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RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Provides addl response to NRC 800310 ltr re auxiliary feedwater sys design requirements.Licensee response to generic recommendations & basis for auxiliary feedwater sys flow requirements encl.

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MAY 07 1981
U.S. NUCLEAR REGULATORY COMMISSION

Mr. Harold R. Denton
Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington D.C. 20555

Subject: Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2 and 3
Docket Nos. STN-50-528/529/530
File: 81-056-026

References: (A) Letter from D. F. Ross NRC, to all pending OL applicants of NSSS designed by Westinghouse and Combustion Engineering, dated March 10, 1981.
(B) ANPP-16560-JMA/JPS, dated October 17, 1980
(C) ANPP-17268-JMA/TFQ, dated February 10, 1981
(D) ANPP-17417-JMA/TFQ, dated March 6, 1981

Dear Mr. Denton:

Your letter of March 10, 1980, Reference (A), states actions you require from us concerning the PVNGS Auxiliary Feedwater (AFW) System design. These actions are:

(a) provide an evaluation which shows how the AFW System meets each requirement in Standard Review Plan 10.4.9 and Branch Technical Position ASB 10-1.

(b) perform a reliability evaluation similar in method to that described in Enclosure 1 and submit it for staff review.

(c) factor the recommendations of Enclosure 1 into the plant design.

(d) respond to Enclosure 2, which requests the information necessary to determine the design basis for the AFW System flow requirements and to verify that the AFW System will meet these requirements.

We have completed our response to your request and will address each of the above items in turn.

(a) The PVNGS Auxiliary Feedwater System Independent Design Review (IDR) was held in Phoenix, Arizona on August 21-22, 1980. In this IDR, the Bechtel design team presented the AFW System

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Design and a comparison of the design to the requirements of Standard Review Plan Section 10.4.9, Revision 1, including Branch Technical Position ASB 10-1. This presentation and discussion of the presentation are in the transcript of the Auxiliary Feedwater System IDR, which was submitted to you through Reference (B).

(b) The reliability evaluation of the PVNGS AFW System was performed using a method similar to that described in Enclosure 1 of Reference (A). This evaluation was submitted to you through Reference (C). This evaluation had the following recommendations:

<u>RECOMMENDATION #1</u>

Provide the capability to supply the start-up auxiliary feedwater pump from the train A diesel generator.

<u>Response</u>

The design has been modified to incorporate this recommendation.

<u>RECOMMENDATION #2</u>

Provide position indication in the control room for the pump test bypass valves.

<u>Response</u>

The design has been modified to incorporate the recommendation.

<u>RECOMMENDATION #3</u>

Provide power to the suction valves for the start-up auxiliary feedwater pump from the train A diesel generator.

<u>Response</u>

The design has been modified to incorporate the recommendation.

<u>RECOMMENDATION #4</u>

Perform a total system test once every 18 months.

<u>Response</u>

PVNGS will adopt Technical Specifications to assure that, prior to plant start-up following an extended cold shutdown, a flow test will be performed to verify the normal flow path from the primary AFW system water source to the steam generators.

<u>RECOMMENDATION #5</u>

Perform testing on different shifts.

<u>Response</u>

Having different operators perform surveillance tests on the AFWS will not be required at PVNGS. Surveillance tests are of a frequency and complexity such that the operator will be

required to use detailed written procedures to conduct the tests. These procedures will contain appropriate sign-offs and checklists to insure that the testing is conducted in accordance with the procedure.

Maintenance or testing procedures which require realignment of valves from the normal position will incorporate a valve line-up checklist as part of the restoration.

(c) Reference (A), Enclosure 1, stated a number of short-term generic, additional short-term, and long-term generic recommendations. These recommendations are addressed in Attachment 1.

(d) The basis for AFWS flow requirements are presented in Attachment 2. The required emergency feedwater flow, based on residual heat removal requirements is 875 GPM delivered to the steam generator(s) downcomer feedwater nozzle.

