APPENDIX C

PRETEST PREDICTIONS OF THE THERMAL AND HYDRAULIC RESPONSES OF THE FUELED OPEN TEST ASSEMBLIES TO THE 35 PERCENT POWER NATURAL CIRCULATION FFTF PLANT STARTUP TEST

TC-1799

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PRETEST PREDICTIONS OF THE THERMAL AND HYDRAULIC
RESPONSES OF THE FUELED OPEN TEST ASSEMBLIES
TO THE 35 PERCENT POWER NATURAL CIRCULATION
FFTF PLANT STARTUP TEST

ABSTRACT

Reported are the expected thermal and hydraulic responses of the specially instrumented fueled open test assemblies (FOTA's) to the FFTF's 35 percent power natural circulation plant startup test. This test is the second in the series of 4 natural circulation transient tests.

The FOTA responses are representative of all the driver assemblies in the core.

These calculations, which are made using the Westinghouse Hanford Company's CORA computer program, indicate that the peak transient coolant temperatures will exceed the initial steady state values by less than 25°F.

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ACKNOWLEDGMENT

The contributions of W. T. Nutt of the Systems Dynamics and Thermal Analysis Section are acknowledged. He provided the problem forcing boundary condition inputs for the CORA computer program, the uncertainties in the boundary conditions, and the process measurement time response data used in the reported pretest predictions.

1.0 INTRODUCTION

Best estimate pretest predictions of the thermal and hydraulic responses of the fueled open test assemblies to the 35 percent power natural circulation FFTF plant startup test are provided. The 35 percent power test is the second in the series of 4 natural circulation tests. Predictions for the 5 percent test, which is the first one in the series, are reported in Reference (1). The reactor core arrangement, including the 2 FOTA's (Fueled Open Test Assemblies), is the same as the one reported on for the 5 percent test. Descriptions of the core and FOTA test articles are given in Reference (1). The locations of the two FOTA's within the core are shown in Figure 1.1

2.0 SUMMARY

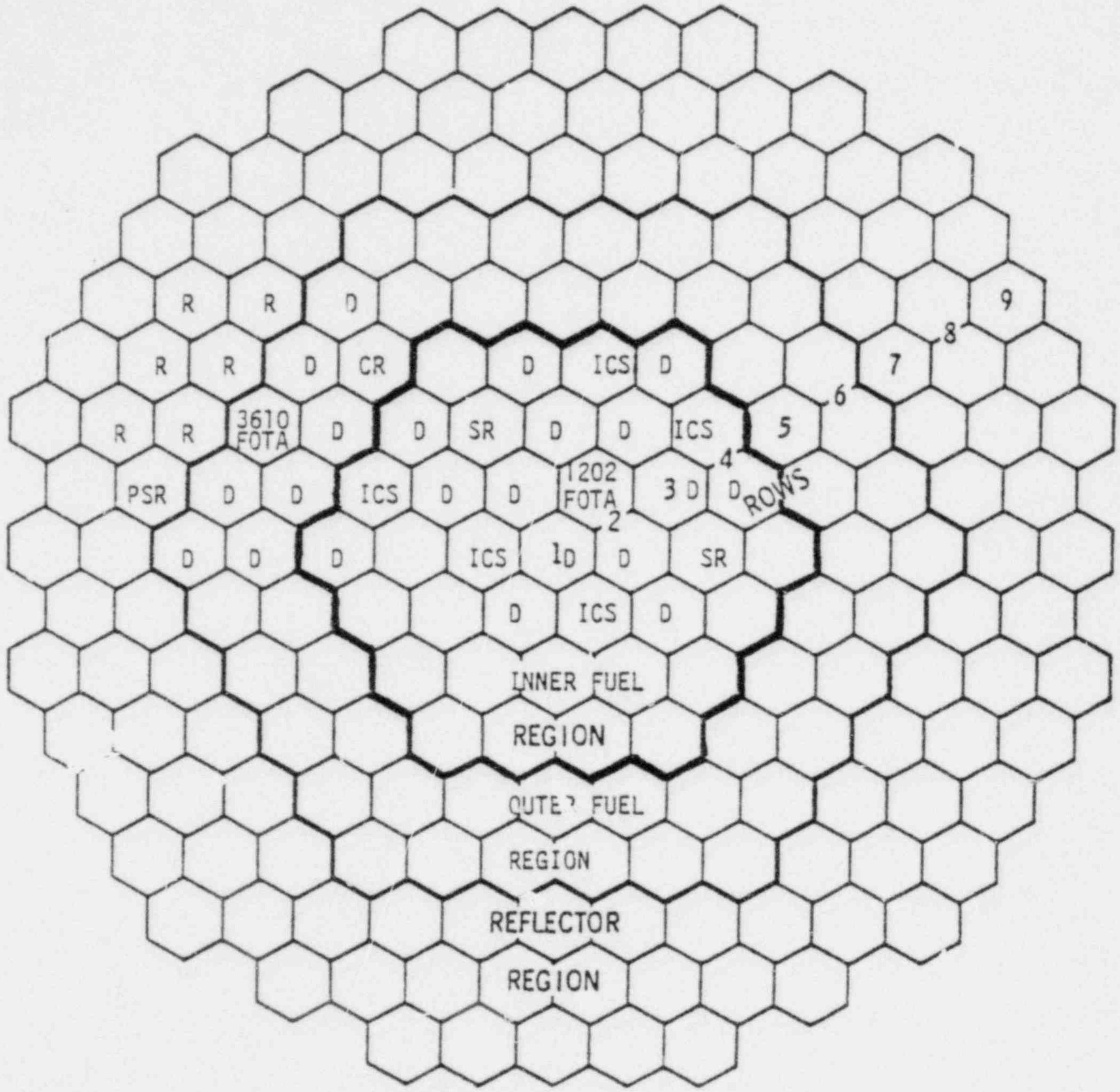
Pretest predictions of the thermal and hydraulic responses of the FFTF core to the plant startup 35 percent power natural circulation test are made using the Westinghouse Hanford Company's CORA Computer Program. Detailed temperature and flow data are presented for the rows 2 and 6 FOTA's as being representative of the core response.

