LTR-NRC-15-33 NP-Attachment

WCAP-17721-P NRC Set 2, Safety and Code Review Branch – RAI 2.32 Response Supplement (Non-Proprietary)

Westinghouse Electric Company LLC
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066

Background

Request for Additional Information (RAI) 2.32[1] requested Westinghouse to generate plots of integrated secondary side energy release for the FLECHT SEASET steam generator (SG) test case simulations presented in WCAP-17721-P Section 3.2. The RAI also requested that Westinghouse provide a discussion which demonstrates that WCOBRA/TRAC (WCT) provides an adequate prediction of the FLECHT SEASET data. The response to the RAI is documented in Westinghouse letter LTR-NRC-15-20[2] and provided the requested plots. The response indicated that 3 of the 7 FLECHT SEASET simulations calculated secondary to primary heat transfer rates that [ ]^{a,c} than the test data (R21806, R22314, and R22503). Test data was unavailable for a large portion of R21909, and code calculated secondary to primary heat transfer was [ ]^{a,c} for 3 tests (R22701, R22920, and R23402). The response to RAI 2.32 indicated that the SG heat transfer data from the test was only an estimate, and it was based on the primary side energy balance. Plots showing calculated and measured secondary side temperature vs. elevation were referred to, and largely the WCT simulations calculated [ ]^{a,c}, even for R22701, R22920, and R23402. During the April 8-9 Nuclear Regulatory Commission (NRC) audit, the NRC pointed out that the WCT [ ]^{a,c} than measured and that the measured [ ]^{a,c}. There was also an ongoing discussion relative to the 'spike' in secondary to primary heat transfer shown early in time for some of the tests.

Further Discussion

Westinghouse's argument that the WCT FLECHT SEASET SG simulations provided conservative results relative to secondary to primary heat transfer was primarily based on the [ ]^{a,c}. WCAP-9724 (NUREG/CR-1534)[3] contains isometric plots which show radial secondary side temperatures vs elevation above the tube sheet for R22701. Figure 5-46 through Figure 5-48 (reproduced below) indicate that there is [ ]^{a,c} at any given time and elevation. The lack of [ ]^{a,c} can be demonstrated for R22920 and R23402 as well with

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[1] Request for Additional Information Re: Westinghouse Electric Company Topical Report WCAP-17721-P, Revision 0, and WCAP-17721-NP, Revision 0, "Westinghouse Containment Analysis Methodology - PWR [Pressurized Water Reactor] LOCA [Loss-Of-Coolant Accident] Mass and Energy Release Calculation Methodology," - Set 2 (Safety and Code Review Branch) (TAC No. MF1797), October 14, 2014 (ADAMS Accession No. ML14254A251)

[2] LTR-NRC-15-20, "Submittal of "WCAP-17721-P NRC Set 2, Safety and Code Review Branch – Response to Selected RAIs" (Proprietary/Non Proprietary)," March 2015

[3] WCAP-9724 (NUREG/CR-1534), "PWR FLECHT SEASET Steam Generator Separate Effects Task Data Analysis and Evaluation Report," February 1982

information from WCAP-9621[4] (detailed data report). Figure 1 and Figure 2 show the secondary fluid temperature at 69 ft from the tube inlet (i.e. near the outlet) for radial positions 1 (close to centerline) and 4 (closest to SG shell) for R22920. The temperature profiles for radial positions 1 and 4 [ ]^{a,c}. Figure 3 and Figure 4 show the same comparison for R23402. This indicates that the SG was cooling down [ ]^{a,c}.

Regarding the secondary to primary heat transfer spike, shown most notably in WCAP-17721-P Figure 3-6 (R22701), Figure 3-12 (R23402), and Figure 3-42 (R22920), WCAP-9724 on page 5-35 provides some key information. It is stated (for the reference case, R22701) that this early peak is due to a flow transient caused by the loop flow and pressure controllers, and after the first minute, the transient decays into steady state flow. Omitting the transient data, the peak secondary to primary heat transfer rate is estimated to be approximately 144kW (137 BTU/s) on page 5-35, as compared to the 200kW (190 BTU/s) peak which occurs during the transient flow period. Figure 5-14 of WCAP-9724 (NUREG/CR-1534) indicates that the transient flow condition exists for more than 60 seconds for the R22701 test, as it does not drop to 144kW until about 125 seconds. Therefore, the initial peak in heat transfer for the FLECHT SEASET test data is attributed to transient behavior that was not modeled in the WCT simulations.

