Proprietary Information

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

TVA-BFN-TS-445

December 19, 2003

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop: OWFN P1-35
Washington, D.C. 20555-0001

Gentlemen:

In the Matter of	)	Docket No. 50-296
Tennessee Valley Authority	)	

BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 3 - TECHNICAL SPECIFICATIONS (TS) CHANGE 445 - SAFETY LIMIT MINIMUM CRITICAL POWER RATIO (SLMCPR) - CYCLE 12 OPERATION - RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (RAI) (TAC NO. MC0918)

This letter is in response to the December 5, 2003, RAI regarding BFN TS change request 445. The proposed amendment, which was submitted October 1, 2003, revises the numeric value of SLMCPR in TS 2.1.1.2 for one and two recirculation loop operation to incorporate the results of the Unit 3 Cycle 12 core reload analysis. The SLMCPR values provided in TS-445 were determined by Framatome Advanced Nuclear Power (FANP) for TVA.

The NRC questions are repeated in the two enclosures along with the TVA responses for each question. Enclosure 1 provides an RAI response, which includes information considered proprietary by FANP. Accordingly, FANP has requested that this proprietary response be withheld from public disclosure pursuant to 10 CFR 2.790. In consideration, an affidavit, as required by 10 CFR 2.790(b)(1), is also included in Enclosure 1. Enclosure 2 provides a non-proprietary version of RAI response.

T007

Proprietary Information Enclosure 1

TVA has determined this additional information response does not change the determination in the October 1, 2003, TS-445 submittal that there are no significant hazards considerations associated with the proposed change and that the TS change qualifies for a categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9). Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and the enclosures to the Alabama State Department of Public Health.

Approval of TS-445 is needed for BFN Unit 3 Cycle 12 operation, which begins in Spring 2004. Therefore, TVA has previously requested that TS-445 be approved by February 1, 2004, and that the implementation of the revised TS be made within 60 days of NRC approval. The final Unit 3 Cycle 12 core configuration is currently being modified based on the recent identification of a leaking bundle, which will result in a nominal increase in the batch size of fresh ATRIUM-10 fuel assemblies being used. The modified core design will maintain the SLMCPR values being requested in TS-445.

There are no regulatory commitments associated with this submittal. If you have any questions about this TS change, please contact me at (256)729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 19th day of December, 2003.

Sincerely,

T. E. Abney
Manager of Licensing
and Industry Affairs

Enclosures:
1. Affidavit and Proprietary Version of RAI Response
2. Non-proprietary Version of RAI Response

cc (Enclosures):
State Health Officer
Alabama State Department of Public Health
RSA Tower - Administration
Suite 1552
P.O. Box 303017
Montgomery, Alabama 36130-3017

Enclosure 1

Technical Specifications (TS) Change 445
Safety Limit Minimum Critical Power Ratio (SLMCPR)
Unit 3 Cycle 12 Operation

Affidavit and Proprietary Version of RAI Response

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Jerald S. Holm. I am Manager, Product Licensing, for Framatome ANP, Inc. ("FANP"), and as such I am authorized to execute this Affidavit.

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

3. I am familiar with the FANP information in the report denoted as Attachment A, Browns Ferry Nuclear Plant Unit 3 TS-445 Request for Additional Information Responses, dated December 15, 2003, and referred to herein as "Document." Information contained in this Document has been classified by FANP as proprietary in accordance with the policies established by FANP 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 FANP 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.

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

(a) The information reveals details of FANP'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 FANP.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for FANP in product optimization or marketability.

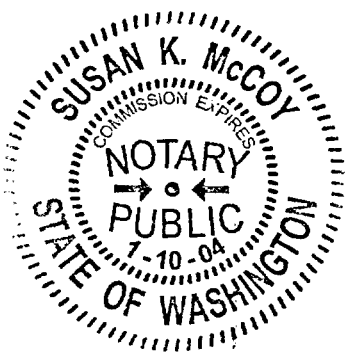
(e) The information is vital to a competitive advantage held by FANP, would be helpful to competitors to FANP, and would likely cause substantial harm to the competitive position of FANP.

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

8. FANP 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.

SUBSCRIBED before me this 16th day of December, 2003.



Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/10/04

Enclosure 2

Technical Specifications (TS) Change 445
Safety Limit Minimum Critical Power Ratio (SLMCPR)
Unit 3 Cycle 12 Operation

Non-proprietary Version of RAI Response

Attachment A

Browns Ferry Nuclear Plant Unit 3
TS-445 Request for Additional Information
Responses

Nonproprietary Version

December 15, 2003

Browns Ferry Nuclear Plant Unit 3
TS-445 Request for Additional Information / Responses

NRC Question 1

Please provide a reference core loading pattern for cycle 12 operation and a detailed description of the final core and fuel design to achieve a 24-month fuel reload cycle at the licensed rated power of 3458 Mwt and operation to normal end of full power (EOFP); (cycle exposure of approximately 16,700 Mwd/MTU). Please include post-EOFP and coastdown extensions.

The Browns Ferry Nuclear Plant (BFN) Unit 3 Cycle 12 reference core loading pattern used in the safety limit minimum critical power ratio (SLMCPR) analysis that the Technical Specifications (TS) - 445 submittal is based upon is shown in Figures A.1 and A.2, and includes exposed GE13 and GE14 fuel assemblies, and a reload batch of new ATRIUM™-10* fuel assemblies. Table A.1 provides an accounting of the fuel types for Cycle 12 operation and Figures A.3, A.4, and A.5 show details on the fresh Framatome ANP (FANP) ATRIUM-10 fuel assemblies. The core design accommodates the cycle length and energy needs and includes approximately 1,100 MWd/MTU post-EOFP and coastdown operations.

