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August 31, 2022
NRC:22:014

U.S. Nuclear Regulatory Commission
Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Response to Request for Additional Information for EMF-2310, Revision 1, Supplement 2P, Revision 0, "SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors"

Framatome Inc. (Framatome) requested the NRC's review and approval of the topical report EMF-2310, Revision 1, Supplement 2P, Revision 0, "SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors" in Reference 1. The NRC provided a Request for Additional Information (RAI) in Reference 2. This letter submits a response to the Reference 2 RAI.

Framatome considers some of the material contained in Enclosure 1 to be proprietary. As required by 10 CFR 2.390(b), an affidavit is enclosed to support withholding of information from public disclosure.

There are no regulatory commitments within this letter or its enclosures.

If you have any questions related to this submittal please contact Mr. Morris Byram, Product Manager, Licensing & Regulatory Affairs. He may be reached by telephone at 434-221-1082 or by e-mail at Morris.Byram@framatome.com.

Sincerely,

Gary Peters

Gary Peters, Director
Licensing & Regulatory Affairs
Framatome Inc.

cc: N. Otto
Project 728

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References:

1. Letter NRC-22-004, Gary Peters (Framatome Inc.) to Document Control Desk (NRC), "Request for Review and Approval of EMF-2310, Revision 1, Supplement 2P, Revision 0, 'SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors'," dated February 24, 2022.
2. Letter (email), Ngola Otto (NRC) to Gary Peters (Framatome Inc.), "U.S. NRC Requests for Additional Information Regarding Framatome Topical Report, EMF-2310, Revision 1 Supplement 2P, Revision 0, 'SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors' – EPID L-2022-TOP-0008'," dated July 1, 2022.

Enclosures:

1 EMF-2310, Revision 1, Supplement 2, Revision 0, Q1P, Revision 0 (PROPRIETARY)
2 EMF-2310, Revision 1, Supplement 2, Revision 0, Q1NP, Revision 0 (NON-PROPRIETARY)
3 Affidavit

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SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors

EMF-2310, Revision 1,
Supplement 2, Revision 0
Q1NP, Revision 0

Topical Report

August 2022

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Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

Contents

List of Tables

List of Figures

Nomenclature

Acronym	Definition
CE	Combustion Engineering
CHF	Critical Heat Flux
DNB	Departure from Nucleate Boiling
LOCA	Loss of Coolant Accident
MDNBR	Minimum Departure from Nucleate Boiling Ratio
MSLB	Main Steam Line Break
RAI	Request for Additional Information
SRP	Standard Review Plan
TR	Topical Report

Introduction

Requests for additional information (RAIs) related to Topical Report (TR) Supplement EMF-2310, Revision 1, Supplement 2P, Revision 0 are documented in Reference 1. Responses to these RAIs are provided herein.

1.0 RAI 1

Question:

In Table 2-1, "Range of Application of Thermal Hydraulic Conditions," of the TR, Framatome provided the application domain of the Biasi correlation. [

] Additionally, please discuss how the correlation will be restricted to use in its application domain.

Response:

[

] The original range of application of thermal hydraulic conditions for the Biasi CHF correlation is defined in Reference 3, shown in Table 1-1. The application domain used by Framatome is defined in Table 2-1 of the Topical Supplement, Reference 2. [

]

Table 1-1: Original Biasi Range of Application of Thermal Hydraulic Conditions

Parameter	Units	Minimum Value	Maximum Value
Pressure	ata	2.7	140
	psia	39.7	2057
Mass Flux	g/sec-cm2	10	600
	Mlbm/hr-ft2	0.0737	4.424
Quality In	Fraction	n/a	0
Quality Out	Fraction	$\frac{1}{1+\rho_l/\rho_g}$	1

Table 1-2: Updated Biasi Range of Application of Thermal Hydraulic Conditions

[

]

In the Table 2-1 of the Topical Supplement, Reference 2, the minimum mass flux value was defined to be [

]

Figure 7-3 in the Topical Report Supplement, Reference 2, shows the relationship between the mass flux and the Correlation Acceptance Criteria (CAC). The CAC is defined in the Topical Report Supplement, Reference 2. [

]

Figure 1-1 and Figure 1-2 show the mass flux with respect to quality and pressure, respectively. [

]

Figure 1-1 Data Domain –Quality vs. Mass Flux

Figure 1-2 Data Domain – Mass Flux vs. Pressure

Figure 1-3 comes from Figure 2-1 in the Topical Report Supplement, Reference 2, with the addition of the original Biasi range of application and the Framatome application domain explicitly shown. [

]

Figure 1-3 Design Limit Application Range and Associated Penalties

[

]

With regard to restricting the use of the correlation to its application domain, Figure 1-3, it is standard practice for the analyst to check the application limits of the CHF correlation being used. Additionally, it is standard practice to implement error checking in the code and for the analyst to check for these warnings for the CHF correlation being applied outside of the allowed application domain.