The design AFW pump flow capacity is the sum of the flow requirements to the steam generators, plus the required pump mini flow, of 135GPM, for a total flow of 1010 GPM. No additional flow margin was added to the design specification. The design pump head includes approximately 5% margin based upon the pump total head. This 5% margin in total head provides approximately 80 GPM flow margin, or 8% above the required flow, to allow for seal leakage and pump wear.

We expect minimal pump wear of the two essential AFW pumps because these pumps are not used during start-up, hot standby or normal shutdown. PVNGS has a nonessential AFW pump which provides AFW during these plant operations. This third pump also has been designed to the aforementioned design specifications.

We believe this response, in conjunction with the Auxiliary Feedwater System Independent Design Review documentation and the Auxiliary Feedwater System Reliability Analysis, addresses any concerns you may have of the PVNGS AFW System. If your staff has any questions with this response or the mentioned AFW documents, we believe such questions should be raised promptly so that such subjects can be closed out completely.

Sincerely,

E. E. Van Brunt

E. E. Van Brunt, Jr.
APS Vice President
Nuclear Projects
ANPP Project Director

EEVB/TFQ/wp

Attachments

cc: J. Kerrigan
O. Parr
G. Bradley (Sandia Labs)
J. Wermiel

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, Edwin E. Van Brunt, Jr., represent that I am Vice President, Nuclear Projects of Arizona Public Service Company, that the foregoing document has been signed by me on behalf of Arizona Public Service Company with full authority so to do, that I have read such document and know its contents, and that to the best of my knowledge and belief, the statements made therein are true.

Edwin E. Van Brunt, Jr.

Edwin E. Van Brunt, Jr.

Sworn to before me this 1st day of May, 1981.

Helen M. Conover

Notary Public

My Commission Expires:

~~May~~ Apr. 1, 1983

SHORT-TERM GENERIC RECOMMENDATIONS

RECOMMENDATION GS-1

The licensee should propose modifications to the Technical Specifications to limit the time 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.

RESPONSE

PVNGS Technical Specifications state that in modes 1, 2, 3, and 4 (Tavg $>$ 350^{o}F) with only one emergency feedwater pump operable, restore at least one inoperable pump to operable status within 72 hours or be in hot shutdown with an operable shutdown cooling loop in operation within the next 12 hours. These time limits are based on current Standard Technical Specifications.

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 proposed for incorporation into the surveillance requirements of the plant Technical Specifications. See Recommendation GL-2 for the longer term resolution of this concern.

RESPONSE

PVNGS will lock open manual valves in the essential AFW system pump suction piping and valves in the discharge lines of the pumps to prevent interruption of all AFW flow. In addition, monthly inspections of these valves will be performed to verify that these valves are locked and in the open position.

RECOMMENDATION GS-3

The licensee should verify that the AFW system will supply on demand sufficient initial flow to the necessary steam generators to assure adequate decay heat removal following loss of main feedwater flow and a reactor trip from 100% power. In cases where this reevaluation results in an increase in initial AFW system flow, the licensee should provide sufficient information to demonstrate that the required initial AFW system flow will not result in plant damage due to water hammer.

RESPONSE

PVNGS does not plan to throttle back on AFAS valves to prevent water-hammer. Should an actual AFAS signal be received, the system would be allowed to function as designed; that is, pump and valve control would be automatic with no operator action. After automatic initiation, some operator action will be required to prevent overcooling of the reactor coolant system. This will be accomplished by throttling the auxiliary feedwater flow control valves to the steam generators, AF-HV30, 31, 32 and 33.

Some throttling may be done to accommodate surveillance testing, and normal start-up and shutdown when low flow rates may be required. Surveillance testing will require throttling of the auxiliary feedwater flow test valves to the condensate tank, AF-V018 and AF-V027. During normal start-up and shutdown, feedwater flow will be controlled by throttling AF-HV30, 31, 32 and 33, as required.

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:

(1) 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.

(2) 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.

RESPONSE

(1) The emergency operating procedures will incorporate the necessary operator action to protect the AFW pumps if the primary source is lost. This will involve realignment to the backup source, the Reactor Makeup Water Tank (RMWT), when the primary source, Condensate Storage Tank (CST) is lost.

(2) When the primary source is being depleted, the emergency operating procedure will insure that the RMWT is lined up as needed to supply the AFW pumps when the CST is at its minimum allowable level.