NRC Question 2

Provide a flow chart including input parameters to describe the analysis done for the safety limit minimum critical power ratio (SLMCPR) in the mixed core configuration. Also, identify the approved methodologies used in this analysis and justify their applicability to the SLMCPR analysis for Cycle 12 operation. Please address the technical position and limitations, and conditions in the staff Safety Evaluation Report stated in ANF-524(P)(A) Revision 2 and ANF-524(P)(A) Supplements 1 and 2, EMF-2209(P)(A) Revision 1, and EMF-2158(P)(A), Revision 0.

An overall SLMCPR analysis flow chart is presented in Figure A.6. The statistical analysis portion of that figure is detailed in Figure A.7. The flow charts are consistent with the presentation and description in Reference A.1.

The NRC-approved topical report methodologies for the process are:

A. EMF-2209(P)(A) Revision 1 (Reference A.2).

This report supports the applicability of the SPCB critical power correlation for ATRIUM-10 fuel. The NRC Safety Evaluation Report (SER) limitations, conditions, and restrictions applicable for the process are Items 1–3 in the Conclusions section of the SER, which deal with the range of applicability for the critical power correlation. Compliance with the range of applicability is handled within the SLMCPR code SAFLIM2. The remaining NRC SER condition (Item 4) is related to technology transfer to a utility. Since the application of the methodology was performed by FANP for TVA, Item 4 is not applicable.

* ATRIUM is a trademark of Framatome ANP.

B. EMF-2245(P)(A) Revision 0 (Reference A.3).

This report supports the application of an approved FANP critical power correlation for co-resident fuel. This methodology was used to characterize the GE13 and GE14 fuel types with the SPCB critical power correlation based on the indirect method as detailed in the topical report. The only NRC SER restriction in the topical is related to technology transfer to a utility. Since the application of the methodology was performed by FANP for TVA, this restriction is not pertinent.

C. EMF-2158(P)(A) Revision 0 (Reference A.4).

This report supports the application of the CASMO-4/MICROBURN-B2 methodology as a replacement for CASMO-3/MICROBURN-B. As stated in the NRC SER, the change does not require changes to safety analysis methodology. The treatment of the limitations, conditions, and restrictions in the NRC SER are provided below (paraphrased in some cases for brevity).

1. *CASMO-4/MICROBURN-B2 shall be applied within the range of validation criteria (Tables 2.1 and 2.2 of Reference A.4 and measurement uncertainties of Table 2.3 of Reference A.4.*

   FANP's application of this methodology meets these criteria.

2. *The CASMO-4/MICROBURN-B2 code system shall be validated for analyses of any new fuel design which departs from current orthogonal lattice designs and/or exceeds gadolinia and U-235 enrichments.*

   The fuel represented for BFN Unit 3 Cycle 12 operation does not violate this condition.

3. *The CASMO-4/MICROBURN-B2 code system shall only be used for BWR licensing analyses and BWR core monitoring applications.*

   BFN is a boiling water reactor; therefore, the SLMCPR analysis meets this condition.

4. *The review of the CASMO-4/MICROBURN-B2 code system does not imply a generic review of each code.*

   CASMO-4/MICROBURN-B2 is used as a code system for input into the SLMCPR analysis.

5. *The CASMO-4/MICROBURN-B2 code system is approved as a replacement for CASMO-3 /MICROBURN-B code system used in NRC-approved BWR methodology and core monitoring applications. Such replacements shall be evaluated to ensure affected methodology continues to comply with its SER restrictions and/or conditions.*

   Since the SLMCPR analysis consists of a core monitoring simulation, it is appropriate that the methods used for core monitoring are used in the SLMCPR analysis. Because CASMO-4/MICROBURN-B2 is used in the POWERPLEX®-III* core monitoring software

* POWERPLEX is a trademark of Framatome ANP registered in the United States and various other countries.

system (CMSS), the methods and corresponding uncertainties of CASMO-4 /MICROBURN-B2 are applicable for the SLMCPR analysis. This is supported by the response to NRC Question 11 in Reference A.1 Supplement 2 page 11, which states that the Reference A.1 methodology can be used with a core monitoring system if sufficient information is available about the uncertainties for the core monitoring code. In this case, sufficient information is available for the uncertainties of POWERPLEX-III CMSS. As shown in Item D below, compliance with the NRC SER restrictions of Reference A.1 is maintained.

6. *Any customer who proposes to use the CASMO-4/MICROBURN-B2 code system independent of any fuel contract will be notified of conditions 1-4.*

   The BFN Unit 3 Cycle 12 analysis is not impacted by this condition since it is based on a fuel contract.

D. ANF-524(P)(A) Revision 2 and Supplements 1 and 2 (Reference A.1)

This report supports the SLMCPR methodology. The NRC SER limitations, conditions, and restrictions applicable for the process are:

1. *The NRC-approved MICROBURN-B power distribution uncertainties should be used in the SLMCPR determination.*

   This NRC SER restriction was addressed in the letter from J.F. Mallay (FANP) to USNRC, "EMF-2158(P) Revision 0, *Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2*," NRC:99:050, December 20, 1999. The NRC confirmed that this SER restriction does not apply to CASMO-4/MICROBURN-B2 in letter, Stuart A. Richards (USNRC) to J.F. Mallay (FANP), "Acceptance of Clarifications on Topical Report EMF-2158(P) Revision 0, *Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2* (TAC No. MA4592)," February 29, 2000. As detailed in Item C, the approved uncertainties used are based on MICROBURN-B2.

2. *The ANFB additive constant uncertainty should be verified per fuel design.*

   The SPCB critical power correlation replaces the ANFB critical power correlation in the methodology. SPCB additive constant uncertainties were specifically determined for ATRIUM-10, GE13, and GE14 fuel assemblies (References A.2 and A.3).

