Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609

APR 18 1994

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

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - NRC BULLETIN 93-02, SUPPLEMENT 1 - DEBRIS PLUGGING OF EMERGENCY CORE COOLING SYSTEM (ECCS) SUCTION STRAINERS

This letter provides TVA's response to the subject supplement to Bulletin 93-02, dated February 18, 1994. In response to the original Bulletin, TVA previously performed a walkdown of the Unit 2 drywell (primary containment) and confirmed that there are no temporary or permanently installed fibrous air filter or other sources of fibrous material not designed to withstand a Loss of Coolant Accident (LOCA). As detailed in Enclosure 1 to this letter, TVA has concluded, based on currently available information, that debris induced clogging of the BFN suppression pool strainers is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition. Nevertheless, TVA is actively participating in the ongoing work of the Boiling Water Reactor Owners' Group (BWROG) ECCS Suction Strainers Committee and the BWROG Emergency Procedure Committee.

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TVA's commitments to augment the operator's required reading program, revise appendices in the BFN Emergency Operating Instructions (EOIs), conduct classroom and/or simulator training, and change the applicable design control procedure are considered additional defense in depth against potential debris blockage of the ECCS strainers. TVA's commitments will be completed prior to June 30, 1994. While not explicitly conforming to the 90 day completion schedule (May 19, 1994) suggested in the Bulletin, this implementation schedule is considered adequate due to the time constraints dictated by the need to develop the EOI changes and train the operators on the content of those changes. This training will be accomplished during the next normally scheduled requalification training cycle.

A detailed summary of the commitments contained in this letter is provided as Enclosure 2. If you have any questions, please telephone me at (205) 729-2636.

Sincerely,

Pedro Salas
Manager of Site Licensing

Enclosures
cc: see page 3

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ENCLOSURE 1
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

NRC BULLETIN 93-02, SUPPLEMENT 1
DEBRIS PLUGGING OF EMERGENCY CORE COOLING SUCTION STRAINERS

BACKGROUND

On May 11, 1993, NRC issued Bulletin 93-02 (Reference 1), which notified licensees of a previously unrecognized contributor to the potential loss of net positive suction head (NPSH) for the Emergency Core Cooling Systems (ECCS) during the recirculation phase of a loss of coolant accident (LOCA). The filtering of corrosion products, dust, fibrous thermal insulation, debris, and other temporary material may cause an unexpectedly rapid loss of net positive suction head for the ECCS pumps when they are needed to perform their intended function. Licensees were requested to identify fibrous air filters or other temporary sources of fibrous material, not designed to withstand a LOCA, which are installed or stored within the primary containment and take prompt action to remove any such material.

TVA responded to Bulletin 93-02 on May 23, 1992 (Reference 2). Each Browns Ferry unit is a BWR 4 with a Mark I containment. TVA performed a walkdown of the Unit 2 drywell (primary containment) and confirmed that there are no temporary or permanently installed fibrous air filter or other sources of fibrous material not designed to withstand a LOCA. BFN Units 1 and 3 are shutdown for extended outages. TVA previously committed to evaluate these units for permanent fibrous material. These units will be inspected and temporary fibrous material will be removed prior to their respective startup.

On February 18, 1994, NRC issued Supplement 1 to Bulletin 93-02 (Reference 3). The staffs' ongoing review of this issue suggests that the previous method of estimating the fragmentation of insulation materials may not be representative of the large break LOCA scenario and that the extent of debris generation due to a jet from a postulated pipe break may have been underestimated. In addition, small particles, in combination with debris fibers, have been found to significantly increase the pressure drop across strainers.

BFN'S ECCS DESIGN

Each BFN unit employs a pressure suppression containment system which houses the reactor vessel, the reactor coolant recirculating loops, and other branch connections of the Reactor Primary System. The pressure suppression system consists of a drywell, a pressure suppression chamber (alternatively referred to as the torus or wetwell) which stores a large volume of water, a connecting vent system between the drywell and the suppression chamber, isolation valves, containment cooling systems, equipment for establishing and maintaining a pressure differential between the drywell and pressure suppression chamber, and other service equipment.

