Mr. A. J. Scalice
Chief Nuclear Officer
and Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

September 3, 1999

SUBJECT: BROWNS FERRY NUCLEAR PLANTS, UNITS 2 AND 3 - ISSUANCE OF AMENDMENTS REGARDING CREDITING OF CONTAINMENT OVERPRESSURE FOR NET POSITIVE SUCTION HEAD CALULATIONS FOR EMERGENCY CORE COOLING PUMPS (TAC NOS. MA3492 AND MA3493)

Dear Mr. Scalice:

The Commission has issued the enclosed Amendment Nos. 261and 220to Facility Operating License Nos. DPR-52 and DPR-68 for the Browns Ferry Nuclear Plant Units 2 and 3, respectively. These amendments respond to your application dated September 4, 1998, as supplemented by letter dated November 25, 1998, and relate to Generic Letter 97-04 concerns about assurance of sufficient net positive suction head for emergency core cooling and containment heat removal pumps.

We have completed our review of the unresolved safety question issue regarding use of containment overpressure for Browns Ferry Units 2 and 3. We hereby condition each license to indicate that credit for containment overpressure has been approved to the extent described in the enclosed safety evaluation.

The Notice of Issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

Original signed by:

William O. Long, Senior Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-260 and 50-296

Enclosures:
1. Amendment No. 261 to License No. DPR-52
2. Amendment No. 220 to License No. DPR-68
3. Safety Evaluation

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 3, 1999

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-260

BROWNS FERRY NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 261
License No. DPR-52

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated September 4, 1998, as supplemented by letter dated November 25, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the updated FSAR to reflect Browns Ferry, Unit 2, credit for use of a limited amount of containment overpressure in calculations of net positive suction head available for emergency core cooling pumps, as described in the staff safety evaluation dated September 3, 1999 are authorized. The licensee shall submit the revised description authorized by this amendment with the next update of the FSAR.

3. This license amendment is effective as of its date of issuance, and shall be implemented as specified in 2 above.

FOR THE NUCLEAR REGULATORY COMMISSION

Sheri R. Peterson

Sheri R. Peterson, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: September 3, 1999

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-296

BROWNS FERRY NUCLEAR PLANT, UNIT 3

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 220
License No. DPR-68

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated September 4, 1998, as supplemented by letter dated November 25, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the updated FSAR to reflect Browns Ferry, Unit 3, credit for use of a limited amount of containment overpressure in calculations of net positive suction head available for emergency core cooling pumps, as described in the staff safety evaluation dated September 3, 1999, are authorized. The licensee shall submit the revised description authorized by this amendment with the next update of the FSAR.

3. This license amendment is effective as of its date of issuance, and shall be implemented as specified in 2 above.

FOR THE NUCLEAR REGULATORY COMMISSION

Sheri R. Peterson

Sheri R. Peterson, Chief, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: September 3, 1999

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 261 TO FACILITY OPERATING LICENSE NO. DPR-52

AND AMENDMENT NO. 220 TO FACILITY OPERATING LICENSE NO. DPR-68

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT, UNITS 2, AND 3

DOCKET NOS. 50-260 AND 50-296

1.0 INTRODUCTION

By letter dated September 4 (Reference 1), as supplemented by letter dated November 25, 1998 (Reference 2), Tennessee Valley Authority (TVA), the licensee, requested a change to the Browns Ferry Nuclear Plant, Units 2 and 3 licensing basis. The requested change involves the use of containment overpressure to ensure sufficient net positive suction head (NPSH) for the emergency core cooling system (ECCS) pumps following a loss of coolant accident (LOCA). Specifically, TVA requested that the licensing basis be changed to credit 3 psi of containment overpressure for both the short and long term following a LOCA.