3. *The CPR channel bowing penalty for non-ANF fuel should be made using conservative estimates of the sensitivity of local power peaking to channel bow.*

   Channel bow specific for the GE13 and GE14 fuel types was explicitly used in the analyses, which results in conservative estimates of local power peaking to channel bow.

4. *The methodology for evaluating the effect of fuel channel bowing is not applicable to reused second-lifetime fuel channels.*

   No reused second-lifetime fuel channels are being used for the BFN Unit 3 Cycle 12 core.

NRC Question 3

Please demonstrate, based on results of the SLMCPR analysis, that the margin for the proposed increase of the SLMCPR value is adequate. Also, identify the dominant fuel type with respect to cycle exposure during the Cycle 12 operation, and the main contributors for the increase of the proposed SLMCPR value.

Based on the BFN Unit 3 Cycle 12 reference core loading pattern used in the SLMCPR analysis, the 0.1% rods in boiling transition (BT) criterion for a two recirculation loop operation SLMCPR of 1.09 was met. Likewise, the criterion was met for an SLMCPR of 1.11 for single-loop operation. The margin was adequate.

Because of the inherent conservatism of the indirect method of Reference A.2 (the application of an approved CPR correlation to co-resident fuel) in determining additive constant uncertainty, a GE14 assembly will contribute more rods in BT than an ATRIUM-10 assembly if compared on an equal MCPR basis. At the beginning of cycle (BOC), the limiting GE14 and ATRIUM-10 assemblies have approximately the same MCPR margin. At later exposures, the limiting GE14 assembly falls off in power and increases in MCPR margin relative to the limiting ATRIUM-10 assembly. Therefore, the dominate MCPR fuel type with respect to cycle exposure is ATRIUM-10 for the cycle except at BOC. Please refer to Table A.2 for additional detail on MCPR values versus exposure and the lowest MCPR fuel type.

Because TVA has switched from Global Nuclear Fuel methodology to FANP methodology for the Cycle 12 analysis, it is not informative to compare the previous cycle's results for explanations on the calculated 0.01 SLMCPR value increase. The change in methodology alone can cause a change in SLMCPR value.

NRC Question 4

Please describe the procedures used in the approved methodologies to generate fuel- and plant-related uncertainties listed in Table A.1 of Attachment A of the October 1, 2003, submittal. Please provide an equation, as a function of these uncertainties, that can be used as an input to the SLMCPR calculations.

The Fuel Uncertainties in Table A.1 of Attachment A of the October 1, 2003 submittal for BFN3C12 are identified as [ ] for a mixed core. The procedure used in the determination of the ATRIUM-10 additive constant uncertainty is described in Section 3.6.2 of Reference A.2. The procedure used in the determination of the GE13 and GE14 additive constant uncertainties applied the indirect method as described in Reference A.3. The procedure for determining the [ ] is described in Section 9 of Reference A.4 (also refer to Answer 5). The [ ], determined from

[

]. The plant measurement uncertainties are not fuel design dependent; therefore, the same plant uncertainties used in the previous cycle SLMCPR analysis have been retained.

The SLMCPR is determined by a Monte Carlo analysis that convolves the uncertainties. Reference A.1 describes the procedure used for generation of the SLMCPR. Specifically, the SLMCPR is determined by a [

]. Uncertainties are input as numerical values; therefore, an equation is not applicable.

NRC Question 5

In relation to the SLMCPR analysis, the submittal did not provide a reference for the conditions listed below. Please identify which approved methodology has the condition listed below.

(a) 50 percent of the local power range monitors (LPRMs) out of service (LPRM bypass model on or off);
(b) up to two traversing incore probe (TIP) machines out of service, or the equivalent number of TIP channels;
(c) 2500 effective full power hour (EFPH) LPRM calibration interval; and
(d) no reused channels.

Also, please describe the rationale for each of the above conditions.

Items *(a)–(c)* are core monitoring equipment out-of-service conditions. These equipment out-of-service (OOS) conditions are considered typical for operating domestic BWR plants using the POWERPLEX-III CMSS and are conditions that determine the [ ] used in the SLMCPR analysis. With an increase in the number of LPRMs OOS, TIPs OOS, and the extended LPRM calibration interval, the [ ] increases. Reference A.4 Section 9 discusses the [ ] The method for calculating the increased [ ] is presented in the May 6, 1996 letter, H.D. Curet (SPC) to H.J. Richings (NRC), "POWERPLEX® Core Monitoring: Failed or Bypassed Instrumentation and Extended Calibration."

Item *(d)* deals with channel bow used in the SLMCPR analysis. The channel bow methodology presented in Reference A.1 does not allow for second-lifetime channels. No reused second-lifetime fuel channels are being used for the BFN Unit 3 Cycle 12 core.

References

A.1 ANF-524(P)(A) Revision 2 and Supplements 1 and 2, *ANF Critical Power Methodology for Boiling Water Reactors,* Advanced Nuclear Fuel Corporation, November 1990.

A.2 EMF-2209(P)(A) Revision 1, *SPCB Critical Power Correlation,* Siemens Power Corporation, July 2000.

A.3 EMF-2245(P)(A) Revision 0, *Application of Siemens Power Corporation's Critical Power Correlations to Co-Resident Fuel,* Siemens Power Corporation, August 2000.

A.4 EMF-2158(P)(A) Revision 0, *Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4 and MICROBURN-B2,* Siemens Power Corporation, October 1999.

