TVA

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

August 31, 1998

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

10 CFR 50.54(f)

Gentlemen:

In the Matter of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328
		50-390

SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2, AND WATTS BAR NUCLEAR PLANT (WBN) UNIT 1, RESPONSE TO NUCLEAR REGULATORY COMMISSION (NRC) REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO NRC GENERIC LETTER (GL) 96-06, "ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN BASIS ACCIDENTS" (TAC NOS. M96866, M96867, AND M96884)

This letter provides TVA's reply to the NRC letters dated July 2, 1998 and July 9, 1998 for SQN and WBN respectively, regarding equipment operability and containment integrity during design basis accidents.

On September 30, 1996, the NRC issued the referenced GL regarding thermally induced overpressurization of isolated water-filled piping sections inside containment that could jeopardize the ability of accident-mitigating-systems to perform their safety function. Also, the NRC requested that the effects of a loss of coolant accident on the containment cooling system including waterhammer and two-phase flow be reviewed.

A072

By letter dated January 28, 1997, TVA indicated that voiding is not expected to occur in cooling systems inside containment, therefore, no waterhammer or two-phase flow problems are expected. Enclosures 1 and 2 provide additional details for SQN and WBN respectively which support our position.

No commitments are made in this response. If you have any questions, please telephone me at (423) 751-2508.

Sincerely,

Mark J. Burzynski
Manager
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Enclosures
cc: See page 3

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO NRC GENERIC LETTER (GL) 96-06, ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN BASIS ACCIDENTS

NRC Request 1

Provide a complete and detailed description of the "worst case" scenarios for both waterhammer and two phase-flow that could occur in the Essential Raw Cooling Water (ERCW) system within the constraints imposed by the licensing basis of the plant taking into consideration the complete range of event possibilities, parameters, and system configurations (including situations where containment isolation has not occurred. If this is a possibility).

TVA Response

The ERCW system serves the Lower Compartment Coolers (LCCs), upper compartment coolers, the control rod drive coolers, and the reactor coolant pump motor coolers. This system is isolated post-accident by redundant, safety-related, inboard and outboard isolation valves served by separate trains of power, and the isolation function has been analyzed for single failure. As such, it is ensured that the ERCW system will isolate post-accident.

The limiting licensing basis accidents are the Loss of Coolant Accident (LOCA) and Main Steam Line Break (MSLB). After such an event, the four loops of the ERCW system would be expected to isolate at the containment boundary. The containment temperature would increase up to a maximum of 327°F followed by a gradual decrease under the action of the ice condenser system. It would reach a long-term average containment temperature of ~120°F within one hour of event initiation. This temperature excursion would heat the isolated sections of the ERCW up to ≤327°F. This temperature is less than the saturation pressure of the fluid at the relief valve setpoint for the ERCW system, 150 psig. The duration and amplitude of the containment temperature excursion under a licensing basis accident will, therefore, not lead to voiding in the ERCW system. Accordingly, waterhammer and two-phase flow will not occur.

The ERCW system and LCCs are credited in the SQN safety analysis for long-term containment cooling starting four hours after the initiation of a MSLB. Post design basis accident recovery procedures at SQN allow operators to start the ERCW system as soon as one hour after the event. As previously stated, the containment temperature at the earliest probable start of the system is less than 120°F. This precludes significant void formation in the ERCW system, therefore, waterhammer and two-phase flow would not occur.

The ERCW system has been evaluated for a postulated, single failure of a stuck open relief valve. Relief valves on the ERCW system are installed on piping inside containment with the maximum design operating pressure of 150 psig. This corresponds to a saturated steam temperature of 366°F. With a stuck open relief valve on one of four ERCW loops, the affected loop coils will boil dry (i.e., the pressure on the coils is reduced which allows boiling at a lower temperature). The safety function of long-term cooling will be accomplished by any two of the remaining three ERCW loops. The faulted loop would likely have significant voiding during the isolation phase. The open relief valve would act to smooth the system pressure equalization by pulling in air from the containment environment. As ERCW flow is re-established, the entrained air and the still open relief valve would buffer the system from momentum induced waterhammer. With the ERCW loop refilled with water, the loop would also be available to perform the safety function of long-term cooling using a standard flow of 200 gpm that is reduced by the 5 gpm flow through the still open relief valve.

NRC Request 2

If a methodology other than that discussed in NUREG/CR 5220, "Diagnosis of Condensation-induced Waterhammer" was used in evaluating the effects of waterhammer, describe this alternate methodology in detail.

