



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

CNL-15-129

July 30, 2015

10 CFR 50.4
10 CFR 50.90

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Response to Follow-up NRC Request for Additional Information
Regarding Proposed Technical Specification Change to Modify
Technical Specification 2.1.1, Reactor Core Safety Limits (BFN TS-492)
(TAC Nos. MF5412, MF5413, MF5414)**

- References:
1. Letter from TVA to NRC, "Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3 - Application to Modify Technical Specification 2.1.1, Reactor Core Safety Limits (BFN TS-492)," dated December 11, 2014 (ADAMS Accession No. ML14363A158)
 2. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Request for Additional Information Related to License Amendment Request for Technical Specification Changes to Reactor Core Safety Limits," dated May 12, 2015 (TAC Nos. MF5412, MF5413, and MF5414) (ADAMS Accession No. ML15126A530)
 3. Letter from TVA to NRC, "Response to NRC Request for Additional Information Regarding Proposed Technical Specification Change to Modify Technical Specification 2.1.1, Reactor Core Safety Limits (BFN TS-492)," dated June 5, 2015
 4. Electronic Mail from NRC to TVA, "BFN SL: Revised Follow-up RAI," dated July 1, 2015 (ML15189A236)

By letter dated December 11, 2014 (Reference 1), Tennessee Valley Authority (TVA) submitted a license amendment request (LAR) for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, to modify Technical Specification (TS) 2.1.1, Reactor Core Safety Limits, to revise the reactor dome pressure limit.


By letter dated May 12, 2015 (Reference 2), the Nuclear Regulatory Commission (NRC) transmitted a request for additional information (RAI). By letter dated June 5, 2015 (Reference 3), TVA submitted responses to the Reference 2 RAIs. By electronic mail dated July 1, 2015 (Reference 4), the NRC transmitted an RAI requesting additional information. The due date for the response is July 31, 2015.

Enclosure 1 contains AREVA report ANP-3427P, Revision 1, that provides the responses to the Reference 4 RAI. Enclosure 1 contains information that AREVA Inc. considers to be proprietary in nature and subsequently, pursuant to 10 *Code of Federal Regulations* 2.390, "Public inspections, exemptions, requests for withholding," paragraph (a)(4), it is requested that such information be withheld from public disclosure. Enclosure 2 contains the non-proprietary version of the Enclosure 1 report with the proprietary material removed, and is suitable for public disclosure. Enclosure 3 provides the affidavit supporting this request.

There are no new regulatory commitments contained in this submittal. Please address any questions regarding this submittal to Mr. Edward D. Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 30th day of July 2015.

Respectfully,



J. W. Shea
Vice President, Nuclear Licensing

Enclosures:

1. ANP-3427P Revision 1, "AREVA Round 2 RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits" (Proprietary)
2. ANP-3427NP Revision 1, "AREVA Round 2 RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits" (Non-proprietary)
3. Affidavit for ANP-3427P Revision 1

cc (Enclosures):

NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant
NRC Branch Chief - Region II
State Health Officer, Alabama State Department of Health

ENCLOSURE 2

**TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3**

**ANP-3427NP Revision 1, "AREVA Round 2 RAI Responses for Browns Ferry Steam
Dome Pressure for Reactor Core Safety Limits" (Non-proprietary)**



**AREVA Round 2 RAI
Responses for Browns
Ferry Steam Dome
Pressure for Reactor Core
Safety Limits**

ANP-3427NP
Revision 1

July 2015

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Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	1-1	Changed “an initial set of questions” to “a second round of questions”.

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Nomenclature

Acronym

Definition

BFN

Browns Ferry Nuclear Plant

BWR

Boiling Water Reactor

CPR

Critical Power Ratio

LAR

Licensing Amendment Request

MCPR

Minimum Critical Power Ratio

NRC

U. S. Nuclear Regulatory Commission

PRFO

Pressure Regulator Failure Open

RAI

Request for Additional Information

TS

Technical Specification

TVA

Tennessee Valley Authority

1.0 INTRODUCTION

Tennessee Valley Authority (TVA) submitted a License Amendment Request (LAR) to change the Browns Ferry Nuclear Plant (BFN) Technical Specifications (TS) in support of steam dome pressure for reactor core safety limits. In response to the LAR, the U. S. Nuclear Regulatory Commission (NRC) has issued a second round of questions, in the form of Request for Additional Information (RAI), Reference 1.