The drywell is a steel pressure vessel with a spherical lower portion 67 feet in diameter, and a cylindrical upper portion 38 feet 6 inches in diameter. The overall height is approximately 115 feet. In the event of a process system piping failure within the drywell, reactor water and steam would be released into the drywell air space. The resulting increased drywell pressure would then force a mixture of air, steam, and water through the vents into the pool of water which is stored in the suppression chamber. The steam would condense rapidly and completely in the suppression pool, resulting in rapid pressure reduction in the drywell. Air that is transferred to the suppression chamber pressurizes the chamber and is subsequently vented to the drywell to equalize the pressure between the two vessels.

The pressure suppression chamber is a steel pressure vessel in the shape of a torus below and encircling the drywell, with a centerline diameter of approximately 111 feet and a cross-sectional diameter of 31 feet. Large vent pipes form a connection between the drywell and the pressure suppression chamber. A total of eight circular vent pipes are provided, each having a diameter of 6.75 feet. Jet deflectors are provided in the drywell at the entrance of each vent pipe to prevent possible damage to the vent pipes from jet forces which might accompany a pipe break in the drywell. The eight vent pipes are connected to a 4-foot 9-inch diameter vent header, which is contained in the airspace of the suppression chamber. Projecting downward from the vent header are 96 downcomer pipes, 24 inches in diameter, and terminating approximately 3 feet below the water surface of the pool.

A 30-inch diameter suction header circumscribes the suppression chamber. Four 30-inch diameter tees are used to connect the suction header to the suppression chamber. Four strainers (approximately ⅛ inch mesh) on connecting lines between the suction header and the suppression chamber have been provided. The suction lines from the Residual Heat Removal (RHR), High Pressure Coolant Injection (HPCI), Core Spray and Reactor Core Isolation Cooling (RCIC) systems are supplied from this header.

In addition, the following BFN plant design features should be noted. The major equipment of the BFN RHR System consists of four heat exchangers and four main system pumps for each unit, and twelve RHR service water (RHRSW) pumps for the plant, eight of which can be used for RHRSW purposes. The pump suction and heat exchanger discharge lines of one loop in Unit 1 (Loop II) are cross-connected to the pump suction and heat exchanger discharge lines of one loop (Loop I) in Unit 2. Unit 2 and Unit 3 systems are cross-connected in a similar manner. A simplified diagram of the cross-connect capability is provided as Figure 1. Additional information on this design feature is contained in Section 4.8 of the Browns Ferry Updated Final Safety Analysis Report. The long term operability of the cross connect capability of two RHR pumps and associated heat exchangers is required by Technical Specification Limiting Conditions for Operation 3.5.B.11.

By proper valve alignment, which is controlled by existing operating instructions, the network created by the standby coolant supply connection and RHR crossties permits the D2 (or D1) RHR service water pump and header to supply raw river water directly to the reactor core of Units 1 or 2 as the reactor pressure approaches 50 psig.

TVA'S EVALUATION OF ECCS STRAINER BLOCKAGE

TVA has always been sensitive to the potential for debris blockage of ECCS strainers after a LOCA. However, TVA has reevaluated this issue based on the information contained in Supplement 1 to Bulletin 93-02 and Information Notices 88-28, 90-07, 92-71, 93-34, and Supplement 1 to 93-34. Based on the currently available information, it is TVA's conclusion that debris induced clogging of the BFN suppression pool strainers is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition. This conclusion is based on the following considerations:

- During the initial design of BFN, the sizing of the strainers in the torus and the pipes connecting the torus and suction header was conservatively based on the assumption that at least one of the four strainers was completely plugged during the postulated accident. The suction points are located above the bottom of the torus to minimize the potential for debris blockage. Additional safety is provided by locating the four connecting pipes so that they will not be directly subjected to the water jet issuing from the downcomers. In addition, the curved surface of the strainers minimize the possibility of clogging.

- BFN primarily uses half cylinder reflective metallic insulation in the drywell (NOTE: One approximately two square foot piece of encapsulated fibrous insulation is used for thermal protection of a cable). As discussed in NUREG/CR-3616, Transport and Screen Blockage Characteristics of Reflective Metallic Insulation Materials, the tested reflective metallic insulation specimens never became "water borne". The path the reflective metallic insulation would have to travel at BFN to reach the ECCS suction strainers is convoluted. Debris generated from the metallic insulation would have to travel around drywell equipment and supports, around the jet deflectors at the entrance to the vent pipes, through the vent pipes, into the vent header, through the 24 inch downcomers, to the bottom of the suppression chamber, and then up through the water to the ECCS suction strainers. Therefore, the probability for the deposition of the reflective metallic insulation on the BFN ECCS suction strainers is considered to be low.