TVA Response

SQN does not experience waterhammer as described in the response to Request 1 above. Therefore, this question is not applicable to SQN. The faulted loop will have an open relief valve that will dampen any sudden changes in pressure within the system by allowing air to enter the loop and cushion water flows. The intact loops will not experience voids and therefore waterhammer will not occur.

NRC Request 3

For both waterhammer and two-phase flow analysis, provide the following information:

a. Identify any computer codes.
b. Describe and justify all assumptions and input parameters.
c. Determine the uncertainty in the waterhammer and two-phase flow analysis.

TVA Response

Based on the evaluation described in the response to Request 1, SQN will not experience waterhammer or two-phase flow. Therefore, this question is not applicable to SQN.

NRC Request 4

Confirm that the waterhammer and two-phase flow loading conditions do not exceed any design specifications or recommended service conditions for the piping system and components, including those stated by equipment vendors; and confirm that the system will continue to perform its design-basis functions as assumed in the safety analysis report for the facility and that the containment isolation valves will remain operable.

TVA Response

Based on the evaluation described in the response to Request 1, SQN will not experience waterhammer or two-phase flow. Therefore design-basis conditions are unaffected, and systems will perform their functions as previously analyzed.

The containment isolation valves have been analyzed for the conditions in which they are to operate and these conditions remain unchanged; therefore, the valves will perform their functions as previously analyzed.

NRC Request 5

Describe positive measures that have been taken (or will be taken) to eliminate the potential for waterhammer and two-phase flow conditions in the ERCW system, such as placing restrictions on use of the ERCW system following an accident. Describe the worst-case scenarios and how much margin to boiling will exist.

TVA Response

Based on the evaluation described in the response to Request 1, SQN will not experience waterhammer or two-phase flow. Existing safety-grade isolation schemes will preclude ERCW system voiding for design basis accidents. Existing procedures allow operators to start ERCW within one hour after initiation of a design basis event. At this time in the event scenario, the containment temperature has been reduced to ~120°F. For further assurance that the system does not experience waterhammer or two-phase flow, TVA plans to revise emergency plan implementing procedures to include a precaution to consider the potential for waterhammer when restarting ERCW after a design basis accident.

NRC Request 6

Implementing measures to assure that waterhammer will not occur, such as restricting post-accident operation of the affected system or maintaining head tank pressure, is an acceptable approach for addressing the waterhammer and two-phase flow concerns. However, all scenarios must be considered to ensure that the vulnerability to waterhammer has been adequately addressed. Confirm that all scenarios have been considered such that the measures that have been established are adequate to address all situations.

TVA Response

Based on the evaluation described in the response to Request 1, SQN will not experience waterhammer or two-phase flow in the isolated ERCW loops. ERCW system pressure in post-accident conditions is governed by the system relief valve setpoints. Relief pressures of 150 psig and associated saturation temperatures are high enough to preclude voiding at temperatures expected in the SQN containment following design basis accidents. Procedural guidance to start the ERCW one hour after event initiation ensures that the system operation will occur at a relatively benign containment temperature of 120°F. As described in the response to Request 5, additional enhancements are being added to ensure the system is not operated when voiding is possible.

The response to Request 8 discusses the SQN licensing basis methodology for consideration of failure scenarios.

NRC Request 7

Discuss specific system operating parameters that must be maintained in order for the waterhammer and two-phase flow analysis to be valid (e.g., head tank pressure, temperature, and level), and explain why it would not be appropriate to establish technical specification requirements for these system parameters. Also, describe and justify reliance on any nonsafety-related instrumentation and controls in this regard.

TVA Response

Based on the evaluation described in the response to Request 1, SQN will not experience waterhammer or two-phase flow. Isolation logic currently implemented at SQN ensures that the ERCW system isolation will occur before voiding will occur in the system. No additional technical specification constraints are required to address the issue. The isolation logic and isolation valves relied upon to avoid voiding are safety-grade.

NRC Request 8

Confirm that a complete failure modes and effects analysis (FMEA) was completed for all components (including electrical and pneumatic failures) that could impact performance of the cooling water system and confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.

TVA Response

The SQN FSAR describes the plant compliance with single failure criteria in FSAR sections 3.11 and 3.12. The above discussion is consistent with the FSAR analysis and the SQN licensing basis.

