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AUG 15 2007

U. S. Nuclear Regulatory Commission
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SUSQUEHANNA STEAM ELECTRIC STATION PROPOSED LICENSE AMENDMENT NO. 285 FOR UNIT 1 OPERATING LICENSE NO. NPF-14 AND PROPOSED LICENSE AMENDMENT NO. 253 FOR UNIT 2 OPERATING LICENSE NO. NPF-22 EXTENDED POWER UPRATE APPLICATION RE: REACTOR SYSTEMS TECHNICAL REVIEW REQUEST FOR ADDITIONAL INFORMATION RESPONSES **Docket Nos. 50-387**
PLA-6264 **and 50-388**

References: 1) PLA-6076, B. T. McKinney (PPL) to USNRC, "Proposed License Amendment Numbers 285 for Unit 1 Operating License No. NPF-14 and 253 for Unit 2 Operating License No. NPF-22 Constant Pressure Power Uprate," dated October 11, 2006.

2) Letter, R. V. Guzman (NRC) to B. T. McKinney (PPL), "Request for Additional Information (RAI) - Susquehanna Steam Electric Station, Units 1 and 2 (SSES 1 and 2) - Extended Power Uprate Application Re: Reactor Systems Technical Review (TAC Nos. MD3309 and MD3310)," dated August 1, 2007.

Pursuant to 10 CFR 50.90, PPL Susquehanna LLC (PPL) requested in Reference 1 approval of amendments to the Susquehanna Steam Electric Station (SSES) Unit 1 and Unit 2 Operating Licenses (OLs) and Technical Specifications (TSs) to increase the maximum power level authorized from 3489 Megawatts Thermal (MWt) to 3952 MWt, an approximate 13% increase in thermal power. The proposed Constant Pressure Power Uprate (CPPU) represents an increase of approximately 20% above the Original Licensed Thermal Power (OLTP).

The purpose of this letter is to provide responses to the Request for Additional Information transmitted to PPL in Reference 2.

The Attachments contain the PPL responses.

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Attachment 1 contains AREVA NP, Inc. proprietary information. As such, AREVA NP, Inc. requests that it be withheld from public disclosure in accordance with 10 CFR 2.390 (a) 4 and 9.17 (a) 4. The Affidavit supporting this request is contained in Attachment 3. Attachment 2 contains a non-proprietary version of the responses. Attachment 4 contains the report requested in NRC Question 1F.

There are no new regulatory commitments associated with this submittal.

PPL has reviewed the "No Significant Hazards Consideration" and the "Environmental Consideration" submitted with Reference 1 relative to the Enclosure. We have determined that there are no changes required to either of these documents.

If you have any questions or require additional information, please contact Mr. Michael H. Crowthers at (610) 774-7766.

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

Executed on: 8/15/2007

for B.T. McKinney

B. T. McKinney

Attachment 1: Proprietary Version of the Request for Additional Information Responses
Attachment 2: Non-Proprietary Version of the Request for Additional Information Responses
Attachment 3: AREVA NP, Inc. Affidavit
Attachment 4: XN-NF-80-19 (P)(A) Vol.2, 2A, 2B and 2C

Copy: NRC Region I
Mr. R. V. Guzman, NRC Sr. Project Manager
Mr. R. R. Janati, DEP/BRP
Mr. F. W. Jaxheimer, NRC Sr. Resident Inspector

Attachment 2 to PLA-6264
Non-Proprietary Version of the Request for Additional Information Responses

Introduction

The NRC provided a request for additional information (RAI) to support the Susquehanna Constant Pressure Power Uprate (CPPU) application. Based on AREVA NP[2] input, PPL provided responses to the NRC in Letter, B. T. McKinney (PPL) to U.S. Nuclear Regulatory Commission, PLA-6250, dated July 30, 2007. This response included the results for a LOCA with a break size of 0.05 ft^2 and other break conditions specified by the NRC. On August 1, 2007, the NRC staff identified follow-up questions regarding the modeling for countercurrent flow (CCFL) and timing during the 0.05 ft^2 break.

The NRC reviewers indicated they are interested in the AREVA CCFL models and AREVA results for small breaks because the Peak Cladding Temperatures (PCTs) calculated for small breaks with codes and models being developed by the NRC are higher than calculated with the NRC-approved AREVA EXEM BWR-2000 methodology. The primary purpose of plant and fuel type specific LOCA analyses is to demonstrate that the 10 CFR 50.46 acceptance criteria are satisfied. It is expected that different LOCA methodologies will have different levels of conservatism for different break sizes. As a result, it is expected that different approved methods, while still predicting an overall conservative PCT, may predict different break sizes as limiting. This is part of the basis for requiring a break spectrum instead of selecting a single break case that has been determined to be limiting for a particular plant.

NRC Question 1:

Counter-current flow limitation (CCFL) model: In Figure A.27 of the SSES 1 and 2, July 30, 2007, response, the hot rod peak clad temperature (PCT) curve drops at about 12 seconds after the low pressure core spray (LPCS) starts. It appears that the top spray cooling from LPCS dominates over a bottom reflood cooling effect, such that the CCFL effect is not obvious. Please justify the CCFL model and spray heat transfer.

NRC Question 1(A)

Provide the reference and/or description of the models governing CCFL at the exit to the hot bundle/core. Also, identify the reference that describes the validation (separate effects and integral test data comparisons) of the CCFL limit model governing top down cooling in rod bundles.

PPL Response 1(A):

In the NRC-approved AREVA NP EXEM BWR-2000 methodology, CCFL is calculated for the average core and hot channel regions independently using the Kutateladze

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

correlation (Reference A.1). The Ohkawa-Lahey Drift Flux Model (Reference A.2) is used to calculate two-phase slip at junctions in the fuel bundle and collapses to the Kutateladze formulation at the CCFL limit. In the Safety Evaluation Report for XN-NF-80-19(P) (A) (Reference A.3) the NRC places the following restriction on AREVA concerning the use of CCFL correlations.

> *The CCFL Models and coefficients used to predict spray water entry to the core region and by-pass drainage to control rod guide tube region in FLEX have been amply supported by results of experimental studies conducted by ENC in their FCTF test facility. Application of the model to specific fuel designs will, however, require justification of CCFL correlation coefficients used if designs vary from the measured test configurations.*

AREVA tests new fuel designs to demonstrate that the Kutateladze correlation coefficients are applicable to the fuel design. The CCFL test data generated by AREVA for ATRIUM™-10 fuel (ATRIUM is a trademark of AREVA NP) is compared to the CCFL predicted by Kutateladze in Figures A.1 and A.2. The testing justifies continued use of the current Kutateladze correlation coefficients to predict countercurrent flow in ATRIUM-10 fuel.

NRC Question 1(B)

Provide plots of the liquid and vapor velocities at the exit to the core average and hot bundle regions. Also, mass flow into the hot bundle.

PPL Response 1(B):

Figures A.3 and A.4 show the RELAX system and hot channel nodalization for Susquehanna. The nodalization is included as a reference for the locations of the nodal and junction data presented in the Figures which follow.

The requested liquid and vapor velocity plots are provided in Figures A.5 – A.8. The definition of superficial velocity used here is the velocity an individual phase would have if the entire flow region were filled with the selected phase at the predicted volumetric flow rate for that phase.

The mass flow into the hot bundle from the lower plenum (Junction 1) and the mass flow out of the hot bundle to the upper plenum (Junction 10) are shown in Figure A.9.

