, pumps, valves, motors, piping, service water and fire protection systems) are seismic Category 1 and tornado missile protected, designed to Quality Group C. (Class 1E for electrical equipment). The 300,000 gallon condensate make up tank is non-seismic.

X.9.1.3 Power Sources

The motor driven pumps and motor operated valves are supplied from the Class 1E A-C emergency buses which may be powered by the diesel generators, 3A from Emergency Bus 1H, 3B from emergency bus 1J. The steam admission valves for the turbine pump are air-operated using DC solenoids and are energized from the emergency battery buses.

Instrumentation and Controls

The instrumentation and Control power supplies are from the 120 VAC vital bus system. There are 4 vital buses, each supplied by an inverter from the 125 VDC power system. The motor driven pump breaker controls are powered from the 125 VDC power system provided from the Class 1E emergency DC buses.

X.9.1.4 Controls

Steam generator level is controlled remote manually from either the Main Control Room (MCR) or the Auxiliary Shutdown Panel (ASP) with safety grade instrumentation provided (level and flow indications).

The valves in the water flow lines to the steam generators consist of three motor operated valves from one header and three air operated valves from the other header. Any pump can supply either header by operating manual valves in the pump's discharge. (For normal alignment refer to Section X.9.1.1.) The air operated valves are normally open and fail open on loss of power, the MOV's are normally open and fail as-is on loss of power. The MOVs or air operated valves are positioned by the operator to maintain proper level in the steam generators.

The steam admission valves to the turbine are air operated, normally closed and fail open. These valves can be controlled from the MCR or ASP.

X.9.1.5 Information Available to the Operator

The following indications are available at both operating stations except as noted.

1. Position indication of the MOVs and air operated valves
2. Flow, gpm to each steam generator (Main Control Board (MCB)) only
3. Pump Current and Voltage (MCB only)
4. Steam Pressure to Aux feed pump turbine (MCB Only)
5. Steam Generator Levels
6. Pump Discharge and suction pressures (MCB only)
7. Breaker (motor driven pumps) position
8. Condensate storage tank level emergency

X.9.1.6 Initiating Signals for Automatic Operations

The following signals start the pump motors and open the steam control valves to the turbine:

1. Steam generator water level, low-low in any steam generator (2 out of 3 signals)
2. Safety Injection signal* (Delay of 35-60 seconds on Motor driven pumps)
3. Loss of offsite power
4. Main Feed pump trip (loss of all Main feed pumps)
5. Manual

X.9.1.7 Testing

The systems are tested periodically in accordance with tech spec requirements. The frequency of periodic testing is 31 days. In addition, the particular system is tested in accordance with the technical specifications after performing system maintenance. The systems are tested using the recirculating lines, with various plant parameters noted. (Suction and discharge pressure, etc.) The instrumentation systems are checked periodically, in accordance with the technical specifications, on a per shift, monthly or refueling time frame basis.

*There is no delay of the S.I. signal to the turbine driven pump control. The reason for the delay in the motor driven pump control circuit is to limit the loads during emergency diesel generator loading.

X.9.1.8 Technical Specifications

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

X.9.2 Reliability Evaluation

X.9.2.1 Dominant Failure Modes

Successful delivery of feedwater is considered to be the flow of at least 350 gpm to one (or more) of the three steam generators for the transients considered here

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

Loss of MFW with Offsite Power Available

The reliability analysis of the North Anna AFWS based on this initiating transient did not identify any single failures or double failures which would fail the entire AFWS. This assessment indicates the dominant AFWS failure mode to be a combination of the failure of both actuation trains to actuate their respective components, coupled with failure of the operator to detect the non-actuation of the system and to manually actuate it.

Loss of MFW with Only Onsite AC Power Available

This transient is somewhat different in character than in the case above, in that reliance for AC power is now on the station diesel generators rather than offsite power. In essence, this adds failure modes such as diesel-generator failure to start to the overall list of failure modes of trains of the AFWS.

The dominant failure modes for the AFWS discussed for the above case are not dependent on the actual source of AC power (i.e., offsite vs. onsite). Thus the probability of the failure mode discussed above should not change. Further, the addition of the diesel-generator failure mode to other train failure modes is not sufficiently important to make the probability of such a combination of modes significant. For these reasons, the AFWS failure probability for this case is still dominated by the coincident loss of both actuation trains, coupled with the failure of the operator to subsequently manually actuate the AFWS.

Loss of MFW with Only DC Power Available

In this case, no AC power (offsite or onsite) is available; the AFWS is thus reduced to the one steam-driven train for feedwater delivery. A number of single failures within this train can fail the AFWS (e.g., hardware failure in the pump and valves, control system failures, etc.). The dominant failure mode for this train is that the train is out of service for maintenance when the transient occurs.

X.9.2.2 Principal Dependencies

The potential for location dependencies was noted during this reliability evaluation, in that some portions of the AFWS were located in common rooms. However, because no location dependencies were found which could potentially affect all trains of the AFWS, these dependencies do not appear to be a significant concern.