The ERCW system is isolated post-accident. It has been analyzed for single failure and, as such, is ensured that the system will isolate after a LOCA or MSLB. The system has redundant, safety-related, check valves or motor-operated isolation valves (inboard and outboard) served by separate trains of power. Single failure design takes into account the design basis events and, therefore, the system is designed for a "worst case" scenario. ERCW is used post-MSLB (along with the LCCs) for long-term cooling and is analyzed to restart at four hours following the initiation of the event. Procedural direction at SQN can have ERCW restart as soon as one hour after the event. The containment temperature at the earliest possible start of the system is less than 120°F. As described in the response to Request 1, ERCW has been evaluated (for GL 96-06) for the effects of a stuck open relief valve to ensure the safety function is performed despite a single failure.

NRC Request 9

Explain and justify all uses of "engineering judgment."

TVA Response

Engineering judgment was used for the assumed faulted loop. This judgment is that a stuck open relief valve will act as a vent to the faulted loop. This is based on the size of the relief valve being approximately the same size as a vent valve. The stuck open relief valve will allow containment atmosphere to enter the faulted cooling loop as the containment temperature decreases and the ERCW piping in the faulted loop cools. The water in the faulted loop will cool and shrink slowly as containment cools to its long-term temperature of 120°F. The cooling will be slow and follow the containment cooling curve. The water in the piping and coils thus being cooled will be at low temperatures (less than boiling), will not collapse quickly enough to result in waterhammer. Additionally, as containment is relatively cool (temperature less than boiling) at this time, two-phase flow will not occur. As the water shrinks and cools it will create a vacuum in the piping thus pulling air into the pipe. This air then acts as a cushion during refilling. Opening the discharge side of the system first allows the water to gravity drain back into the faulted loop similar to that for a normal fill of the system. A normal fill of the system does not result in waterhammer.

NRC Request 10

Provide a simplified diagram of the affected systems, showing major components, active components, relative elevations, lengths of piping runs, and the location of any orifices and flow restrictions.

TVA Response

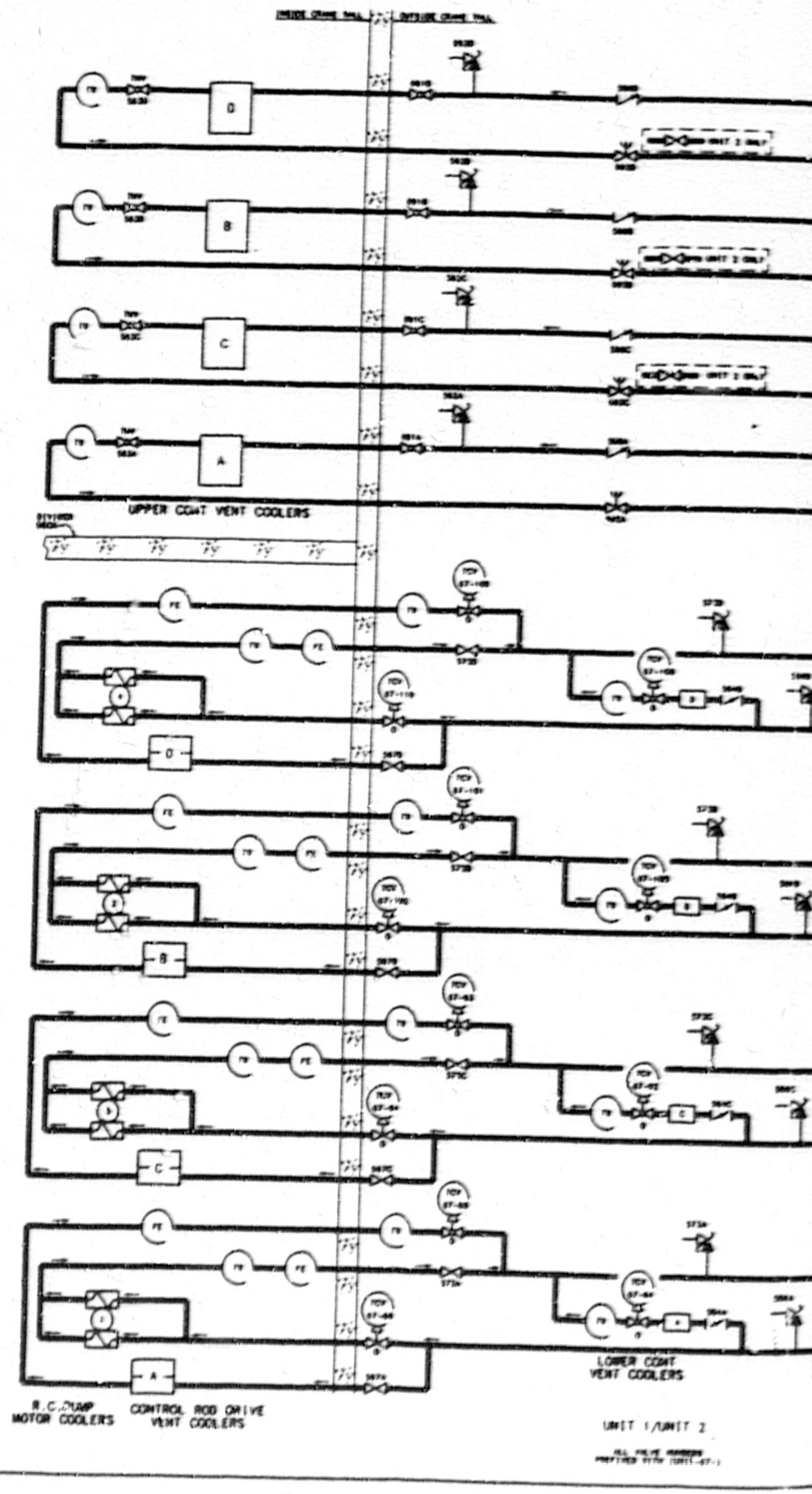
A simplified diagram of relative elevations and lengths of piping runs was not provided since SQN does not have the potential for waterhammer or two-phase flow in any safety-related coolers, and no analysis of waterhammer effects was performed. The flow diagram for ERCW shows the major components, active components, and any orifices and flow restrictions for the ERCW system inside containment. This flow diagram is available to the NRC as UFSAR Figure 9.2.2-3 (copy attached to this enclosure).