The summary data on page 22920-1 of WCAP-9621 for R22920 indicates that the temperature of the steam flow was 157°C, which was modeled in WCT; however, the plot showing the SG inlet temperature on page 22920-7 (copied below as Figure 5) shows the SG inlet temperature [ ]^{a,c} There is also a flow transient shown on page 22920-4 (copied below as Figure 6). The R22920 case was re-run with WCT accounting for the aforementioned items. The WCT calculated integral of the SG energy release is still [

]^{a,c}

Considering the transient effects in the FLECHT SEASET test data and allowing for some uncertainty in measured values (temperatures, flows, etc.) and calculated heat transfer rates, the WCT simulations demonstrate that the heat transfer is relatively well predicted compared to test data.

[4] WCAP-9621, "PWR FLECHT SEASET Steam Generator Separate Effects Task Data Report," January 1980

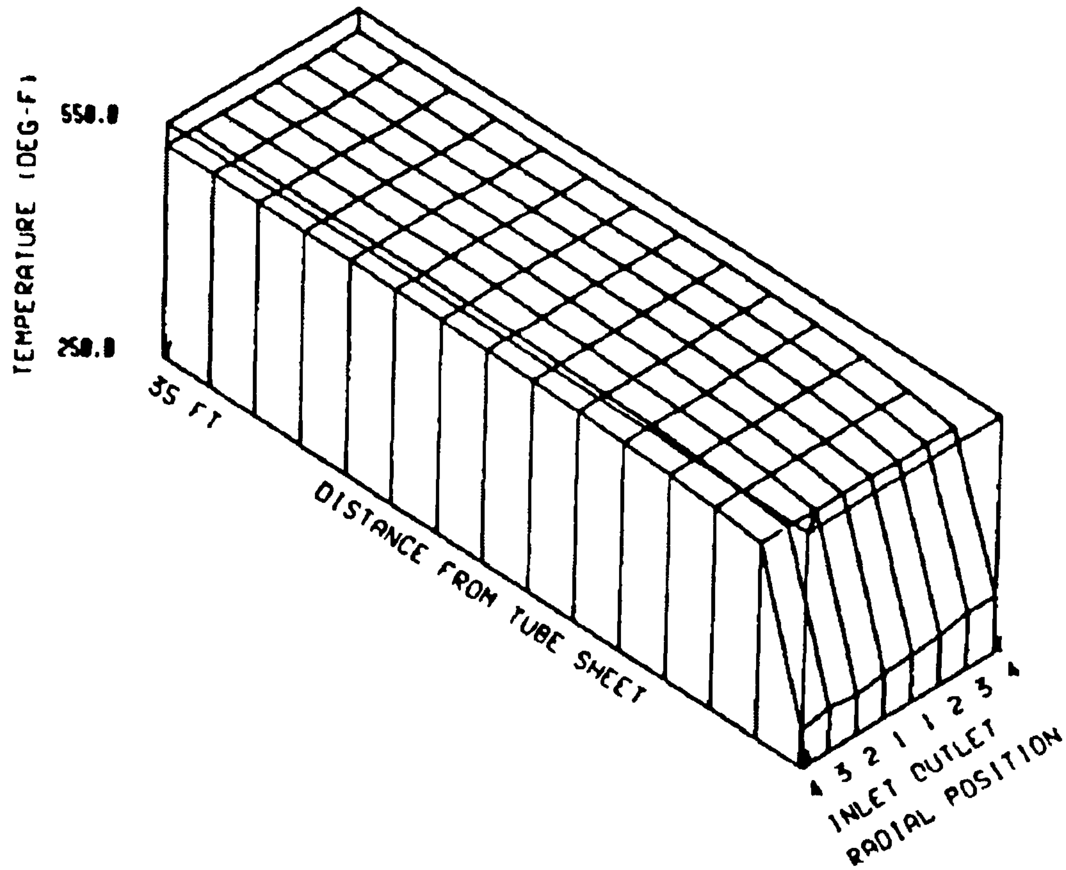

Figure 5-46. Isometric Plot of Secondary Fluid Temperatures at 3.4 Minutes Into Transient, Reference Run

