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April 30, 1996

ComEd

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Responses to NRC Request for Additional Information (RAI) on ComEd Licensing Topical Report NFSR-0111
BWR Transient Analysis Methods for:
LaSalle County Nuclear Power Station Units 1 and 2,
Dresden Nuclear Power Station Units 2 and 3, and
Quad Cities Nuclear Power Station Units 1 and 2
NRC Docket Nos. 50-373/374, 50-237/249, and 50-254/265

References: 1) Letter, D. M. Skay (USNRC) to D. L. Farrar (ComEd), "Request for Additional Information (TAC No. M92914)", dated April 4, 1996.

2) Letter, G. G. Benes (ComEd) to USNRC, "Commonwealth Edison BWR Transient Analysis Methods", dated June 26, 1995.

Attached are the responses to the questions transmitted in the Reference 1 letter. This additional information is in support of the ComEd BWR Transient Analysis Methods licensing topical report (LTR) which was submitted for NRC staff review in the Reference 2 letter.

Upon NRC approval, ComEd plans on using the methods for reload licensing and operational support applications for Dresden 2 and 3, Quad Cities 1 and 2, and LaSalle 1 and 2.

Please contact Gary Benes (708 663-7282) should further information be required.

Sincerely,

John B Hosmer

John B. Hosmer
Engineering Vice President

Attachment: Responses to 4/4/96 NRC Request for Additional Information on ComEd Licensing Topical Report NFSR-0111

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cc: H. Miller, Region Administrator, Region III
P. Brochman, Senior Resident Inspector - LaSalle
C. Miller, Senior Resident Inspector - Quad Cities
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Question 1

In your topical report dated June 1995 for the LaSalle Reactor Water Level Setpoint Change (RWLSC), you state that core power, steam flow rate, and reactor pressure remain relatively constant as expected over the course of the transient (page 4-5). Provide those results and compare them to the test data, if available.

Response 1

The negative 5 inch reactor water level setpoint change is a mild event which results in small changes to the reactor power, reactor pressure and steam flow rate. Figure 1 shows the comparison to the Average Power Range Monitor (APRM) channel for core power. The data shows acceptable agreement. Figure 2 shows the comparison of the reactor dome pressure response to the reactor water level setpoint change. The results show acceptable agreement. Both the startup test data and the RETRAN02 results show less than 2% variation over the duration of the reactor water level setpoint change event. Figure 3 shows the steam flow comparison for this event. The RETRAN02 results show acceptable agreement to the startup test data. Again both the startup test data and the RETRAN02 results show less than 2% variation over the period of interest for a RWLSC event. Since dome pressure and steam flow vary by less than 2%, the statement that these variables remain relatively constant is acceptable.

Question 2

From the several tests/benchmarks presented in the report, pressure discrepancies between the test data and RETRAN02 results could be observed throughout. For example, for the LaSalle Pressure Regulator Setpoint Change (PRSC), test data stabilized 1.5 psi higher than the RETRAN02 results; for the Dual Recirculation Pump Trip (DRPT), a 3 psi difference is observed; for the Main Steam Isolation Valve Closure (MSIVC), the test data stabilized 8 psi lower than the RETRAN02 results; and for the Peach Bottom turbine trip test 2, the reactor dome pressure shows a 3 psi difference.

Considering that most of the other parameters plotted show superior agreement, discuss why these pressure differences are observed. Where is the pressure parameter measured (both for the test data and in the RETRAN02 model)?

Response 2

The pressure differences described in Question 2 were considered acceptable as these differences met the benchmarking acceptance criteria as outlined in the Licensing Topical Report, NFSR-0111, henceforth referred to as (LTR). The purpose of the startup test benchmarking was to validate the ComEd models and methods for transient analysis. Although small pressure differences were observed for some startup test cases, the models predict the correct physical phenomena. Some of the system model inputs, as described below, may affect the calculated pressure, but the LTR model inputs are considered valid. Below is a discussion of the observed reactor dome pressure differences for the examples cited in Question 2.

Response 2 - PRSC

Dome pressure differences in the LaSalle PRSC from Figure 4.2-5 of the LTR were investigated. The pressure regulator pressure which is measured at the turbine inlet provides a good match between RETRAN02 results and measured data as shown in Figure 4. There is a discrepancy between the dome pressures, which indicates that the steamline pressure drop changed during the startup test. There are three possible contributions for the startup test data reflecting a change in the steamline pressure drop: first, if the steam flow rate changed significantly from the initial condition (time = 0 seconds) to the final condition (time = 20 seconds); second, if the steam quality changed significantly from the initial condition to the final condition; and third, the pressure instrumentation characteristics may limit the accurate prediction of small pressure changes.

Response 2 - PRSC continued

As shown in Figure 4.2-3 from the LTR, the initial and final steam flow rates vary by less than 0.1 Mlb/hr. This difference in steam flow can not account for a significant portion of the change in steamline pressure drop measured for the startup test. The pressure regulator setpoint change is a mild event. None of the major parameters such as reactor power, reactor dome pressure, feedwater flow rate, or steam flow rate change significantly. Since no major parameters reflect large changes, the steam quality will not change by a notable amount. If the steam quality does not change significantly, it can not account for the change in measured steamline pressure drop. The dome pressure and turbine inlet pressure detectors employ different sensing techniques, hence the two transmitters would have different values for linearity, hysteresis, dead band, and repeatability. All of these factors contribute to reference accuracy. Also, these transmitters are set up to measure different spans. Based on this information it is reasonable to expect that the two transmitters would exhibit different transient responses. The observed difference of approximately 1.5 psi between the two indications is not considered unreasonable for transmitters measuring a system pressure between 950 and 1000 psig. Therefore the 1.5 psi difference in dome pressure between the plant measured data and the RETRAN results are considered acceptable based on instrumentation characteristics.

Response 2 - DRPT

As stated in section 4.2.3.3 of the LTR, pressure differences of 3 psi between the LaSalle DRPT startup data and RETRAN02 model can be explained based on pressure regulator settings. The LTR Figure 3.1-8 shows a function generator control block that serves to linearize the total control valve flow to the pressure regulator demand. The ideal curve is set to be a transposition of the measured turbine control valve position versus total flow. However, for startup this curve was not known and had to be estimated based on idealized design specifications. This function generator curve as implemented in the plant equipment assumes several linear segments to represent the measured turbine control valve position versus total flow curve. During startup, any or all of these segments may have had a slope different from the ideal curve. Records of this curve and other pressure regulator settings used for the DRPT startup test were not available from the startup test report. The RETRAN02 results using an adjusted function generator curve are shown in Figure 5 through Figure 8. The adjustment provides improved pressure results as shown in Figure 8. The change incorporated to this function generator curve has no notable effects on any of the other parameters shown in Figure 5 through Figure 7. Also, it should be noted this change will not noticeably affect any of the other startup tests. Instrumentation characteristics can contribute to the observed pressure differences as discussed previously.

Response 2 - MSIVC

Differences between the LaSalle MSIVC startup data and the RETRAN02 model pressures of 8 psi can be partially attributed to the flow capacity used for the safety/relief valves (SRVs). Section 3.1.2.4 of the LTR describes the SRVs used in the analysis as ASME certified flow capacity. However, Section III, Division 1, Subsection NB-7735.1 W79 of the 1978 ASME Code states that the rated capacity of SRVs should be 90% of the average tested capacity of the SRVs. Using this information, the actual or best estimate relief capacity would be 111% of the ASME rated capacity. Applying this best estimate SRV capacity in the RETRAN02 model provides a better match to the startup test data as shown in Figure 9. The reactor dome pressure discrepancy between RETRAN02 results and the startup test data was reduced significantly with the best estimate SRV capacity, but was still conservative. For best estimate calculations or benchmarking, the best estimate SRV capacity will be considered. No other parameters are affected by the best estimate SRV capacity as shown in Figure 10 through Figure 12. It should be noted that the change to the SRV capacity will not noticeably affect any of the other startup tests. Also, instrumentation characteristics can contribute to the observed pressure differences as discussed previously.