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 ac power source. If manual AFW system initiation or flow control is required following a complete loss of ac 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 ac power, design or procedureal 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 ac 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 ac power is restored. Adequate lighting powered by direct current (dc) 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.)

RESPONSE

The turbine-driven auxiliary feedwater pump turbine control system and its associated power-operated valves is connected to the Class IE DC Power System. Water for cooling of the lube oil for the turbine-driven pump bearings is supplied from the first stage of the pump, and therefore is not dependent on ac power. The turbine-driven AFW train will be initiated automatically following a complete loss of ac power; therefore, emergency procedures are not required.

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:

(1) 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.

(2) The licensee should propose Technical Specifications to assure that, prior to plant start-up 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.

RESPONSE

(1) Any maintenance or test which requires valve positions to be altered will require valve lineup and verification in accordance with written procedures as part of system restoration.

(2) PVNGS will adopt Technical Specifications to assure that, prior to plant start-up following an extended cold shutdown, a flow test will be performed to verify the normal flow path from the primary AFW system water source to the steam generators.

RECOMMENDATION GS-7

The licensee should verify that the automatic start AFW system 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.

(1) The design should provide for the automatic initiation of the AFW system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of AFW system function.

(3) Testability of the initiation signals and circuits shall be a feature of the design.

(4) The initiation signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the AFW 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.

(6) The ac motor-driven pumps and valves in the AFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) 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.

RESPONSE

The automatic start AFW System signals and associated circuitry has been verified to be safety-grade.

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 2.1.7.a of NUREG-0578.[13] For the longer-term, the automatic initiation signals and circuits should be upgraded to meet safety-grade requirements, as indicated in Recommendation GL-2.

(1) The design should provide for the automatic initiation of the AFW system flow.

(2) The automatic initiation signals and circuits should be designed so that a single failure will not result in the loss of AFW system function.

(3) Testability of the initiation signals and circuits shall be a feature of the design.

(4) The initiation signals and circuits should be powered from the emergency buses.

(5) Manual capability to initiate the AFW 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.

(6) The ac motor-driven pumps and valves in the AFW system should be included in the automatic actuation (simultaneous and/or sequential) of the loads to the emergency buses.

(7) 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.

RESPONSE

Refer to the PVNGS TMI-2 Lessons Learned Implementation Report, Section II.E.1.2.

ADDITIONAL SHORT-TERM RECOMMENDATIONS

RECOMMENDATION

The licensee should provide redundant level indication 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 occuring. The low-level alarm setpoint should allow at least 20 minutes for operation action, assuming that the largest capacity AFW pump is operating.

RESPONSE

The AFW system primary water supply, the CST, will have redundant Class IE level indication in the control room. The low-level alarm setpoint will allow at least 20 minutes for the operator to make up water in the CST or transfer to the alternate water supply, the RMWT.

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.

RESPONSE

PVNGS will perform as part of the start-up test requirements a 72 hour endurance test on the two (2) essential AFW system pumps. Following the 72 hour pump run, the pumps will be shutdown and cooled down and then restarted and run for one hour. Test acceptance criteria will include demonstrating that the pumps remain within design limits with respect to bearing/bearing oil temperatures and vibration and that the pump room ambient conditions do not exceed environmental qualification limits for safety-related equipment in the room.

RECOMMENDATION

The licensee should implement the following requirements as specified by Item 2.1.7.b on page A-32 of NUREG-0578:

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

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

RESPONSE

Refer to the PVNGS TMI-2 Lessons Learned Implementation Report, Section II.E.1.2.

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 from the test mode to its operational alignment.

RESPONSE

PVNGS will require local manual realignment of valves to conduct periodic tests on one AFW system train and will have one remaining essential AFW train available for operation. In addition, the Start-Up AFW Pump, which is provided with an emergency power source, will be available to supply auxiliary feedwater to the steam generators from the Condensate Storage Tank. The flow path used by the Start-Up AFW Pump is separate from the Essential AFW Pump flow paths.