- TVA committed in the Browns Ferry Nuclear Performance Plan to perform walkdown inspections of unqualified coatings on components installed inside primary containment. The walkdown was performed on Unit 2 to determine the quantity of unqualified coatings and to assess the general condition of the existing qualified coatings. An analysis was performed to determine the maximum allowable quantity of coating debris which could be transported to the suction strainers without affecting the ability of the ECCS pumps to perform their post-Loss of Coolant Accident (LOCA) function.

The results of this walkdown and evaluation were provided to NRC by letter on October 4, 1989 (Reference 4). In summary, TVA determined that the existing amount of unqualified coatings within the primary containment is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition. In addition, corrective actions have been taken to ensure that the addition of unqualified coating quantities is maintained below the maximum allowable quantity. TVA has previously committed to implement the containment coatings program on Units 1 and 3 in accordance with the Unit 2 precedent prior to the restart of each unit (Reference 5).

NRC's review of the containment coatings evaluation is documented in Section 3.7 of NUREG-1232, Volume 3, Supplement 2 (Reference 6). It states that the staff has reviewed the analysis and considered it acceptable and conservative as no credit was taken for debris settling in the drywell.

- As previously discussed, TVA had performed a walkdown of the Unit 2 drywell (primary containment) and confirmed that there are no temporary or permanently installed fibrous air filters or other sources of fibrous material not designed to withstand a LOCA. This walkdown is required after each refueling outage by General Operating Instruction (GOI) 2-GOI-200-2, Drywell Closeout. BFN Units 1 and 3 are shutdown for extended outages. These units will be evaluated for permanent fibrous material prior to their respective startup. These units will be inspected and temporary fibrous material will be removed prior to their respective startup.

  In addition to the walkdown for temporary fibrous air filters or other sources of fibrous material, 2-GOI-200-2 requires the drywell be checked prior to closure for the following:

  - Piping intact and insulation in place
  - All trash removed
  - No loose tools or equipment
  - Scaffolding removed

- Temporary hoses disconnected and removed
- Temporary lighting disconnected and removed
- Temporary shielding removed
- Floor drains free of debris and screens installed
- Oil pillows, ropes, or any other foreign materials removed from floor drain sump
- Suppression chamber suction header interior clean and free of debris
- Each Safety Relief Valve discharge line drywell to suppression chamber vacuum breaker free of debris

* Site Standard Practice 12.8, Foreign Material Exclusion, provides the requirements for maintaining cleanliness by preventing the uncontrolled introduction of foreign materials, such as maintenance residue, dirt, debris, or tools, into open systems. This procedure normally requires a Foreign Materials Exclusion Area boundary be established prior to entry into the suppression chamber. Unsecured items are required to be logged, periodically accounted for, and removed from the area.

  These walkdowns and administrative controls minimize the potential quantity of other types of debris that would be available to block the ECCS strainers.

As discussed above, based on the currently available information, TVA has concluded that debris induced clogging of the BFN suppression pool strainers is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition. In addition, BFN has plant specific design features which would assist the operators in recovering the plant in the unlikely event that the ECCS suction strainers in the suppression pool became blocked. Nevertheless, TVA is actively participating in the ongoing work of the BWR Owners' Group (BWROG) ECCS Suction Strainers Committee. Therefore, TVA's actions in response to the requests contained in Supplement 1 to Bulletin 93-02 are considered an additional defense in depth against potential debris blockage of the ECCS strainers.

SPECIFIC ACTIONS REQUESTED AND TVA'S RESPONSE

Supplement 1 to Bulletin 93-02 requested licensees take the following interim actions to enhance the capability to prevent or mitigate loss of the ECCS following a LOCA due to strainer clogging:

NRC REQUEST 1 -

Provide training and briefings to apprise operators and other appropriate emergency response personnel of the information contained in Supplement 1 to Bulletin 93-02 and in Information Notices 88-28, 90-07, 92-71, 93-34, and Supplement 1 to 93-34 regarding the potential for suppression pool strainer clogging.

TVA RESPONSE

Information Notices 88-28, 90-07, 92-71, 93-34, Supplement 1 to 93-34, Bulletin 93-02, and Supplement 1 to Bulletin 93-02 will be reviewed and the information relevant to the potential for suppression pool strainer clogging at BFN will be included in the operator's required reading program. In addition, classroom and/or simulator training will be conducted to familiarize the operators with the recognition of ECCS strainer blockage and the mitigating actions allowed by the BFN Emergency Operating Instructions (EOIs).