NRC Question 1(C)

Provide the liquid levels and two phase levels in the core average and hot bundle regions.

PPL Response 1(C):

The requested data is not available since the core volumes are homogeneous nodes. However, in response to the NRC request, the liquid mass in each of the core average and hot bundle core nodes is provided in Figures A.10 and A.11. These figures illustrate how liquid moves through the core average and hot bundle core nodes during the LOCA.

NRC Question 1(D)

Provide the limiting top skewed axial power shape used in the SBLOCA analyses.

PPL Response 1(D):

The break conditions requested by the NRC include a top skewed axial power shape and a core flow of 108 Mlb/hr. The axial power shape for these conditions is shown in Figure 4.5 of Reference A.4. Reference A.4 was provided to the NRC in Reference A.5.

NRC Question 1(E)

Provide the steam and liquid velocities at the inlet and outlet to the core bypass region.

PPL Response 1(E):

The requested plots are provided in Figures A.12 – A.15.

NRC Question 1(F)

Provide the reference, XN-NF-80-19 (P)(A) Vol.2, 2A, 2B and 2C.

PPL Response 1(F):

XN-NF-80-19 (p)(a) Vol.2, 2A, 2B and 2C is provided in Attachment 4.

NRC Question 2:

Perform and provide the results from the same 0.05 ft2 SBLOCA analysis using a conservative bottom up reflooding of the hot bundle (i.e., no top down cooling from the core spray entering the top of the bundle from the upper plenum).

PPL Response 2:

[

] To accommodate the NRC request, however, the same SBLOCA analysis was repeated with the modification that the injection of LPCS was moved from the upper plenum (node 1 in Figure A.3) to the bypass (node 9 in Figure A.3). This allowed for the injection of water from the LPCS, which is needed to refill the lower plenum, without LPCS being available for CCFL into the core. Review of the results confirmed there was no top-down cooling from liquid entering the top of the bundle from the upper plenum after the time when LPCS flow starts (the LPCS did not fill the bypass and then flow into the upper plenum).

The PCT for this analysis is 1460°F.

Moving the LPCS injection and the associated absence of liquid water in the upper plenum may alter the system response in ways that are not directly related to the absence of countercurrent flow at the core outlet. Additionally, it should be recognized that moving the LPCS injection results in a model that no longer reflects the ECCS configuration of the Susquehanna plant. Nonetheless, injection of LPCS into the bypass instead of the upper plenum is the closest modeling achievable to the requested analysis that is possible without RELAX code modifications.

Since LPCS is injected into the upper plenum and the AREVA CCFL model has been shown by testing to be applicable for ATRIUM-10 fuel, the result obtained using the approved methodology (PCT = 1296°F) is a more appropriate result for these break conditions.

NRC Question 3:

The heat up period before the safety injection is expected to be longer than shown in the SSES 1 and 2 limiting node quality plot (Figure A.24). Additionally, the quality stays lower than expected (about 0.06) for about 110 seconds (365 seconds to 475 seconds) before the heat up, and the heat up time before LPCS starts is about 83 seconds. It is expected that the heat up would be significantly longer and thus, the PCT would be higher than reported in the SSES 1 and 2 analyses. Since it is a top-peaked profile, the quality (void fraction) before heat up seems to be low and heat up time seems to be short. Please provide justification for the low limiting node quality and the short heat up time. If this is related to the modeling of LPCS cooling and CCFL, include this reasoning in your justification.

PPL Response 3:

The references in this response are provided following the response.

The decrease in the limiting node quality at about 365 seconds is in response to the rapid system depressurization resulting from opening the ADS valves at 355.7 seconds. The lower plenum begins to flash at 360.2 seconds. As illustrated in Figure A.16, opening the ADS valves caused the liquid mass in upper core nodes to increase (nodes 7, 8, 9, and 10). The decrease in the limiting node quality is due to the increase in the liquid mass in the node. The increase in liquid mass in the upper nodes results from the level swell associated with rapid system depressurization.

Figure A.27 in Reference A.6 shows the heatup initially began just before ADS opened but the cladding temperature decreased in response to the improved heat transfer when the ADS valves opened (refer to Figure A.25 in Reference A.6).

Figure A.17 shows the flow into and out of the limiting node in the hot bundle. This shows that there is upward flow through the limiting node until the second heatup begins at about 475 seconds. This is similar to the flow into and out of the hot bundle previously shown in Figure A.9. The upward flow is maintained by steam generation in the lower plenum and lower core as the system continues to blow down through the ADS valves.

References:

A.1 K. H. Sun and R. T. Fernandez, "Countercurrent Flow Limitation Correlation for BWR Bundles During LOCA," ANS Transactions, Volume 27, pp. 605-606, 1977.

A.2 K. Ohkawa and R.T. Lahey Jr., "The Analysis of Proposed BWR Inlet Flow Blockage Experiments in PBF," NES-486, Rensselaer Polytechnic Institute, Troy, NY, December 1978.

A.3 XN-NF-80-19(P)(A) Volumes 2, 2A, 2B, and 2C, *Exxon Nuclear Methodology for Boiling Water Reactors EXEM BWR ECCS Evaluation Model*, Exxon Nuclear Company, September 1982.

A.4 EMF-3242(P) Revision 0, *Susquehanna LOCA Break Spectrum Analysis for ATRIUM™-10 Fuel and Extended Power Uprate*, AREVA NP, November 2005.

A.5 Letter, B. T. McKinney (PPL) to U. S. Nuclear Regulatory Commission, PLA-6155, February 13, 2007.

A.6 Letter, B. T. McKinney (PPL) to U. S. Nuclear Regulatory Commission, PLA-6250, July 30, 2007.

Figure A.1 ATRIUM-10 Upper Tie Plate CCFL Test Data Compared to Kutateladze Correlation