Response 2 - TT2

The Peach Bottom turbine trip test 2 reactor dome pressure response was presented in the LTR, Figure 5.4-6. This figure shows excellent agreement between the measured data and the RETRAN02 calculation for the first 3 seconds of the transient. The figure also shows a maximum pressure difference of about 3 psi. The good agreement during the initial part of the transient indicates that the steam line dynamics and the bypass delay and opening time are accurately predicted with the RETRAN02 model. The RETRAN02 model accurately predicts the initial pressure response observed for the dome pressure. Predicting the initial dome pressure oscillation is of primary importance since the Peach Bottom reactor core power feedback will be heavily dependent on the first 2.0 seconds of the pressurization.

The pressure differences observed after about 3 seconds are considered small compared to the magnitude of the pressurization event (~65 psi). The 3 psi difference is less than 5% of the pressure increase for this event. These pressure differences are mainly dependent on the fuel stored energy and the bypass capacity. These are considered important because the peak pressure for the transient is dependent on the steam production rate and the steam removal rate. The fuel stored energy will affect the steam production rate and the bypass capacity will affect the steam removal rate.

Response 2 - TT2 continued

The RETRAN02 main steam bypass model inputs were developed to achieve the design bypass flow rate. The fuel stored energy is set with the RETRAN02 pellet to cladding gap thermal conductivity input. The thermal conductivity establishes the initial fuel temperature and hence the initial fuel stored energy. However, considering the small difference of about 3 psi, the fuel stored energy and bypass capacity are considered to be adequately modeled and the results conservatively over predict the pressure.

Response 2 - Pressure Sensor Location

Both the LaSalle and Peach Bottom RETRAN02 model calculate the sensed dome pressure as a lag control block as described in Section 3.1.6.1 of the LTR. This control block receives input from the pressure in volume node #100 on Figures 3.1-1 and 5.2-1 of the LTR. Control block inputs were summarized in Table 3.1-4 of the LTR.

LaSalle dome pressure measurement presented in Figures 4.2-5, 10, 11 and 16 of the LTR are for the narrow range indications. Dome pressure is transmitted through a nozzle which has an elevation approximately 3 feet above the normal water level and four feet below the main steam nozzles centerline.

The Peach Bottom pressure instrument nozzle location on the reactor vessel described in the references below is similar to the LaSalle pressure instrument nozzle location. However, at Peach Bottom GE installed special transmitters and instrument lines as described in the references below.

References:

EPRI Document: NP-563, "Core Design and Operating Data for Cycles 1 and 2 of Peach Bottom 2", June 1978, Figure 25.

EPRI Document: NP-564, "Transient and Stability Tests at Peach Bottom Atomic Power Station Unit 2 at End of Cycle 2", June 1978, Appendix B, Sections B.1, B.2 and Figure B-2.

Question 3

In the same report, on page 4-51, you state that "the measured data is clearly in error as the power was measured to level off around 10% after the reactor scram". Discuss/prove that the model results are correct.

Response 3

The term "measured data" in the statement "the measured data is clearly in error as the power was measured to level off around 10% after the reactor scram." refers to the recorded APRM signal displayed in Figure 3.27.1 of LTR Reference 11, NEDC-10810, March 1973, page 99. The value of 10% (10% rated neutron flux) being in error is obvious because startup test reports document the fact that a reactor scram due to turbine stop valve closure occurred, as designed, during this test.

The model results for reactor power are shown to be correct based on the following:

- Figure 4.3-11 illustrates very close agreement between the RETRAN02 reactor power and the measured APRM response during the first 0.5 seconds.
- Figures 4.2-9 and 4.3-8 demonstrate the ability of the 1-D kinetics and reactor system models to represent the reactor power during a dual recirculation pump trip which occurs without a reactor scram, while Figure 4.2-12 and Figure 4.2-17 demonstrate the same ability during a reactor scram.
- The normalized core average LPRM responses for the Peach Bottom turbine trip tests in Figures 5.4-21, 5.4-26 and 5.4-31 indicate that the RETRAN02 modeling of the reactor power after scram is accurate.
- The Figure A-2 comparison of RETRAN02 calculated control rod worth with MICROBURN calculations shows good agreement. This comparison shows that the RETRAN02 model calculates the appropriate scram reactivity.

Question 4

On page 4-51, you state that the initial rise of the steam flow for the turbine trip with bypass benchmark is not believed to reflect the physical process and represents a temporary error in the flow measurement. Discuss how/why the test data is wrong and describe the expected physical process.

Response 4

Figure 4.3-14 shows the comparison of main steam flow. The magnitude meets "acceptable" criterion in LTR, Table 4.1-1 since the RETRAN02 prediction is very close to, but at a slightly lower value than the plant data beyond the t=2.0 second period. RETRAN02 does not predict the measured initial rise in the main steam flow. But this rise in flow is not believed to reflect the physical process.

The measured initial increase in flow cannot be the physical process since a turbine trip reduces the main steam flow to zero after closure of the turbine stop valves. The turbine stop valves have been measured to close typically in 225 milliseconds. Steam flow is halted for a brief period until the main steam bypass valves can open. There will be oscillations in steam pressure and flow in the main steam piping during this period

By examining the dome pressure in the LTR, Figure 4.3-12, the reactor pressure increases following the turbine trip as expected. An initial increase in steam flow would cause a corresponding initial decrease in dome pressure. A dome pressure increase is the result of a mismatch between the steam generation rate and the steam removal rate. The steam generation rate does not have any appreciable change initially. Thus, the dome pressure increase is attributed to the rapid flow reduction caused by the closure of the turbine stop valves. This is the reason why the initial steam flow increase observed from the test data is believed to be non-physical. The rapid pressure oscillations that occur after closure of the turbine stop valves may have contributed to the observed instrument readings. The observed steam flow measurement after about 1.5 to 2.0 seconds is believed to represent the physical process. At this point in time the magnitude of the steam line pressure oscillations have dissipated.

The RETRAN02 model reflects the large flow reduction and dome pressure increase. The rate of flow reduction is considered acceptable since the dome pressurization rate closely matches the measured data.

In summary, the RETRAN02 model accurately simulated the plant response for this transient. The predicted main steam flows and bypass valve positions indicated in this report are acceptable and within measurable error ranges for the Quad-Cities RETRAN02 model. All valid measured data parameters were

Response 4 - Continued

predicted with a high degree of accuracy using the RETRAN02 models. Despite main steam flow measurement errors in the startup test data, the RETRAN02 main steam flow predictions were acceptable.

Question 5

On page 6-6, you include the statement "The results show that the RETRAN model would be more conservative." Discuss how you reached this conclusion from the results presented.

Response 5

The transient results for the RETRAN02 Peach Bottom Turbine Trip Licensing case are judged to be more conservative than the GE and BNL results. This conclusion is based on the results presented in the LTR Figure 6.3-6. This figure shows the RETRAN02 peak average heat flux to be about 15% higher than the GE calculation and it is about 30% higher than the BNL calculation. The heat flux response is the principal indicator for determining the severity of a turbine trip event. Thus, since the RETRAN02 heat flux is higher than the GE and BNL calculations, the RETRAN02 results are judged to be more conservative.