NRC Request 11

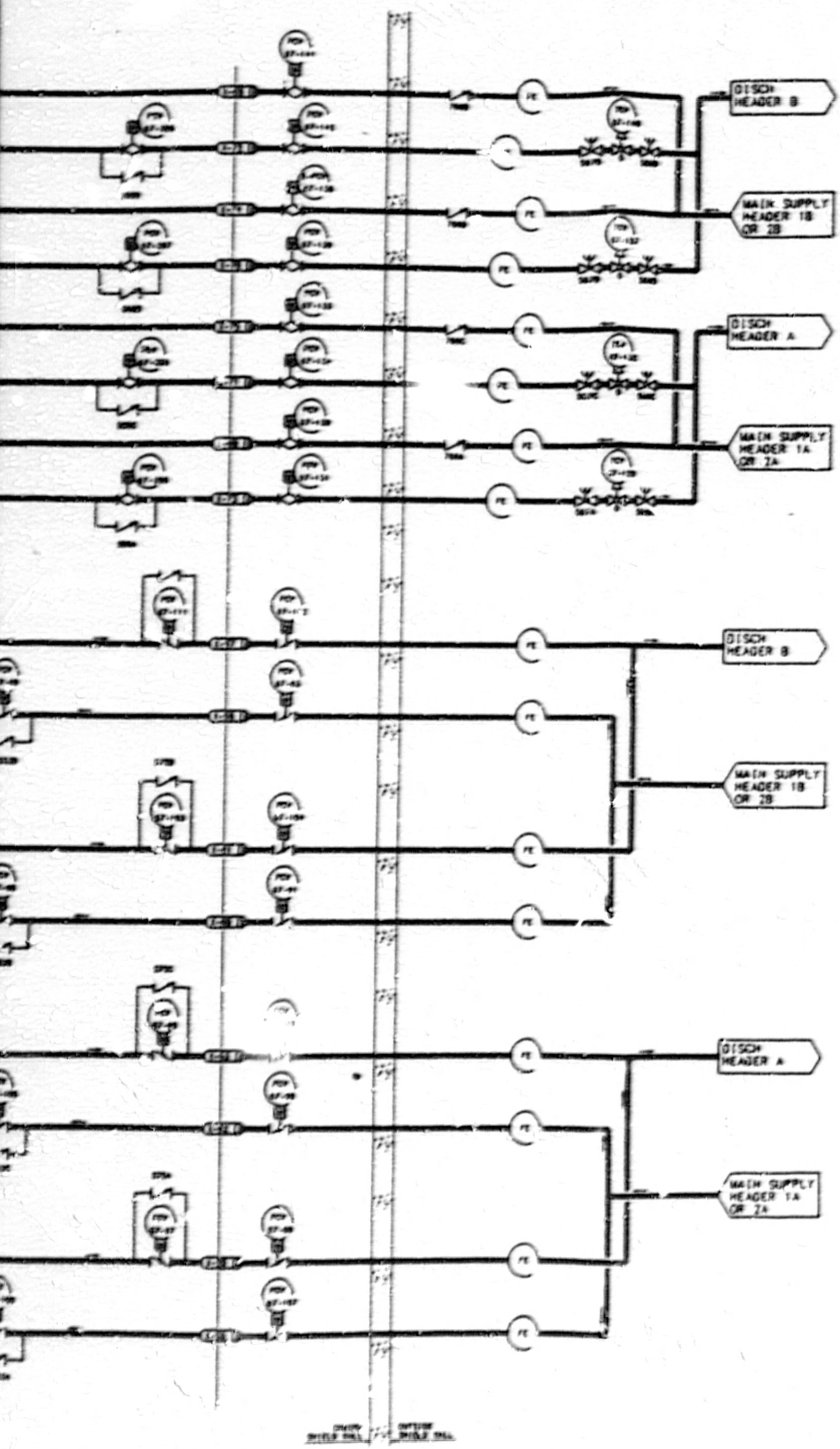
Describe in detail any plant modifications or procedure changes that have been made or are planned to be made to resolve the waterhammer and two-phase flow issues, including schedules for completing these actions.