The Browns Ferry Nuclear Power Plant units are BWR/4s with a Mark I containment. The Browns Ferry ECCS system consists of a high pressure coolant injection (HPCI) pump, an automatic depressurization system, two trains of core spray, and two trains of low pressure coolant injection (LPCI). The HPCI system is designed to inject water from the condensate storage tank or suppression pool into the reactor vessel via a feedwater line. The HPCI system provides makeup water to the reactor vessel in the event of a small break LOCA which does not result in a rapid depressurization of the reactor vessel. Containment overpressure is not required to ensure adequate NPSH for the HPCI pumps following a small break LOCA. The core spray system injects water from the suppression pool to the reactor vessel via the core spray spargers located above the core. The LPCI is designed to inject water from the suppression pool into the downcomer region of the reactor vessel. The LPCI system is an operating mode of the residual heat removal system (RHR). Both the core spray system and LPCI system provide makeup water to the reactor vessel at low pressure following a large break LOCA and depressurization of the reactor vessel.

TVA installed new large capacity ECCS strainers at Browns Ferry Units 2 and 3 to meet the requested actions of U.S. Nuclear Regulatory Commission (NRC) Bulletin 96-03 (Reference 3). According to TVA, credit for available containment overpressure to maintain adequate NPSH is required due to their resolution of Bulletin 96-03. TVA stated that "the requirement for containment overpressure is primarily necessary for a short period of time for the loop of RHR that is assumed to be in the maximum flow condition (limited by orifices) during a postulated LOCA. Other injection pathways are available and functional without containment overpressure being relied upon. Analysis also indicates that a minor amount of overpressure (0.24 psi) is needed by core spray pumps for a very short period of time at about 3.5 hours into the event. This need is momentary and is considered negligible since at this point in the event the operator is in control of pump utilization and flows."

2.0 EVALUATION

2.1 NPSH Analyses

In response to Generic Letter 97-04 (Reference 4), TVA provided the relationship which was used to calculate the available NPSH (NPSHA) for the core spray and RHR pumps.

$$NPSHA = h_a + h_s - h_{vp} - h_f$$

where

- h_a = atmospheric pressure (also called initial airspace pressure)
- h_s = static suction pressure between the water surface in the suppression chamber and the ECCS pump suction nozzle
- h_{vp} = saturation pressure of the suppression pool
- h_f = pressure drop due to the piping system configuration and condition

The NRC staff notes that the licensee's Generic Letter 97-04 response (Reference 5) included the results of NPSH analyses with the old strainers and existing licensing basis (i.e., no credit for containment overpressure) along with results of NPSH analyses with the new strainers and proposed licensing basis (i.e., credit for containment overpressure). For the proposed licensing basis, the strainer head loss associated with the new strainers is included in the revised NPSH calculations. This additional head loss is represented by $h_{strainer}$ which is added to the h_f term in the equation above.

The NRC staff reviewed the new strainer design criteria and estimates for the proposed strainer head loss. TVA designed the new Browns Ferry suction strainers assuming a frequency for cleaning the suppression pool of once every 10 years (approximately five two year cycles). The staff questioned whether the Browns Ferry cleaning frequency contributed to the need of containment overpressure. After several conversations with the licensee and our contractor, the staff concluded that the licensee's estimates for head loss were reasonable. The staff also concluded that frequent cleaning of the suppression pool or removal of the small amount of fibrous insulation would not eliminate the need for containment overpressure.

2.1.1 Short Term NPSH Requirements

At Browns Ferry, containment overpressure is defined as available pressure above 14.4 psia. The staff has previously approved credit for containment overpressure for some facilities when the objective of Safety Guide 1 (Reference 6) cannot be met. However, approval was not considered until all other options such as throttling or orificing had been demonstrated to be impractical.

For the short term analysis, the licensee postulated a break in the recirculation pump discharge line. The "short term" for this accident analysis is defined as the first ten minutes after the LOCA. Operator action to control pump flows or to initiate the containment cooling mode of RHR operation is not credited during the short term. For this analysis, two RHR pumps in LPCI mode are assumed to be injecting into the broken recirculation loop and subsequently into the drywell. The RHR pump discharge lines are orificed and, therefore, are limited to a maximum flow condition by the throttling effects of the discharge orifices. For analysis purposes, two RHR pumps are at their run-out flow of 11,000 gpm and the other two are at the rated flows of 10,000 gpm. Additionally, four core spray pumps are at design flow of 3,125 gpm per pump.