Table A.1 BFN Unit 3 Cycle 12
Core Composition

Fuel Description	Cycle Loaded	Number of Assemblies	Serial Number Prefix
GE13-P9DTB400-13GZ1-100T-146-T	10	124	YJV
GE13-P9DTB414-15GZ-100T-146-T	10	72	YJV
GE14-P10DNAB402-15GZ-100T-150-T	11	220	JLB
GE14-P10DNAB401-14GZ-100T-150-T	11	64	JLB
ATRIUM-10 A10-3812B-13GV80	12	64	FCA
ATRIUM-10 A10-4075B-15GV80	12	152	FCA
ATRIUM-10 A10-4087B-13GV80	12	68	FCA

Table A.2 BFN Unit 3 Cycle 12
MCPR Versus Exposure

[

]

	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
60									YJV138	YJV289	YJV331	YJV384	YJV325	YJV135	YJV322
58								YJV407	YJV168	YJV299	YJV321	YJV140	YJV236	YJV396	YJV292
56						YJV287	YJV242	YJV237	JLB495	FCA281	JLB352	FCA277	JLB492	FCA273	JLB343
54						YJV404	YJV315	JLB345	FCA269	JLB552	FCA265	JLB359	FCA261	JLB517	FCA257
52					YJV329	YJV319	YJV324	FCA253	JLB336	FCA213	JLB549	FCA209	JLB555	FCA205	JLB502
50			YJV408	YJV405	YJV147	FCA249	FCA201	JLB330	FCA197	JLB525	FCA193	JLB334	FCA189	JLB356	FCA185
48			YJV282	YJV326	YJV128	FCA181	JLB559	FCA177	JLB335	FCA173	JLB354	FCA169	JLB346	FCA165	JLB479
46		YJV307	YJV141	JLB472	FCA245	JLB481	FCA161	JLB511	FCA157	JLB344	FCA153	JLB329	FCA061	JLB500	FCA149
44	YJV131	YJV175	JLB494	FCA241	JLB333	FCA145	JLB357	FCA141	JLB473	FCA137	JLB474	FCA133	JLB355	FCA057	JLB516
42	YJV232	YJV143	FCA237	JLB550	FCA129	JLB469	FCA125	JLB341	FCA121	JLB515	FCA053	JLB608	FCA117	JLB523	FCA049
40	YJV240	YJV281	JLB340	FCA233	JLB603	FCA113	JLB351	FCA109	JLB361	FCA045	JLB518	FCA105	JLB508	FCA041	JLB558
38	YJV327	YJV136	FCA229	JLB342	FCA101	JLB557	FCA097	JLB348	FCA093	JLB560	FCA089	JLB332	FCA037	JLB605	FCA033
36	YJV328	YJV129	JLB480	FCA225	JLB556	FCA085	JLB347	FCA029	JLB353	FCA081	JLB331	FCA025	JLB349	FCA021	YJV132
34	YJV296	YJV234	FCA221	JLB337	FCA077	JLB360	FCA073	JLB338	FCA017	JLB339	FCA013	JLB551	FCA009	YJV134	JLB553
32	YJV323	YJV332	JLB468	FCA217	JLB350	FCA069	JLB501	FCA065	JLB358	FCA005	JLB598	FCA001	YJV297	JLB554	YJV142
30	YJV363	YJV398	JLB484	FCA220	JLB431	FCA072	JLB470	FCA068	JLB487	FCA008	JLB600	FCA004	YJV272	JLB591	YJV186
28	YJV254	YJV285	FCA224	JLB443	FCA080	JLB430	FCA076	JLB454	FCA020	JLB521	FCA016	JLB589	FCA012	YJV192	JLB592
26	YJV361	YJV179	JLB433	FCA228	JLB597	FCA088	JLB452	FCA032	JLB456	FCA084	JLB434	FCA028	JLB450	FCA024	YJV183
24	YJV359	YJV267	FCA232	JLB447	FCA104	JLB586	FCA100	JLB485	FCA096	JLB595	FCA092	JLB435	FCA040	JLB599	FCA036
22	YJV241	YJV271	JLB486	FCA236	JLB585	FCA116	JLB429	FCA112	JLB458	FCA048	JLB451	FCA108	JLB478	FCA044	JLB607
20	YJV245	YJV191	FCA240	JLB590	FCA132	JLB498	FCA128	JLB449	FCA124	JLB490	FCA056	JLB588	FCA120	JLB483	FCA052
18	YJV182	YJV125	JLB462	FCA244	JLB441	FCA148	JLB524	FCA144	JLB455	FCA140	JLB522	FCA136	JLB457	FCA060	JLB482
16		YJV199	YJV189	JLB520	FCA248	JLB432	FCA164	JLB471	FCA160	JLB444	FCA156	JLB442	FCA064	JLB460	FCA152
14			YJV180	YJV356	YJV177	FCA184	JLB596	FCA180	JLB436	FCA176	JLB440	FCA172	JLB448	FCA168	JLB428
12			YJV409	YJV402	YJV188	FCA252	FCA204	JLB594	FCA200	JLB488	FCA196	JLB438	FCA192	JLB505	FCA188
10					YJV353	YJV358	YJV357	FCA256	JLB439	FCA216	JLB587	FCA212	JLB593	FCA208	JLB512
8						YJV394	YJV278	JLB446	FCA272	JLB477	FCA268	JLB459	FCA264	JLB513	FCA260
6						YJV197	YJV288	YJV293	JLB467	FCA284	JLB453	FCA280	JLB461	FCA276	JLB445
4								YJV410	YJV306	YJV294	YJV362	YJV195	YJV201	YJV387	YJV250
2									YJV194	YJV249	YJV382	YJV395	YJV360	YJV284	YJV355