TVA Response

Based on the evaluation described in the responses to Requests 1 and 5, SQN will not experience waterhammer or two-phase flow. No modifications are planned regarding this issue. For further assurance that the system does not experience waterhammer or two-phase flow, TVA plans to revise emergency plan implementing procedures to include a precaution to consider the potential for waterhammer when restarting ERCW after a design basis accident.



UPPER CONT VENT COOLERS
LOWER CONT VENT COOLERS
R.C.PUMP MOTOR COOLERS
CONTROL ROD DRIVE VENT COOLERS
UNIT 1/UNIT 2



NOTES:
1. TYPICAL FOR UNIT 1 & UNIT 2 AS NOTED.

SEQUOYAH NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

FIGURE 9.2.2-3
ESSENTIAL RAW COOLING WATER
(REVISED BY AMENDMENT 13)

9809100039-01

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

REQUEST FOR ADDITIONAL INFORMATION REGARDING RESPONSE TO NRC GENERIC LETTER (GL) 96-06, ASSURANCE OF EQUIPMENT OPERABILITY AND CONTAINMENT INTEGRITY DURING DESIGN BASIS ACCIDENTS

NRC Request 1

Describe controls that exist and positive measures that have been taken (or will be taken) to ensure that the ERCW system will be isolated from the containment and will not be restored by plant operators as an option following a loss-of-coolant accident or a main steam line break inside containment.

TVA Response

The portion of the ERCW system inside containment has redundant safety-related containment isolation valves on each line entering and leaving containment. The isolation valves are safety-grade check valves or motor-operated valves which receive a Phase B isolation signal consistent with their accident mitigation function. The instrumentation and actuation logic as well as the isolation valves are safety-grade and designed for a single failure.

The portion of the ERCW system inside containment is not credited for post-accident mitigation and has no auto-start functions. At least 1.5 hours after the event initiation, WBN procedures permit the operators to manually reset the isolation signal and restart the Lower Compartment Cooling (LCC) fans to support long-term containment cooling.

The LCC fans are analyzed to be manually started between 1.5 and 4 hours following the initiation of the event. The only system that would be required for accident mitigation is the LCC fans (which are required to circulate air only following a Main Steam Line Break [MSLB]).

The Upper Compartment Coolers (UCCs) are on an ERCW header separate from the LCCs. The UCCs are not used post-accident, and there is no existing procedural guidance to return the system to operation following an accident. As the system does not void and is not used post-accident, there is no potential for waterhammer and/or two-phase flow.

The containment temperature would increase up to a maximum of 327°F followed by a gradual decrease under the action of the ice condenser system., The LCCs which are located outside the crane wall will see a maximum temperature of 235°F. The containment temperature would heat and pressurize the ERCW supply to the LCCs, but the fluid temperature would remain below saturation temperature corresponding to the system relief valve setpoint of 150 psig (approximately 366°F). Therefore, no voiding will occur and any hydraulic pressures created can be accommodated by the system relief valve. If a single relief valve is postulated to fail open, the affected ERCW loop will gradually void under the effect of elevated containment temperature. As containment temperature is reduced by the action of the ice condenser, the steam in the faulted ERCW loop would gradually condense with pressure equalization provided by the stuck open relief valve which would preclude a waterhammer.