Based on the information provided in this report, TVA will prepare a formal response to the NRC RAIs.

2.0 NRC QUESTIONS AND AREVA RESPONSE

The NRC questions (i.e., RAIs) listed below are according to Reference 1:

RAI-08: Response to RAI-04b points out for pressures below 700 psia an enthalpy offset is added to the nodal enthalpy used by the SPCB/GE14 correlation. The dashed curves in Figure 4.5 appear to be horizontal extensions from the corresponding values at 700 psia.

- a) Clarify with an example how the offset was applied in generating the dashed curves in Figure 4.5 of ANP-3245P Revision 1 (Attachment 5 to the LAR).

AREVA Response a):

Consider the following example from core monitoring. The pressure is 600 psia. The inlet subcooling is 20 Btu/lb. At this state point, the saturated liquid enthalpy is 471.6 Btu/lb. Therefore, the inlet enthalpy is $471.6 - 20 = 451.6$ Btu/lb. At a mass flow rate of 0.05 Mlb/h, the critical power for this point is shown as the square symbol at a pressure of 600 psia in Figure 4.5.

Now, for this state point, the critical power is to be calculated with the SPCB/GE14 correlation. For the purpose of calculating critical power only, the pressure is limited to a minimum of 700 psia. At this pressure, the saturated liquid enthalpy is 491.5 Btu/lb. Calculate the enthalpy offset. This is

$$\Delta h_{\text{offset}} = h_f(700) - h_f(600) = 491.5 - 471.6 = 19.9 \text{ Btu/lb}$$

Add the enthalpy offset to the inlet enthalpy, to obtain the effective enthalpy associated with the pressure of 700 psia.

$$h_{\text{in}}^{700} = 451.6 + 19.9 = 471.5 \text{ Btu/lb}$$

The SPCB/GE14 correlation is applied with this inlet enthalpy and a pressure of 700 psia. The critical power after applying the enthalpy offset is shown as the square

symbol located at 700 psia in Figure 4.5, the intersection of the solid line curve and the dashed line curve. As a check, the difference between this inlet enthalpy and the saturated liquid enthalpy at 700 psia can be calculated. It is

$$\Delta h_{\text{sub}} = 491.5 - 471.5 = 20 \text{ Btu / lb}$$

Thus, the critical power has been calculated at the boundary, 700 psia, preserving the inlet subcooling of 20 Btu/lb.

The dashed curves (at pressures lower than 700 psia) are calculated using the method applied in this example.

- b) Did the limiting case with the minimum steam dome pressure shown in Figure 3.2 of ANP-3245P Revision 1 reach a core inlet condition that is saturated (two-phase)? What is the core inlet enthalpy when the steam dome pressure reaches the minimum in Figure 3.2? Will the SPCB/GE14 correlation issue an error message during the transient calculation when the core inlet or the node of interest reaches a condition that is beyond the applicability range of the correlation?

AREVA Response b):

- The limiting case with the minimum steam dome pressure shown in Figure 3.2 of ANP-3245P Revision 1 did not reach saturated conditions at the core inlet at any time during the event.*
- The core inlet enthalpy at the time at which minimum steam dome pressure was achieved is [] .*
- Consistent with Section 2.6 of the EMF-2209(P)(A) Revision 3 licensing topical report, the SPCB/GE14 correlation will issue a message to alert the analyst if the core inlet or the node of interest reaches a condition that is beyond the range of applicability.*

- c) The SPCB correlation is applicable to the ATRIUM-10 fuel. The SPCB/GE14 correlation was developed using the indirect method (Indirect Correlation Application) and is applicable to the legacy GE14 fuel in BFN Unit1 for pressures not less than 700 psia. Clarify whether the solid curves in Figure 4.5 were calculated using the SPCB or the SPCB/GE14 correlation.

