An AREVA and Siemens company

ANP-10298Q1NP
Revision 0

ACE/ATRIUM 10XM Critical Power Correlation – RAI's

June 2009

AREVA

ACE/ATRIUM 10XM
Critical Power Correlation – RAI's

Abstract

Responses to RAI questions 2 through 7 with regard to the ACE/ATRIUM 10XM Critical Power Correlation are provided by this document.

Nature of Changes

Item	Page	Description and Justification
1.	All	This is a new document.

Contents

This document contains a total of 41 pages.

Tables

Figures

Nomenclature

Acronym	Definition
CPR	Critical Power Ratio, defined to be the critical power divided by the power of the assembly.
ECPR	Experimental Critical Power Ratio, defined to be the ACE/ATRIUM 10XM calculated critical power divided by the experimentally measured critical power
RAI	Request for additional information

1.0 Introduction

This document provides responses to initial requests for additional information regarding the ACE/ATRIUM 10XM[1], AREVA NP Inc.[2] critical power correlation for the boiling water reactor ATRIUM 10XM fuel design.

[1] ATRIUM is a trademark of AREVA NP Inc. an AREVA and Siemens company registered in the United States and various other countries.

[2] AREVA NP Inc. is an AREVA and Siemens company.

2.0 RAI Question 1

In the December 2008 submittal for the ACE/ATRIUM 10XM correlation, 2309 data points were collected for 24 different assemblies. These data points were taken to represent corner-to-corner coverage of the expected normal and transient operational space of the correlation. In chapter 9 of the same submittal, it is revealed that the actual spacer of the production assembly uses a combination spring/dimple rod bearing surface instead of a total dimple load bearing surface. To demonstrate that the spring/dimple spacer behaves consistently with that of total dimple design, additional tests were conducted. However, only sixty data points were taken. It is not clear to the staff as to how these 60 points can be considered representative of the normal and transient operational range of the correlation. Justify the use of 60 points as an experimental design to provided adequate corner- to-corner coverage of all applicable input parameters, as well as providing appropriate statistical basis for a sound correlation and additive constant uncertainties.

Response:

The response to Question 1 is in preparation and will be submitted at a later date.

3.0 RAI Question 2

Produce a correlation coefficient (Pearson) between input variables and CPR in a format similar to the table below:

Input parameter	Production bundle [ ]	Tested bundle [ ]
Exit pressure		
Inlet subcooling		
Inlet mass		
Power		

Response

The Pearons Coefficients are shown in Q1-6-13. Because questions request information to be added to some of the existing tables, the Table numbering in Reference 1 is retained with a Q1 prefix. New tables will receive new sequential numbers. As shown in the Table, the Pearson Coefficients that are requested are consistent between the validation test STS 112 and the original test STS 109.1A as well as the remainder of the test body.

Table Q1-6-13 Pearson Coefficients

4.0 RAI Question 3

Reproduce Figure 6-1 through 6-6 and superimpose the 60 production bundle points or indicate where these 60 points would have fitted in.

Response

The Figures 6-1 through 6-6 are reproduced in Figures Q1-6-1 through Q1-6-6 and show the validation test data points superimposed on the correlation data base.

Figure Q1-6-1 Calculated vs Measured Critical Power (Defining and STS 112)

Figure Q1-6-2 ECPR as a Function of Mass Flow Rate (Defining and STS 112)

Figure Q1-6-3 ECPR as a Function of Pressure (Defining and STS 112)

Figure Q1-6-4 ECPR as a Function of Inlet Subcooling (Defining and STS 112)

Figure Q1-6-5 ECPR as a Function of Axial Power Shape (Defining and STS 112)

Figure Q1-6-6 ECPR as a Function of K-Factor (Defining and STS 112)

5.0 RAI Question 4

Reproduce Table 6-1 and Tables 6-2 through 6-6 with the counterpart production bundle statistics given in parentheses.

Response

The comparable statistics have been added as requested to the Reference 1 Tables.

Table Q1-6-1 Overall Statistics (Defining)

Table Q1-6-2 Higher Moments of ECPR Mean (Defining)

Table Q1-6-3 Statistics by Binned Mass Flow Rate (Defining)

Table Q1-6-4 Statistics by Binned Pressure (Defining)

Table Q1-6-5 Statistics by Binned Inlet Subcooling (Defining)

Table Q1-6-6 Statistics by Axial Power Shape (Defining)

6.0 RAI Question 5

Provide a statistical analysis showing that the average CPR for the production bundles (versus the tested bundles) is at least as good as that of the tested bundles. Show detailed calculation.

Response:

Statistical methods such as found in Reference 2 provide the characterization sought.

7.0 RAI Question 6

Provide statistics showing that the CPR uncertainty for the production bundles is no larger than that of the tested bundles.

Response:

Statistical methods such as found in Reference 2 provide the characterization sought.

8.0 RAI Question 7

Repeat the last comparisons (items 5 and 6) for each of the following mass flow application bins (binning is made by classification given in table 6-3): 0.0175, 0.025, 0.050, 0.075, 0.100, 0.125, 0.150.

Response:

Statistical methods such as found in Reference 2 provide the characterization sought.

9.0 Summary Table for RAI Questions 5, 6, and 7

Table Q1-6-14 Response Matrix for RAI Questions 5, 6, and 7

The conclusions affirm that the validation test behaves the same as the correlation tests.

10.0 References

1. ANP-10298P ACE/ATRIUM 10XM Critical Power Correlation, December 2008.

2. Experimental Statistics, Handbook 91, M.G. Natrella, 1966 printing, National Bureau of Standards, U.S. Government Printing Office.