NRR-PMDAPEm Resource

From:	Byam, Timothy A:(GenCo-Nuc) <timothy.byam@exeloncorp.com>
Sent:	Thursday, March 31, 2016 3:56 PM
To:	Haskell, Russell
Subject:	[External_Sender] Clarification of Dresden and Quad Cities Fuel Transition RAIs
Attachments:	RAI Clarification Supplement (Draft Attachment).pdf

Russ,

In a letter from Patrick R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Request for License Amendment Regarding Transition to AREVA Fuel," dated February 6, 2015, Exelon Generation Company, LLC (EGC) requested an amendment to Dresden Nuclear Power Station (DNPS) Units 2 and 3, and Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2. The proposed change supports the transition from Westinghouse SVEA-96 Optima2 (Optima2) fuel to AREVA ATRIUM 10XM fuel at DNPS and QCNPS. The NRC subsequently requested additional information in support of their review of the EGC amendment request. EGC provided a response to the request in a letter from Patrick R. Simpson (EGC) to the U. S. NRC, "Response to Request for Additional Information Regarding Request for License Amendment Regarding Transition to AREVA Fuel," dated January 28, 2016.

Following their review of the RAI responses, the NRC contacted EGC and requested a conference call to obtain clarification on several of the RAI responses we provided in our letter dated January 28, 2016. The reviewers were looking for clarification on the EGC responses to the following four RAIs:

RAI 16
RAI 17
RAI 18a and b
RAI 21b

The conference call was conducted on March 2, 2016 and included participants from EGC, AREVA, and the NRC. It was agreed during the call that the following requested clarification would be provided by email to Russell Haskell (NRC PM).

<u>RAI-17 Clarification:</u>
The NRC reviewer requested clarification regarding the application of the channel bow model within AREVAs approved methodology. The requested clarification was not in regard to the clearance issue identified in RAI-17.

<u>AREVA Response:</u>
Details of the application of the channel bow model in AREVAs approved methodology is the subject of RAI-20. Specifically, the response to RAI-20(c) addresses the adjustments made to the channel bow model for the eight fuel channels that were found to be outside of the fast fluence gradient lower bound.

This channel bow model is utilized in the application of AREVAs approved methodology such as SAFLIM3D (ANP-10307PA) as described on Page 5-2 of ANP-3338P. The details of the channel bow model are described in Appendix B of the RODEX4 licensing topical report (BAW-10247PA). This channel bow model is not used in the determination of mechanical clearance on in-core components which is the subject of RAI-17.

<u>RAI-18 Clarification:</u>
Table 18.1 of the response shows that the OPTIMA2 and ATRIUM 10XM assemblies have very different flow characteristics (as shown by the differences in pressure and inlet subcooling).

What procedure/methodology/approach was used to develop the additive constants?

<u>AREVA Response:</u>
The overall methodology for applying a previously approved AREVA critical power correlation to a non-AREVA co-resident fuel design (e.g. OPTIMA2) is presented in EMF-2245(P)(A). EMF-2245(P)(A) describes the basic aspects of the indirect approach which is used when a co-resident fuel critical power correlation is available, but the experimental critical power data for the co-resident fuel is not. It also presents the process to determine the additive constant uncertainty for the co-resident fuel. EMF-2245(P)(A) states that the additive constants for the co-resident fuel must be consistent with the requirements of the specific correlation to be used (See EMF-2245(P)(A) Section 3.1).

The SPCB correlation is used for the OPTIMA2 fuel design. NRC approval of the SPCB critical power correlation is provided in EMF-2209(P)(A). The process described in EMF-2209(P)(A) Section 2.3.6 was used to develop the OPTIMA2 additive constants for the SPCB correlation. With the final additive constants, the correlation was evaluated to demonstrate it behaves well over the ranges of applicability.

RAI-21b Clarification:
Please provide additional detail on the interpolation method including applicable references.

<u>AREVA Response:</u>
EMF-1833(P) describes the cross section structure in Section 3.2 titled “Reconstruction of Macroscopic Cross Sections”.

The remaining clarifications will be provided formally by a supplement to the original amendment request. However, in accordance with our discussion on March 24, 2016, I am providing for your information the proposed draft clarifications to RAIs 16 and 18.

Tim

Timothy A Byam
Regulatory Engineer
Exelon Nuclear

4300 Winfield Rd.
Warrenville, IL 60555
Office:630 657 2818 | Fax: 630 657 4327
timothy.byam@exeloncorp.com www.exeloncorp.com

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ATTACHMENT
RAI response clarification for Dresden Nuclear Power Station and
Quad Cities Nuclear Power Station

The following Clarification of RAI responses provided in the January 28, 2016 letter from Exelon generation Company, LLC (EGC) are provided in response to the NRC request as discussed during the March 2, 2016 teleconference between the U. S. NRC and Exelon. It was agreed that the following clarifications would be provided as a supplement to the license amendment request. The remaining clarifications were provided in an email from Timothy A. Byam (Exelon Generation Company) to Russell Haskell (U. S. NRC), "Subject," dated March XX, 2016.

RAI-16 Clarification:
The NRC reviewer requested additional detail concerning the mechanical design analyses. A recent AREVA document supporting another US utility customer was provided as an example of the desired level of detail.