The transient is very mild as shown by the data plots. The peak transient ΔT's are less than 25°F higher than the initial steady temperature rises, and the maximum rates of temperature changes are about 2.3°F/sec increasing and 1.3°F/sec decreasing, excluding the initial drops from steady state.

3.0 CORA COMPUTER PROGRAM FOR ANALYSIS

The predictions are made using the Westinghouse Hanford Company's CORA Computer Program, a preliminary version of which is described in Reference (2). Each FOTA is analyzed as the center assembly in a cluster of 19 assemblies arranged in a hexagonal array. Forcing boundary conditions are obtained from the output of the IANUS System Computer Program, Reference (3), for the nominal test conditions of core irradiation as follows:

Figure 1.1 Locations of FOTA Assemblies Within the Core



D driver
CR control
ICS in-core shim
R reflector
PSR peripheral shim
SR safety

Plant Power Level Fraction of 400 MW Design Power	Time at This Power, Days
0.05	0.04
0.0	1.17
0.1	1.56
0.2	2.72
0.35	2.33

The nominal locations of the FOTA pin bundle thermocouples, and the subdivision of the FOTA assemblies into the program's parallel flow channels are shown in Appendix B. Thermocouple and flow meter time response data are given in Reference (1).

3.1 Definition of Calculated Data

Predictions of coolant temperatures at all of the FOTA thermocouple locations are made by interpolation of CORA's axial and radial nodal point data, but not all of the predictions are included in this report. Representative results are given for the thermocouples tabulated in Table 3.1. Computed results are saved on tape for the FOTA's and the 12 assemblies adjacent to the 2 FOTA's. Data for the other 24 assemblies, for a total of 38 assemblies, are available on microfiche, but in less detail. Fuel, cladding, duct wall, interstitial coolant, orifice assembly and instrument stalk temperatures are available in addition to the pin bundle coolant temperature data. Overall assembly and subchannel flow rate data are also available.

3.2 Uncertainties in the Predictions

The uncertainties in the predictions are due to:

1. CORA Program modeling and calculational uncertainties,
2. System program modeling and calculational uncertainties, and
3. Test performance uncertainties.

TABLE 3.1

LIST OF THERMOCOUPLE DATA PLOTTED[1][2]

ROW 2 FOTA		ROW 6 FOTA	
Pin No.	TX No.	Pin No.	TX No.
Core Midplane			
10, 1	1034	16, 10	9002
9, 10	1009	8, 8	[illegible]39
9, 16	1011	2, 1	9022
Top of Fuel			
9, 1	1032	1, 1	9025
9, 4	1036	2, 2	9026
8, 8	1016	4, 4	9018
9, 14	1012	9, 9	9009
9, 17	1008	14, 9	9004
		16, 9	9003
		17, 9	9001
Top of Pins			
7, 1	1031	1, 2	9024
9, 3	1035	3, 3	9019
9, 5	1039	5, 5	9017
10, 8	1041	10, 9	9012
9, 13	1010	17, 8	9044
		13, 9	9041

(1) Refer to Appendix B for locations of these T/C's within the assemblies.

(2) Data are also provided for the instrument stalk T/C's.

The CORA uncertainties include such things as tolerances on heat transfer and fluid flow correlations, uncertainties in pin power deposition data and the like. System code uncertainties are similar. Test performance uncertainties include deviations from the nominal initial steady state power and flow rates. An uncertainty is not included for changes in the makeup of the core from the nominal so-called startup core.

The uncertainties of 2 and 3, above, enter CORA as boundary condition uncertainties.

The uncertainties given below are considered to be approximate limiting values.

The CORA calculational uncerta y on coolant temperature predictions is estimated as ± 7 percent of the coolant temperature rise to any given axial height, and the flow rate uncertainty is estimated as ± 5 percent. These are the uncertainties expected if boundary conditions were specified exactly.

The system program calculational uncertainty is estimated to be ± 16 percent of the coolant temperature rise to any given axial height. The test performance uncertainty contribution is estimated to be ± 8.6 percent of the coolant temperature rise.

The combined uncertainty for the coolant temperature rise is ± 20 percent, and the combined assembly flow rate uncertainty is about ± 16 percent of the indicated transient rates.

4.0 PRETEST PREDICTIONS

Temperature data are provided herein for the thermocouple locations listed in Table 3.1. Data are also given for the FOTA assembly flow rates. These results are based on the nominal code input values, listed in the Appendix A, as obtained from the system's code.

Each plot includes a curve for the calculated coolant temperature or flow and a second curve of the calculated temperature or flow as adjusted for measurement delays. The uncertainty of these plots are discussed in Section 3.2.

Additional data points are included for the "real" calculated averages at the given core elevations in Figures 4.15, 4.16, 4.35 and 4.36. "Real", in this case, denotes the CORA calculated thermal average of all the pin bundle flow channels and takes into account the flow rates and temperatures of each of these channels. The calculated coolant and adjusted curves are simple averages of all T/C data at the given elevation.