NRC REQUEST 2 -

Assure that the emergency operating procedures make the operator aware of possible indications of ECCS strainer clogging and provide guidance on mitigation.

TVA RESPONSE

Revision 4 of the Emergency Procedure Guidelines (EPGs) have been implemented in the BFN EOIs. The EOIs are based upon symptoms or operator recognition of the indications available. They do not require recognition of a specific event such as ECCS suction strainer blockage. If pumps fail and the reactor water level decreases, the operator would be led through steps to restore the reactor water level through alternate water sources.

However, in order to be as responsive as possible to the actions requested by the Bulletin, TVA will revise the applicable appendices of the BFN EOIs to include caution statements and actions for monitoring NPSH. The operators will be trained on these procedure changes prior to the revised procedures becoming effective. In addition, TVA will continue to follow this issue in conjunction with the BWROG Emergency Procedure Committee.

NRC REQUEST 3 -

Institute procedures and other measures to provide compensatory actions to prevent, delay or mitigate a loss of available NPSH margin under LOCA conditions. Such measures should be consistent with providing the design basis emergency system functions for core and containment cooling. Actions to assure sufficient core and containment cooling may include:

A) Reduction of flow (consistent with delivering the required ECCS flow) through the strainers to reduce head loss and extend the time for debris deposition.

B) Operator realignment of existing systems to allow backflushing of clogged strainers.

C) Operator realignment of existing systems to allow injection to the core from water sources other than the suppression pool.

D) Intermittent operation of the containment sprays, when possible, to reduce the transport of debris to the strainers.

E) Other plant-specific measures which assure availability of sufficient core and containment cooling to meet the design basis of the plant.

TVA RESPONSE

TVA has reviewed each of the suggested measures to prevent, delay or mitigate a loss of available NPSH margin under LOCA conditions.

A) Reduction of Flow Through the Strainers - The BFN EOIs direct the operator to monitor and control reactor pressure vessel (RPV) water level within various bands by using one or more of the listed injection sources. Net Positive Suction Head (NPSH) curves are provided for Core Spray and RHR pumps for operator guidance. No priority between the use of each listed system is intended in order to allow the operator to use the most appropriate means available under the current plant conditions. The operators are expected to exercise continued manual control and adjustment of system lineups and injection flows in order to remain within the preferred RPV water level control band. Further reduction of flow from the suppression pool beyond those currently specified in the BFN EOIs are not considered advisable at this time.

B) Backflushing of Clogged Strainers - Due to the nature of the four intakes on a common ECCS suppression chamber suction header design and the limited driving head of the gravity feed from the CST, backflushing the strainers is not considered an effective mitigating action at BFN.

C) Alternate Injection Sources - While in the current BFN EOIs, if pumps fail and the reactor water level decreases, the operator would be led through steps to restore the reactor water level through alternate water sources. For example, during a postulated large break LOCA, Contingency 6, Step 9 directs the operator to use the following available injection sources which can take suction on a source of water external to the suppression pool as needed to flood the primary containment. System specific EOI Appendices provide step-by-step guidance for lining up and injecting into the RPV.

Injection Source	Injection Pressure
Condensate Storage	410 PSIG
Control Rod Drive	1640 PSIG
RCIC with Condensate Storage Tank (CST) Suction Only	1240 PSIG
Low Pressure Coolant Injection (LPCI) with CST Suction Only	320 PSIG
Standby Coolant	160 PSIG
RHR Crosstie to Other Units	310 PSIG
Pressure Suppression Chamber (PSC) Head Tank Pumps	30 PSIG
Condensate Storage Transfer Pumps to RHR and Core Spray	110 PSIG
RHR Drain Pumps	50 PSIG
RCIC (Auxiliary Boiler Steam if Reactor Steam is not Available) with CST Suction Only	1240 PSIG
HPCI (Auxiliary Boiler Steam) with CST Suction Only	780 PSIG
Fire Protection System	150 PSIG
Standby Liquid Control	1450 PSIG

D) Intermittent Operation of Containment Sprays - The BFN EOIs direct the operator to initially attempt to maintain the primary containment pressure below 2.4 psig using the Standby Gas Treatment and Containment Atmospheric Dilution systems, as required. The containment sprays are manually initiated if the primary containment pressure exceeds 12 psig, provided that the containment spray permissive logic is satisfied (LPCI initiation signal present, reactor vessel water level above ⅔ core height, and drywell high pressure). As described in Section 14.6 of the Browns Ferry Updated Final Safety Analysis Report, the primary containment pressure is expected to be brought under 10 psig approximately 16 minutes after the initiation of the LOCA. This is well before the potential loss of ECCS due to debris induced strainer blockage.