Figure A.1 BFN Unit 3 Cycle 12
Reference Loading Pattern

	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59
60	YJV350	YJV158	YJV336	YJV391	YJV344	YJV252	YJV156								
58	YJV280	YJV345	YJV308	YJV170	YJV335	YJV257	YJV137	YJV346							
56	JLB381	FCA274	JLB465	FCA278	JLB378	FCA282	JLB463	YJV279	YJV259	YJV157					
54	FCA258	JLB496	FCA262	JLB392	FCA266	JLB570	FCA270	JLB385	YJV274	YJV399					
52	JLB489	FCA206	JLB565	FCA210	JLB571	FCA214	JLB368	FCA254	YJV340	YJV337	YJV386				
50	FCA186	JLB390	FCA190	JLB372	FCA194	JLB506	FCA198	JLB394	FCA202	FCA250	YJV161	YJV400	YJV348		
48	JLB364	FCA166	JLB387	FCA170	JLB373	FCA174	JLB370	FCA178	JLB567	FCA182	YJV149	YJV339	YJV305		
46	FCA150	JLB367	FCA062	JLB380	FCA154	JLB374	FCA158	JLB514	FCA162	JLB363	FCA246	JLB491	YJV169	YJV160	
44	JLB509	FCA058	JLB395	FCA134	JLB493	FCA138	JLB393	FCA142	JLB396	FCA146	JLB369	FCA242	JLB466	YJV203	YJV152
42	FCA050	JLB475	FCA118	JLB604	FCA054	JLB503	FCA122	JLB382	FCA126	JLB507	FCA130	JLB563	FCA238	YJV310	YJV276
40	JLB601	FCA042	JLB519	FCA106	JLB510	FCA046	JLB388	FCA110	JLB366	FCA114	JLB561	FCA234	JLB375	YJV260	YJV301
38	FCA034	JLB609	FCA038	JLB376	FCA090	JLB569	FCA094	JLB371	FCA098	JLB562	FCA102	JLB379	FCA230	YJV163	YJV341
36	YJV153	FCA022	JLB391	FCA026	JLB504	FCA082	JLB497	FCA030	JLB383	FCA086	JLB568	FCA226	JLB362	YJV172	YJV349
34	JLB566	YJV164	FCA010	JLB606	FCA014	JLB377	FCA018	JLB384	FCA074	JLB365	FCA078	JLB386	FCA222	YJV277	YJV298
32	YJV173	JLB564	YJV251	FCA002	JLB602	FCA006	JLB499	FCA066	JLB476	FCA070	JLB389	FCA218	JLB437	YJV347	YJV334
30	YJV219	JLB574	YJV253	FCA003	JLB612	FCA007	JLB422	FCA067	JLB545	FCA071	JLB528	FCA219	JLB547	YJV388	YJV370
28	JLB577	YJV221	FCA011	JLB580	FCA015	JLB532	FCA019	JLB426	FCA075	JLB417	FCA079	JLB416	FCA223	YJV266	YJV273
26	YJV225	FCA023	JLB412	FCA027	JLB401	FCA083	JLB420	FCA031	JLB407	FCA087	JLB578	FCA227	JLB529	YJV223	YJV376
24	FCA035	JLB611	FCA039	JLB400	FCA091	JLB573	FCA095	JLB409	FCA099	JLB583	FCA103	JLB414	FCA231	YJV216	YJV377
22	JLB582	FCA043	JLB536	FCA107	JLB531	FCA047	JLB424	FCA111	JLB539	FCA115	JLB572	FCA235	JLB410	YJV269	YJV265
20	FCA051	JLB464	FCA119	JLB576	FCA055	JLB546	FCA123	JLB405	FCA127	JLB413	FCA131	JLB610	FCA239	YJV218	YJV248
18	JLB540	FCA059	JLB418	FCA135	JLB527	FCA139	JLB427	FCA143	JLB419	FCA147	JLB404	FCA243	JLB534	YJV148	YJV230
16	FCA151	JLB541	FCA063	JLB397	FCA155	JLB526	FCA159	JLB543	FCA163	JLB530	FCA247	JLB538	YJV217	YJV214	
14	JLB542	FCA167	JLB411	FCA171	JLB415	FCA175	JLB402	FCA179	JLB579	FCA183	YJV206	YJV375	YJV229		
12	FCA187	JLB421	FCA191	JLB423	FCA195	JLB544	FCA199	JLB399	FCA203	FCA251	YJV215	YJV403	YJV412		
10	JLB537	FCA207	JLB575	FCA211	JLB584	FCA215	JLB398	FCA255	YJV365	YJV367	YJV374				
8	FCA259	JLB548	FCA263	JLB425	FCA267	JLB581	FCA271	JLB406	YJV246	YJV406					
6	JLB408	FCA275	JLB535	FCA279	JLB403	FCA283	JLB533	YJV312	YJV231	YJV213					
4	YJV270	YJV380	YJV239	YJV224	YJV368	YJV261	YJV193	YJV411							
2	YJV372	YJV209	YJV366	YJV385	YJV379	YJV233	YJV211								