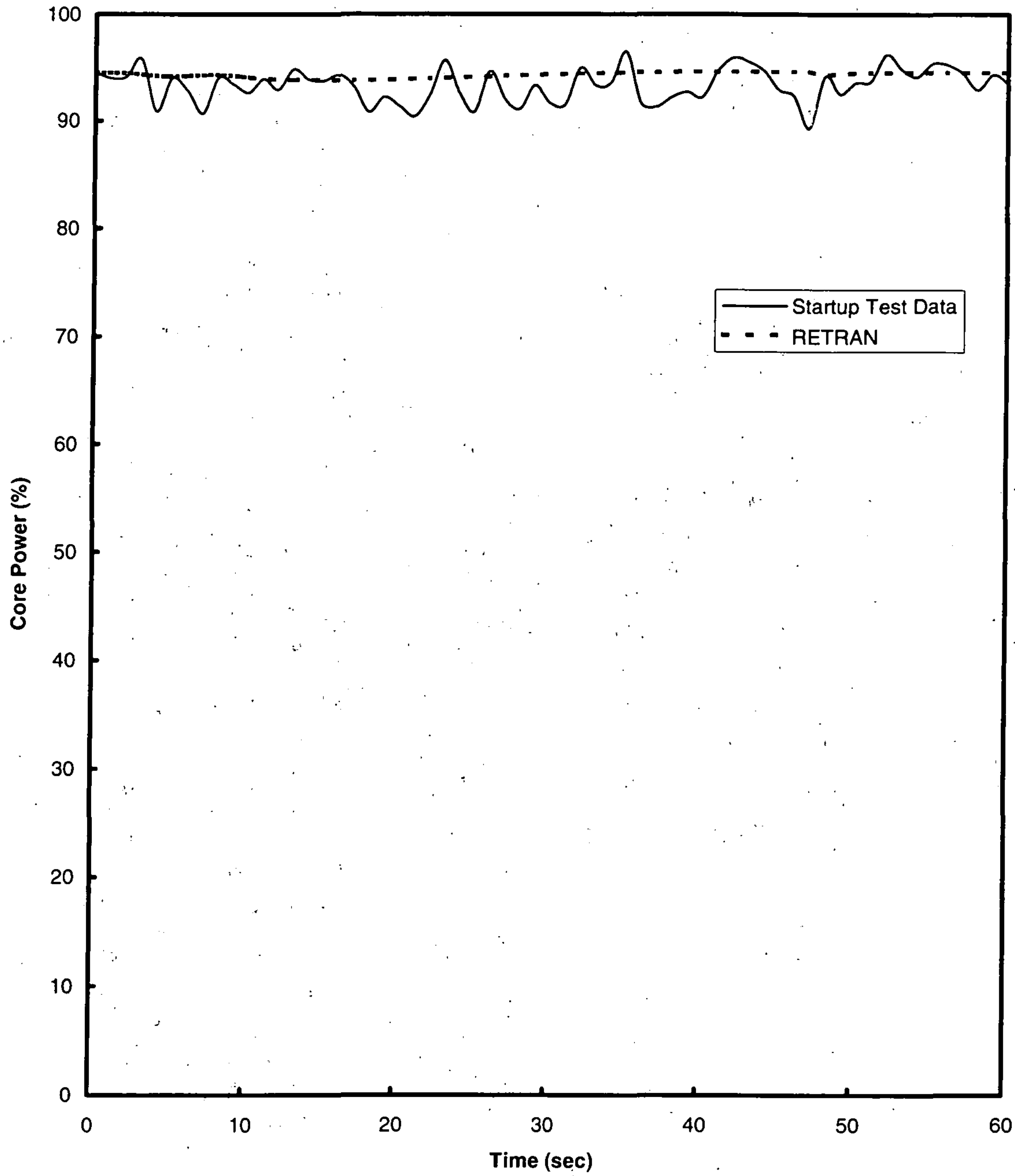

Figure 1 LaSalle BWR/5 RWLSC Core Power

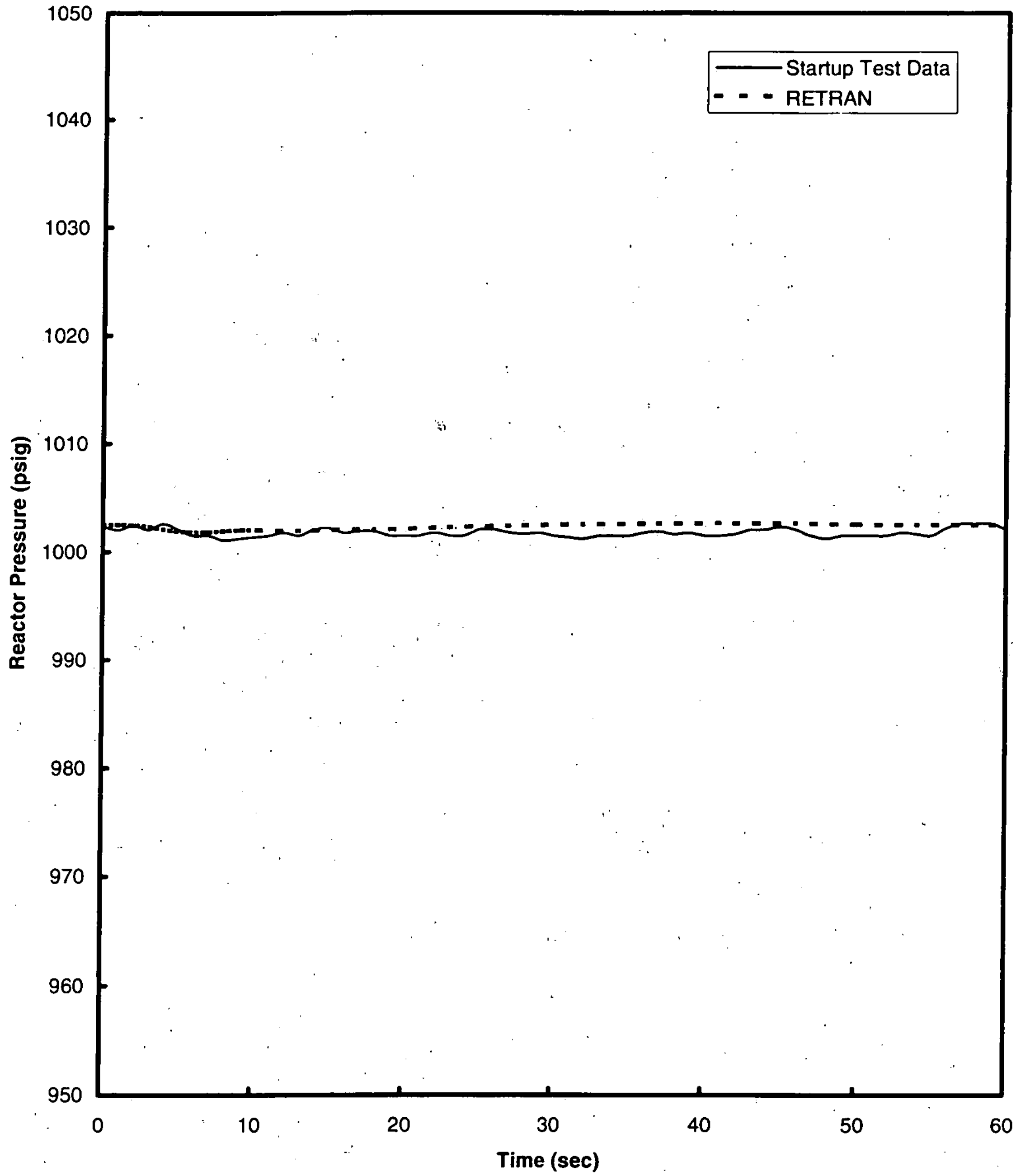

Figure 2 LaSalle BWR/5 RWLSC Dome Pressure