During the long term (several hours), terminating drywell sprays when drywell pressure decreases below 2.4 psig ensures that the primary containment pressure is not reduced below atmospheric. Avoiding a negative primary containment pressure is desirable because:

1) it prevents air from entering the primary containment, through the the reactor building to suppression chamber vacuum breakers, and de-inerting the atmosphere, and

2) it precludes containment failure due to exceeding the negative pressure design limits of the primary containment.

TVA does not currently intend to revise these initiation and termination setpoints or direct the operator to intermittently use the containment sprays in this operating band.

E) Other Plant-Specific Measures -

The existing plant-specific design features and administrative controls that assure availability of sufficient core and containment cooling to meet the design basis of the plant have been previously discussed. In addition, in order to further reduce the potential for inadvertent introduction of fibrous material into the drywell, TVA will change the design control procedure to require the evaluation of fibrous material being introduced into the drywell.

IMPLEMENTATION SCHEDULE

TVA's commitments will be completed prior to June 30, 1994. While not explicitly conforming to the 90 day completion schedule (May 19, 1994) suggested in the Bulletin, this implementation schedule is considered adequate for the following reasons:

- The time constraints dictated by the need to develop the EOI changes and train the operators on the content of those changes. This training will be accomplished during the next normally scheduled requalification training cycle.

- TVA's conclusion that debris induced clogging of the BFN suppression pool strainers is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition.

- TVA's commitments in response to the requests contained in Supplement 1 to Bulletin 93-02 are considered additional defense in depth against potential debris blockage of the ECCS strainers.

- The plant unique capability provided by the cross-ties between the units.

- The extremely low probability that a high energy pipe would break without a preceding period of detectable leakage.

TVA will submit a report confirming the completion of these actions within 30 days of their completion.

CONCLUSION

TVA has concluded, based on currently available information, that debris induced clogging of the BFN suppression pool strainers is less than the amount which would adversely affect ECCS pump performance in a post-LOCA condition. TVA is actively participating in the ongoing work of the BWR Owners' Group (BWROG) ECCS Suction Strainers Committee and the BWROG Emergency Procedure Committee. TVA's commitments are considered additional defense in depth against potential debris blockage of the ECCS strainers.

REFERENCES

1) NRC letter to All Holders of Operating Licensees or Construction Permits for Nuclear Power Reactors, dated May 11, 1993, NRC Bulletin No. 93-02: Debris Plugging of Emergency Core Cooling Suction Strainers

2) TVA letter to NRC, dated May 23, 1993, NRC Bulletin No. 93-02, "Debris Plugging of Emergency Core Cooling Suction Strainers"