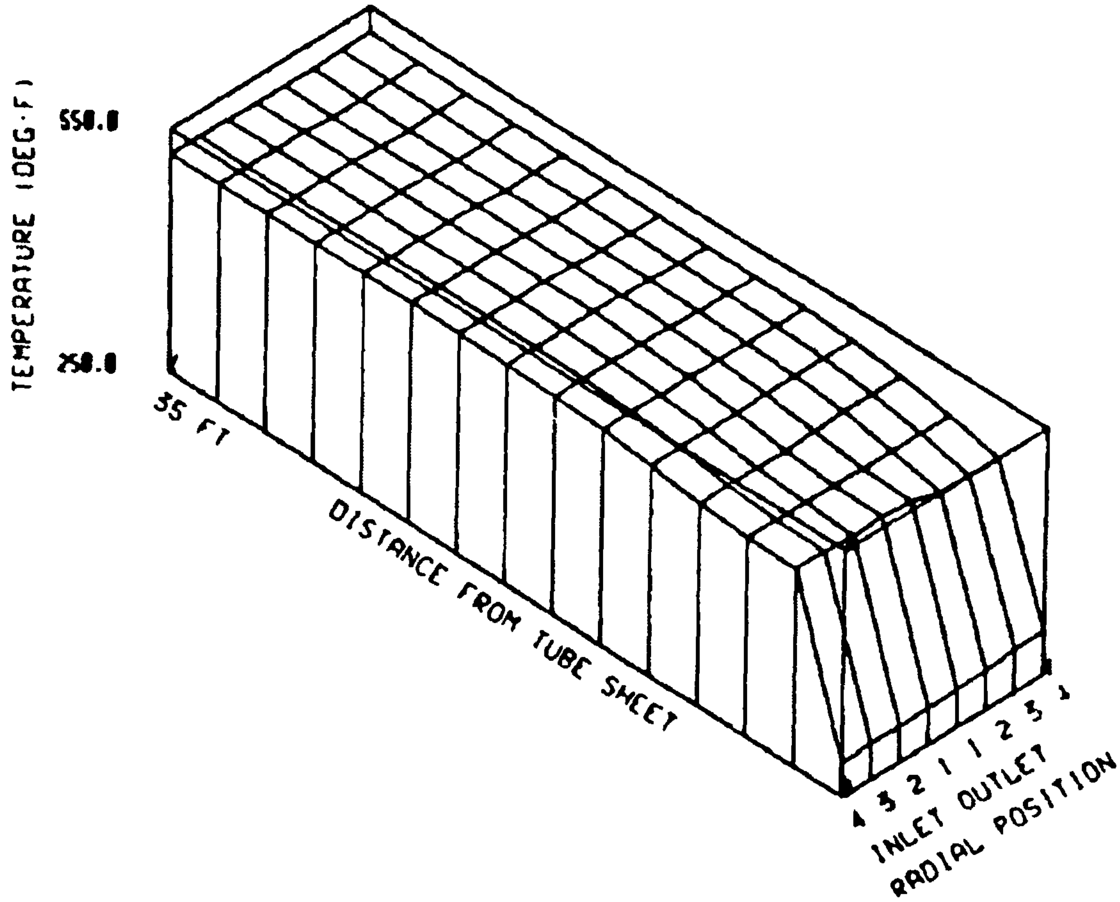

Figure 5-47. Isometric Plot of Secondary Fluid Temperatures at 6.1 Minutes Into Transient, Reference Run