Figure A.1 BFN Unit 3 Cycle 12
Reference Loading Pattern *(Continued)*

	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59
30	21	26	21	31	26	31	25	32	25	32	25	33	25	22	22
	34.0	18.1	34.1	0.0	20.7	0.0	22.1	0.0	21.8	0.0	21.4	0.0	22.0	35.3	39.1
28	26	21	31	26	31	25	31	25	32	25	32	25	33	21	21
	18.1	33.7	0.0	20.2	0.0	21.9	0.0	21.5	0.0	21.4	0.0	21.6	0.0	38.8	39.6
26	21	31	25	31	25	32	25	31	25	32	26	33	25	21	22
	33.9	0.0	20.1	0.0	21.2	0.0	21.6	0.0	21.6	0.0	20.2	0.0	20.2	38.0	41.3
24	31	26	31	25	32	26	32	25	32	26	32	25	33	21	22
	0.0	20.8	0.0	21.4	0.0	20.7	0.0	21.4	0.0	20.5	0.0	22.1	0.0	38.6	42.1
22	26	31	25	32	25	31	25	32	25	32	26	33	25	21	21
	20.5	0.0	22.1	0.0	22.5	0.0	21.8	0.0	21.5	0.0	20.3	0.0	21.1	35.6	36.9
20	31	25	32	26	31	25	32	25	32	25	32	26	33	21	21
	0.0	21.9	0.0	20.7	0.0	22.4	0.0	18.6	0.0	21.9	0.0	18.6	0.0	38.3	41.1
18	25	31	25	32	25	32	25	32	25	32	25	33	25	21	21
	22.3	0.0	21.6	0.0	21.6	0.0	21.2	0.0	21.5	0.0	20.6	0.0	20.0	32.6	41.7
16	32	25	31	25	32	25	32	25	32	25	33	25	21	21	
	0.0	21.6	0.0	21.4	0.0	18.6	0.0	22.1	0.0	20.6	0.0	20.9	37.3	42.0	
14	25	32	25	32	25	32	25	32	26	32	21	22	21		
	22.4	0.0	21.6	0.0	21.6	0.0	21.5	0.0	20.6	0.0	34.9	36.1	41.3		
12	32	25	32	25	32	25	32	25	32	33	21	22	22		
	0.0	20.7	0.0	19.5	0.0	22.2	0.0	19.4	0.0	0.0	35.4	39.8	40.5		
10	25	32	26	32	26	32	25	33	22	22	22				
	21.3	0.0	20.6	0.0	20.3	0.0	20.6	0.0	35.0	34.6	41.0				
8	33	25	33	25	33	26	33	25	21	22					
	0.0	21.8	0.0	22.0	0.0	18.6	0.0	21.0	35.4	39.7					
6	25	33	25	33	25	33	25	21	21	21					
	21.9	0.0	20.5	0.0	21.8	0.0	20.0	37.7	41.7	41.7					
4	21	22	21	21	22	21	21	22							
	36.7	35.6	37.2	38.2	36.2	38.4	32.8	40.4							
2	22	21	22	22	22	21	21								
	39.5	39.3	41.5	42.0	40.9	42.1	41.9								

Nuclear Fuel Type
BOC Exposure (GWd/MTU)

Fuel Type	Description	Cycle Loaded
21	GE13-P9DTB400-13GZ1-100T-146-T	10
22	GE13-P9DTB414-15GZ-100T-146-T	10
25	GE14-P10DNAB402-15GZ-100T-150-T	11
26	GE14-P10DNAB401-14GZ-100T-150-T	11
31	ATRIUM-10 A10-3812B-13GV80	12
32	ATRIUM-10 A10-4075B-15GV80	12
33	ATRIUM-10 A10-4087B-13GV80	12

Figure A.2 BFN Unit 3 Cycle 12
Lower-Right Quarter Core Layout by Fuel Type

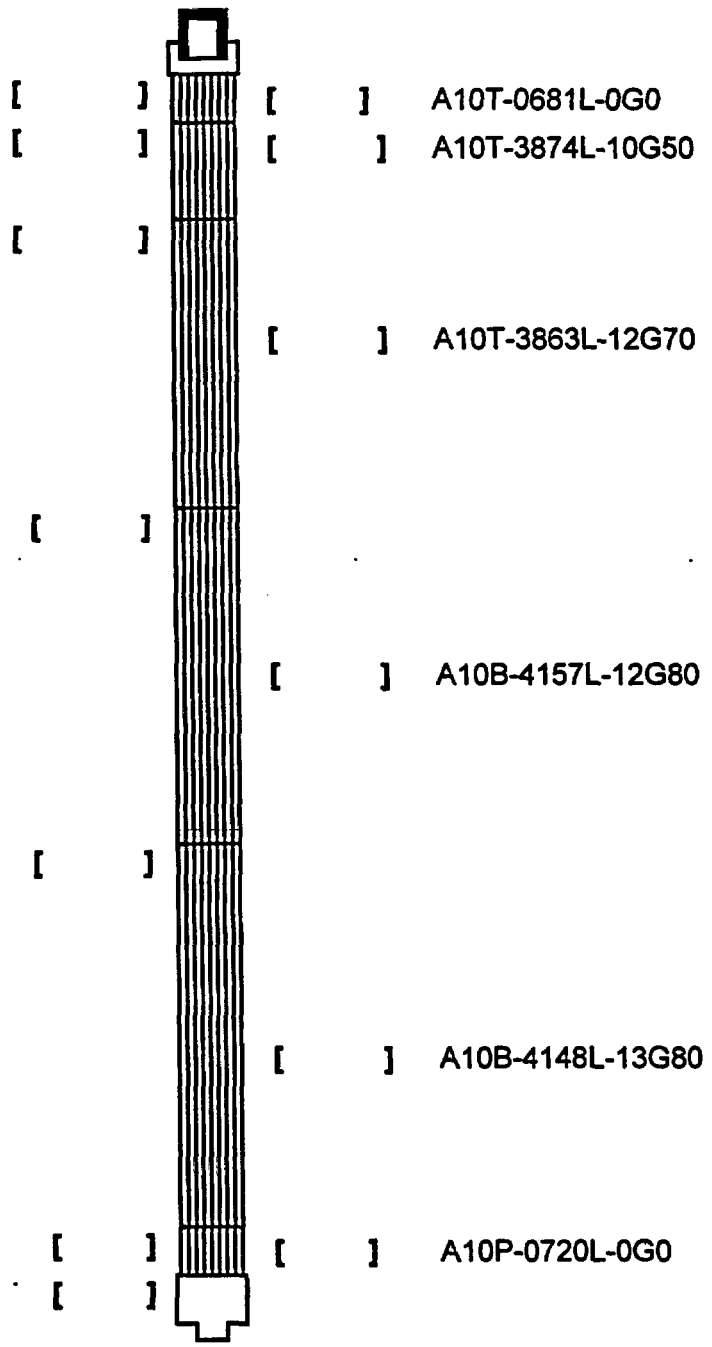


Figure A.3 Elevation View for the BFN Unit 3 Cycle 12 ATRIUM-10 A10-3812B-13GV80 Fuel Assembly Design