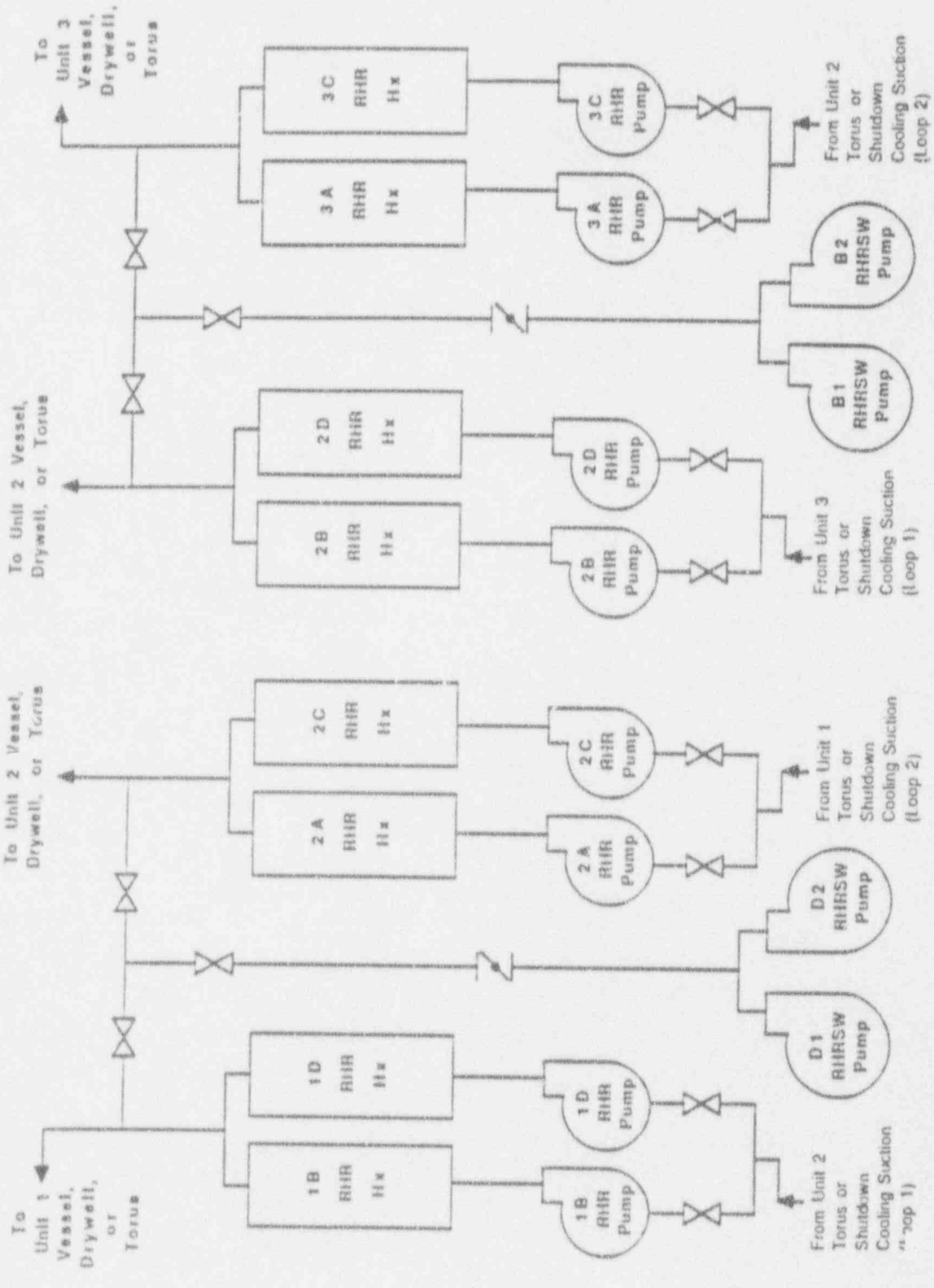
3) NRC letter to All Holders of Operating Licensees or Construction Permits for Boiling-Water and Pressurized-Water Reactors, dated February 18, 1994, NRC Bulletin No. 93-02 Supplement 1: Debris Plugging of Emergency Core Cooling Suction Strainers

4) TVA letter to NRC, dated October 4, 1989, Containment Coatings

5) TVA letter to NRC, dated July 10, 1991, Regulatory Framework for the Restart of Units 1 and 3

6) NRC letter to TVA, dated January 23, 1991, NUREG-1232, Volume 3, Supplement 2 - Browns Ferry, Unit 2

FIGURE 1
RESIDUAL HEAT REMOVAL (RHR) CROSS-CONNECT CAPABILITY



ENCLOSURE 2
TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3

SUMMARY OF COMMITMENTS

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1) Information Notices 88-28, 90-07, 92-71, 93-34, Supplement 1 to 93-34, Bulletin 93-02, and Supplement 1 to Bulletin 93-02 will be reviewed and the information relevant to the potential for suppression pool strainer clogging at BFN will be included in the operator's required reading program.

2) Classroom and/or simulator training will be conducted to familiarize the operators with the recognition of Emergency Core Cooling System strainer blockage and the mitigating actions allowed by the BFN Emergency Operating Instructions (EOIs).

3) TVA will revise the applicable appendices of the BFN EOIs to include caution statements and actions for monitoring net positive suction head (NPSH). The operators will be trained on these procedure changes prior to the revised procedures becoming effective.

4) TVA will change the design control procedure to require the evaluation of fibrous material being introduced into the drywell.

The above commitments will be completed prior to June 30, 1994.

5) TVA will submit a report confirming the completion of these actions within 30 days of their completion.