AREVA Response:
The AREVA ATRIUM 10XM fuel assembly design has been evaluated by AREVA Inc. and EGC to ensure that the mechanical compatibility with the Dresden Nuclear Power Station (DNPS), Units 2 and 3 and Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2 control blades and in-core instrumentation is in compliance with AREVA's generic mechanical design criteria documents for boiling water reactor (BWR) fuel designs (Reference 1) and fuel channels (Reference 2). Page 1-5 of Reference 2 describes the application of channel deformation in mechanical compatibility evaluations. Analyses are used to verify the mechanical compatibility based on specific bounding physical features and attributes of the fuel assembly as defined in the AREVA detailed design drawings and the dimensional data of the reactor core internals and co-resident fuel assemblies officially transmitted by EGC.

The specific evaluations for the control blade and in-core instrumentation compatibility are provided in the following Table 16.1. These evaluations are discussed for the applicable fuel component and the corresponding interface on the co-resident fuel assembly and/or in-core component. The conclusion of each evaluation is also provided. Mechanical compatibility and corresponding analyses are further discussed in Reference 3.

Table 16.1 Control Rod and In-Core Instrumentation Interface Compatibility

AREVA Fuel Assembly Component	In-Core Interface Evaluated	Conclusion
Fuel channel spacers	Axial and lateral interface with co-resident fuel channel spacers throughout the design life	The overlap between the fuel channel spacers is maintained throughout the design life to provide clearance between channels for control rods
	Control rod handle elevation, including scram over-travel	Clearance exists between the fuel channel spacer and the control blade handle at full insertion
Fuel channel fastener	Axial, lateral and radial interface with co-resident fuel channel fastener springs throughout the design life	The fuel channel fastener springs remain in compression and in contact throughout the design life to maintain fuel assemblies in the cell against the upper core guides and to maintain clearance between channels for control rods, including when a fresh AREVA fuel assembly is adjacent to an end-of-life (EOL) co-resident fuel assembly
	Control rod handle elevation, including scram over-travel	Clearance exists between the fuel channel fastener and the control blade handle at full insertion
Fuel channel reduced thickness wall section	Control rod roller or pad elevation, including scram over-travel	The control rod rollers and pads remain within the thinned wall section of the Advanced Fuel Channel for maximum control rod clearance
	Lateral interface with control rod roller or pad	
	Control rod roller or pad thickness	Clearance exists throughout the travel of the control blade between fuel channels at beginning-of-life (BOL) and margin to stuck control rod due to channel bow and bulge remains positive throughout the design life
Fuel channel corners	In-core instrumentation tube	Clearance exists throughout the travel of the instrumentation tube between the fuel channel corners

RAI-18 Clarification:

Table 18.1 of the response shows that the OPTIMA2 and ATRIUM 10XM assemblies have very different flow characteristics (as shown by the differences in pressure and inlet subcooling). The NRC reviewer asked the following clarifying questions:

1. *How will Exelon manage and track flow dynamics and Critical Heat Flux in the mixed cores?*

2. *Please highlight/elaborate on the guidance used in defining the impact on the safety limit minimum CPR determination.*

AREVA Response:

Clarifying Question #1

Table 18.1 shows that the ranges of applicability are different for critical power correlations used for OPTIMA2 and ATRIUM 10XM fuel; particularly for the pressure and inlet subcooling. For all cores (including mixed core configurations), inputs to the codes used to design, license and monitor the core identify the correlation to use in critical power calculations for each fuel assembly. As a result, the critical power correlations are applied on an assembly by assembly basis. This includes checks on the application of the range of applicability of the specific correlation.

Clarifying Question #2

For mixed core configurations of OPTIMA2 and ATRIUM 10XM fuel, two different critical power correlations are used. The SPCB correlation (Reference 4) will be used for the OPTIMA2 fuel and the ACE/ATRIUM 10XM correlation (Reference 5) for the ATRIUM 10XM fuel. The critical power correlations are applied on an assembly by assembly basis in the safety limit minimum CPR analysis. As a result, the ranges of applicability for the critical power correlations are also applied on an assembly by assembly basis.

The core simulator code MICROBURN-B2 is used to model the steady state CPR performance of all the assemblies in the core. Code input identifies the CPR power correlation to use for each assembly. As previously noted, the SPCB correlation will be used for the OPTIMA2 fuel and the ACE/ATRIUM 10XM correlation for the ATRIUM 10XM fuel. The ranges of applicability for the correlations are programmed into the code and checks against the ranges of applicability are made on an assembly by assembly basis. Should a parameter such as mass flux, inlet subcooling, or pressure, fall outside the range of applicability of the correlation for a given assembly, the code is programmed to follow the procedures outlined in Reference 4 Section 2.6 for the SPCB correlation, and Reference 5 Section 5.13 for the ACE/ATRIUM 10XM correlation. The same application and coding of the SPCB and ACE/ATRIUM 10XM correlations are also included in the POWERPLEX core monitoring system. Therefore, the critical power correlations and the associated ranges of applicability are applied on an assembly by assembly basis in the core wide calculations and the core monitoring system.

References

1. ANF-89-98(P)(A), Revision 1 and Supplement 1, "Generic Mechanical Design Criteria for BWR Fuel Designs," Advanced Nuclear Fuels Corporation, May 1995

2. EMF-93-177(P)(A), Revision 1, "Mechanical Design for BWR Fuel Channels," Framatome ANP, August 2005

3. ANP-3305P Revision 1, "Mechanical Design Report for Quad Cities and Dresden ATRIUM 10XM Fuel Assemblies," AREVA Inc., August 2015

4. EMF-2209(P)(A) Revision 3, "SPCB Critical Power Correlation," AREVA NP, September 2009
5. ANP-10298(P)(A) Revision 1, "ACE/ATRIUM 10XM Critical Power Correlation," AREVA, March 2014