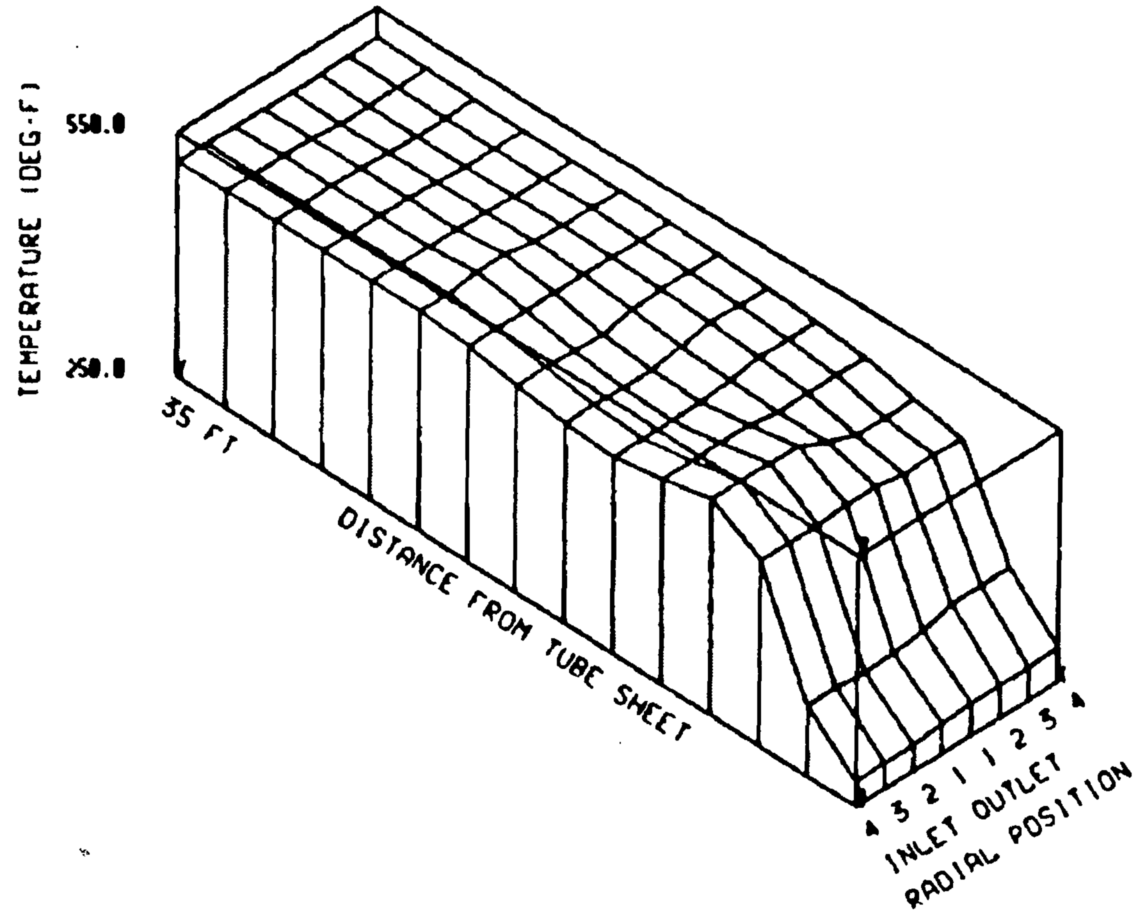

Figure 5-48. Isometric Plot of Secondary Fluid Temperatures at 12.1 Minutes Into Transient, Reference Run