Since the one (1) Essential AFW Train and the Start-Up AFW Train will be available during testing, Technical Specifications to provide that a dedicated individual who is in communication with the control room be stationed at manual valves is not required for PVNGS.

LONG-TERM GENERIC RECOMMENDATIONS

RECOMMENDATION GL-1

For plants with a manual starting AFW system, the licensee should install a system to automatically initiate the AFW system flow. This system and associated automatic initiation signals should be designed and installed to meet safety-grade requirements. Manual AFW system start and control capability should be retained with manual start serving as backup to automatic AFW system initiation.

RESPONSE

PVNGS has automatic initiation of AFW system flow. Refer to response to recommendation GS-8.

RECOMMENDATION GL-2

Licensees with plant designs 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 plant designs in which the primary AFW system water supply passes through valves in a single flow path, 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 into the surveillance requirements.

RESPONSE

The PVNGS AFW system has redundant parallel flow paths, piping and valves, from the primary source of water to the AFW pumps. The AFW system also has redundant parallel flow paths, piping and valves, from the secondary source of water to the essential AFW pumps. Also, refer to response to recommendation GS-2.

RECOMMENDATION GL-3

At least one AFW system pump and its associated flow path and essential instrumentation should automatically initiate AFW system flow and be capable of being operated independently of any ac power source for at least two hours. Conversion of dc power to ac power is acceptable.

RESPONSE

Refer to the response to recommendation GS-5.

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.

RESPONSE

The normal source of water, the Condensate Storage Tank and the piping and valves from the CST to the essential AFW pumps have been designed to meet Seismic Category I requirements. In compliance with Regulatory Guide 1.117, Revision 1, the AFW system is protected from the effects of a design basis tornado.

RECOMMENDATION GL-5

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

RESPONSE

Refer to the response to recommendation GS-7.

ATTACHMENT 2

BASIS FOR AUXILIARY FEEDWATER SYSTEM FLOW REQUIREMENTS

Design Bases

As stated in Section 5.1.4.F.9 of the Combustion Engineering Standard Safety Analyses Report (CESSAR-FSAR) the design bases for the Emergency Feedwater System is that:

" Following the events stated in Section 5.1.4.F.9, the emergency feedwater system shall maintain adequate inventory in the steam generator(s) for residual heat removal and be capable of the following:

a. Maintaining the NSSS at hot standby with or without normal offsite and normal onsite power available.

b. Facilitating NSSS cooldown at the maximum administratively controlled rate of 75°F/hr from hot standby to shutdown cooling initiation with or without normal offsite or onsite power available. (The Shutdown Cooling System becomes available for plant cooldown when the RCS temperature and pressure are reduced to approximately 350°F and 400 psia.) "

Where Section 5.1.4.F.9 requires:

" No single active or passive component failure, single passive or active electrical component failure, or power supply failure shall preclude adequate operation of the Emergency Feedwater System, such as the following events:

a. Loss of normal feedwater with or without a concurrent loss of normal onsite or offsite AC power.

b. Minor secondary system pipe breaks with or without a concurrent loss of normal onsite or offsite AC power.

c. Steam generator tube rupture with or without a concurrent loss of normal onsite or offsite AC power.

d. Major secondary system pipe breaks with or without a concurrent loss of normal onsite or offsite AC power.

e. Small LOCA with or without a concurrent loss of normal onsite or offsite AC power. "

Sizing Criteria

The required emergency feedwater flow, based on residual heat removal requirements is 875 gpm delivered to the steam generator(s) downcomer feedwater nozzle. This flowrate is determined by the feedwater necessary to equal steam flow necessary for heat removal under the following conditions:

a. Maximum decay heat 5 minutes after shutdown.
b. Four RCPs are running.
c. Steam generator (SG) pressure is equal to the lowest safety value set pressure.
d. Feedwater temperature is 120°F.

For heat loads greater than this (e.g. first five minutes following trip), the SG initial inventory in conjunction with the automatic initiation of feedwater maintains the steam generator as an acceptable heat sink.

