FRAMATOME ANP

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FRAMATOME ANP, Inc.

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Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Response to a Request for Additional Information regarding EMF-2103(P) Revision 1, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors"

Ref.: 1. Letter, James F. Mallay (Framatome ANP) to Document Control Desk (NRC), "Request for Review and Approval of EMF-2103(P) Revision 1, 'Realistic Large Break LOCA Methodology for Pressurized Water Reactors'," NRC:04:027, August 9, 2004.

Framatome ANP requested NRC review and approval of the topical report EMF-2103(P) Revision 1, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors," in Reference 1. A request for additional information was provided by the NRC in an e-mail on November 4, 2004. The questions and responses are provided in Attachment A to this letter.

Very truly yours,

Jerald S Holm for

James F. Mallay, Director
Regulatory Affairs

Enclosure

cc: M. C. Honcharik
Project 728

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Attachment 1

Question 1: *Provide the following scatter plots of operational parameters (similar to those provided in Appendix D of EMF-2103(P) Revision 0) for the reference case:*

(a) *containment volume*

(b) *containment gas temperature*

Appendix H should be revised to include this information.

Response 1: The requested information is provided in Figures 1 and 2. These figures will be added to Appendix H, or, alternatively, with the similar figures appearing in Appendix D, when the approved version of EMF-2103 Revision 1 is issued. Statements referring to these figures and recognizing the absence of any observable correlation to PCT will be added to section H.2.3.