Figure A.2 ATRIUM-10 Spacer CCFL Test Data Compared to Kutateladze Correlation

Figure A.3 RELAX LOCA System
Nodal Diagram

Figure A.4 RELAX Hot Channel Nodal Diagram for Top-Peaked Axial

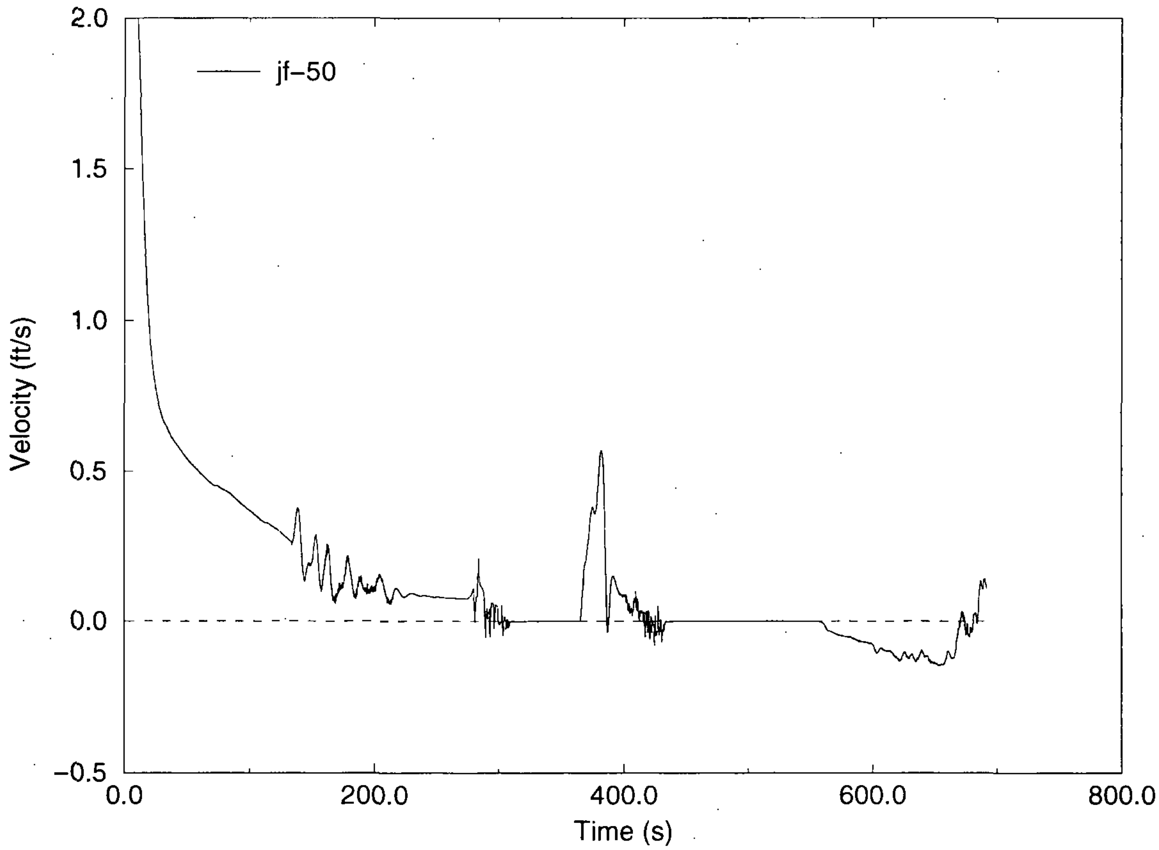

Figure A.5 Liquid Velocity at Exit of Average Core
0.05 FT2/PD SF-BATT TOP 108F CPPU

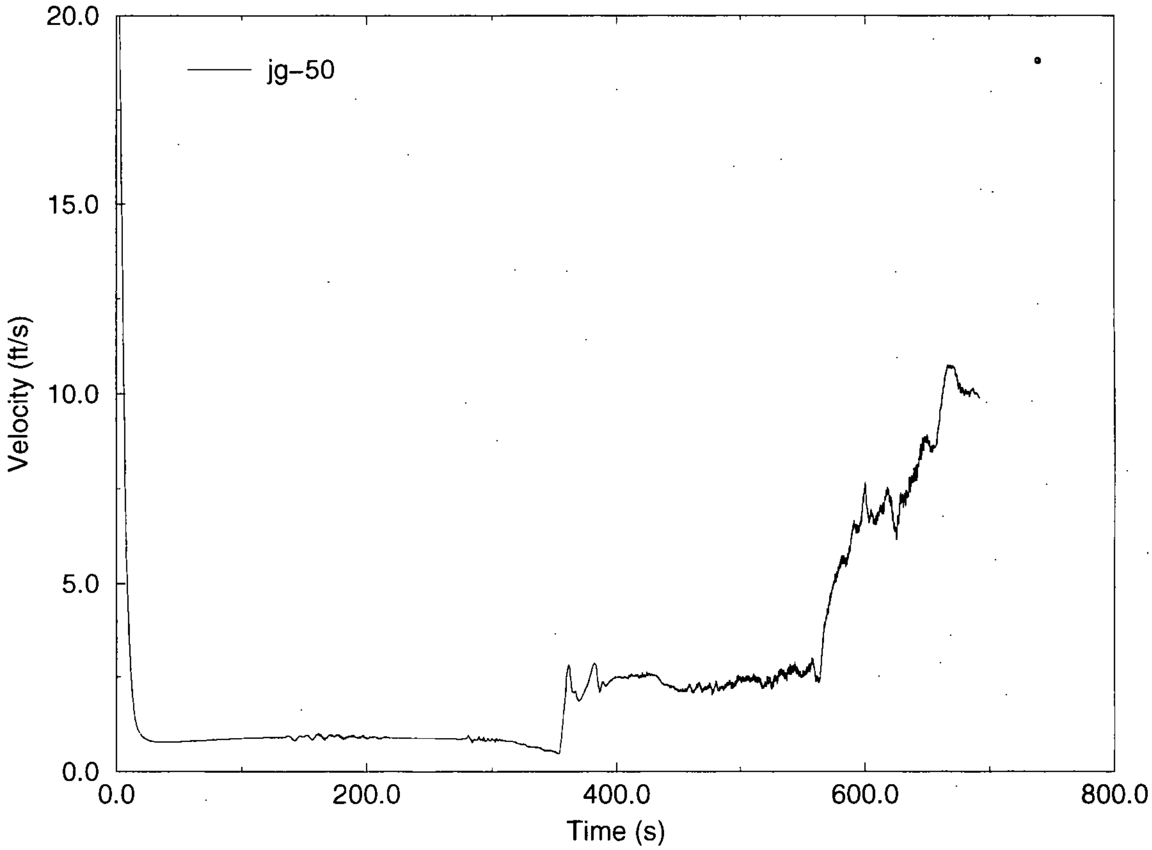

Figure A.6 Vapor Velocity at Exit of Average Core
0.05 FT2/PD SF-BATT TOP 108F CPPU