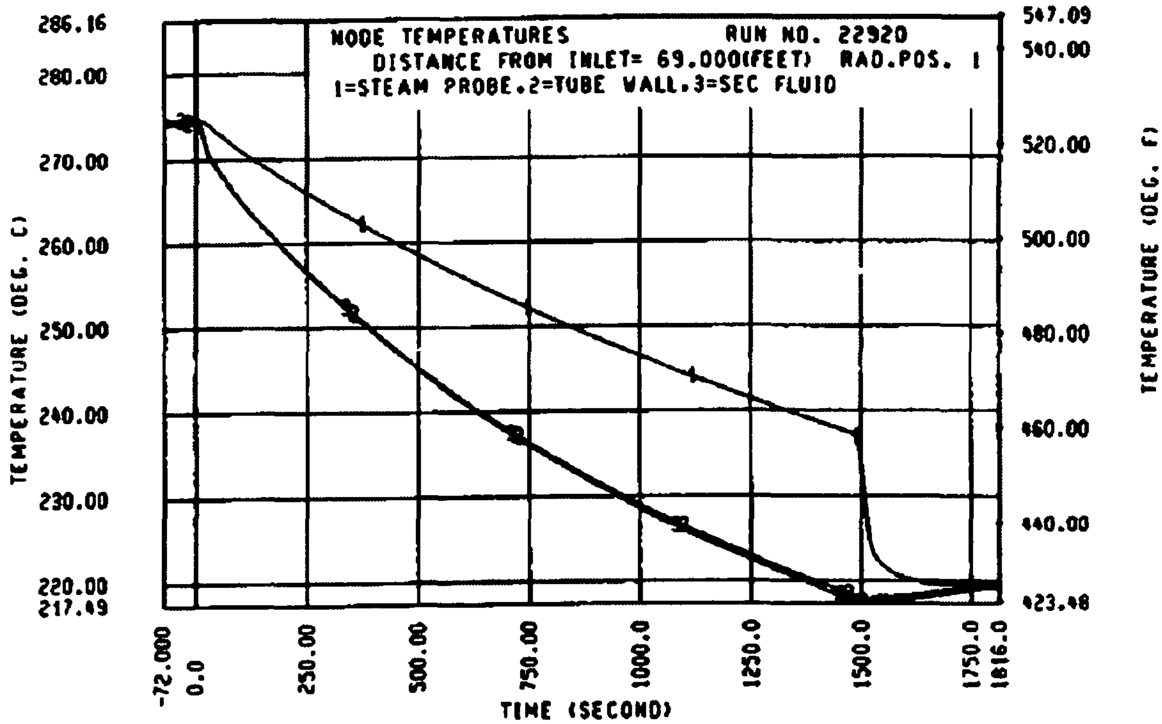

Figure 1: R22920 Steam, Tube Wall, and Secondary Temperature vs. Time for Radial Position 1