Due to RAI 1 resolution, the following updates were made to the EMF-2310 Supplement 2P Topical Report (Shown in Section 6.0 of this document):

[
]

2.0 RAI 2

Question:

Framatome has indicated plans to use the Biasi correlation in [

]

Response:

A similar argument may be made as is provided for the ORFEO-GAIA and ORFEO-NMGRID CHF correlations in the response to RAI-SNPB-09 from Reference 4. The local quality is dependent on the pressure, mass flux, inlet subcooling, and bundle power. [

]

[

Figure 2-1: Test Data Domain – Pressure vs. Quality (2, Figure 4-2), With MSLB Statepoints

[

]

Table 2-1: MSLB Statepoints with DNB Margin Comparison

[ ]

3.0 RAI 3

Question:

Please discuss why the [

]

Response:

The COBRA-FLX code was initially used to take advantage of existing automation for data manipulation and design limit analysis of the CHF data. Using the Biasi correlation within the XCOBRA-IIIC code minimizes changes to the internal analytical processes and licensing bases of existing customers.

[

]

Figure 3-1: Unpenalized XCOBRA-IIIC and COBRA-FLX CAC Comparison

4.0 RAI 4

Question:

Please provide the technical basis and justification for the Minimum DNB ratio (MDNBR) correlation factor for CE 14x14 and CE 16x16 fuel discussed in Table 7-5, "MDNBR Correction Factor," of the TR.

Response:

The following methodology was used for calculating the Biasi geometry correction factor for assembly-based CHF calculations. The Biasi Correlation is given by the following equations (Reference 3):

$$\Phi_0 = \frac{1.883 \cdot 10^3}{D^{\alpha} \cdot G^{\frac{1}{6}}} \left[\frac{y(P)}{G^{\frac{1}{6}}} - X_0 \right] \text{ for low quality cases}$$

$$\Phi_0 = \frac{3.78 \cdot 10^3 \cdot h(p)}{D^{\alpha} \cdot G^{0.6}} [1 - X_0] \text{ for high quality cases}$$

Where

$$\frac{1}{1 + \frac{e_l}{e_g}} < X_0 < 1$$

$$y(P) = 0.7249 + 0.099P \cdot \exp(-0.032 \cdot P)$$

$$h(P) = -1.159 + 0.149P \cdot \exp(-0.019 \cdot P) + \frac{8.99 \cdot P}{10 + P^2}$$

[ ]

A conservative assessment of the impact of the hydraulic diameter term is to take the ratio of [ ] for the sub-channel to that of the assembly to calculate a Correction Factor (shown below) [ ]

[ ]

The pertinent geometric parameters are shown in the Table 4-1 below. These are used for the correlation factors for CE 14x14 and CE 16x16 fuel discussed in Table 7-5, "MDNBR Correction Factor," of Reference 2 because they are the most conservative correction factors found from the analysis.

Table 4-1: Correction Factors for CE 14 and CE 16 Fuel Types

5.0 REFERENCES

1. NRC Letter (email), "Request for Additional Information Regarding Framatome Inc. Topical Report EMF-2310, Revision 1, Supplement 2P, Revision 0, 'SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors' (EPID: L-2022-TOP-0008)," July 1, 2022.
2. EMF-2310, Revision 1, Supplement 2P, Revision 0, "SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors," February 2022.
3. "Studies on Burnout, Part 3 - A New Correlation for Round Ducts and Uniform Heating and its Comparison with World Data," L. Biasi et al., *energia nucleare*, vol. 14, n. 9, September 1967.
4. ANP-10341P-A, Revision 0, The ORFEO-GAIA and ORFEO-NMGRID Critical Heat Flux Correlations, Framatome Inc., September 2018.