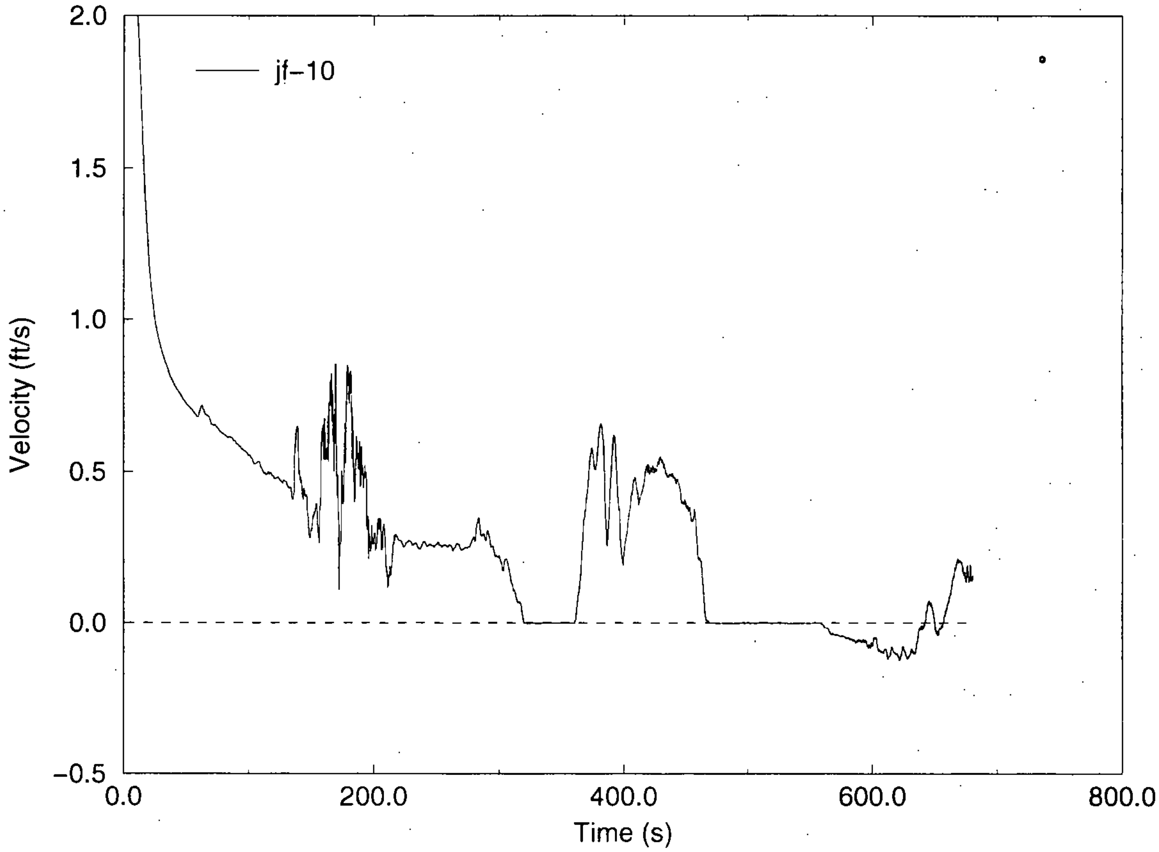

Figure A.7 Liquid Velocity at Exit of Hot Bundle
0.05 FT2/PD SF-BATT TOP 108F CPPU

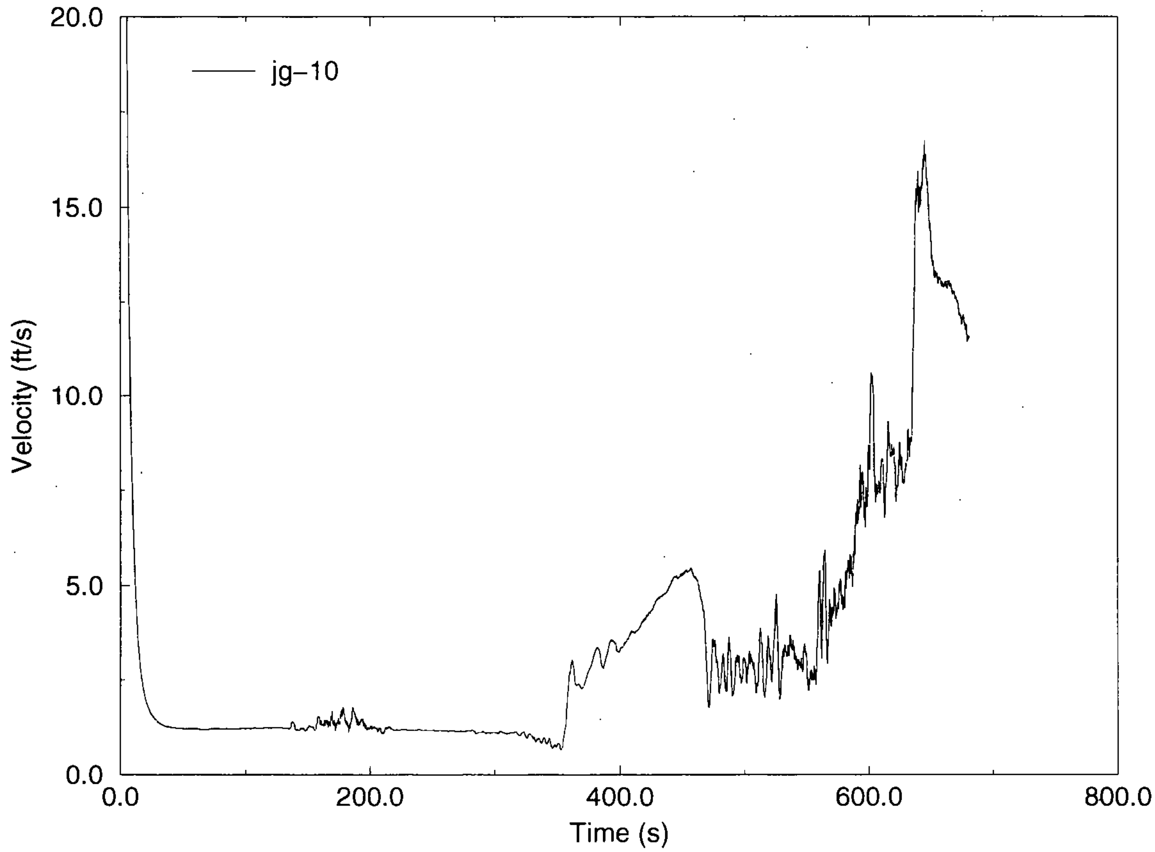

**Figure A.8 Vapor Velocity at Exit of Hot Bundle
0.05 FT2/PD SF-BATT TOP 108F CPPU**

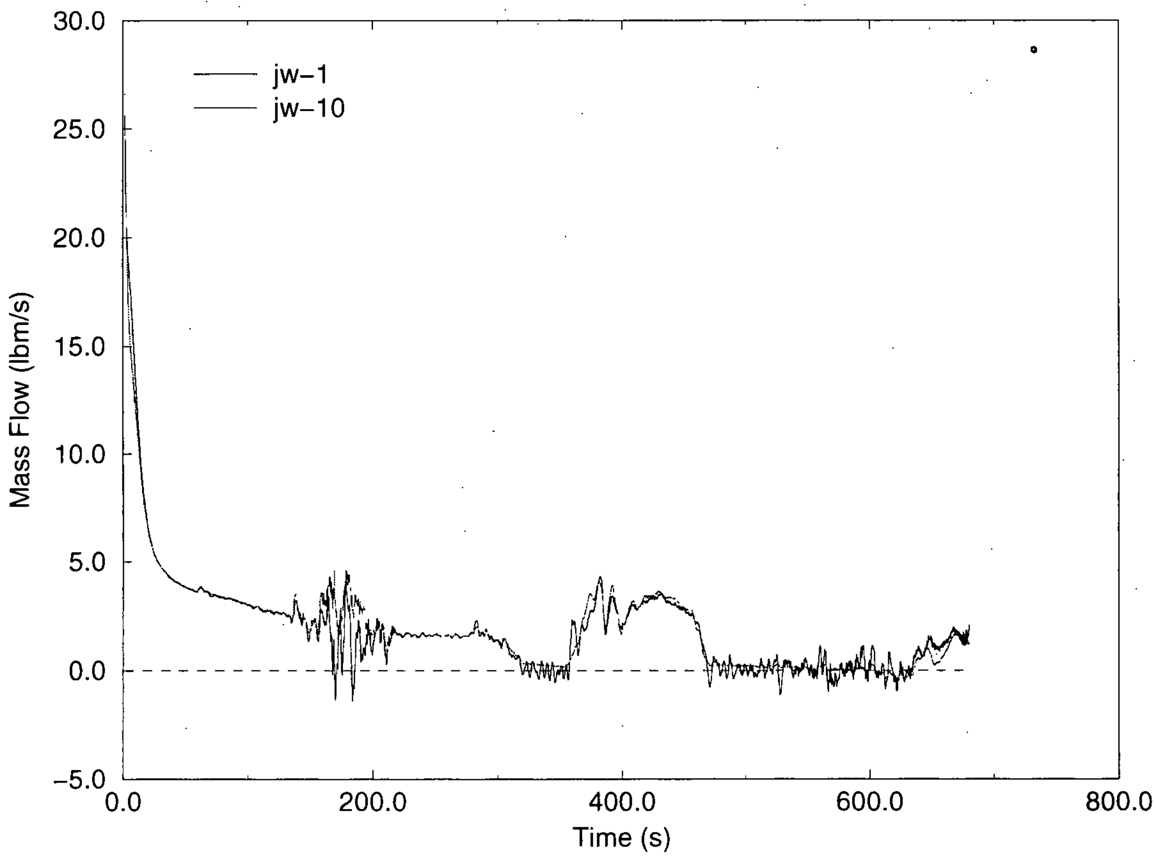

Figure A.9 Mass Flow Into and Out Of the Hot Bundle
0.05 FT2/PD SF-BATT TOP 108F CPPU

