FRAMATOME ANP

July 27, 2001
NRC:01:033

Document Control Desk
ATTN: Chief, Planning, Program and Management Support Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Partial Response to RAI

Ref.: 1. Letter, Stewart Bailey (NRC) to T. A. Coleman, (Framatome Cogema Fuels), "Request for Additional Information - Framatome Topical Report BAW-10231P (TAC NO. MA6792)," August 11, 2000.

Ref.: 2. Letter, T. A. Coleman (Framatome ANP) to U.S. Nuclear Regulatory Commission, GR0-021.doc, February 5, 2001.

Ref.: 3. Letter, Stewart Bailey (NRC) to T. A. Coleman (Framatome ANP), "Request for Additional Information - Chapter 13 of Framatome Topical Report BAW-10231P (TAC NO. MA9783)," May 14, 2001.

Reference 1 provided a request for additional information (RAI) on Framatome Cogema Fuels (FCF) topical report BAW-10231P, "COPERNIC Fuel Rod Design Code." That RAI addressed the UO_2 applications of the code. Reference 2 contained the Framatome ANP response to the RAI.

Reference 3 is the RAI associated with the MOX applications for COPERNIC. However, two of the questions in the RAI (numbers 6 and 7) refer to UO_2 applications. The responses to these two questions are enclosed. Framatome plans to apply the UO_2 portion of the COPERNIC topical report within the next few months. Therefore, receipt of the SER by August 31, 2001 constitutes a critical need in our schedule.

In a telephone conference with the NRC held on May 23, 2001, Framatome ANP agreed to revise some of the figures that had been included in the response to question 2 of the initial RAI. The revised figures are enclosed. Since the topical report was printed double-sided, the enclosed change pages typically have revisions on one side only.

Power level hold time for LOCA initialization is discussed in Chapter 12, "Application Methodology," of BAW-10231P. In order to clarify the manner in which the hold time is determined, Framatome ANP has developed a method for linking the hold time to the requirements in the plant-specific technical specifications. A description of this method is

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enclosed as a clarification to facilitate the NRC's review and should be included in your evaluation of BAW-10231P.

In accordance with the provisions of 10 CFR 2.790(b), Framatome ANP requests that these responses be considered proprietary and withheld from public disclosure. Attachment 1 is an affidavit supporting this request. Attachment 2 is the proprietary version of the RAI responses, revised figures, and unsolicited response. Attachment 3 is the non-proprietary version. After the SER is received, Framatome ANP will incorporate all the enclosed material into either the body or an appendix of the approved version of BAW-10231P.

Very truly yours,

James F. Mallay, Director
Regulatory Affairs

cel

Enclosures

cc: S. N. Bailey, NRC
R. Caruso, NRC
J. S. Wermeil, NRC
S. L. Wu, NRC
C. E. Beyer, PNNL
M. S. Schoppman
20A13 File/Records Management

Attachment 1

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is James F. Mallay. I am Director, Regulatory Affairs, for Framatome ANP ("FRA-ANP"), and as such I am authorized to execute this Affidavit.

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

3. I am familiar with the FRA-ANP information included in two of the attachments (responses to RAI and change pages) to letter NRC:01:033, dated July 27, 2001 from James F. Mallay to (NRC). These two attachments are referred to herein as "Documents." Information contained in these Documents has been classified by FRA-ANP as proprietary in accordance with the policies established by FRA-ANP for the control and protection of proprietary and confidential information.

4. These Documents contain information of a proprietary and confidential nature and is of the type customarily held in confidence by FRA-ANP and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in these Documents as proprietary and confidential.

5. These Documents have been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in these Documents be withheld from public disclosure.

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

(a) The information reveals details of FRA-ANP'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 FRA-ANP.

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

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

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

8. FRA-ANP 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 26th

day of July, 2001.