The TVA calculations state that the maximum suppression pool temperature at 10 minutes is 149.7 degrees Fahrenheit. The licensee's calculations demonstrate that, at the flows described above, with the calculated ECCS strainer head loss and a suppression pool temperature up to 150 degrees Fahrenheit, containment overpressure of 1.9 psi is required for the RHR pumps during the first 10 minutes following a LOCA. The licensee requested that 3 psi of containment overpressure be credited for the short term analysis. This additional margin would be for unexpected occurrences in the future. In the past, the staff has allowed some licensees to credit more containment overpressure than actually needed. Although the amount of margin gained is generally not significant, this practice would allow licensees to use the margin without requesting another review by the staff. Potential reasons for needing the excess margin could be and are not limited to heat exchanger fouling or increased friction losses. In this case, the licensee has requested a total of 3 psi for the first 10 minutes following a LOCA.

Using the information provided by the licensee, the staff performed its own calculations crediting 3 psi of containment overpressure. Currently, TVA's calculation, MD-Q0999-970046 (Reference 7), only credits 2 psi of containment overpressure. The NPSH required (NPSHR) for the RHR pumps at 11000 gpm is 30 feet while the NPSHR for the core spray pumps at 3125 gpm is 27 feet. Table 1 presents the results of the staff's NPSHA calculations for the first 10 minutes following a LOCA.

Table 1: Staff NPSH Analyses with Credit for 3 psi Overpressure

Time (seconds)	RHR NPSHA (feet)	Core Spray NPSHA (feet)
0	38.5	42.2
50	36.4	40.1
89	34.7	38.4
111	34.5	38.2
155	34.7	38.4
205	34.2	38.0
304	33.7	37.4
404	33.3	37.1
504	33.0	36.7
600	32.7	36.4

As noted in Table 1, the NPSH available exceeds the NPSH required for both the RHR and core spray pumps in all cases. Based on both the staff's and the licensee's calculations, adequate NPSH to the RHR and core spray pumps is ensured when credit for 3 psi of containment overpressure is assumed.

The staff evaluated the consequences of a loss of containment overpressure following a LOCA on core spray and RHR pump operation. Both the staff and the licensee recognize that containment overpressure is not required to ensure adequate NPSH for the core spray pumps. Therefore, core spray pump operation is not affected by a loss of containment overpressure during the short term. In the case of the RHR pumps, TVA tests demonstrated that the RHR pumps will operate for short periods of time at NPSH values substantially below the manufacturer's required NPSH without degradation or substantial loss of flow. The deficit was approximately 9 feet of head in these tests. Therefore, RHR pump operation is not affected by a loss of containment overpressure. Based on these analyses, the staff finds the use of 3 psi of containment overpressure above the initial airspace pressure acceptable for the first 10 minutes after the LOCA.

2.1.2 <u>Long-Term NPSH Requirements</u>

The long-term of the accident analysis is defined as the time period from 10 minutes to the end of the accident. For the long-term analysis, the licensee postulated a double-ended recirculation suction line break with no off-site power and the failure of one emergency diesel. The analysis also assumes that after 10 minutes following the LOCA, the operators control ECCS flows and initiate containment cooling. For analysis purposes, two RHR pumps are at 6500 gpm and two core spray pumps are at 3125 gpm.

The TVA calculations state that the maximum suppression pool temperature that will occur is 177 degrees Fahrenheit. The licensee's calculations demonstrate that, at the flows described above, the calculated ECCS strainer head loss and a suppression pool temperature up to 177 degrees Fahrenheit, containment overpressure of 0.24 psi is required for the core spray pumps for a short period of time during the long term following a LOCA. According to the licensee, once the operator establishes long-term cooling, the need for containment overpressure diminishes to essentially zero.