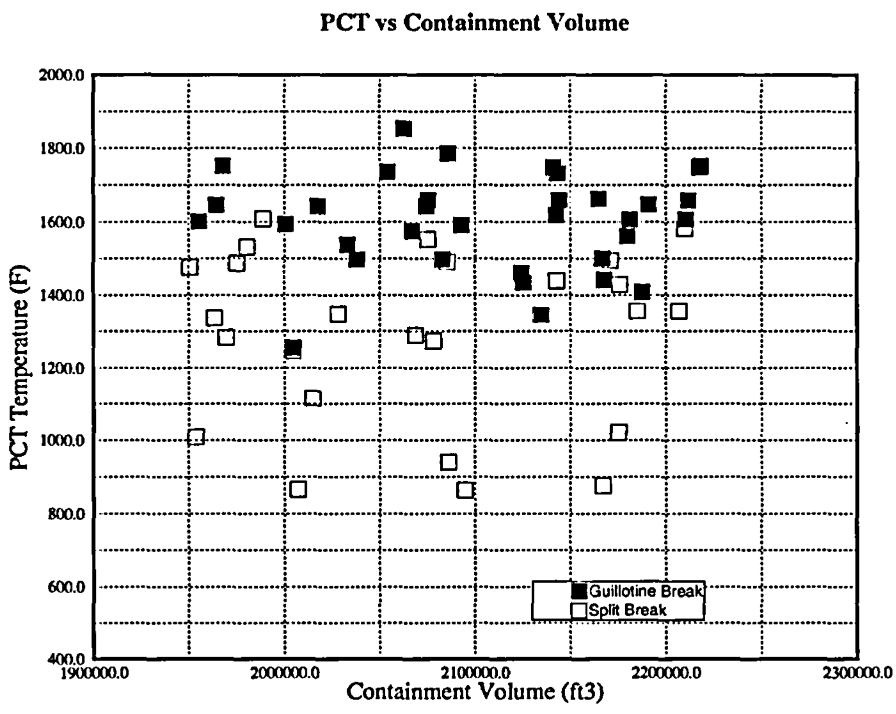

Figure 1 Containment Volume Sampling Scatter Plot for 3-Loop Sample Problem

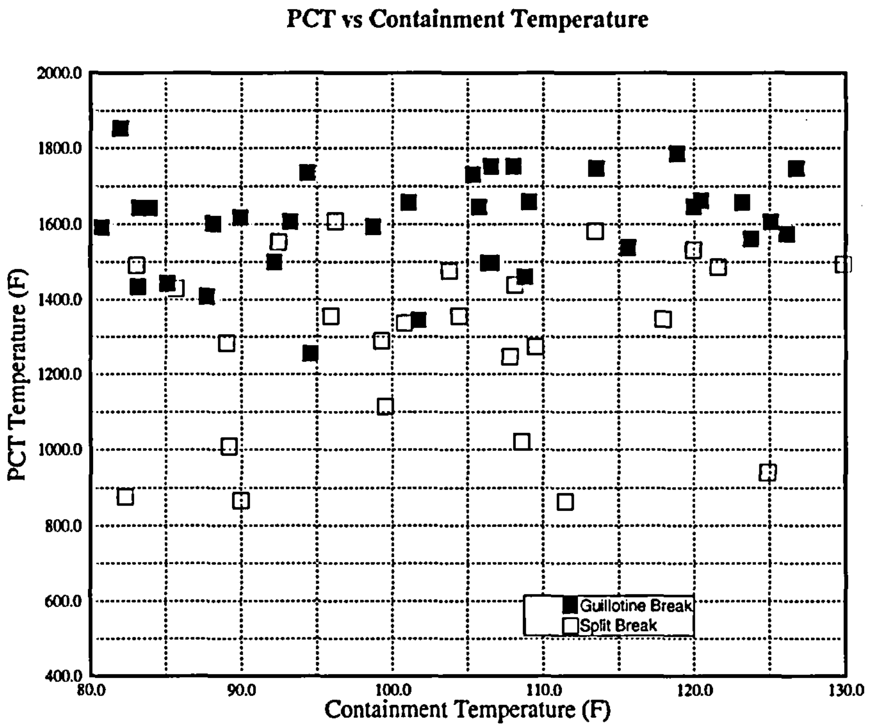

Figure 2 Containment Temperature Sampling Scatter Plot for 3-Loop Sample Problem

Question 2: *Provide the following PCT scatter plots of operational parameters (similar to those provide in Section 5 of EMF-2103(P) Revision 0) for the reference case:*

(a) *containment volume*

(b) *containment gas temperature*

Appendix H should be revised to include this information

Response 2: The requested information is provided in Figures 3 and 4. These figures will be added to Appendix H or, alternatively, with the similar figures appearing in Section 5, when the approved version of EMF-2103 Revision 1 is issued. Statements referring to these figures and recognizing the absence of any observable correlation to PCT will be added to section H.2.3.