____

Valerie W. Smith
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 10/10/04

VALERIE W. SMITH
COMMISSION EXP.
NOTARY PUBLIC
OCT. 10, 2004
STATE OF WASHINGTON

Attachment 3

6. The Halden Reactor Project correction for unirradiated MOX is an 8 percent reduction in the urania thermal conductivity (at all temperatures) when the Pu concentration is equal to or below 12 wt%. This is significantly higher than the value used in COPERNIC. Also, the COPERNIC model for urania and MOX pellet thermal conductivity at high burnups and nominal stoichiometry (x = 0.02) is significantly higher in the range from 500 to 1500 K than similar burnup-dependent models, such as those proposed by ORNL/Kurchatov (Popov, 2000), Halden (Wiesenack, 2000, HPR-589) and Baron (Baron 1998). Please justify the higher thermal conductivity values used by COPERNIC for unirradiated and high burnup MOX (see question 8 below).

The COPERNIC UO_2 fuel thermal conductivity relationship [b, c]

The COPERNIC thermal conductivity relationship [b, c]

the Baron[6] relationship which has been shown to conservatively over-predict measured fuel temperatures[7].

The integrals of the above thermal conductivities are shown in Figures 1, 2 and 3 for MOX and UO_2. [b, c]

APPENDIX A

[b, c]

REFERENCES

[1] P.G. Lucuta, Hj. Matzke, I.J. Hastings, "A Pragmatic Approach to Modeling Thermal Conductivity of Irradiated UO2 Fuel: Review and Recommendations," J. Nucl. Mater., Vol. 232, pp. 166-180(1996).

[2] W. Wiesenack, "Assessment of UO_2 Conductivity Degradation Based on In-pile Temperature Data," Proceedings of the International Topical Meeting on Light Water Reactor Fuel Performance, Portland, U.S.A., pp. 507-511 (1997).

[3] S. Yagnik, "Thermal Conductivity Recovery Phenomena in Irradiated UO2 and (U, Gd)O2, Proceedings of the International Topical Meeting on Light Water Reactor Fuel Performance, Park City, Utah U.S.A., pp. 634-645 (2000).

[4] C. Duriez, J.P. Alessandri, T. Gervais, Y. Philipponneau, "Thermal Conductivity of Hypostoichiometric Low Pu Content $(U,Pu)O_{2-x}$ Mixed Oxide" J.Nucl. Mater., Vol. 277 pp. 143-158 (2000)

[5] S.G. Popov, J.J Carbajo, V.K. Ivanov, G.L. Yoder, "Thermophysical Properties of MOX and UO2 Fuels Including the Effects of Irradiation" Report ORNL/TM-2000/351

[6] D. Baron, "About the Modeling of the Fuel Thermal Conductivity Degradation at High Burnup, Accounting for Recovery Processes with Temperature," Paper 2.5 in proceedings of the NEA Seminar on Thermal Performance of High-Burnup LWR Fuel, Cadarache, France, 3-6 March 1998

[7] D. D. Lanning, C. E. Beyer, "Assessment of Recent Data and Correlations for Fuel Pellet Thermal Conductivity," Presented at the 2001 Enlarged Halden Program Group Meeting, Lillehammer, Norway 11-16 March 2001. Published in Halden Report HRP-356

[8] D. D. Lanning, C. E. Beyer, M. E. Cunningham, " FRAPCON-3 Fuel rod temperature Predictions with fuel conductivity degradation caused by fission products and gadolinia additions," Proceedings of the International Topical Meeting on Light Water Reactor Fuel Performance, Park City, Utah U.S.A., pp. 244-258 (2000).

Table 1: FRAMATOME-ANP database for the validation of the MOX fuel thermal conductivity relationship of COPERNIC

[b, c, d]

Figure 1 – MOX Thermal Conductivity Integrals

[b, c]

7. Recent high-temperature data on unirradiated urania fuel pellet thermal conductivity (Ronchi et al., 1999) has indicated that the conductivity in the range from 2000 to 3000 K is significantly lower than the COPERNIC equations for urania and, by implication, for LWR MOX also. Most of the current conductivity models (including COPERNIC) are based on very old data at high temperature from which there was considerable scatter. The more recent data appears to have less scatter and better experimental techniques to minimize the scatter due to heat loss and other effects. Please justify the higher estimates of COPERNIC conductivity in this high temperature range because the discrepancy affects the LHGR margin to center fuel melting.