NRC Request

Enclosure 2 to Letter from D. F. Ross, NRC, to all pending OL applicants of NSSS designed by Westinghouse and Combustion Engineering dated March 10, 1980, requested the following information regarding Auxiliary Feedwater System flow requirements:

1.a. Identify the plant transient and accident conditions considered in establishing AFWS flow requirements.

1) Loss of Main Feedwater (LMFW)

The LMFW event group is in the infrequent category of the decrease in heat removal by the secondary system. No event in the LMFW event group is as severe as the Loss of Condenser Vacuum with Fast Transfer Failure (LCV) event. Sections 15.2.2.1 and 15.2.2.2 of CESSAR FSAR show that the required flow rate adequately meets the design bases.

2) LMFW with Loss of Offsite AC Power (LOOP)

For this event the required flow rate is less than that for the LMFW event since the reactor trip is not delayed until secondary inventory is reduced to the low level setpoint.

3) LMFW With Loss of Onsite and Offsite AC power.

For this event the required flow rate is identical to that required for LMFW with loss of offsite power.

4) Plant Cooldown

The feedwater flow rate necessary to equal steam flow for a plant cooldown is shown in Figure 1.

5) Turbine Trip With and Without Bypass

Although not a design basis accident for sizing the AFW pumps, the turbine trip case analyzed in FSAR Section 15.2.1.1 demonstrates that the capacity of the AFW system is sufficient to maintain the secondary heat sink.

6) Main Steam Isolation Valve Closure.

This transient is similar to and produces effects no more adverse than the Loss of Condenser Vacuum discussed in Item 1a above.

7) Main Feedline Break (MFLB)

The MFLB is the limiting design base event for the Auxiliary Feedwater System. The analysis of CESSAR FSAR Section 15B demonstrates that the capacity of the AFW system is sufficient to maintain the secondary heat sink. Minimum inventory in the intact steam generator is about 10,000 lbm and occurs at approximately 150 seconds. At approximately 500 seconds inventory has recovered to about 30,000 lbm and primary temperatures are being maintained constant.

8) Main Steam Line Break

The Main Steam Line Break (MSLB) accidents are analyzed in FSAR Section 15C. Rapid depressurization of the affected steam generator results in the actuation of a Main Steam Isolation Signal (MSIS). This MSIS results in closure of the Main Steam Isolation Valves and the Main Feedwater Isolation Valves, isolates the unaffected steam generator from blowdown, and effectively pressures the unaffected steam generator's capability as a heat sink. A steam generator low level signal is generated in the affected steam generator, however, the AFAS logic determines a rupture exists and AFW is not actuated. Thus the AFW system is not automatically actuated within the 30 minutes prior to possible operator manual intervention . If the operator does not take manual control of the event, pressure in the unaffected steam

generator would rise to the safety valve setpoint and begin to blowdown. AFAS logic would eventually detect the inventory loss by a low water level signal and the AFW system would be actuated to preserve the secondary heat sink. 875 gpm is sufficient at that time to maintain inventory in the intact steam generator.

9) Small Break LOCA

This transient produces effects no more adverse on the secondary than the LMFW event, since primary energy inventory is partly released through the break and reactor trip occurs prior to a steam generator low level condition.

10) Other Transient or Accidents not Listed Above.

a. Plant Startup
AFW flow requirement is less than that required for plant cooldown.

b. Hot Standby and Hot Shutdown.

Although not a design base event for determining AFW pump capacity, the AFW system is placed in operation to maintain steam generator water level. Pump flow requirement is less than that required for plant cooldown.

1.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.

RCS Pressure

The Reactor Coolant Pressure Boundary (RCPB) is designed to accommodate the system pressures and temperatures attained under all expected modes of unit operation, including all anticipated transients, and to maintain the stresses within applicable limits. The design meets the requirements of the ASME Code, Section III, Division 1. The following specific criteria evolve from the ASME Code requirements:

Level B - Emergency Condition - the maximum stress will not exceed 120% of the design value.

Level C - Upset Condition - the maximum stress will not exceed 110% of the design value.

For the events discussed in 1.a., above, in all cases except the Main Feed Line Break the maximum RCS pressure result in stresses below the Level C limit. For the MFLB the maximum RCS pressure, 2843 lb/in^2a, results in stresses below the Level B limit.