WBN has parallel suction isolation valves on the residual heat removal line from the reactor coolant system which ensures attainment of cold shutdown. As a result, heat removal via the LCCs is not necessary for long-term, post-MSLB containment cooling. Only the air side of the coolers is required to operate after a MSLB to circulate air in lower containment which supports the heat removal by the containment spray system. Emergency operating procedures do not direct the operators to restore ERCW flow to the LCCs. That action must be evaluated and recommended by the Technical Assessment Team in the Technical Support Center. To provide further assurance that the ERCW system does not experience waterhammer and two-phase flow, TVA plans to revise emergency plan implementing procedures to include a precaution to consider the potential for waterhammer when restarting ERCW after a design basis accident.

NRC Request 2

Implementing measures to ensure that waterhammer will not occur, such as restricting post-accident operation of the affected system, is an acceptable approach for addressing the waterhammer and two-phase flow concerns. However, all scenarios must be considered including situations where the system is not automatically isolated from containment (if this is a possibility), to ensure the vulnerability to waterhammer and two-phase flow has been adequately addressed. Confirm that all scenarios have been considered such that the measures that exist are adequate to address all situations.

TVA Response

As discussed in the response to Request 1 above, consistent with the licensing basis for WBN, the ERCW isolation is implemented by safety-grade equipment capable of performing its safety function despite a single failure. ERCW is not required to be used for accident mitigation. Emergency operating procedures do not direct the operators to restore ERCW flow to the LCCs. That action must be evaluated and recommended by the Technical Assessment Team in the Technical Support Center.

Since isolation of ERCW inside containment precludes voiding, no further actions are needed. As discussed in the response to Request 1, for further assurance that the system does not experience waterhammer or two-phase flow, TVA plans to revise emergency plan implementing procedures to add a precaution against waterhammer during restart of the ERCW system following a design basis event.

Evaluation of appropriate scenarios is performed consistent with the current licensing basis and is discussed in the response to Request 3.

<u>NRC Request 3</u>

Confirm that a complete failure modes and effects analysis (FMEA) was completed for all components (including electrical and pneumatic failures) that could impact performance of the cooling water system and confirm that the FMEA is documented and available for review, or explain why a complete and fully documented FMEA was not performed.

<u>TVA Response</u>

A calculation has been performed which documents the FMEA for the ERCW. It is essentially duplicated in FSAR Table 9.2-2. Items 45 and 54 discuss the redundancy of the inboard and outboard CIVs which isolate ERCW to the LCCs.

<u>NRC Request 4</u>

Explain and justify all uses of "engineering judgment."

<u>TVA Response</u>

Engineering judgment was used for the assumed faulted loop. This judgment is that a stuck open relief valve will act as a vent to the faulted loop. This is based on the size of the relief valve being approximately the same size as a vent valve. The stuck open relief valve will allow containment atmosphere to enter the faulted cooling loop as the containment temperature decreases and the ERCW piping in the faulted loop cools. The water in the faulted loop will cool and shrink slowly as containment cools to its long-term temperature of 120°F. The cooling will be slow and follow the containment cooling curve. The water in the piping and coils thus being cooled will be at low temperatures (less than boiling), will not collapse quickly enough to result in waterhammer. Additionally, as containment is relatively cool (temperature less than boiling) at this time, two-phase flow will not occur. As the water shrinks and cools it will create a vacuum in the piping thus pulling air into the pipe. This air then acts as a cushion during refilling. Opening the discharge side of the system first allows the water to gravity drain back into the faulted loop similar to that for a normal fill of the system. A normal fill of the system does not result in waterhammer.

NRC Request 5

Provide a simplified diagram of the affected systems, showing major components, active components, relative elevations, lengths of piping runs, and the location of any orifices and flow restrictions.