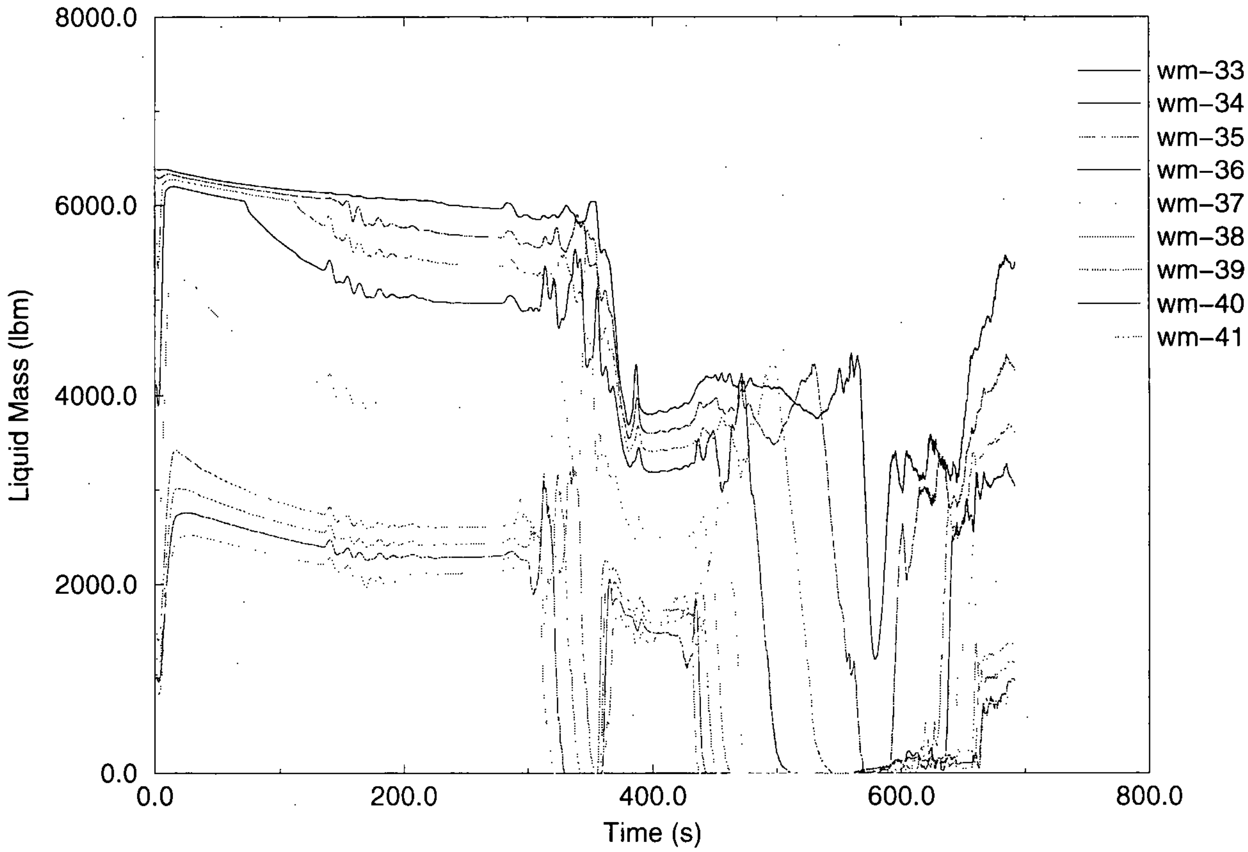

Figure A.10 Liquid Mass in the Core Average Nodes
0.05 FT2/PD SF-BATT TOP 108F CPPU