Row 2 FOTA temperature and flow data are plotted in Figures 4.1 through 4.16 and 4.17, respectively. Row 6 FOTA temperature and flow data are plotted in Figures 4.18 through 4.36 and 4.37, respectively.

5.0 REFERENCES

(1) TC-1778, "Pretest Predictions of the Thermal and Hydraulic Responses of the Fueled Open Test Assemblies to the 5 Percent Power Natural Circulation FFTF Plant Startup Test", H. G. Johnson, August, 1980.

(2) TC-1505, "CORA - A Computer Code for Thermal and Hydraulic Coupling of Reactor Core Assemblies", H. G. Johnson, September, 1979.

(3) HEDL-TC-556, "Simulation of the Overall FFTF Plant Performance", S. L. Additon, T. B. McCall, C. F. Wolfe, March, 1976.

Figure 4.1 Calculated Row 2 FOTA Core Midplane Coolant Temperatures for T/C TX1034 On Pin 10, 1.

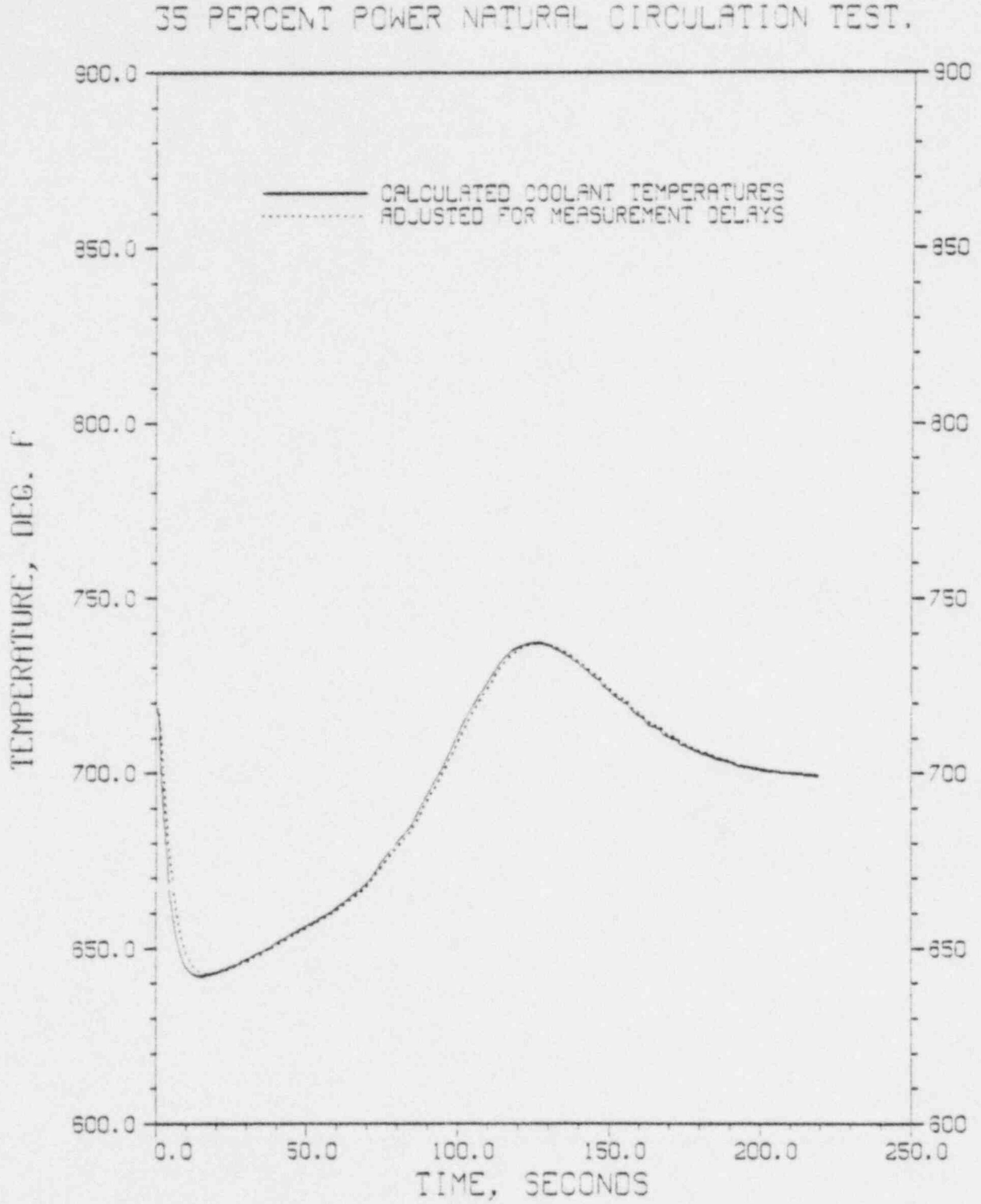


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Figure 4.2 Calculated Row 2 FOTA Core Midplane Coolant Temperatures for T/C TX1009 on Pin 9, 10.