However, the licensee also requested that 3 psi of containment overpressure be credited for the long term. As stated above, 3 psi of containment overpressure is not required to ensure adequate NPSH to the core spray or the RHR pumps for the long term. This is supported by the Browns Ferry Final Safety Analysis Report (FSAR) which states that the standby coolant supply connection and RHR crossties with the other unit are provided to maintain long-term reactor core and primary containment cooling capability irrespective of primary containment integrity or operability of the RHR system associated with a given unit. With the proper valve alignment, suppression pool water which has been circulated through the RHR heat exchangers on one unit can be used to flood the reactor core, spray the drywell and suppression chamber, or be returned to the suppression pool of the adjacent unit. In this manner, decay and residual heat can be removed from the reactor core and primary containment of the adjacent unit on a long-term basis. Thus, the need for containment overpressure in the long term is eliminated.

The staff also evaluated whether containment conditions were considered in determining pump operability in accident scenarios in individual plant examinations (IPEs). The staff found that the method that NPSH is accounted for in IPEs differs between probabilistic risk assessments (PRAs). Many PRAs do explicit calculations, while others will reference Owners Group topicals or analyses performed for similar plants. Some PRAs assume a bounding case and assume pump failure. In the case of Browns Ferry, the staff was unable to identify any analysis of NPSH in the Browns Ferry IPE. Therefore, no PRA case can be made for the use of containment overpressure in the long-term post-LOCA.

Since the licensee requested 3 psi of containment overpressure credit for the long-term analysis, the staff considered approving a small amount of containment overpressure for the long term. The staff believes that allowing some containment overpressure would allow the licensee to use the margin if necessary without requesting another review by the staff. Therefore, using the information provided by the licensee, the staff performed its own calculations crediting 1 psi of containment overpressure for the time periods during which the suppression pool temperature is calculated to be above 171 degrees Fahrenheit. The NPSHR for the RHR pumps at 6500 gpm is 24 feet while the NPSHR for the core spray pumps at 3125 gpm is 27 feet. Table 2 presents the results of the staff's NPSHA calculations for the time period of 5500 to 35000 seconds (approximately 8.2 hours) following a LOCA.

Table 2: Staff NPSH Analyses with Credit for 1 psi Overpressure

Time (seconds)	RHR NPSHA (feet)	Core Spray NPSHA (feet)
5511	33.9	30.6
8008	32.9	29.5
11991	32.2	28.9
12735	32.1	28.8
17438	32.1	28.8
34940	34.2	30.9

As noted in Table 2, the NPSH available exceeds the NPSH required for both the RHR and core spray pumps in all cases. Based on both the staff's and the licensee's calculations, adequate NPSH to the RHR and core spray pumps is ensured when credit for 1 psi of containment overpressure is assumed from 5500 to 35000 seconds (8.2 hours) following a LOCA. The staff notes that containment overpressure is not required to ensure adequate NPSH for the core spray pumps at temperatures below 177 degrees Fahrenheit. Based on the above, the NPSH calculations will not credit containment overpressure from 600 to 5499 seconds and 35001 seconds to the end of the accident.

The staff evaluated the consequences of a loss of containment overpressure following a LOCA on core spray and RHR pump operation. As stated above, once the operator establishes long term cooling, the need for containment overpressure in the long term diminishes to essentially zero. Additionally, the RHR crossties are available to remove decay and residual heat from the adjacent unit if containment overpressure is lost. Therefore, core spray and RHR pump operation are not affected by a loss of containment overpressure during the long term. Based on these analyses, the staff finds the use of 1 psi of containment overpressure above the initial airspace pressure from 5500 to 35000 seconds (approximately 8.2 hours) acceptable for the long term after a LOCA.