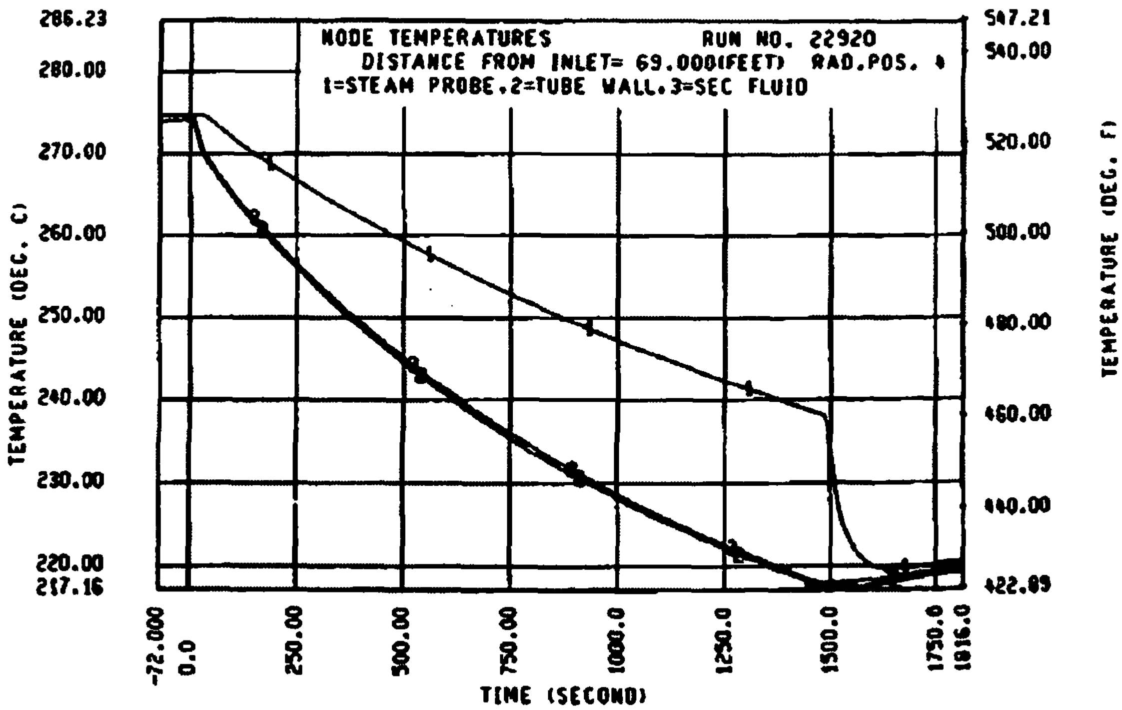

Figure 2: R22920 Steam, Tube Wall, and Secondary Temperature vs. Time for Radial Position 4

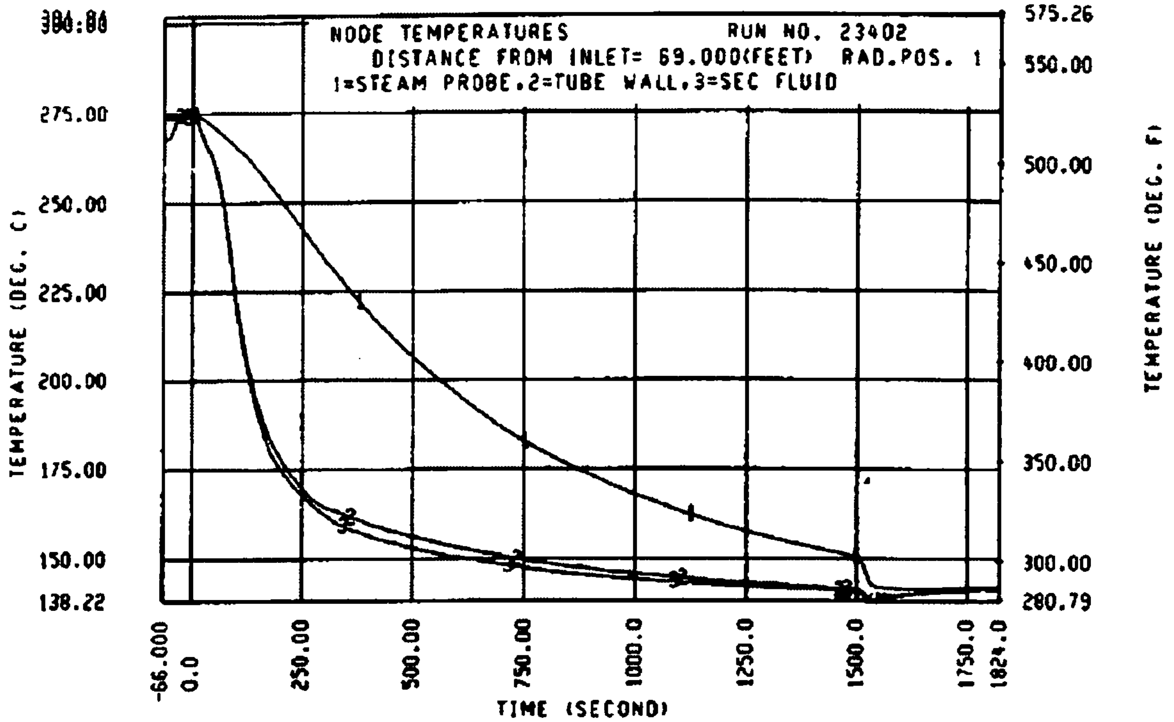

Figure 3: R23402 Steam, Tube Wall, and Secondary Temperature vs. Time for Radial Position 1