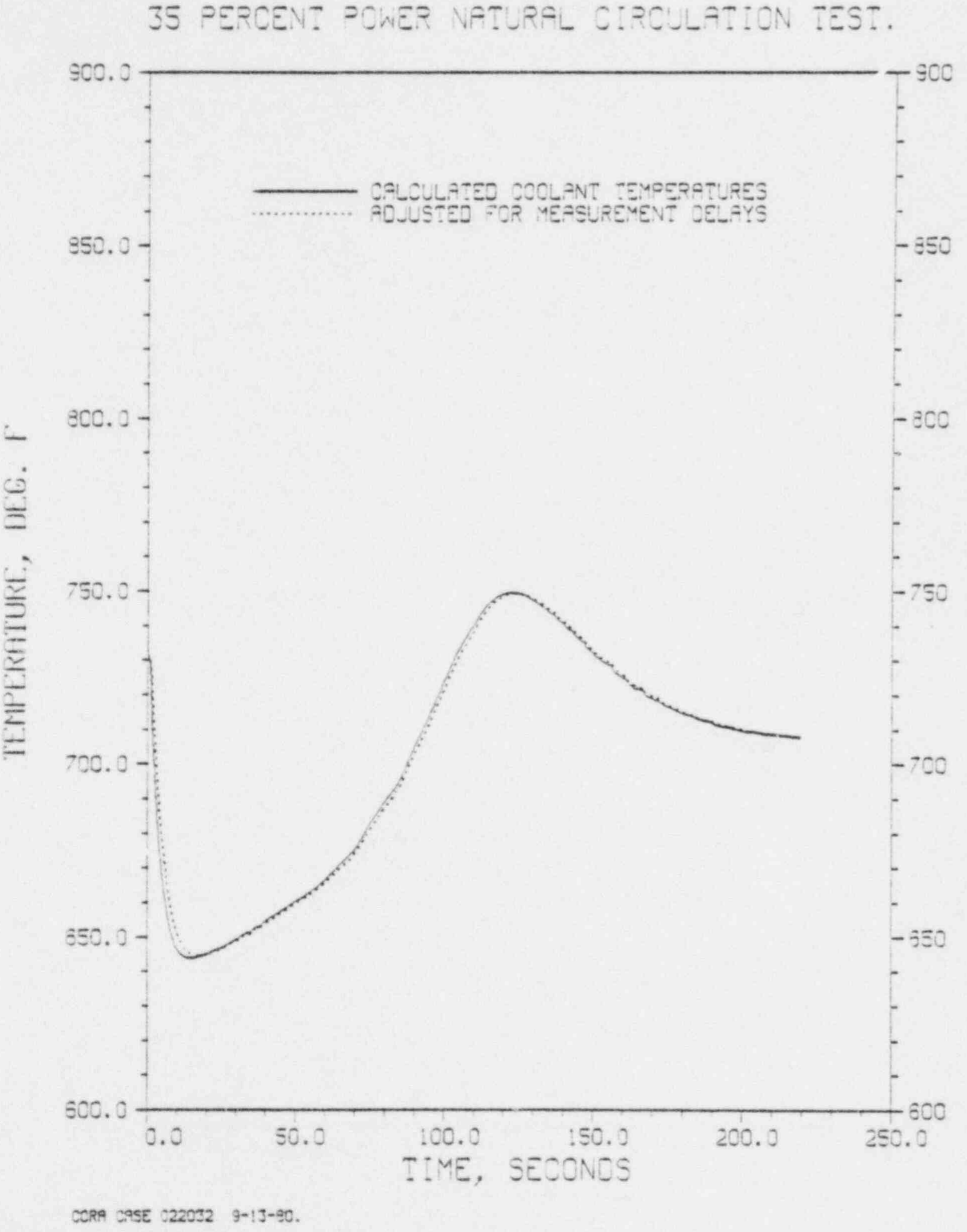

Figure 4.3 Calculated Row 2 FOTA Core Midplane Coolant Temperatures for T/C TX1011 on Pin 9, 16.