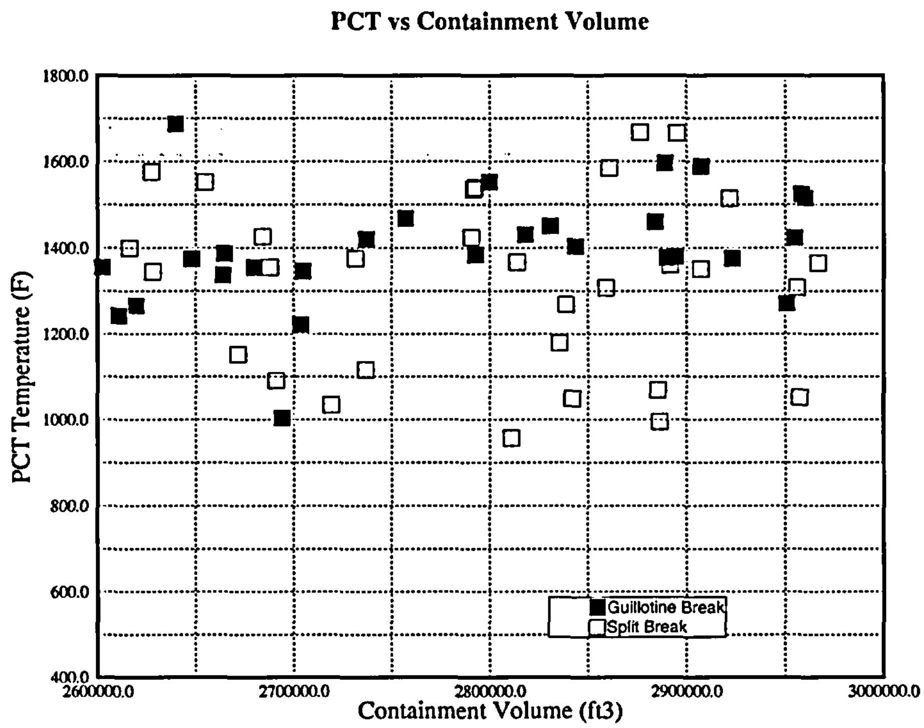

Figure 3 Containment Volume Sampling Scatter Plot for 4-Loop Sample Problem

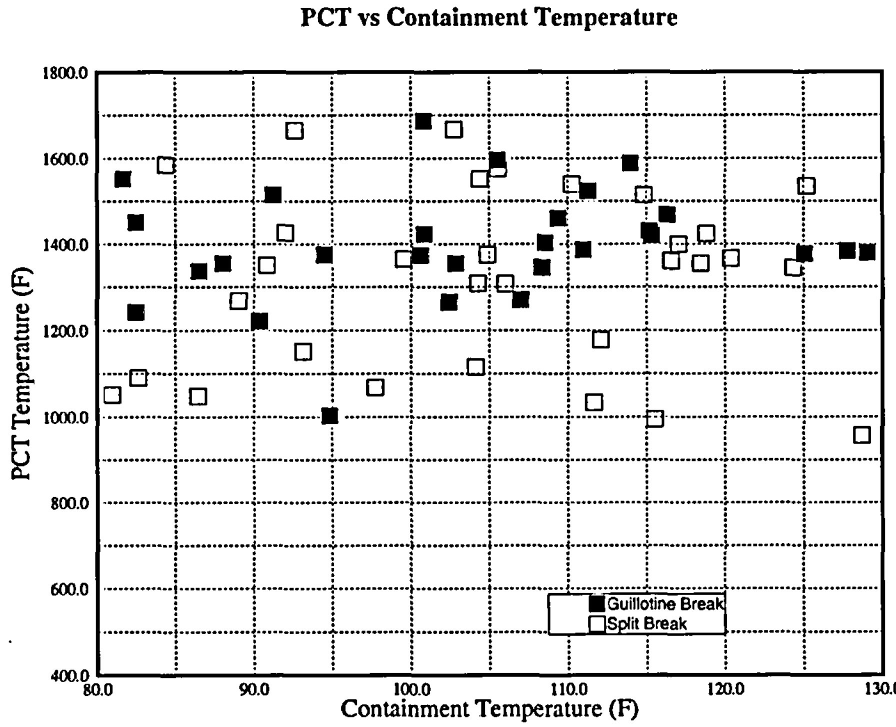

Figure 4 Containment Temperature Sampling Scatter Plot for 4-Loop Sample Problem

Question 3: *In Section H.2.1, "Passive Heat Sinks - Uchida Model," it is stated that the FANP realistic large-break LOCA (RLBLOCA) guidelines require a benchmark analysis against either a best-estimate containment analysis or a minimum containment pressure calculation. The purpose of the benchmark is to establish a reference multiplier for the Uchida model.*

It is expected the current FSAR minimum containment pressure calculations are based on methods very similar to ICECON.

(a) *Provide a definition for a best-estimate containment analysis as compared to a minimum containment pressure calculation, including all inputs and modeling assumption differences (for example, passive heat structures, temperature distributions and heat and mass transfer correlations). Would this calculation be based on a computer model other than ICECON, and possibly include multi-node modeling?*

(b) *Based on the argument provided that the Uchida model, which is based on bulk fluid conditions, is a best-estimate model, wouldn't the value be pre-determined to be 1.0? Or, is the use of ICECON as part of the RLBLOCA methodology with its inherent capabilities a limitation in which case the Uchida multiplier is used to address the difference between the best-estimate model and code calculation and the ICECON model and code calculation?*

(c) *Would having the capability to perform a best-estimate containment response calculation remove the need to address some inputs and assumptions in a conservative manner? If so, identify these changes.*

(d) *The reference case, which appears to be based on a sub-atmospheric design, is well behaved - the Uchida multiplier is a single value with the ICECON pressure prediction being always below the benchmark system pressure response, and generally within about 2 psi through the core reflood period. How will FANP address a situation where the Uchida multiplier for ICECON would not be as well behaved? For example, the early response being over-predicted with the latter response (post blowdown, pre-reflood) being under-predicted. Or, to under-predict the early response, the latter response is significantly under-predicated? Does the guideline require a continuous ICECON under-prediction when benchmarked against the system pressure response?*

Response 3a: Framatome ANP's definition of a best-estimate or realistic containment analysis is consistent with Regulatory Guide 1.157, that is, an analysis represented by a spectrum of mixed best-estimate and conservative, yet realistic, model treatments. This is the context in which the containment model was original presented to and approved by the NRC. For performing the RLBLOCA containment model benchmark, the definition of a best-estimate containment analysis is further refined to one that is performed by applying models and methods that have been reviewed and accepted by the NRC for best-estimate containment calculations. The best-estimate benchmark should include all of the phenomenological and active system processes that would be expected to occur within the containment during a LBLOCA. The model uncertainty is addressed by evaluating a bias (i.e., a multiplier applied to the Uchida correlation) relative to the benchmark solution. The purpose of the benchmark is to determine this bias.