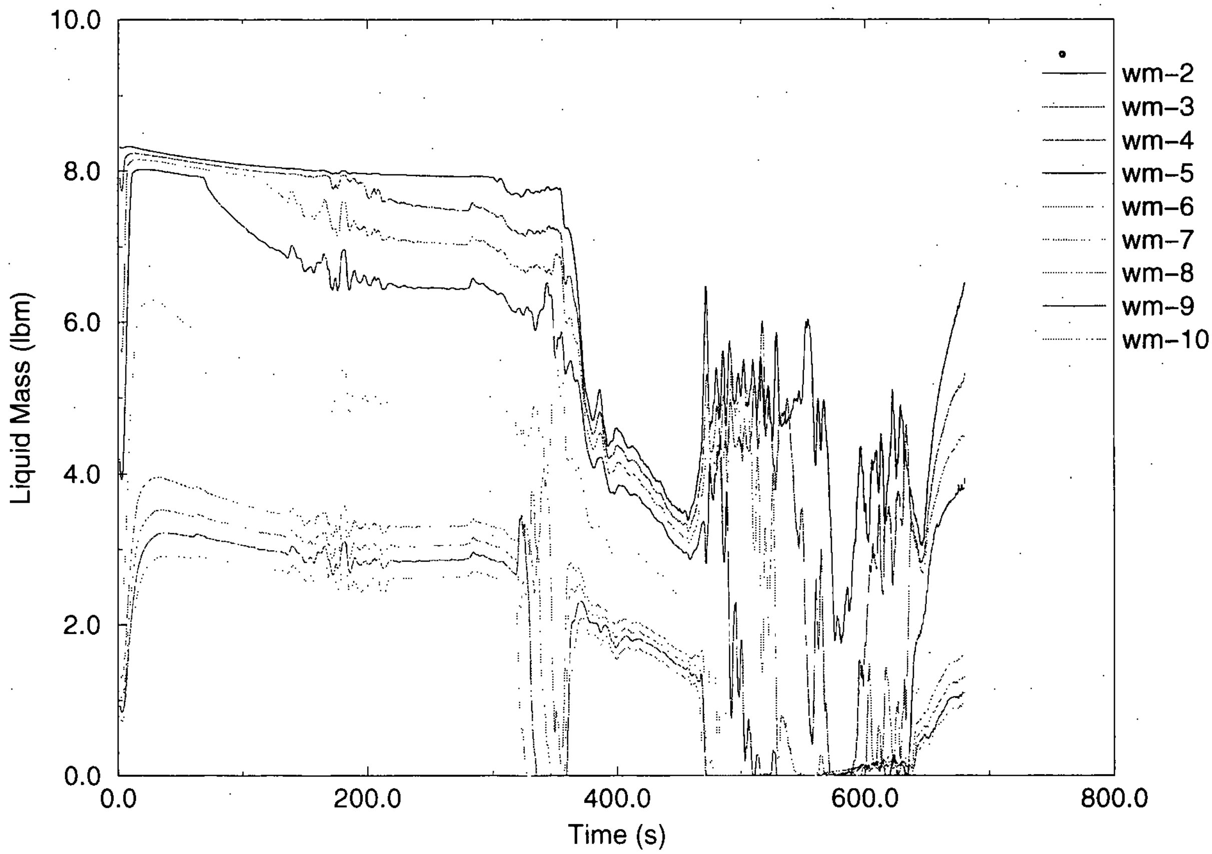

**Figure A.11 Liquid Mass in the Hot Bundle Nodes
0.05 FT2/PD SF-BATT TOP 108F CPPU**

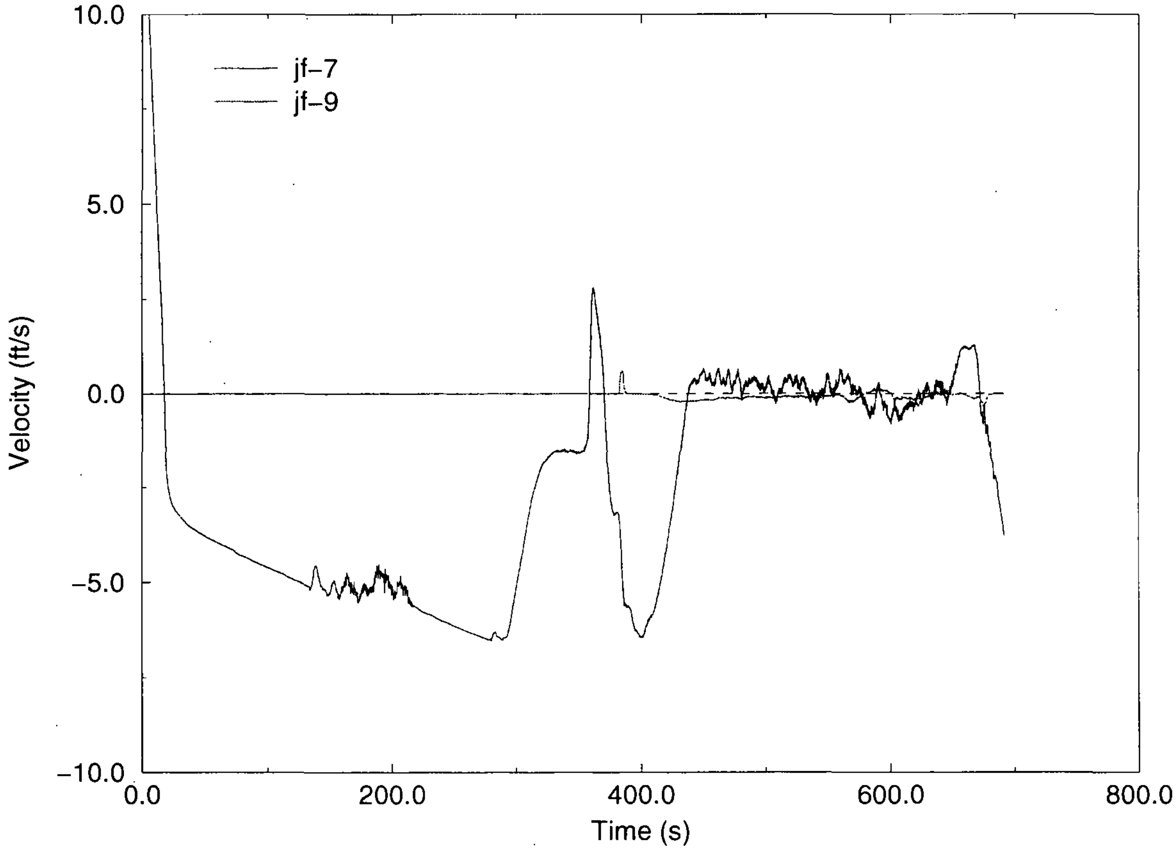

Figure A.12 Liquid Velocity at Inlet to Core Bypass
0.05 FT2/PD SF-BATT TOP 108F CPPU

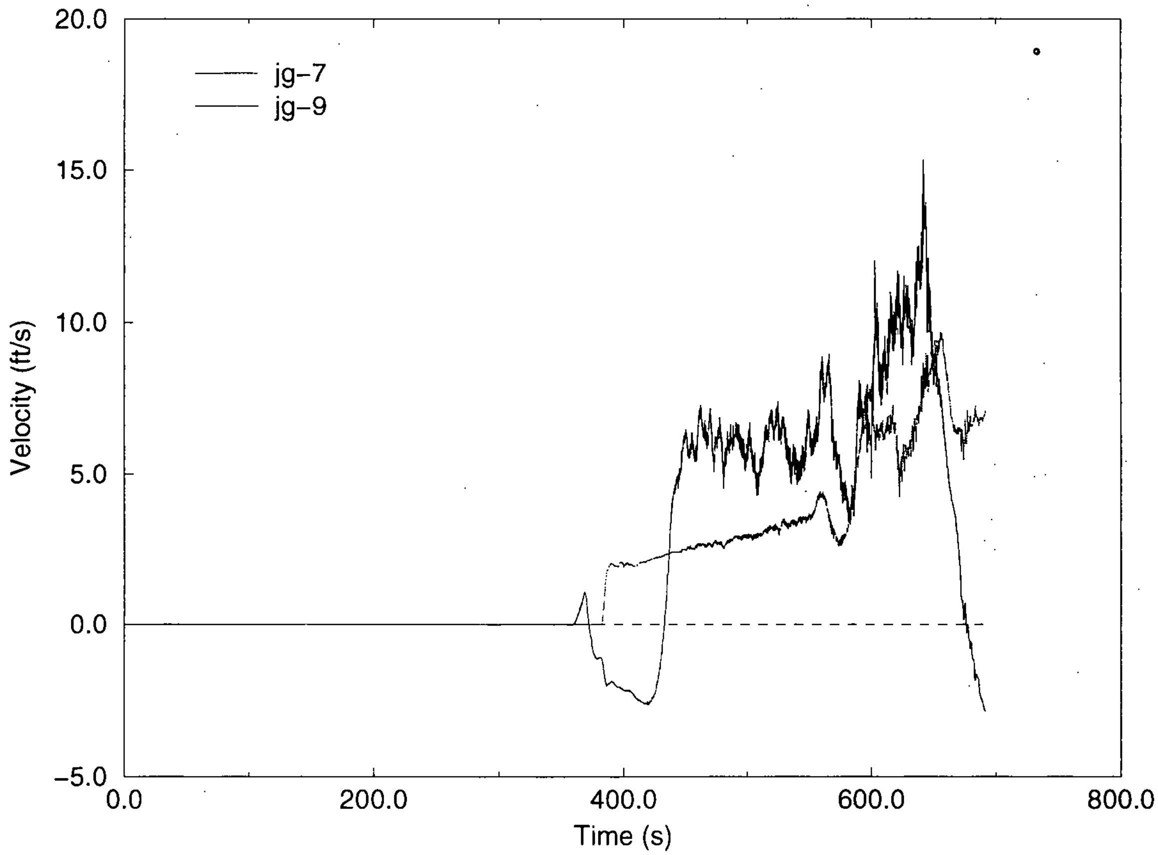

Figure A.13 Vapor Velocity at Inlet to Core Bypass
0.05 FT2/PD SF-BATT TOP 108F CPPU