TVA Response

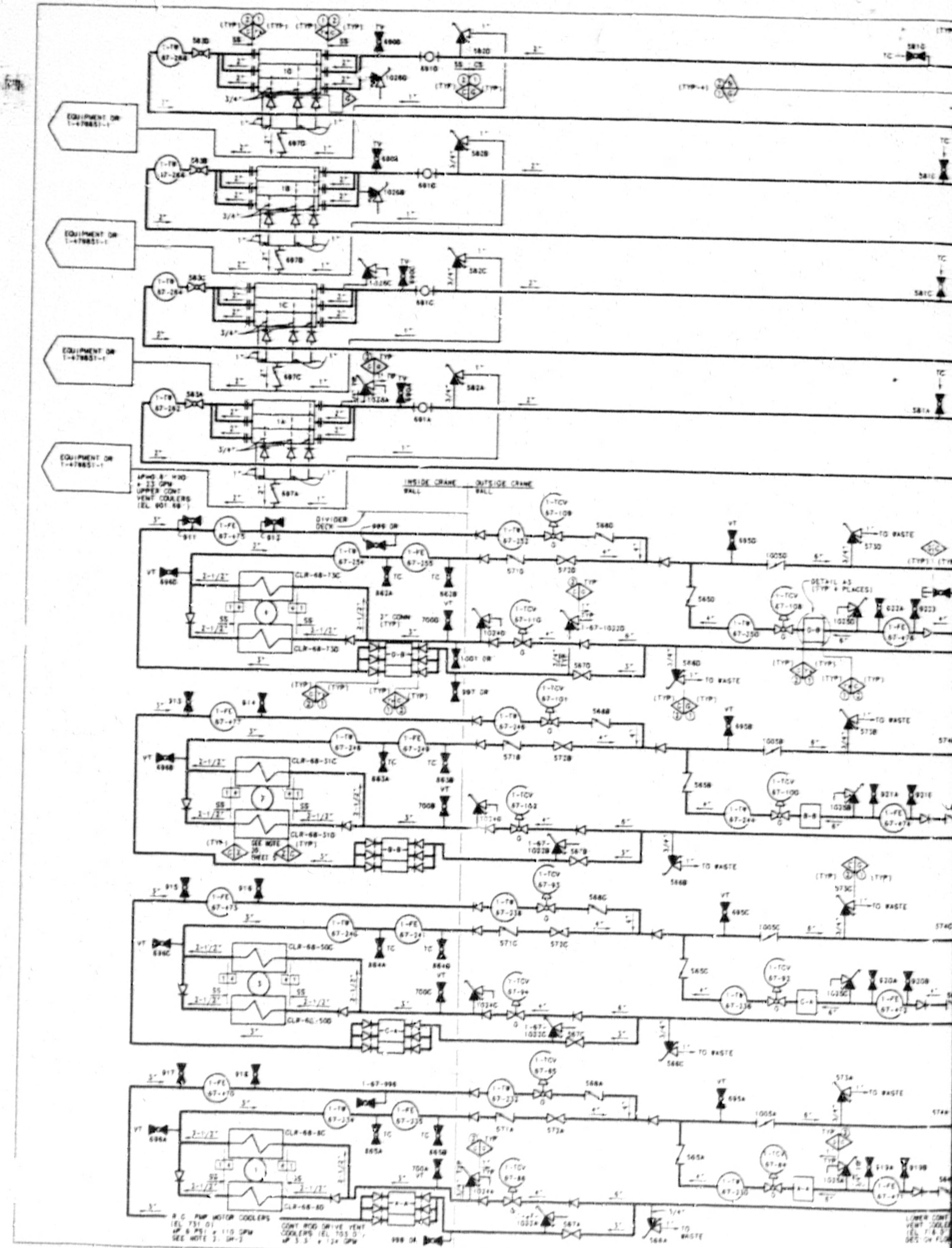
A simplified diagram of relative elevations and lengths of piping runs was not provided since WBN does not have the potential for waterhammer or two-phase flow in any safety-related coolers, and no analysis of waterhammer effects was performed. The flow diagram for ERCW shows the major components, active components, and any orifices and flow restrictions for the ERCW system inside containment. This flow diagram is available to the NRC as FSAR Figure 9.2-3 (copy attached to this enclosure).