Fuel Temperature or Damage Limits

Response to item 1.a. has shown that adequate system cooling is provided by the AFWS. Therefore, the fuel temperature or damage limits as described in Section 15.0 of CESSAR FSAR are not approached.

RCS Cooling Rate

The RCS is designed to withstand the cyclic loads generated by the pressure and temperature transients of normal startup and shutdown.

The AFWS assessment performed here is based on assumed maximum heat loads to ensure the ability of the AFWS to maintain cooling. An analysis concerning excessive primary shrinkage would entail assumptions of minimum heat loads which are not germain to sizing the AFWS. It is the responsibility of the operator to adjust the AFW flow rate, as required, to match the heat load.

Steam Generator Water Level

Steam generator water level is not an explicit acceptance criterion of the FSAR analyses. However, analyses shows that sufficient steam generator water level is maintained in either or both steam generator(s) until the RCS temperature is reduced to the shutdown cooling initiation threshold. At inventories less than 30,000 lbm some increase in primary temperatures are evident due to the reduced heat transfer area.

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

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

The reactor power, including instrument error, at the time of the initiating event is conservatively assumed to be 3876 MWt, which is 102 percent of licensed core power.

b. Time delay from initiating event to reactor trip.

The time delay from the initiating event to the reactor trip for the MFLB is 34.4 seconds. This conservatively represents the time when the affected steam generator is emptied.

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

For the current plant design, AFWS is initiated automatically on steam generator low level signal. AFW flow is assumed to reach the steam generator at 45 seconds after the actuation signal if AC power is lost and 10 seconds if AC power is maintained.

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

The initial inventory for the MFLB is 173,000 lbm per SG. The reactor trip on steam generator low level ensures a minimum steam generator inventory when the cooldown phase begins. Inventory at trip is approximately 45,000 lbm per SG.

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

For the MFLB event, the initial inventory and depletion rate are immaterial since the water level must reach the low level setpoint prior to the reactor trip occuring. Once the AFW flow reaches the steam generator(s), sufficient AFW pump capacity exists to remove decay heat and maintain an appropriate steam generator water level assuming decay heat for a full-power history.

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

The maximum steady state steam generator pressure expected is 1275 psia.

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

Only one steam generator is required to remove sensible and decay heat during all operational transients and accidents.

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

For the MFLB event, total loss of normal on-site and off-site electrical power is assumed to occur simultaneously with the turbine trip signal at 35.8 seconds. Natural circulation takes place thereafter.

i. Maximum AFW inlet temperature.

120°F.

j. Following a postulated steam or feedline 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.

For postulated steam line breaks an early reactor trip and MSIS occurs on low steam generator pressure (11.4 seconds in Section 15C of CESSAR-FSAR). This minimizes the time to isolate the break. The ensuing pressure difference between steam generators will isolate the AFW from the break and direct it to the unaffected steam generator when actuated. However, due to the inventory remaining in the unaffected SG, AFW is not automatically actuated until after 1800 seconds.

For feedline breaks the reactor trip and AFAS occur early on low level due to two-phase flow out of the break. This minimizes time before delivery of AFW flows. The absence of a pressure differential until the low pressure setpoint is reached means that AFW flow is delivered to both steam generators, preserving the heat sink. When the low pressure setpoint is reached all AFW flow will be delivered to the unaffected steam generator (173.6 seconds in section 15B of CESSAR-FSAR).

k. Volume and maximum temperature of water in main feedlines between steam generator(s) and AFWS connection to main feedline.

The initial main feedwater temperature is assumed to be 400°F. For the MFLB case main feedwater is assumed to be unavailable to both steam generators. When AFW flow is assumed to enter the steam generator, no credit is taken for the volume of feedwater that would normally be available in the feedline between the steam generator and the AFW system connection.

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

Steam generator normal blowdown is not considered subsequent to the initiating event. During plant accident conditions blowdown is isolated upon an Auxiliary Feedwater Actution signal (AFAS).

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

1.96×10^6 Btu/°F

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

The condensate storage tank water volume of 300,000 gal is adequate to ensure plant sensible heat removal in addition to 14 hours of decay heat removal. Assuming a maximum cooldown time of 10 hours, this allows for four hours at hot standby.