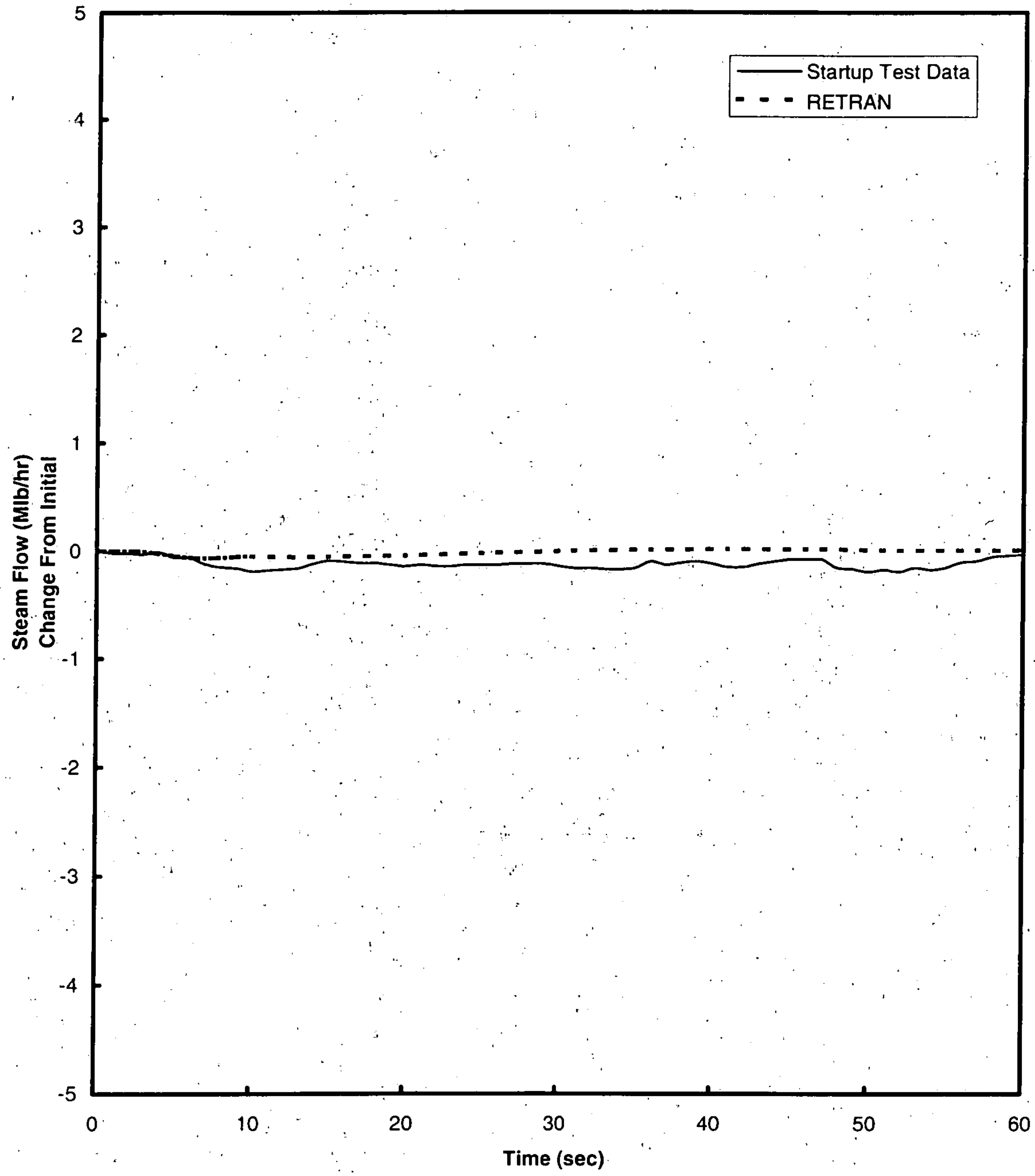

Figure 3 LaSalle BWR/5 RWLSC Steam Flow

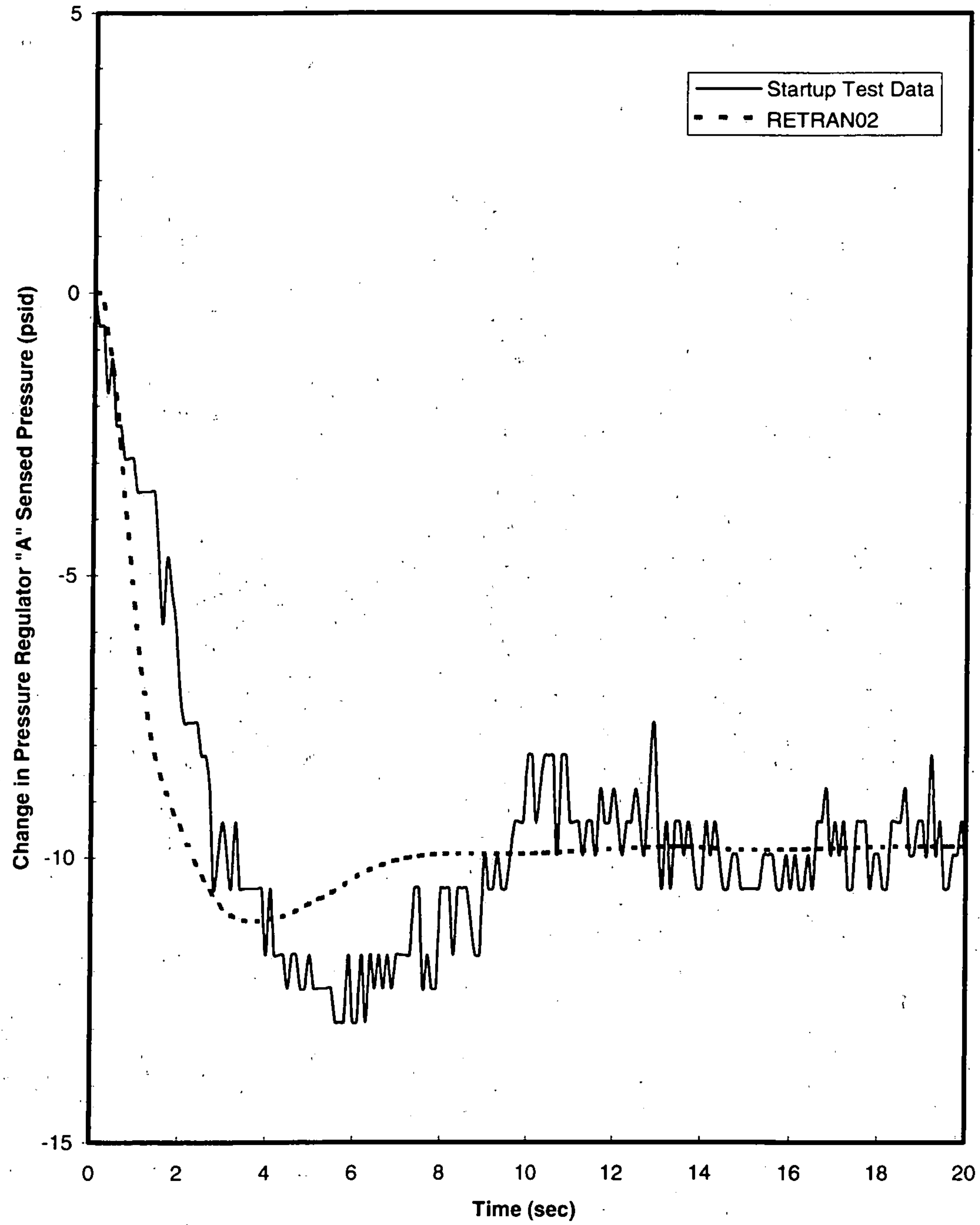

Figure 4 LaSalle BWR/5 Pressure Regulator "A" Sensed Pressure