AREVA Response c):

The solid curves are the application of SPCB/GE14, but without applying the alternative low pressure boundary treatment (enthalpy offset and evaluation at 700 psia). Because the co-resident fuel methodology, EMF-2245(P)(A), [

]

- d) The last paragraph on page 4-2 of the AREVA topical report ANP-3245P Revision 1 states, "For pressures that are lower than the SPCB/GE14 700 psia correlation boundary, the critical power will be evaluated as though the pressure was at 700 psia (preserving the same inlet subcooling). The results of applying the SPCB/GE14 correlation to pressures lower than 700 psia is illustrated with dashed lines in Figure 4.5 and indicates that the alternative low pressure boundary treatment is conservative". It appears that the term "conservative" is used because the dashed line values are lower than the solid line values when the pressure is lower than 700 psia. However, the SPCB correlation is not applicable to the GE14 fuel and the SPCB/GE14 correlation is not applicable for pressures lower than 700 psia. Justify how the alternative low pressure boundary treatment is conservative.

AREVA Response d):

In the co-resident fuel methodology, [

]

In the application of the critical power correlation (including SPCB/GE14), boundaries are checked in the computer code. The boundaries can be separated into two groups. For those cases where there is a mitigating conservative action (described in EMF-2209(P)(A) Revision 3, Section 2.6), a warning message is written and the conservative action is taken. For those cases where there is no mitigating action, an error message is written and the code stops.

ANP-3245(P) describes a mitigating action for low pressure. In this mitigating action, for pressures lower than 700 psia, the SPCB/GE14 correlation will be applied within its range of applicability, at a pressure of 700 psia with an enthalpy offset as demonstrated in the example in part (a) above. This mitigating action is conservative because:

- Critical heat flux increases as the pressure is decreased from 700 psia, as shown in Figure 4.1, but no credit is taken for this increase. [*

].

- The critical power increases as the pressure is decreased (see Figure 4.2 and the statement that the trend continues to a pressure below 600 psia) for BWR fuel assemblies. No credit is taken for this increase.*
- The trend for increase in critical power with decreasing pressure is confirmed with ATRIUM-10 test data (see Figure 4.3) that was used in the development of the SPCB correlation. Using the critical power at 700 psia for the critical power at lower pressures is conservative. No credit is taken for this increase in critical power.*

* ATRIUM is a trademark of AREVA Inc.

The critical power calculated with the SPCB/GE14 correlation, limiting the pressure to 700 psia and applying the enthalpy offset, is lower than that which would be achieved if the measurements were available, and is therefore conservative.

The event that is the basis for the low pressure safety limit is pressure regulator failure open, a MCPR increasing event. The ratio of MCPR to initial CPR is shown in Figure 2-1. The trend in MCPR is shown for both ATRIUM-10 and GE14. The calculation is carried out until 700 psia is reached. The trend is clearly towards increasing MCPR. In addition to any conservatism that is described above, the MCPR is far away from the boiling transition point.

Figure 2-1 Browns Ferry PRFO $MCPR(t)/MCPR_{initial}$

3.0 REFERENCES

1. Email, F. E. Saba (NRC) to G. R. Williams (TVA), "BFN SL: Revised Follow-up RAI," USNRC, July 1, 2015. (38-9243793-000)

ENCLOSURE 3

**TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3**

Affidavit for ANP-3427P Revision 1

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for AREVA Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA to determine whether certain AREVA information is proprietary. I am familiar with the policies established by AREVA to ensure the proper application of these criteria.

3. I am familiar with the AREVA information contained in the report ANP-3427P, Revision 1, "AREVA Round 2 RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits," dated July 2015 and referred to herein as "Document." Information contained in this Document has been classified by AREVA as proprietary in accordance with the policies established by AREVA for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA to determine whether information should be classified as proprietary:

- (a) The information reveals details of AREVA's research and development plans and programs or their results.
- (b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.
- (c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA.
- (d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA in product optimization or marketability.
- (e) The information is vital to a competitive advantage held by AREVA, would be helpful to competitors to AREVA, and would likely cause substantial harm to the competitive position of AREVA.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with AREVA's policies governing the protection and control of information, proprietary information contained in this Document have been made available, on a limited basis, to others outside AREVA only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge,
information, and belief.

Ala L. McGinnis

SUBSCRIBED before me this 20th
day of July, 2015.

Susan K. McCoy

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2016