2.2 Calculation of Containment Pressure

In calculating the required containment overpressure to ensure adequate available NPSH of the ECCS pumps, TVA incorporated several conservative assumptions which maximize the suppression pool temperature and minimize the containment pressure. Reactor power was assumed to be 102% of the licensed power level of 3293 MWt. The licensee calculated decay heat in accordance with American Nuclear Society-5.1-1979 with a 2-sigma uncertainty. This decay heat model is frequently used by the industry and is acceptable to the NRC. For both the short- and long-term periods of the accident, the licensee assumed that the drywell and suppression pool spray efficiencies are 100%. This minimizes the suppression chamber air space pressure. For the long term, the licensee assumed a 20% mixing efficiency of the break-flow liquid with the drywell atmosphere. Since the break-flow is at a higher temperature than the drywell atmosphere, this minimizes the suppression pool pressure. The licensee used a conservatively low value for the RHR heat exchanger heat transfer coefficient. Through independent staff studies, this parameter was found to be very important in determining containment pressure. Minimizing this parameter tends to maximize the spray temperature and maximize the suppression pool temperature. In addition, the licensee assumed the maximum (technical specification) value of the service water temperature.

The licensee used the GE SHEX computer program to perform these calculations. While this computer program has not been approved by the NRC staff, it has been used in a large number of similar calculations and has been satisfactorily compared with other containment calculations several times. By comparison with calculations performed for other BWR-4's with Mark I containments, the staff has determined that TVA's containment calculations appear reasonable and conservative.

3.0 STATE CONSULTATION

In accordance with the U.S. Nuclear Regulatory Commission's regulations, the Alabama State official was notified of the proposed issuance of the amendments. The State official had no comments.

4.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (63 FR 50939). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

5.0 CONCLUSION

The staff has reviewed the licensee's minimum containment pressure and NPSH analyses for the RHR and core spray pumps. The staff finds that the use of the requested containment overpressure to ensure adequate NPSH for the residual heat removal pumps for the first 10 minutes following a LOCA is acceptable. The approved amount of containment overpressure is 3 psi above the initial airspace pressure of 14.4 psia. For the long term following a LOCA, the staff has approved credit for 1 psi above the initial airspace pressure of 14.4 psia for the core spray pumps. The time period of the containment overpressure credit is approximately 5500 to 35000 seconds (about 8.2 hours) post-LOCA. The staff also concludes that there is reasonable assurance that plant operation in this manner poses no undue risk to the health and safety of the public.

Based on this finding, the staff concludes that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributors: K. Kavanagh, NRR
R. Lobel, NRR

Date: September 3, 1999

5.0 REFERENCES

1. Abney, T.E., TVA to NRC, "Browns Ferry Nuclear Plant (BFN) Units 2 and 3 - License Amendment Regarding Use of Containment Overpressure For Emergency Core Cooling System (ECCS) Pump Net Positive Suction Head (NPSH) Analyses," September 4, 1998.

2. Abney, T.E., TVA to NRC, "Browns Ferry Nuclear Plant (BFN) - Response to Request for Additional Information (RAI) Relating to Units 2 and 3 License Amendment Regarding Use of Containment Overpressure for Emergency Core Cooling System (ECCS) Pump Net Positive Suction Head (NPSH) Analyses," November 25, 1998.

3. NRC Bulletin 96-03, "Potential Plugging of Emergency CoreCooling Suction Strainers By Debris in Boiling-Water Reactors," May 6, 1996.

4. NRC Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997.

5. Abney, T.E., TVA to NRC, "Browns Ferry Nuclear Plant (BFN) - Response to NRC Generic Letter (GL) 97-04, Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps," March 24, 1998.

6. US Atomic Energy Commission, Safety Guide 1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps," November 2, 1970.

7. TVA, "NPSH Evaluation of Browns Ferry RHR and CS Pumps," MD-Q0999-970046 Revision 0, November 18, 1998.

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BROWNS FERRY NUCLEAR PLANT

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