/jcp

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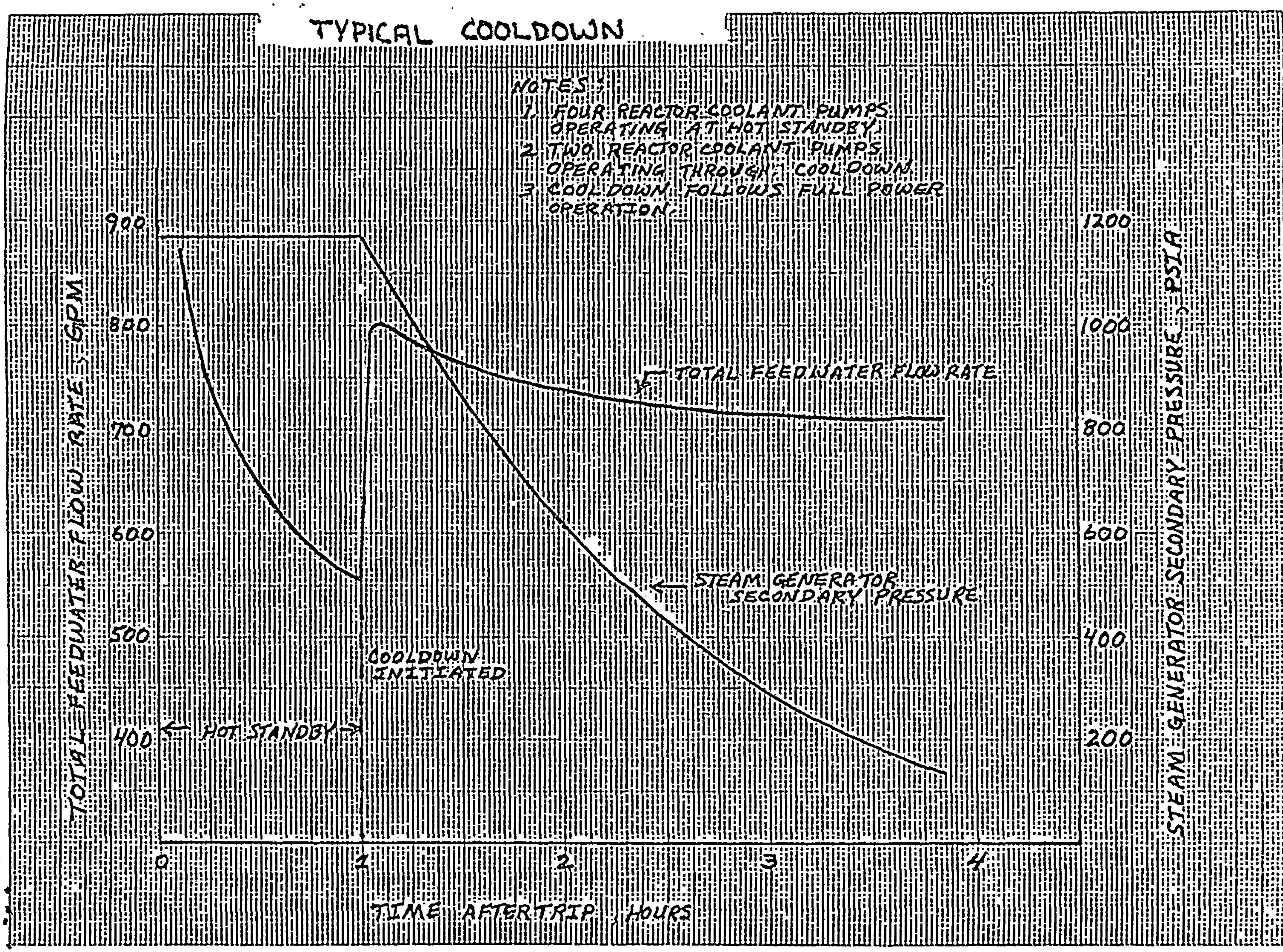

Figure 1

[illegible]