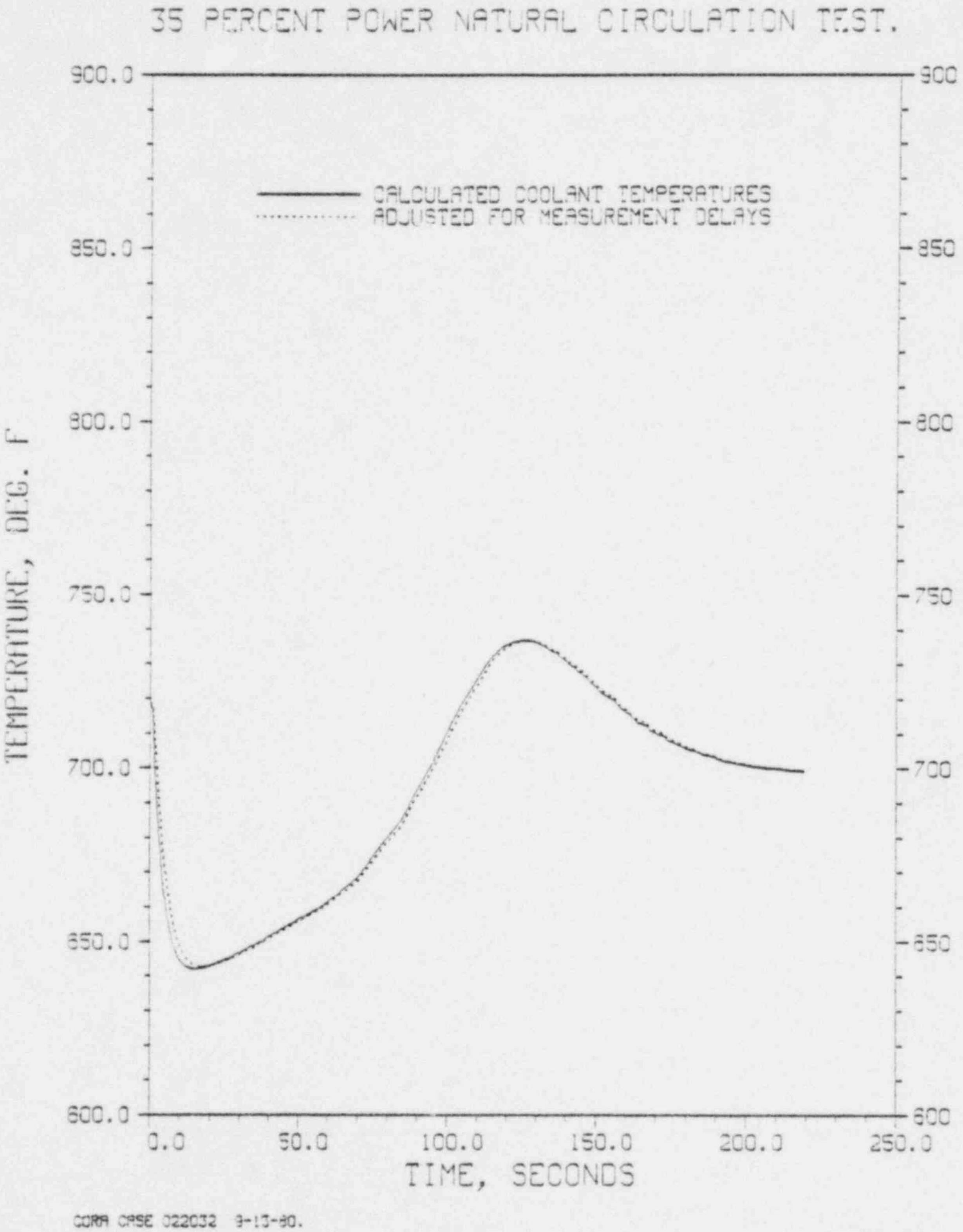

Figure 4.4 Calculated Row 2 FOTA Top of Fuel Coolant Temperatures for T/C TX1032 on Pin 9, 1.

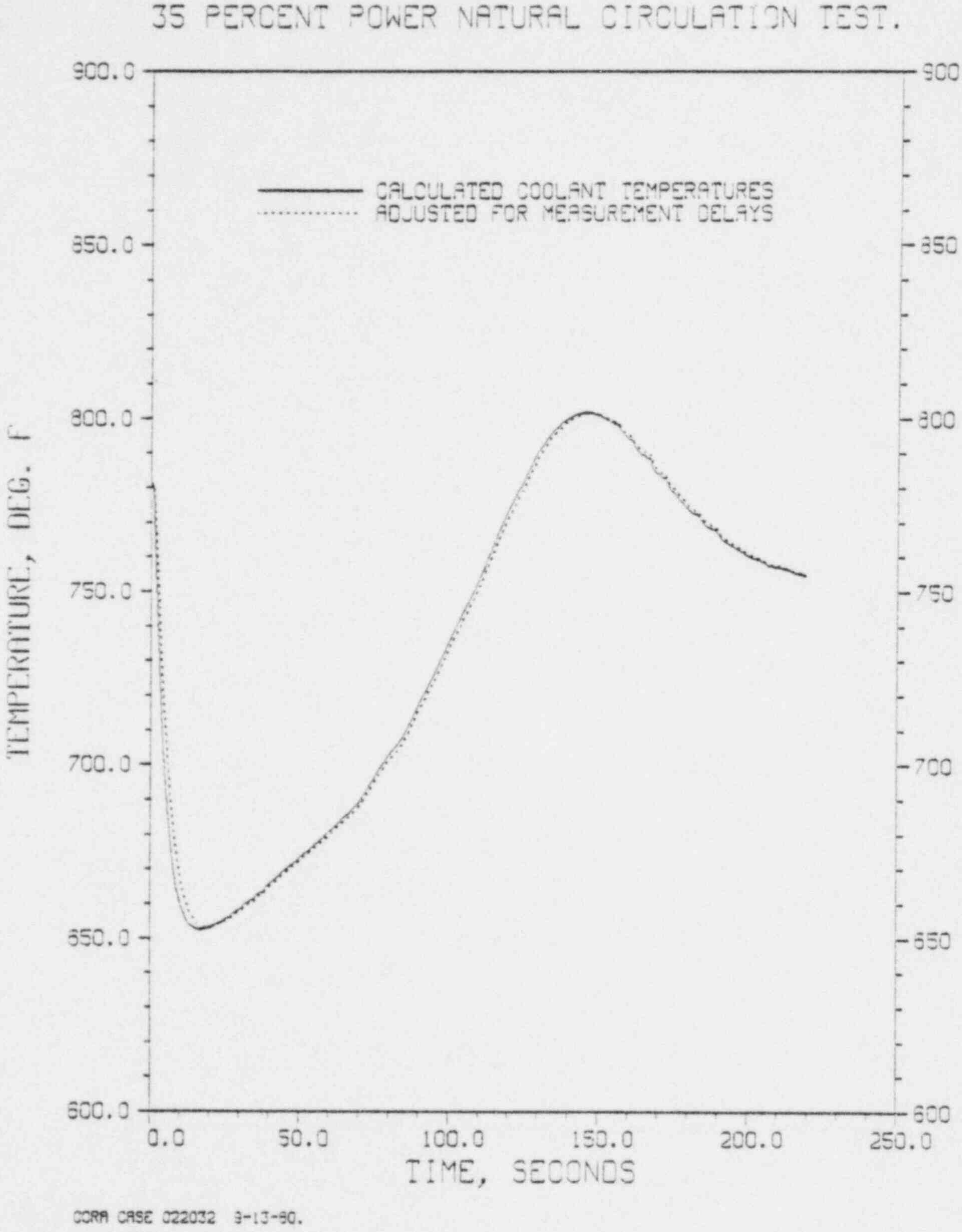

Figure 4.5 Calculated Row 2 FOTA Top of Fuel Coolant Temperatures for T/C TX1036 on Pin 9, 4.