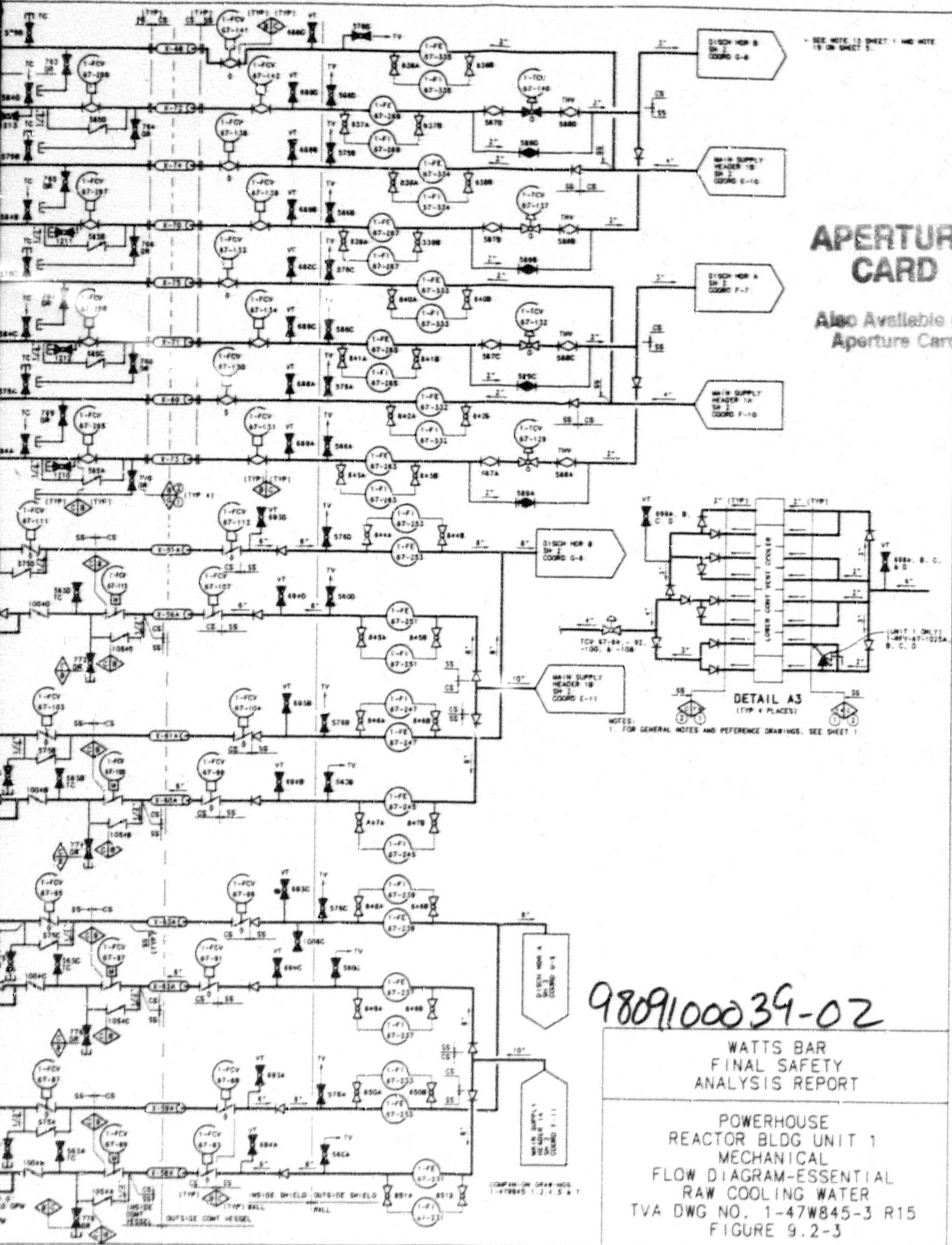
NRC Request 6

Describe in detail any plant modifications or procedure changes that have been made or are planned to be made to resolve the waterhammer and two-phase flow issues, including schedules for completing these actions.

TVA Response

WBN does not experience waterhammer or two-phase flow as described in the response to Request 1 above. To provide further assurance that the ERCW system does not experience waterhammer and two-phase flow, TVA plans to revise emergency plan implementing procedures to include a precaution to consider the potential for waterhammer when restarting ERCW after a design basis accident.


EQUIPMENT DR 1-47W851-1
INSIDE CRANE WALL
OUTSIDE CRANE WALL
DIVIDER DECK
TO WASTE
DETAIL AS (TYP 4 PLACES)
CLR-68-73C
CLR-68-73D
CLR-68-51C
CLR-68-51D
CLR-68-50C
CLR-68-50D
CLR-68-8C
CLR-68-8D
R.C. PMP MOTOR COOLERS
CONT ROD DRIVE VENT COOLERS
UPPER CONT VENT COOLERS



9809100039-02

WATTS BAR
FINAL SAFETY
ANALYSIS REPORT

POWERHOUSE
REACTOR BLDG UNIT 1
MECHANICAL
FLOW DIAGRAM-ESSENTIAL
RAW COOLING WATER
TVA DWG NO. 1-47W845-3 R15
FIGURE 9.2-3