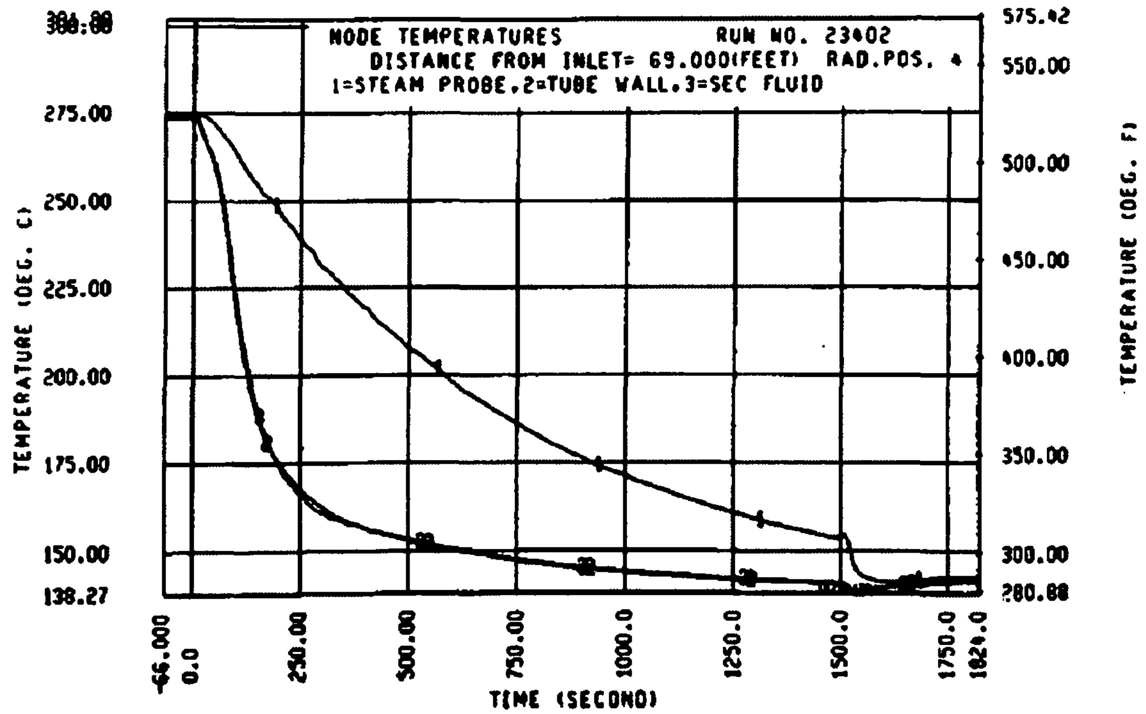

Figure 4: R23402 Steam, Tube Wall, and Secondary Temperature vs. Time for Radial Position 4