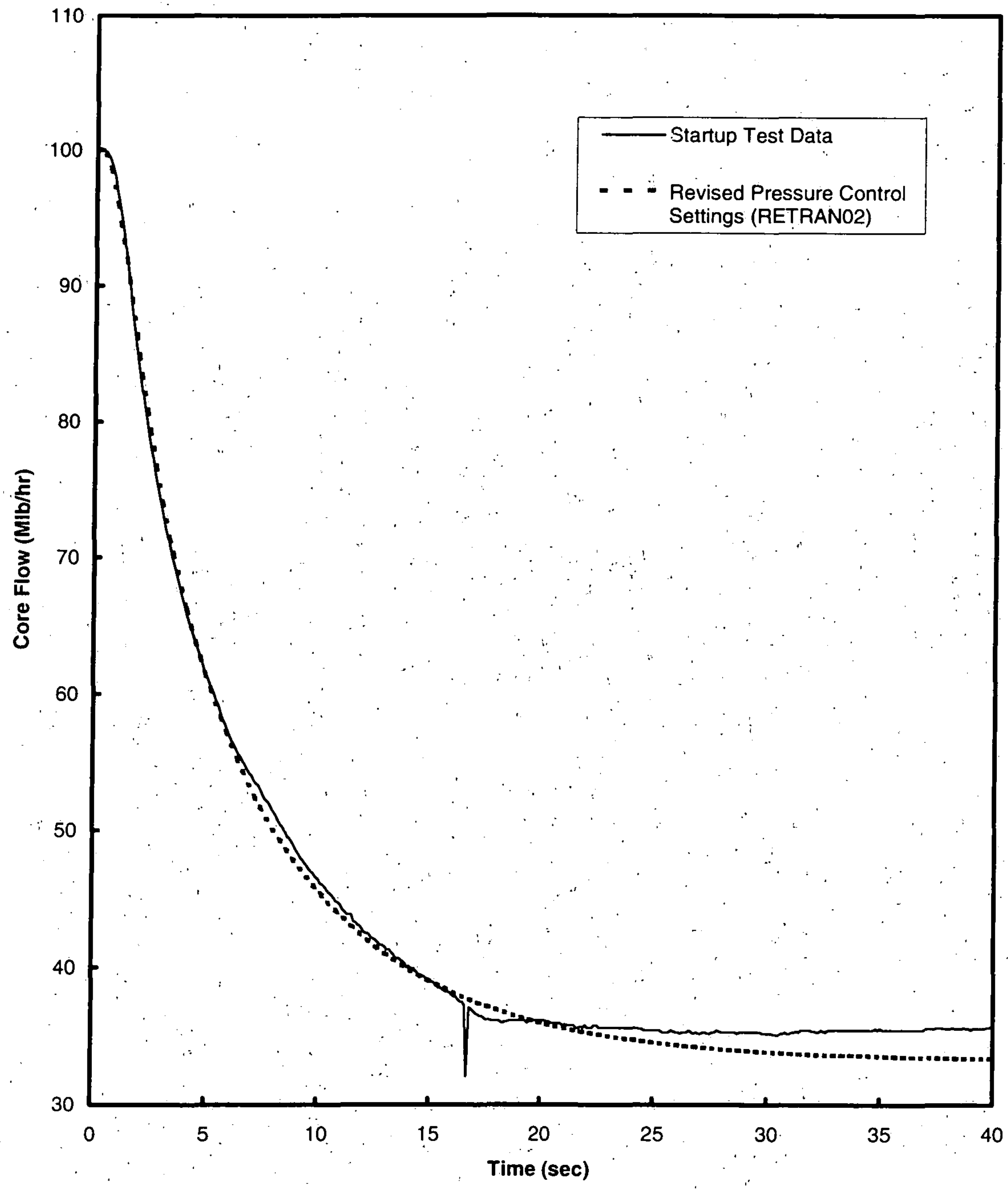

Figure 5 LaSalle BWR/5 DRPT Core Flow

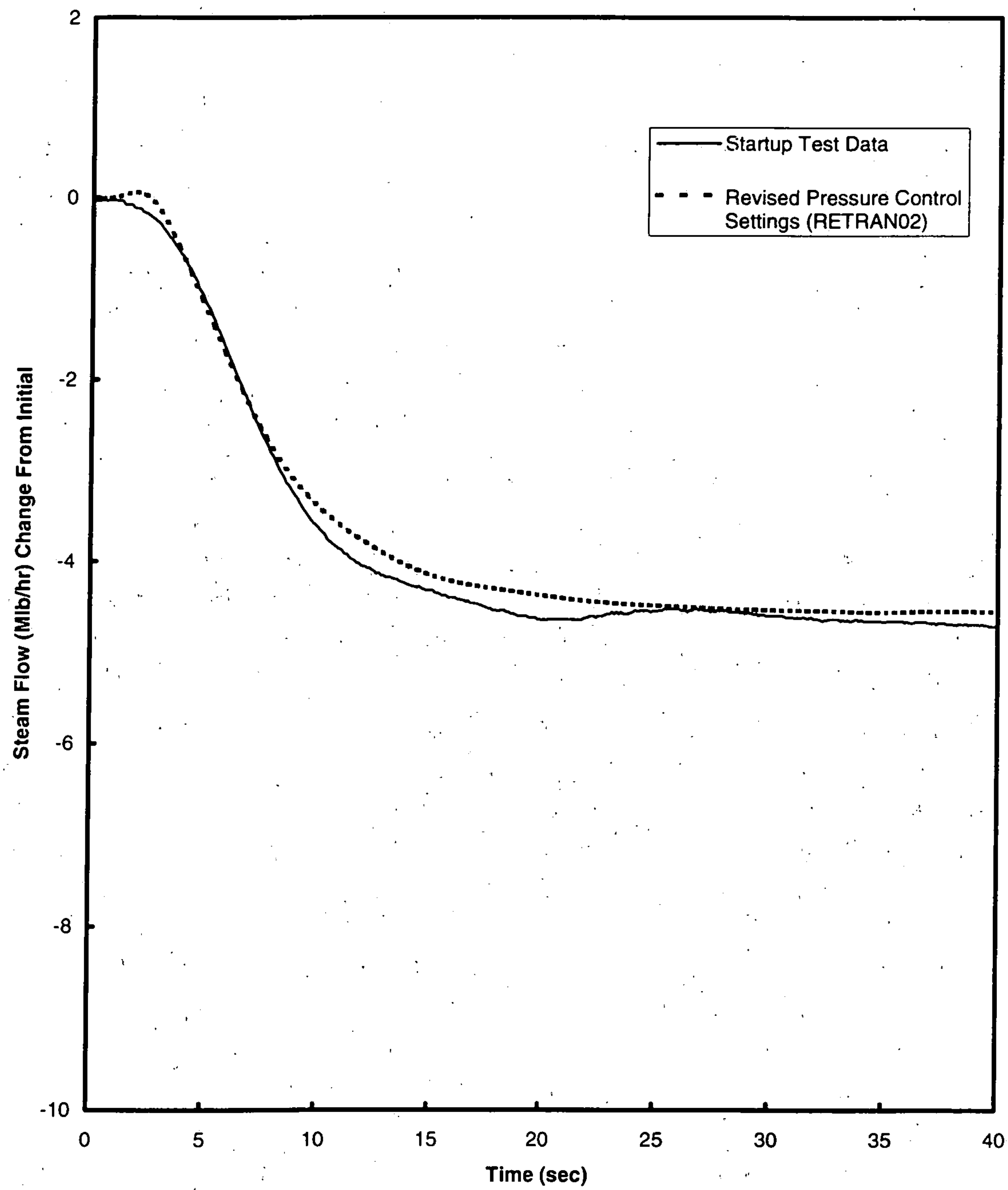

Figure 6 LaSalle BWR/5 DRPT Steam Flow