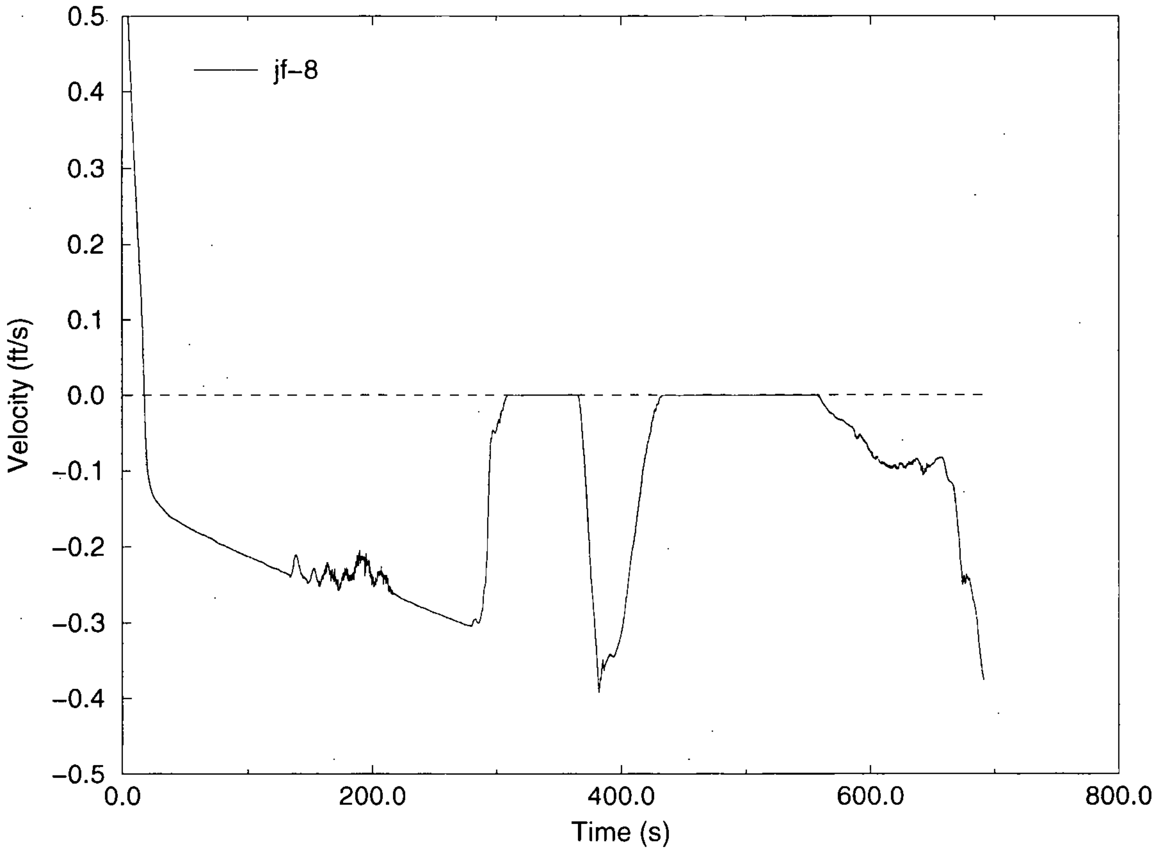

Figure A.14 Liquid Velocity at Outlet to Core Bypass 0.05 FT2/PD SF-BATT TOP 108F CPPU

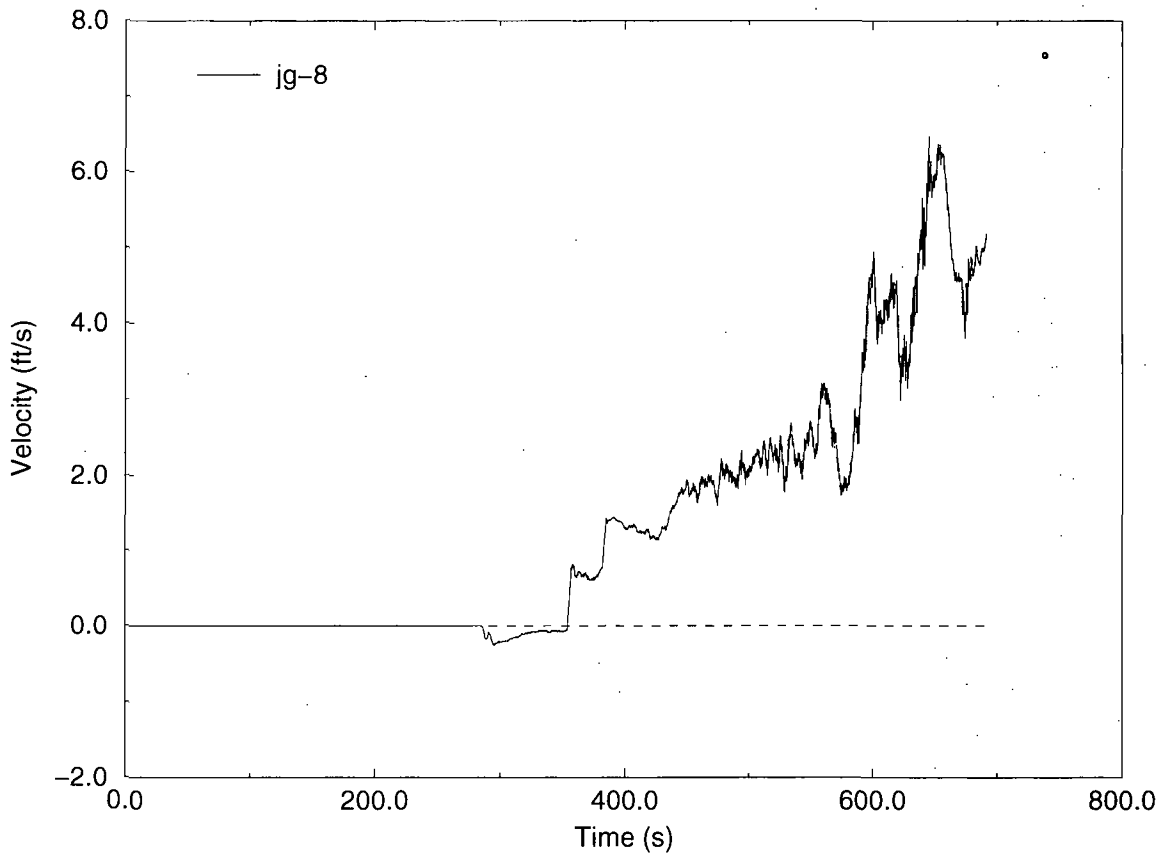

Figure A.15 Vapor Velocity at Outlet to Core Bypass
0.05 FT2/PD SF-BATT TOP 108F CPPU