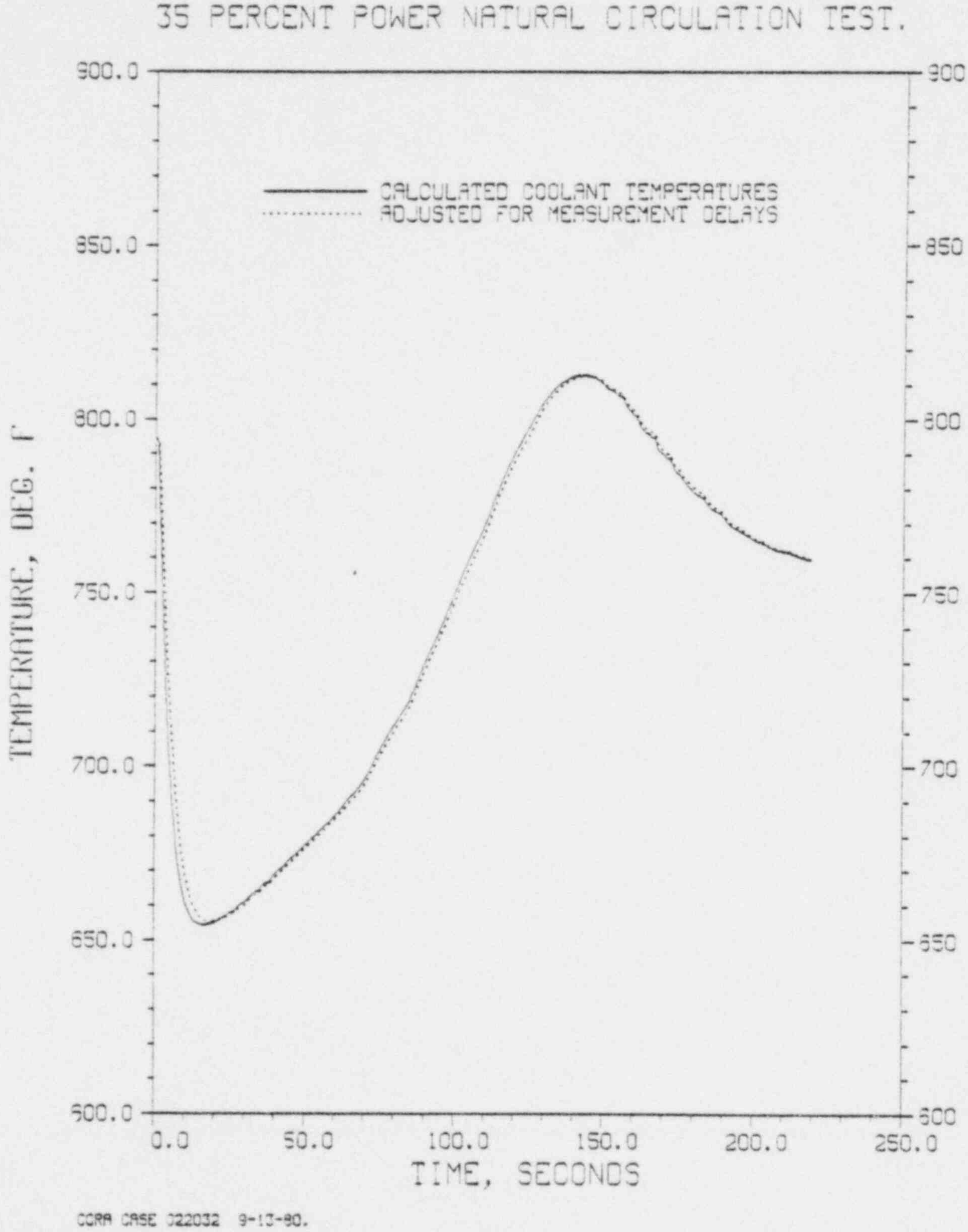

Figure 4.6 Calculated Row 2 FOTA Top of Fuel Coolant Temperatures for T/C TX1016 on Pin 8, 8.