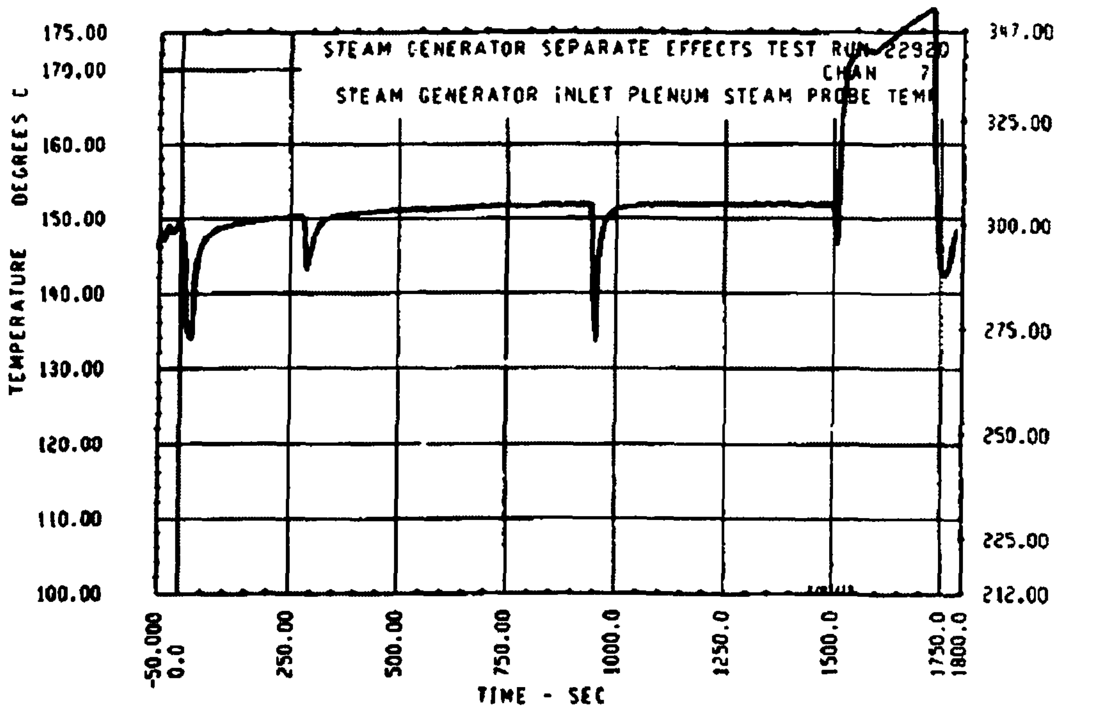

Figure 5: R22920 Primary Side Inlet Temperature

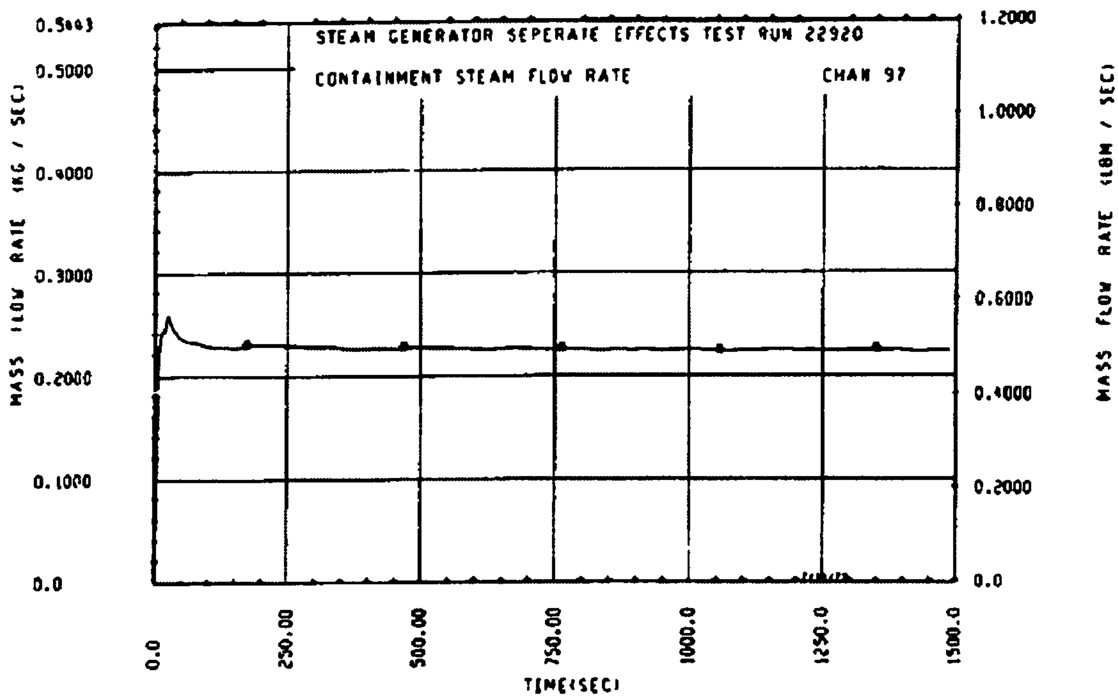

Figure 6: R22920 Primary Side Mass Flow

a,c

Figure 7: Case R22920 Integrated SG Heat Release Rate

a,c

Figure 8: Case R22920 Secondary Fluid Temperature Comparison