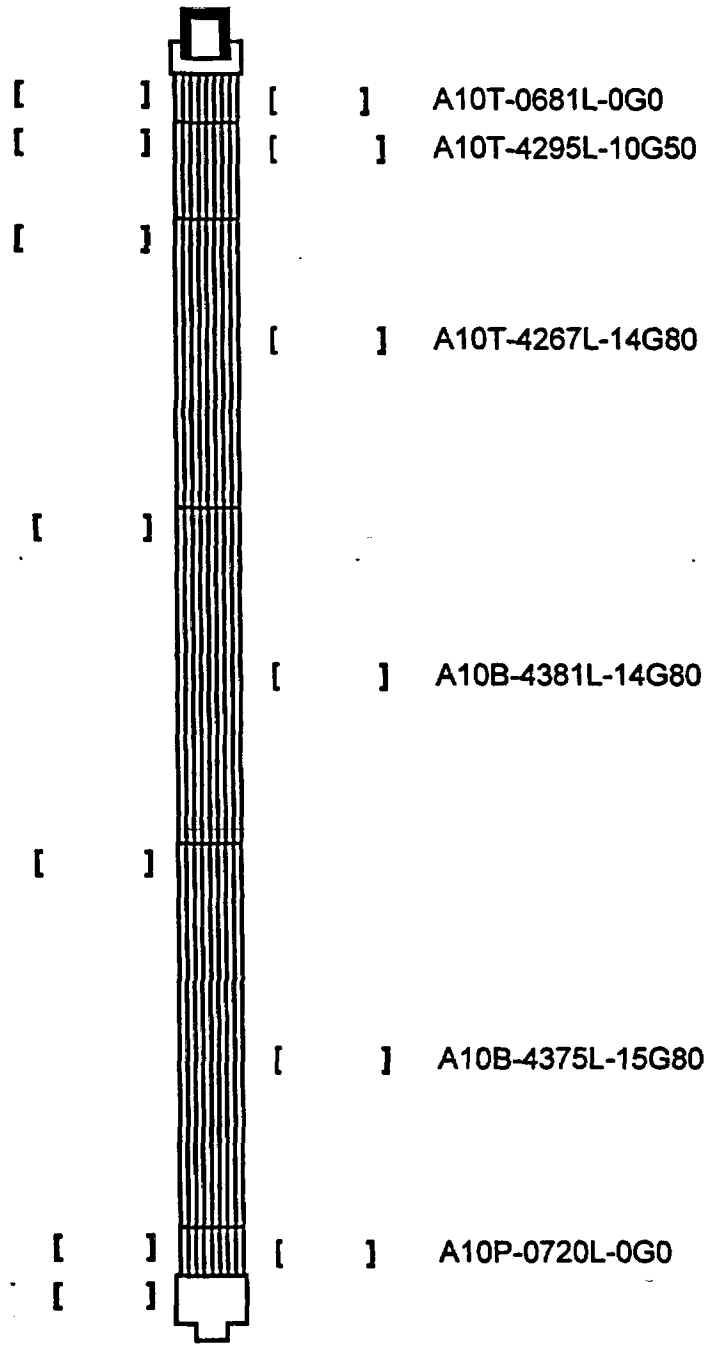


Figure A.4 Elevation View for the BFN Unit 3 Cycle 12 ATRIUM-10 A10-4075B-15GV80 Fuel Assembly Design