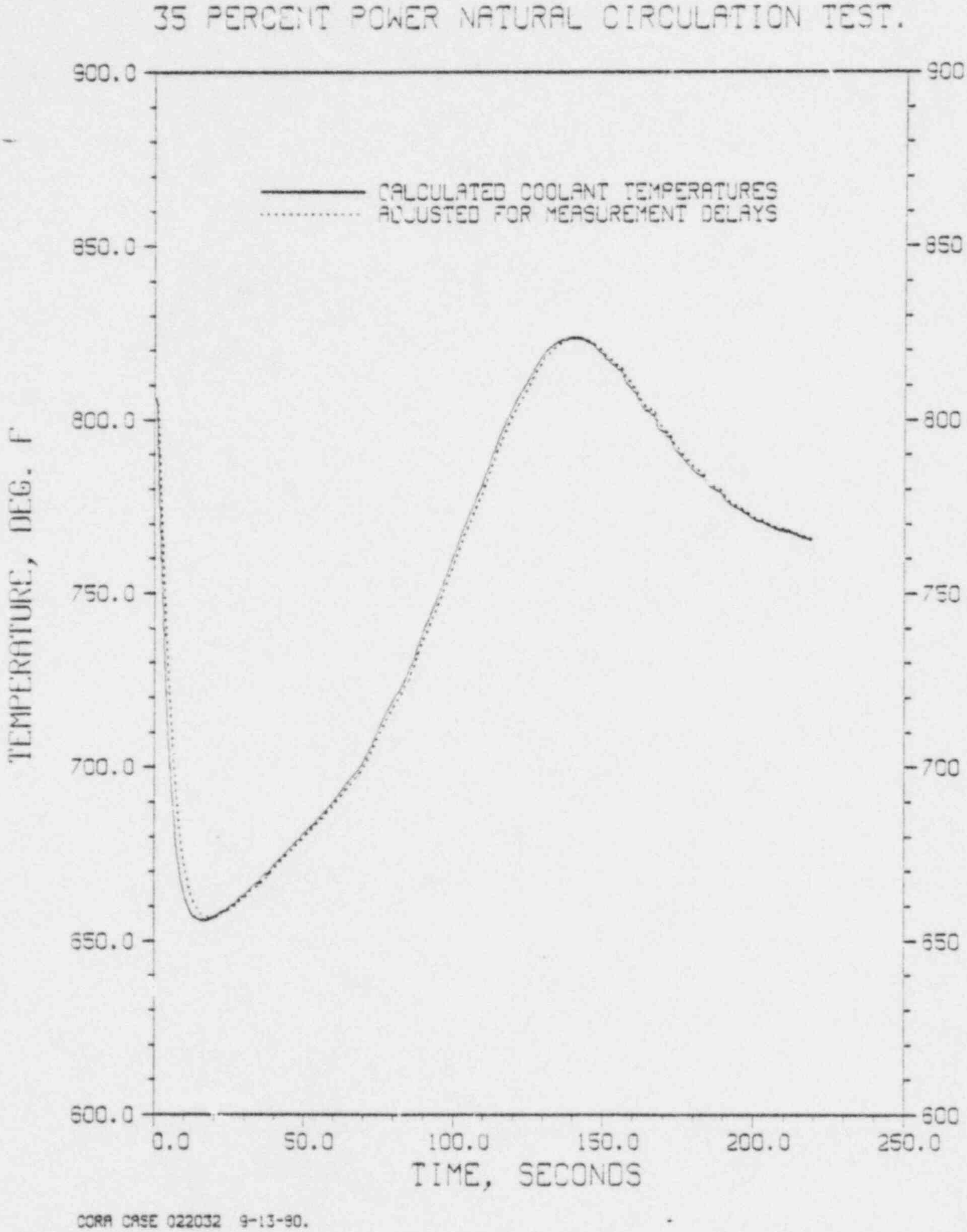

Figure 4.7 Calculated Row 2 FOTA Top of Fuel Coolant Temperatures for T/C TX1012 on Pin 9, 14.