Generally, Framatome ANP does not have control over the original containment pressure calculations used in benchmarks, such as would occur as a result of a fuel vendor transition. Likely, ICECON-type codes will have been used; but, it is conceivable that a more sophisticated code like GOTHIC could be used, as well. Nonetheless, the benchmark solution will either be an accepted best-estimate or a minimum containment pressure calculation. The RLBLOCA containment model will apply the model parameters as presented in Table H.1 for the actual RLBLOCA uncertainty analysis regardless of whether the benchmark is a best-estimate calculation or a minimum pressure calculation.

Response 3b: Framatome ANP doesn't consider the use of the ICECON models within S-RELAP5 a RLBLOCA EM limitiation. The Uchida correlation used in the containment models in S-RELAP5 replaces the Tagami-Uchida correlation in the original ICECON code. This is discussed in section H.2.1. The multiplier was originally derived to equate or tune the Uchida correlation to the implementation of Tagami-Uchida in the standalone ICECON code, thus preserving the relationship between the approved ICECON models and the implementation of these models in the S-RELAP5 code. Similarly, the calculation of a multiplier on the Uchida correlation based on other accepted models is considered to be a functionally equivalent approach. It has been Framatome ANP experience that this procedure is plant-specific. Framatome ANP recognizes that the Uchida correlation without enhancement represents a best-estimate model (also presented in Section H.2.1). Multipliers greater than 1.0 are considered conservative and evidence of the conservative bias inherent in this approach.

Response 3c: Yes, consistent with the statements in Regulatory Guide 1.157, the Framatome ANP RLBLOCA methodology uses best-estimate system specifications "provided their technical basis is demonstrated with appropriate data and analysis." Certainly, bounding values adequately address containment response uncertainties and remain acceptable. Table H.1 identifies a set of parameters (under "Active Heat Sinks") that may be treated either nominal or bounding. As stated in the footnote to Table H.1, nominal values are acceptable "if sufficient justification can be developed." This statement implies the use of plant operational data to calculate the nominal condition and associated uncertainties. This information is often not readily available; however, bounding values are always available; hence, from a cost standpoint the bounding values are often the more practical option. It is Framatome ANP's expectation that some utility customers have or will develop technical bases which may allow best-estimate specifications for these containment parameters used in a RLBLOCA analysis.

A corollary for when best-estimate specification is acceptable is the case when a set of idealized or bounding conditions cannot physically coexist. An example is the RWST temperature. Framatome ANP specifies RWST temperature for both ECCS safety injection and containment spray temperatures. Because the reduction of subcooling in safety injection coolant has a greater impact on clad temperature than the impact of reduced containment pressure from more effective sprays, the specification of both of these parameters would be set to the safety injection coolant temperature value.

Response 3d: The RLBLOCA methodology does not require a continuous under prediction when the S-RELAP5 containment pressure calculation is benchmarked against containment pressure. The Uchida multiplier is used to adjust the containment pressure as calculated with S-RELAP5. The criterion for an acceptable comparison is that the containment pressure calculated by S-RELAP5 be less than +1 psi above that calculated by the benchmark.

It is conceivable, although not likely, that the ICECON-based models used in S-RELAP5 could have difficulty in predicting well-behaved responses relative to a particular benchmark case. For the LBLOCA event the important time period for containment response occurs after the blowdown phase when flow at the break plane unchokes, typically around 20 s for limiting large breaks. The latest time that containment pressure could possible have any impact would occur at the time following PCT when the time clad temperatures drop below 1700 °F. The 1700 °F value is a sufficient threshold at which significant oxidation is no longer possible. At a minimum the model benchmark requires explicit coverage of containment pressure uncertainty over the time period following blowdown to the time during cooldown when the maximum clad temperatures drop below 1700 °F.