6.0 TOPICAL REPORT CHANGES

Due to RAI resolution, markups to EMF-2310 Supplement 2P were required. To facilitate an efficient review, changes to the Topical Report Supplement are provided below.

Table 2-1: Range of Application of Thermal Hydraulic Conditions

[ ]

Figure 2-1: Design Limit Application Range and Associated Penalties

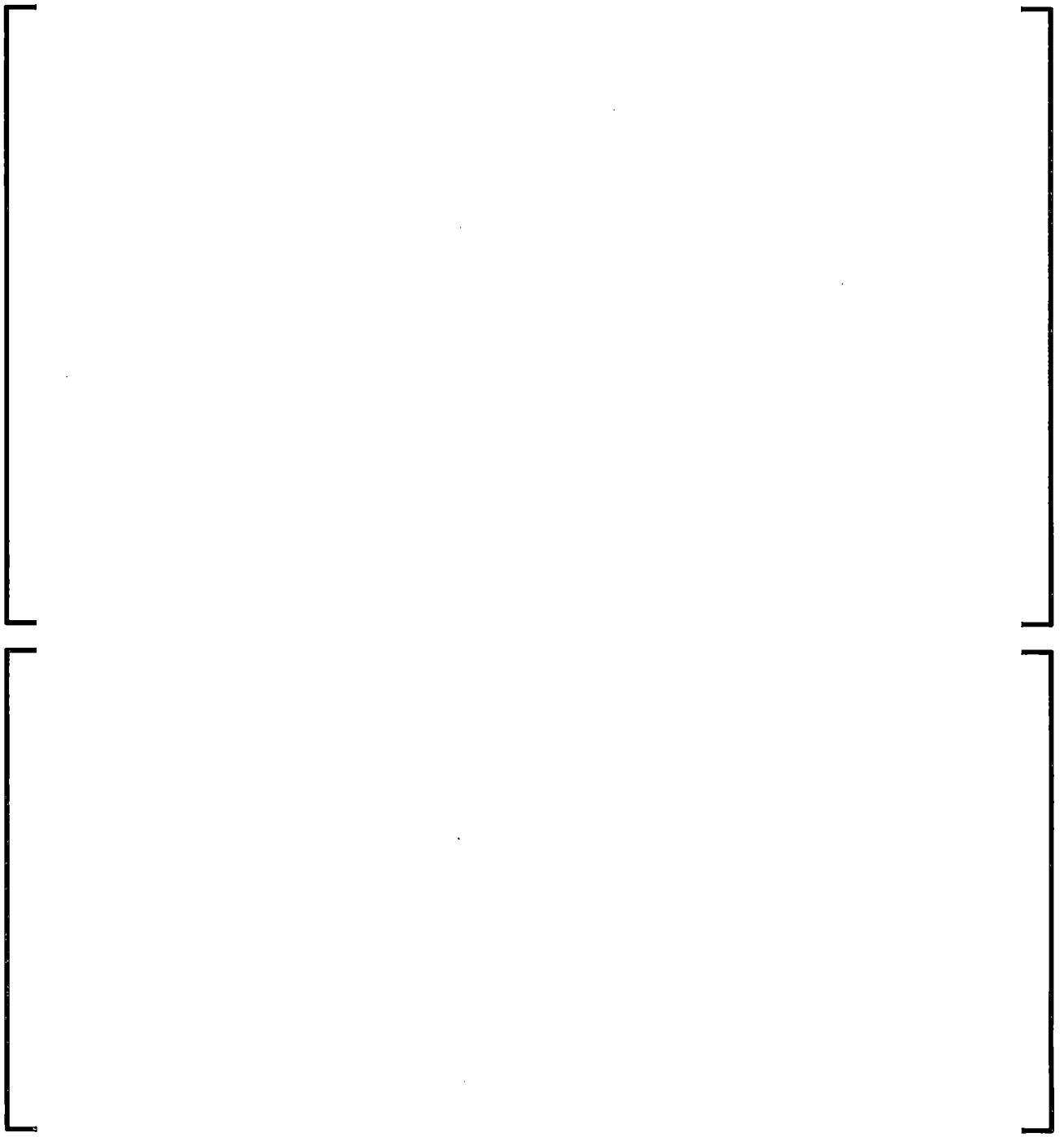


Figure 4-1: Test Data Domain – Pressure vs. Mass Flux

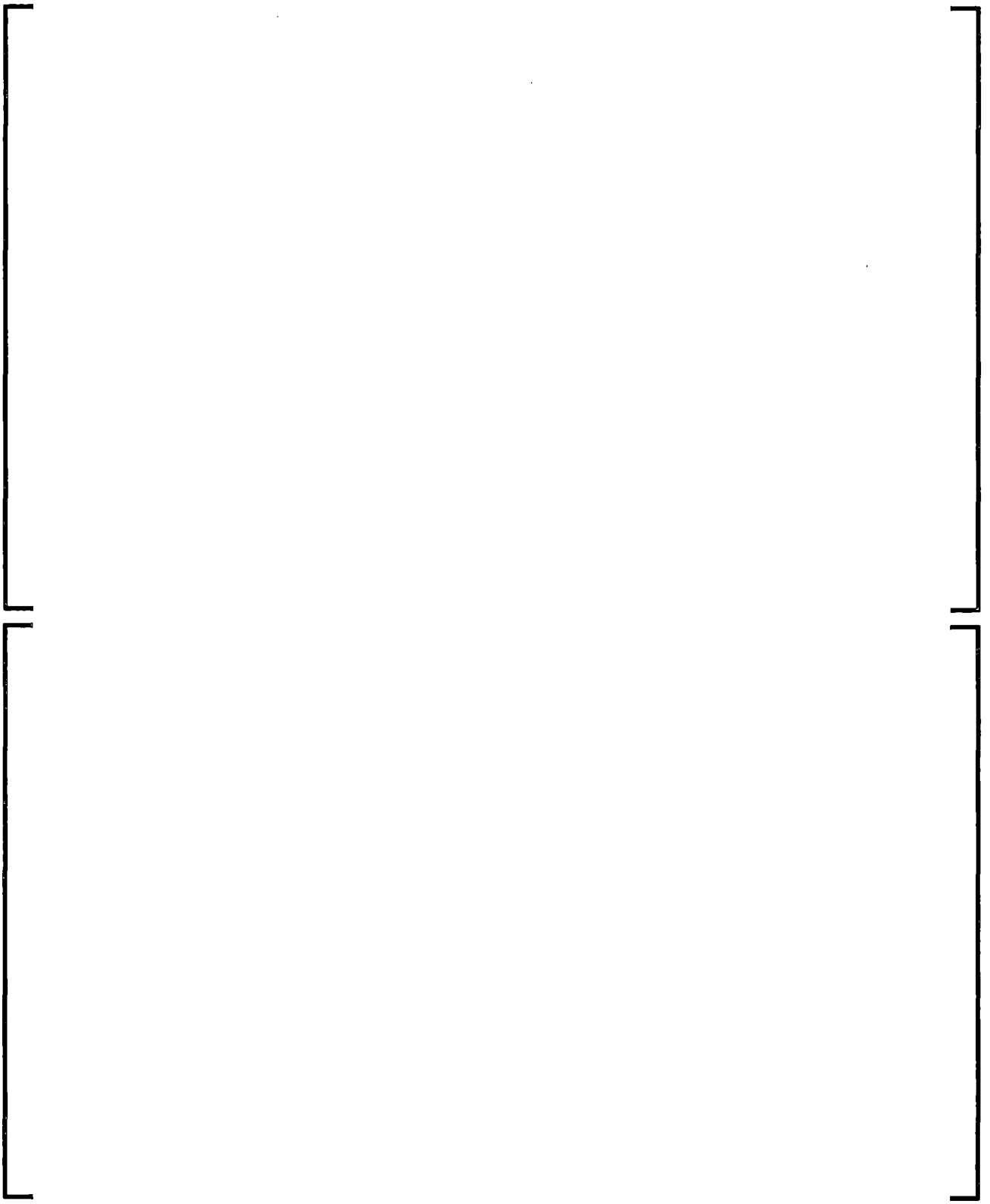
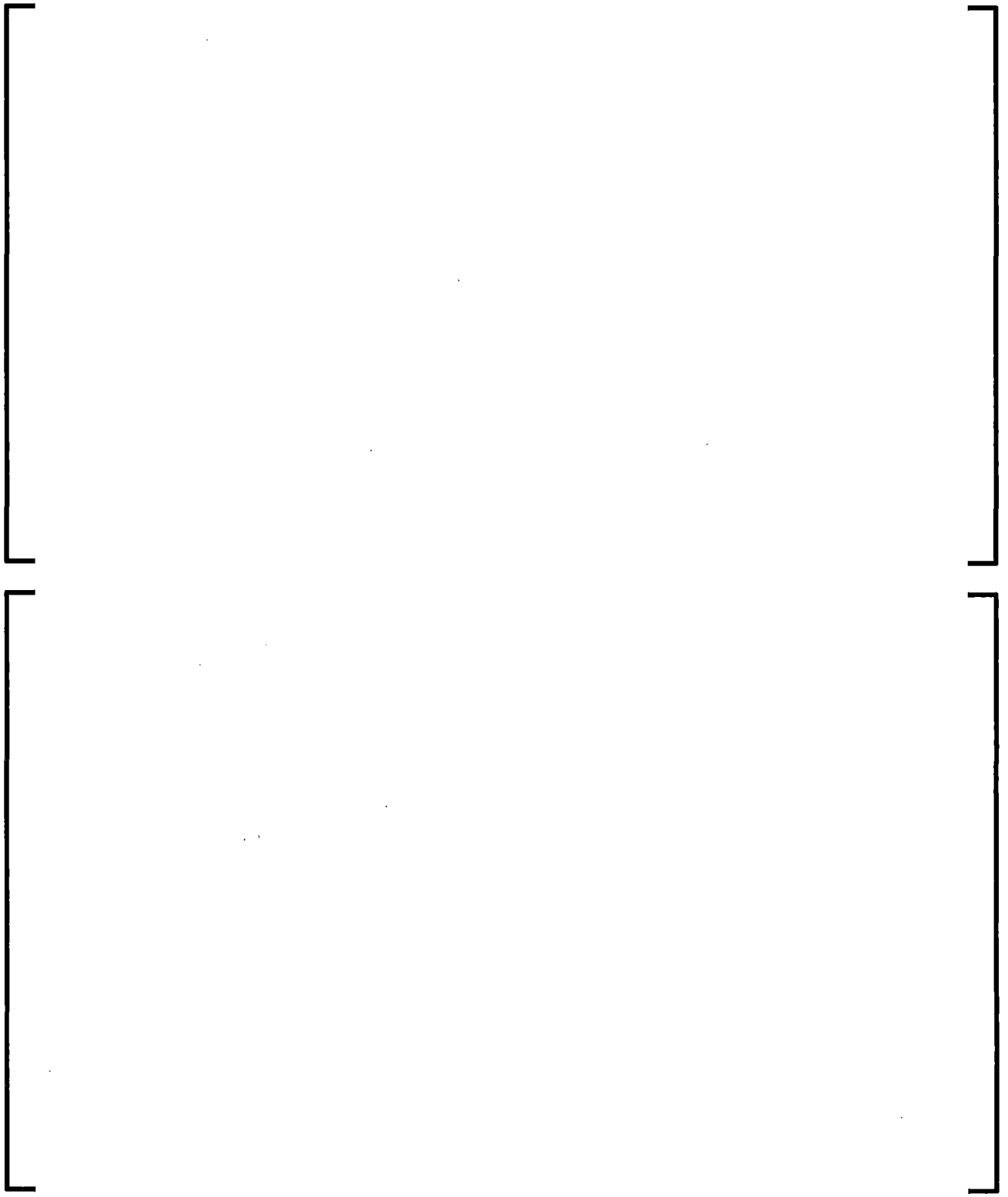


Figure 4-3: Test Data Domain – Mass Flux vs. Quality



AFFIDAVIT

1. My name is Morris Byram. I am Product Manager, Licensing & Regulatory Affairs for Framatome Inc. (Framatome) and as such I am authorized to execute this Affidavit.

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

3. I am familiar with the Framatome information contained in the topical report EMF-2310, Revision 1, Supplement 2P, Revision 0, Q1P, Revision 0, entitled "SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors" and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome 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 Framatome 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 Framatome to determine whether information should be classified as proprietary:

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

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

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

The information in this Document is considered proprietary for the reasons set forth in paragraph 6(c) and 6(d) above.

7. In accordance with Framatome'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 Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome 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.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: (8/31/2022)

BYRAM Morris Digitally signed by BYRAM Morris
Date: 2022.08.31 12:14:41 -07'00'

(NAME)