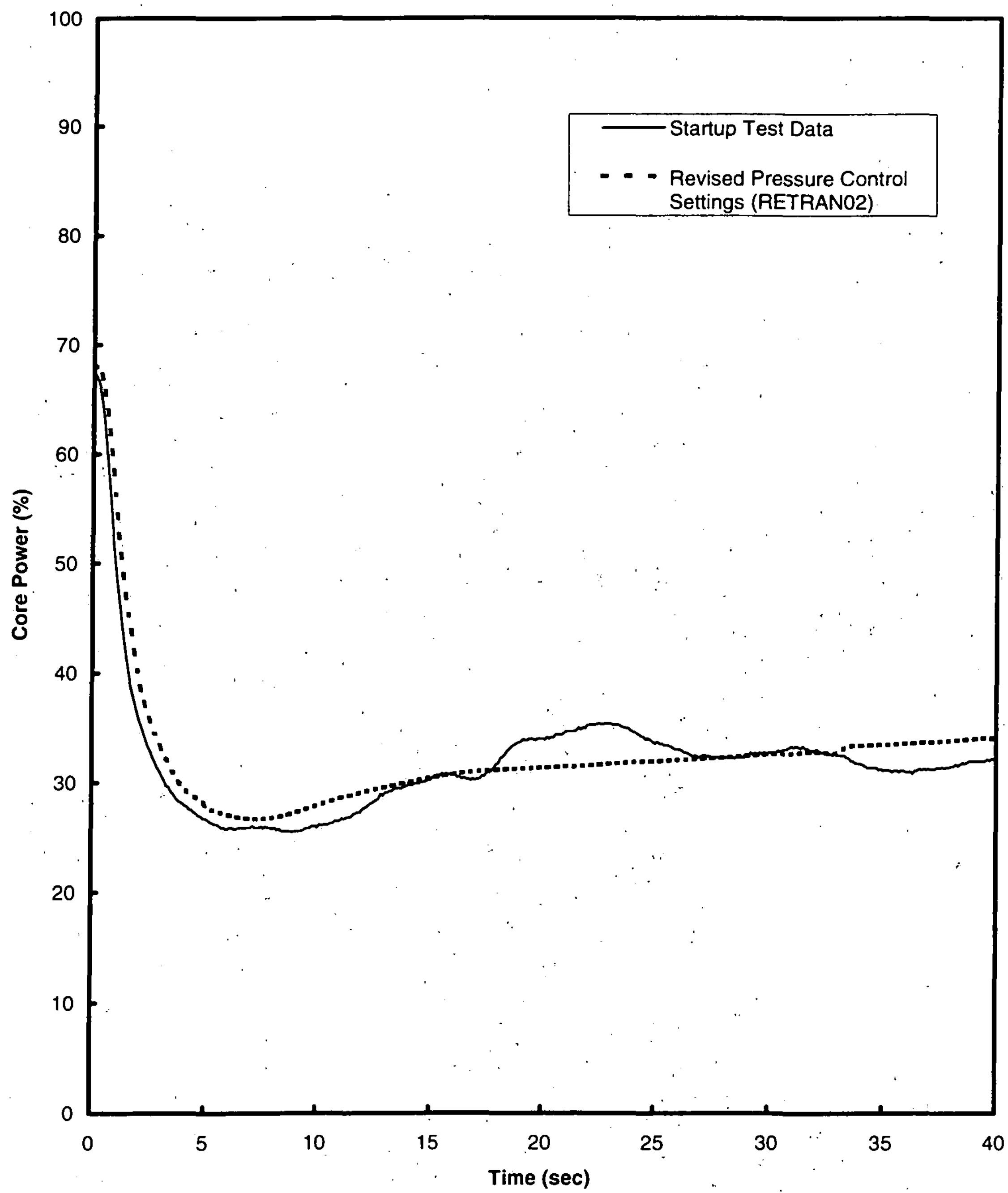

Figure 7 LaSalle BWR/5 DRPT Core Power

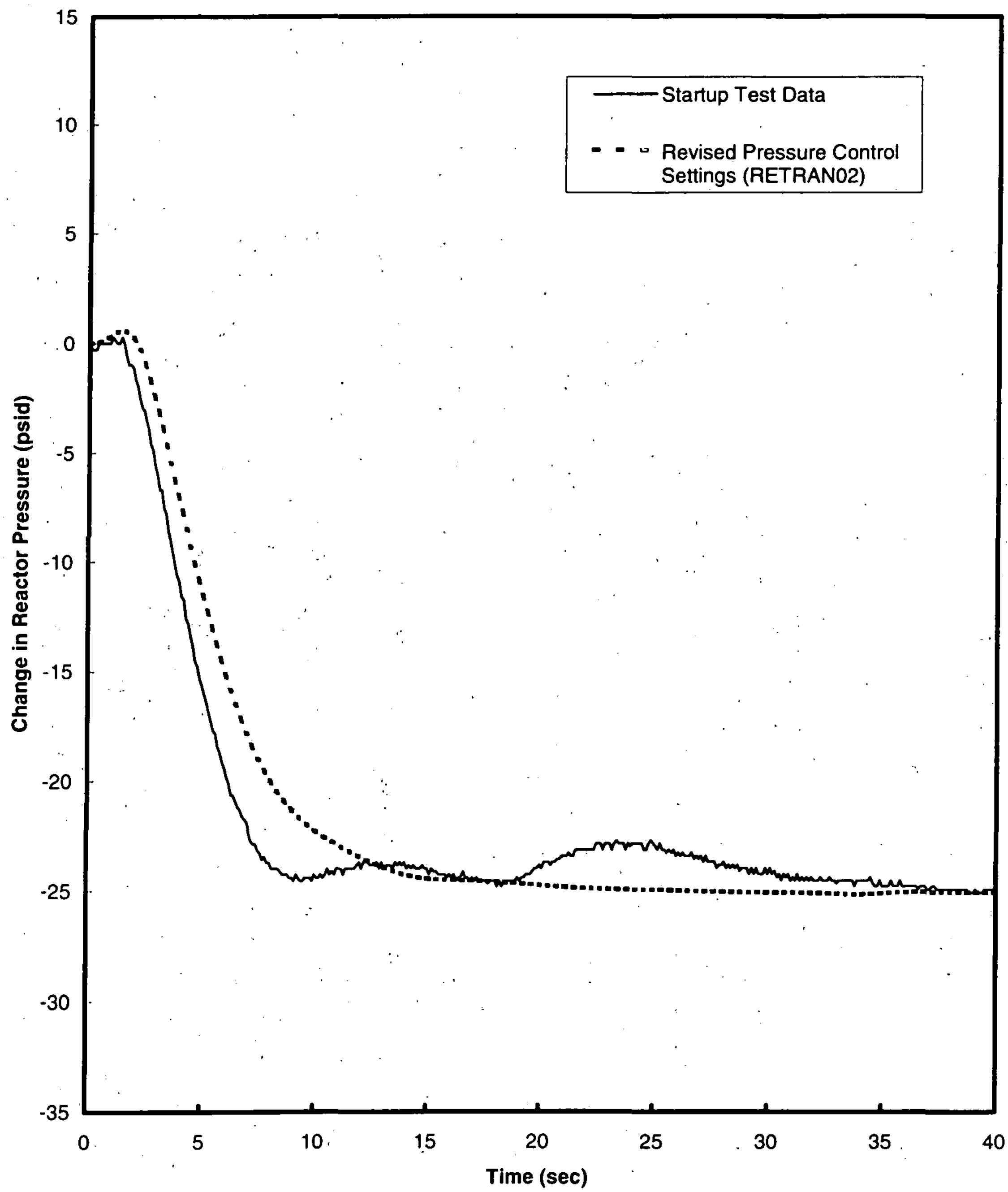

Figure 8 LaSalle BWR/5 DRPT Dome Pressure