XIII.9.3 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.9.3.1 Short Term

1. Recommendation GS-4 - Emergency procedures for transferring to alternate sources of AFW supply should be available to the plant operators. These procedures should include criteria to inform the operator when, and in what order, the transfer to alternate water sources should take place. The following cases should be covered by the procedures:
   - The case in which the primary water supply is not initially

available. The procedures for this case should include any operator actions required to protect the AFW system pumps against self-damage before water flow is initiated; and,

- The case in which the primary water suppl. is being depleted. The procedure for this case should provide for transfer to the alternate water sources prior to draining of the primary water supply.

2. Recommendation GS-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.

3. 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 snould 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.

1212 281

X.9.3.2 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 of 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.

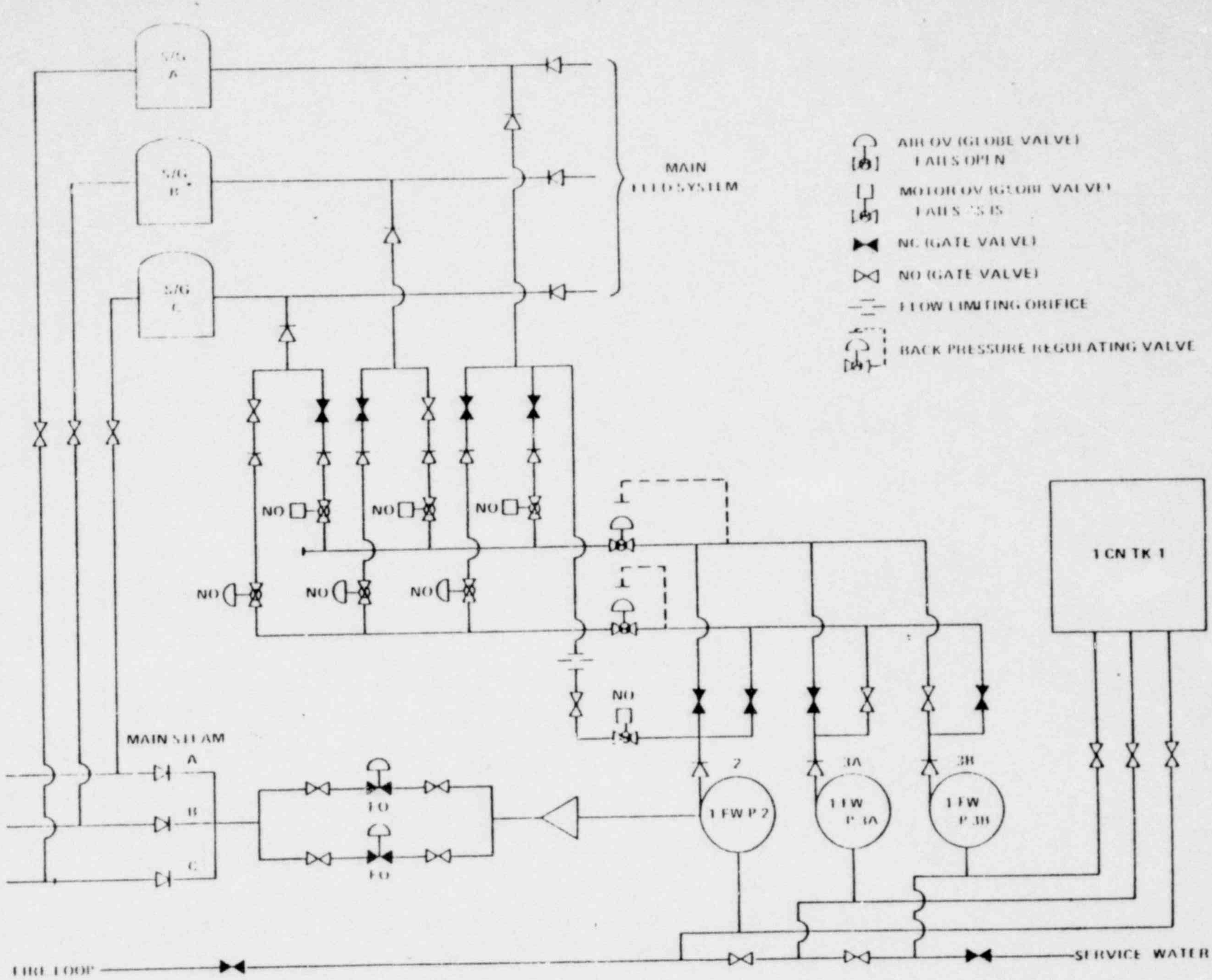
The auxiliary feedwater flow instrument channels shall be powered from the emergency buses consistent with satisfying the emergency power diversity requirements for the auxiliary feedwater system set forth in Auxiliary Systems Branch Technical Position 10-1 of the Standard Review Plan, Section 10.4.9."

4. Recommendation - Licensees with plants which require local manual realignment of valves to conduct periodic tests on one AFW system train and 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.9.3.3 Long Term

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

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



Auxiliary Feedwater System
North Anna
Figure 1

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.