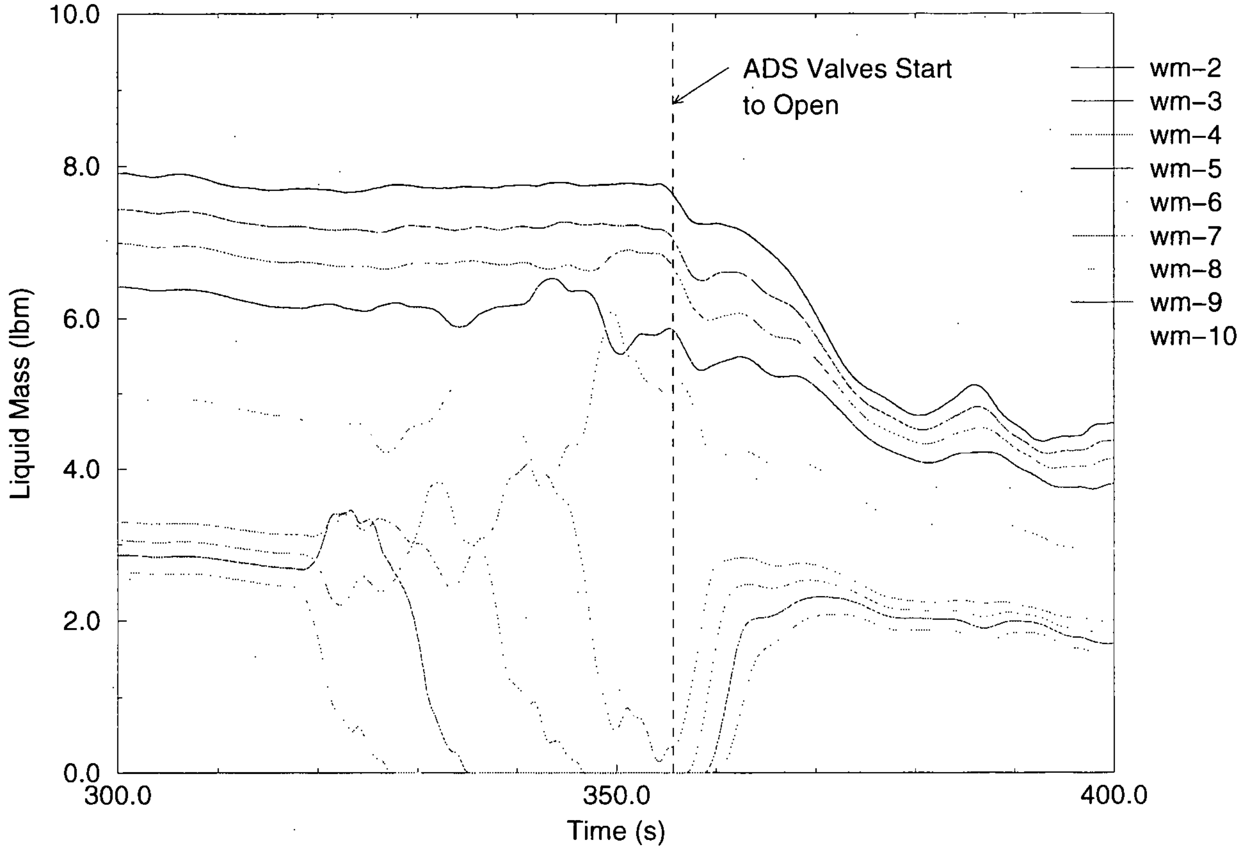

Figure A.16 Liquid Mass in the Hot Channel Nodes 0.05 FT2/PD SF-BATT TOP 108F CPPU

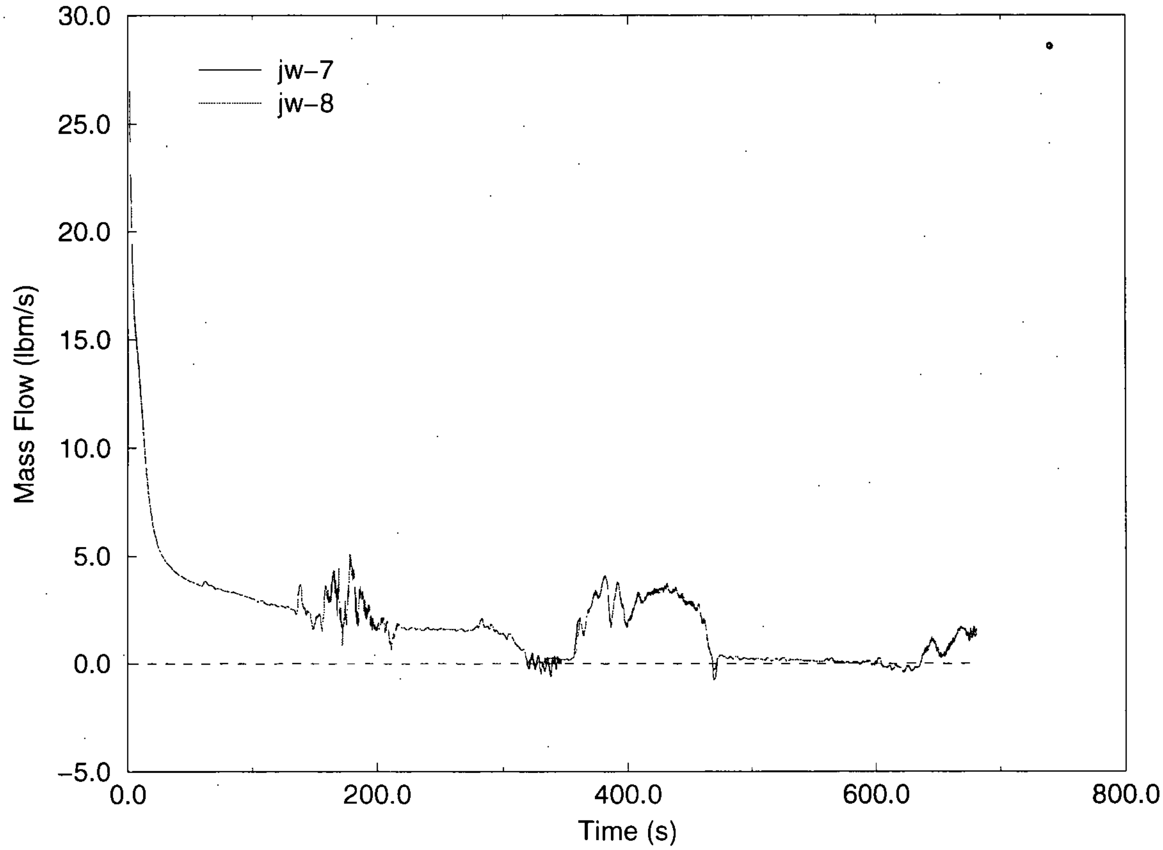

Figure A.17 Mass Flow Into and Out Of the Limiting Node in the Hot Bundle 0.05 FT2/PD SF-BATT TOP 108F CPPU

Attachment 3 to PLA-6264
AREVA NP, Inc. Affidavit

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Jerald S. Holm. I am Manager, Product Licensing, for AREVA NP Inc. and as such I am authorized to execute this Affidavit.

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

3. I am familiar with the AREVA NP information contained in the PPL letter PLA-6264, *Susquehanna Steam Electric Station Proposed License Amendment No. 285 for Unit 1 Operating License No. NPF-14 and Proposed License Amendment No. 253 for Unit 2 Operating License No. NPF-22 Extended Power Uprate Application Re: Reactor Systems Technical Review Request for Additional Information Responses*, and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP 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 AREVA NP 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 AREVA NP to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA NP'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 AREVA NP.

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

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

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b) and 6(c) above.

7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document have been made available,

on a limited basis, to others outside AREVA NP only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA NP 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.

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SUBSCRIBED before me this 13th

day of August, 2007.

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Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/10/2008

SUSAN K. McCOY
COMMISSION EXPIRES
NOTARY PUBLIC
7-10-08
STATE OF WASHINGTON