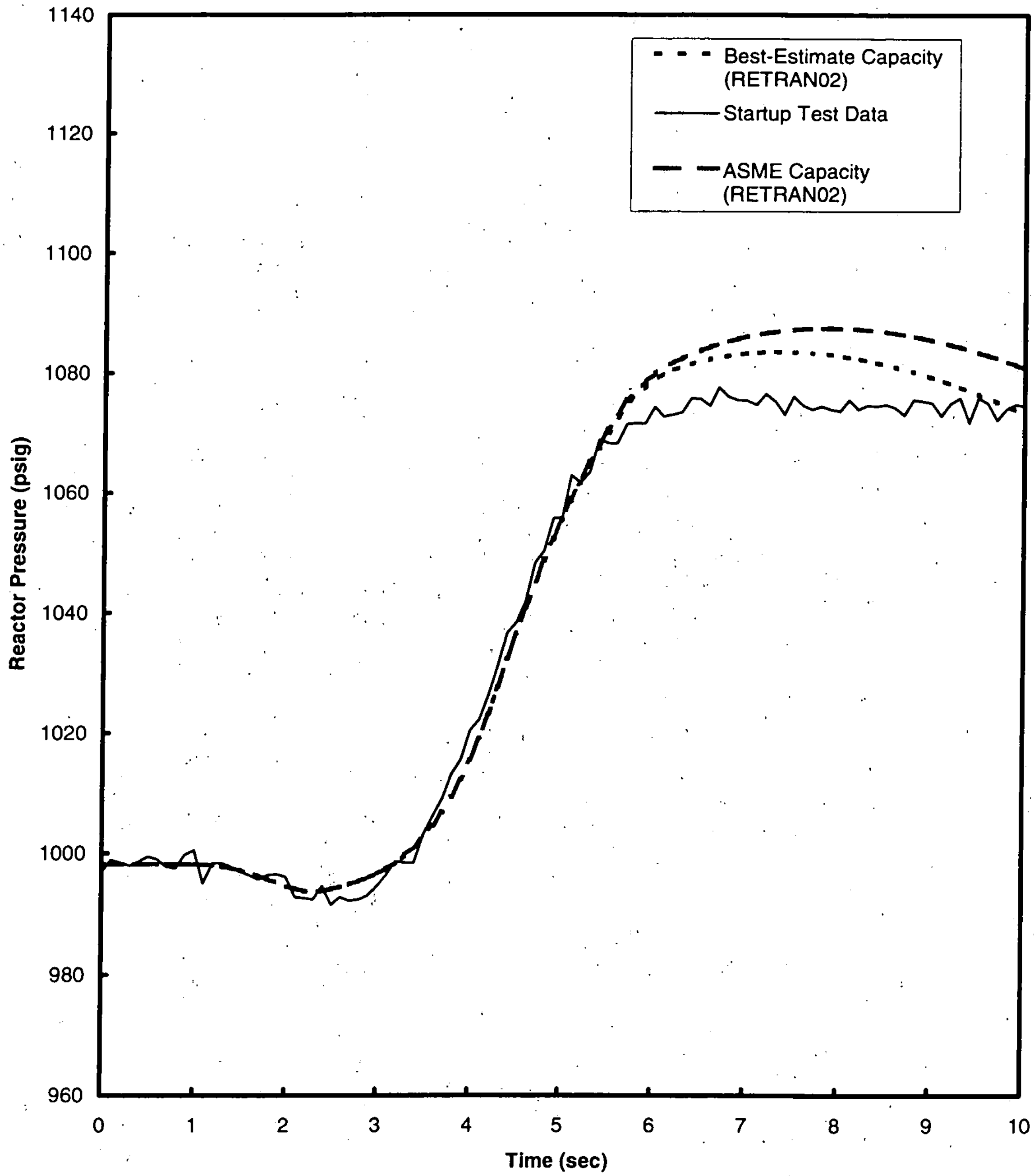

Figure 9 LaSalle BWR/5 MSIVC Reactor Pressure

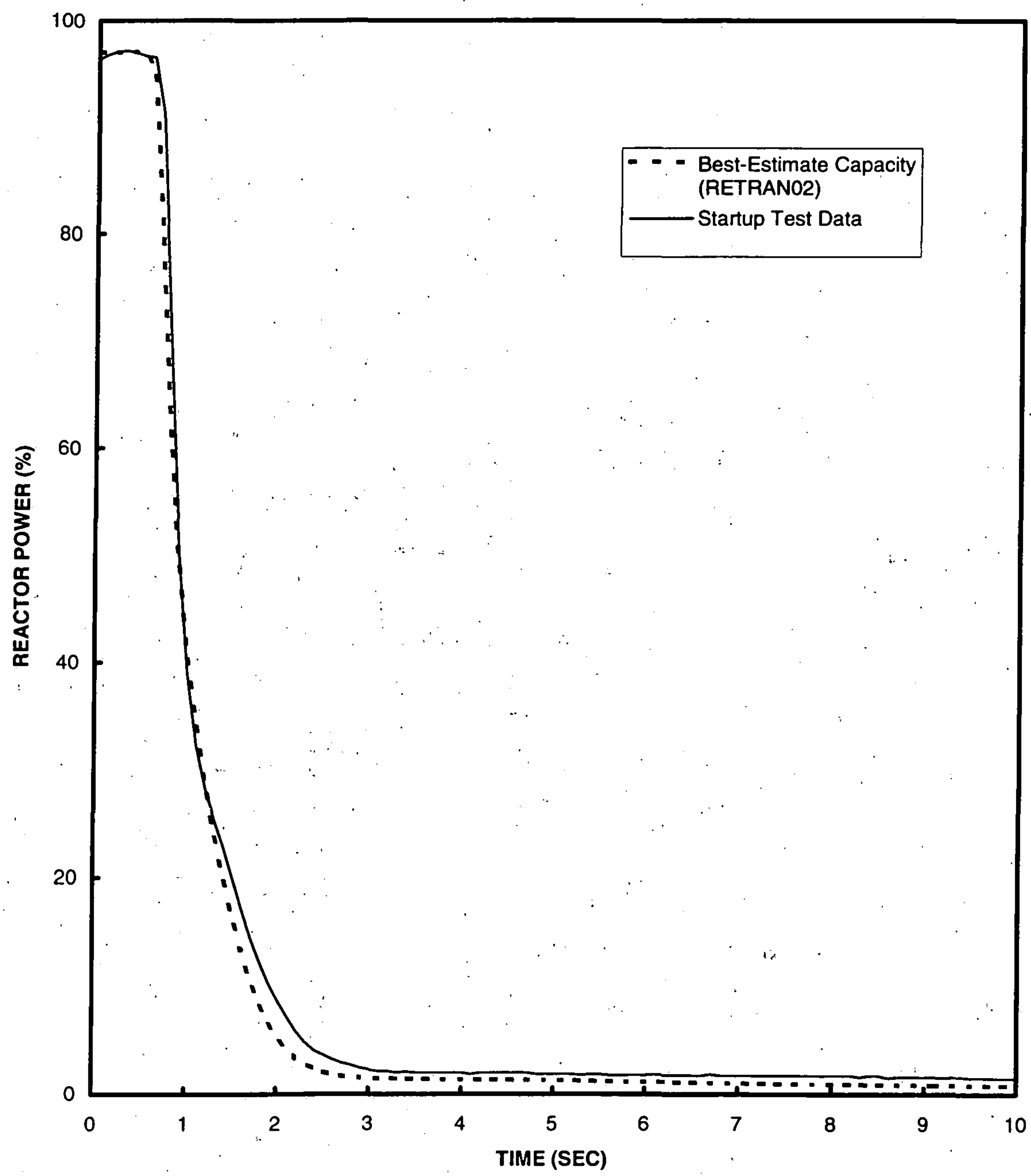

Figure 10 LaSalle BWR/5 MSIVC Reactor Power