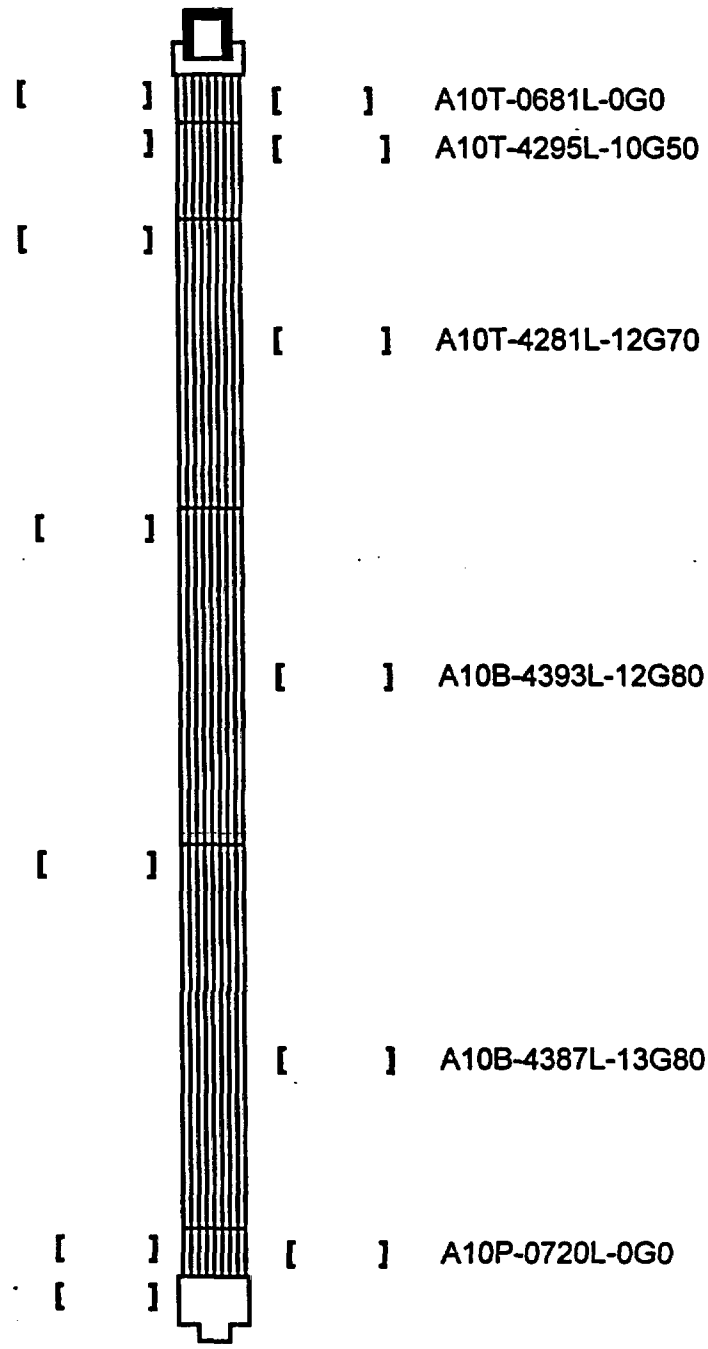


Figure A.5 Elevation View for the BFN Unit 3 Cycle 12 ATRIUM-10 A10-4087B-13GV80 Fuel Assembly Design

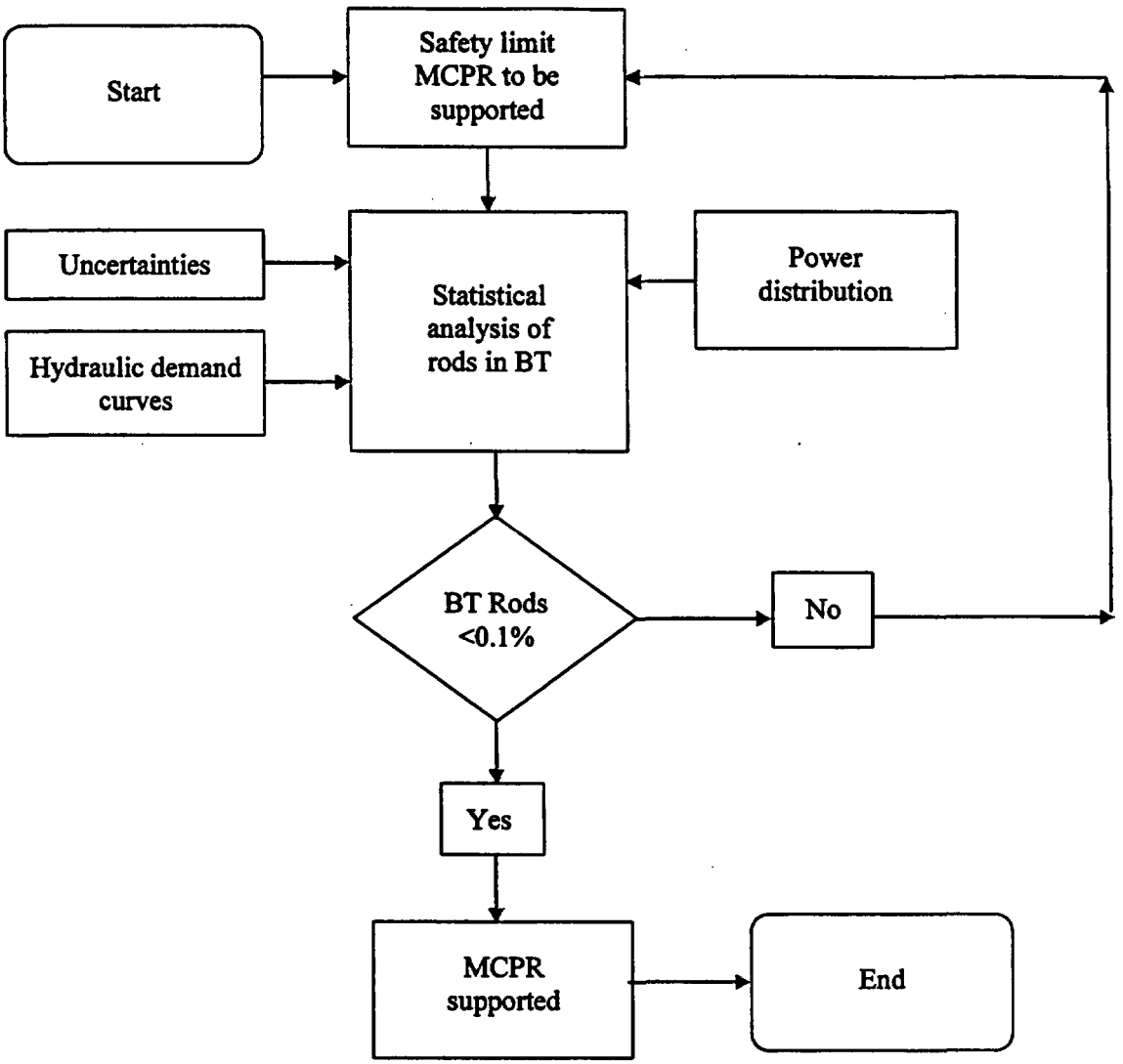


Figure A.6 Overall SLMCPR Analysis Flow Chart

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Figure A.7 Statistical Analysis of SLMCPR Flow Chart