.[b, c, e]

Figure 14-3: COPERNIC and NFIR-III Thermal Conductivity Comparison 60 GWd/tU Burnup – [c]

[b, c, d]

Figure 14-4: COPERNIC and JAERI Thermal Conductivity Comparison - Sample No.2 63 GWd/tU Burnup, 83-89% Density Range, [c]

[b, c, d]

Figure 14-5: COPERNIC and JAERI Thermal Conductivity Comparison - Sample No.3 63 GWd/tU Burnup, 92-96% Density Range, [c]

[b, c, d]

Figure 14-6: Rim Effect at 60 GWd/tU IFA 562

[b, c, d]

Question 6

Is Framatome a member of Halden? If so, Halden has refabricated two high (~ 59 GWd/MTU) burnup rods (one with a functional thermocouple) and placed them first in IFA-597.2 (HWR-442) and subsequently in IFA-597.3 (HWR-543) with measured centerline temperatures. Please compare COPERNIC code predictions to this data and include this data in the response to Question 3.1 above.

Response

The COPERNIC centerline fuel temperature predictions are compared with the IFA-597.2 (HWR-442) and IFA-597.3 (HWR-543) fuel temperature measurements in Figure 14-13. This rodlet attained a burnup of 61.5 GWd/tUO_2 or 69.8 GWd/tU.

Figure 14-13: Fuel Centerline Temperature Measurements and Predictions vs. Burnup, IFA-597.2 and IFA-597.3

[d]

Figure 14-14: Not used

[d]

Question 28

There is a concern that the uncertainty factor provided in Equation 12-1 may be too small at the predicted operating temperatures (stored energy) calculated for LOCA initialization. Please discuss this issue further, particularly in relation to Question 3 above.

Response

[b, d, e].

Question 29

Are any of the example calculations provided in Section 12 for fuel cores with two 24-month cycles? It appears that there are no 24-month cycle results presented for the Mark BW-17 design. If so, please explain because it is anticipated that a large number of plants will be switching to 24-month cycles in the next few years.

Response

[b, d].

Clarification of Power Level Hold Time for LOCA Initialization

Section 12 (Application Methodology) of BAW-10231P describes the methodology that will be used to predict the initialization conditions of fuel rods for reload safety evaluations. Section 12.2.1 specifies the methodology that will be used to generate the LOCA initialization predictions. The fuel rod is simulated to operate with a specified limiting rod power history and is then ramped to the LOCA F_Q limit at the time in life when the LOCA transient originates. The topical states **[b, c]**

Plant technical specifications place limits on key controlled measurable parameters such as control rod insertion, axial power imbalance, and thermal power level to ensure that the initial conditions for accidents are maintained during operation. The limits define boundaries of core operation where power peaking factors could equal the LOCA F_Q limit (or the maximum allowable peaking limit for another accident if it is more limiting than the LOCA). Should one of the control parameters reach or exceed its limit, required actions and completion times are specified by the technical specifications. The required actions and completion times ensure that power peaking factors are restored within their limits promptly. These technical specification limits, together with their corresponding actions and completion times, limit the amount of time that the fuel could operate with power peaking factors in excess of the specified acceptable fuel design limits.

Allowable completion times for these tech spec required actions typically fall in the range of 15 minutes to 4 hours. Plants that operate with fixed incore detector systems have the additional option of generating an incore flux map at regular intervals (typically 2 hours) to provide a direct check on the power peaking factors; this provides assurance that both the F_Q and $F_{\Delta H}$ peaking factors are verified to remain within their technical specification limits.

Based upon the protection provided by the technical specifications, the amount of time that the fuel could operate at LOCA transient initialization conditions is typically limited to a range of 15 minutes to 4 hours, depending upon the individual plant tech spec requirements. **[b, c]**

The primary protection for the LOCA F_Q peaking factor is afforded by the axial power imbalance (or axial flux difference) limits, **[b, c]**