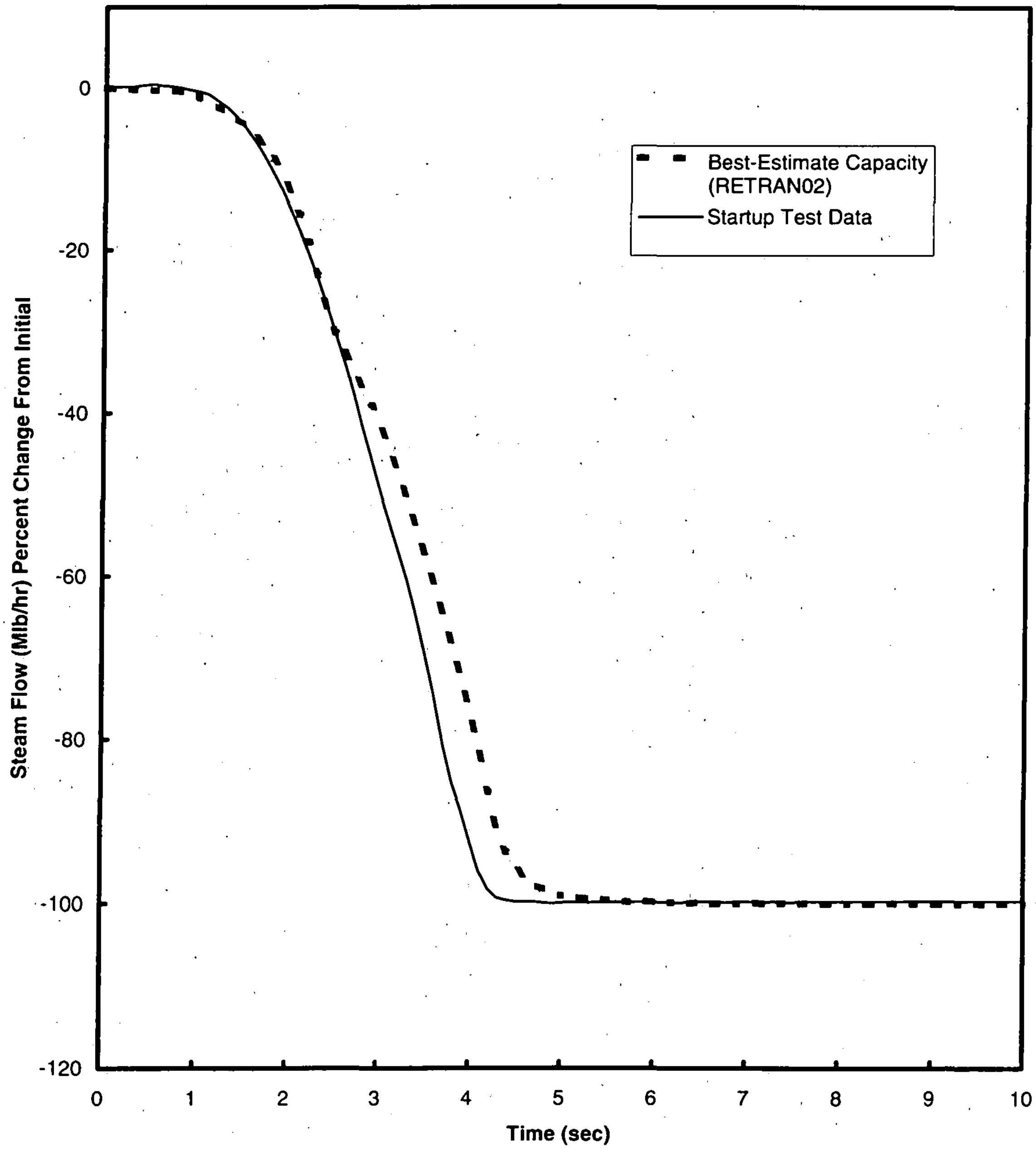

Figure 11 LaSalle BWR/5 MSIVC Steam Flow

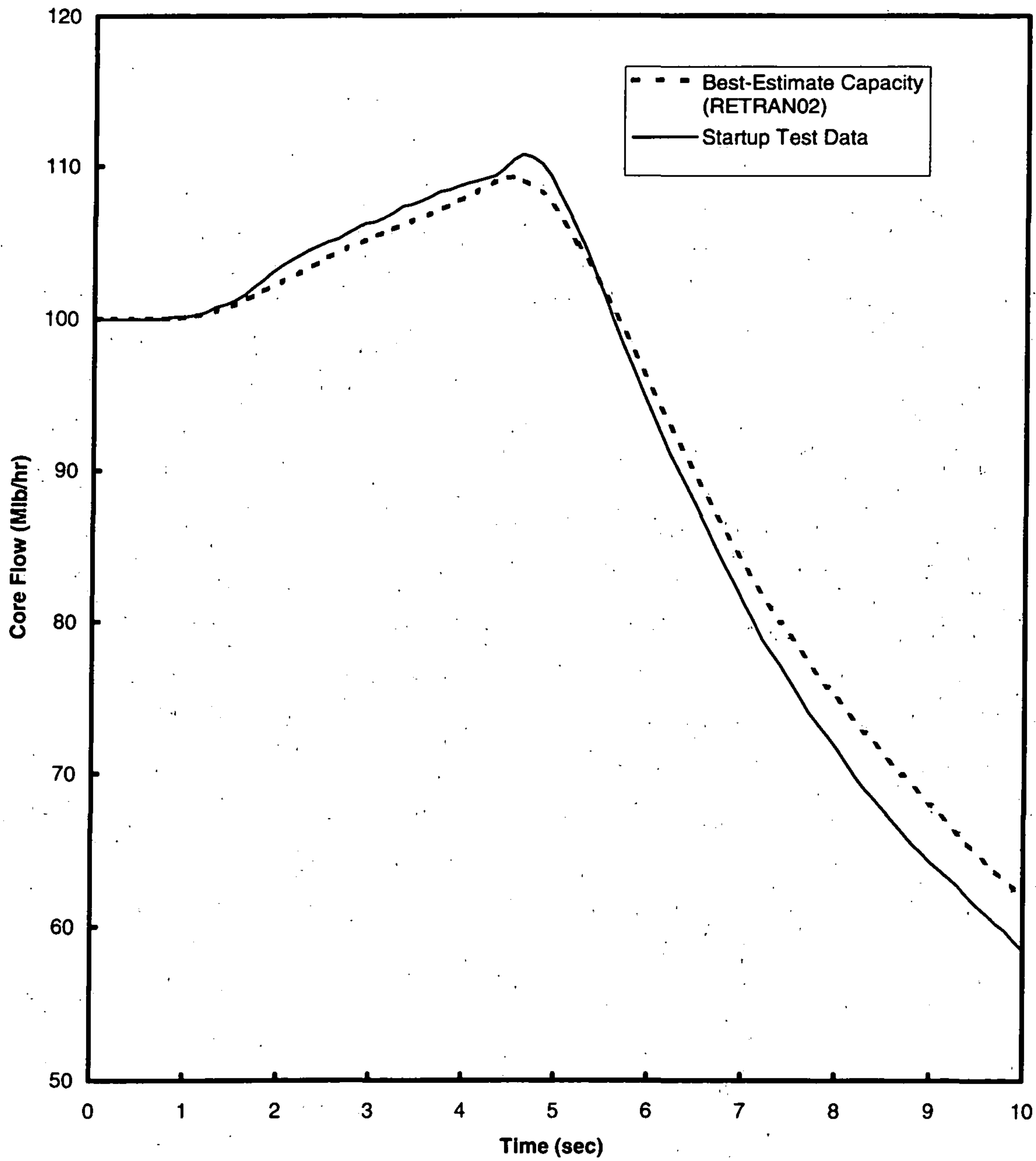

Figure 12 LaSalle BWR/5 MSIVC Core Flow