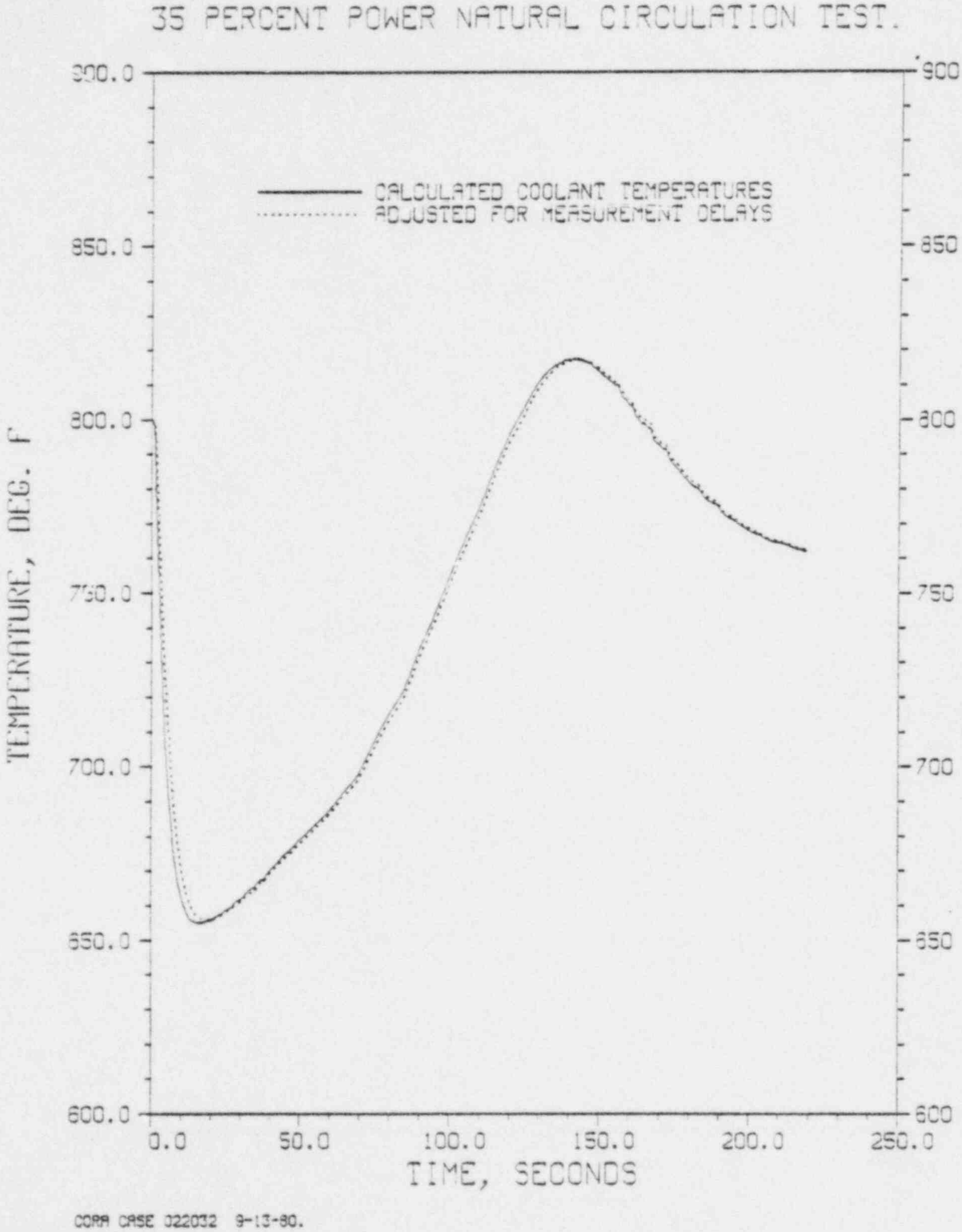

Figure 4.8 Calculated Row 2 FOTA Top of Fuel Coolant Temperatures for T/C TX1008 on Pin 9, 17.

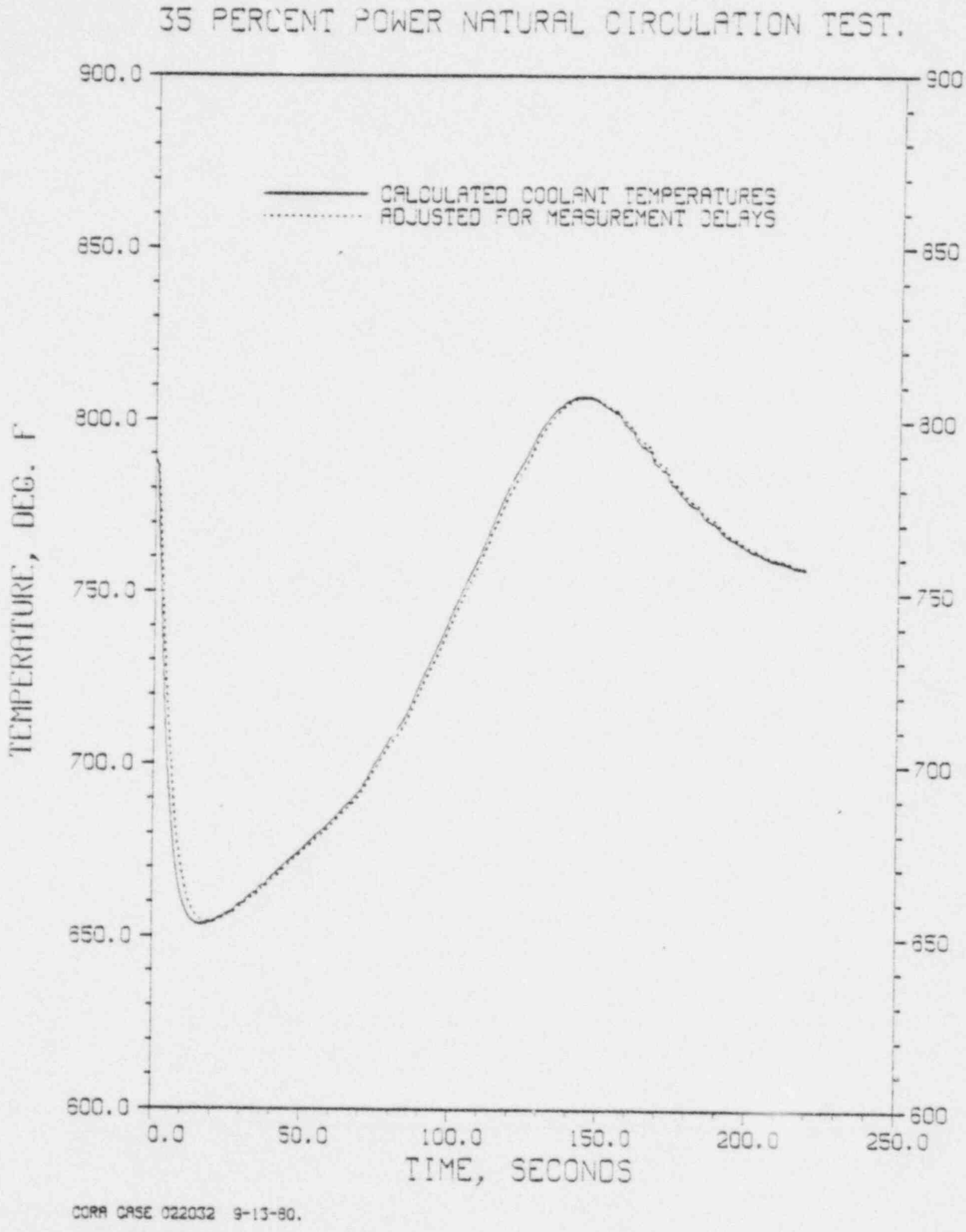

Figure 4.9 Calculated Row 2 FOTA Top of Pins Coolant Temperatures for T/C TX1031 on Pin 7, 1.

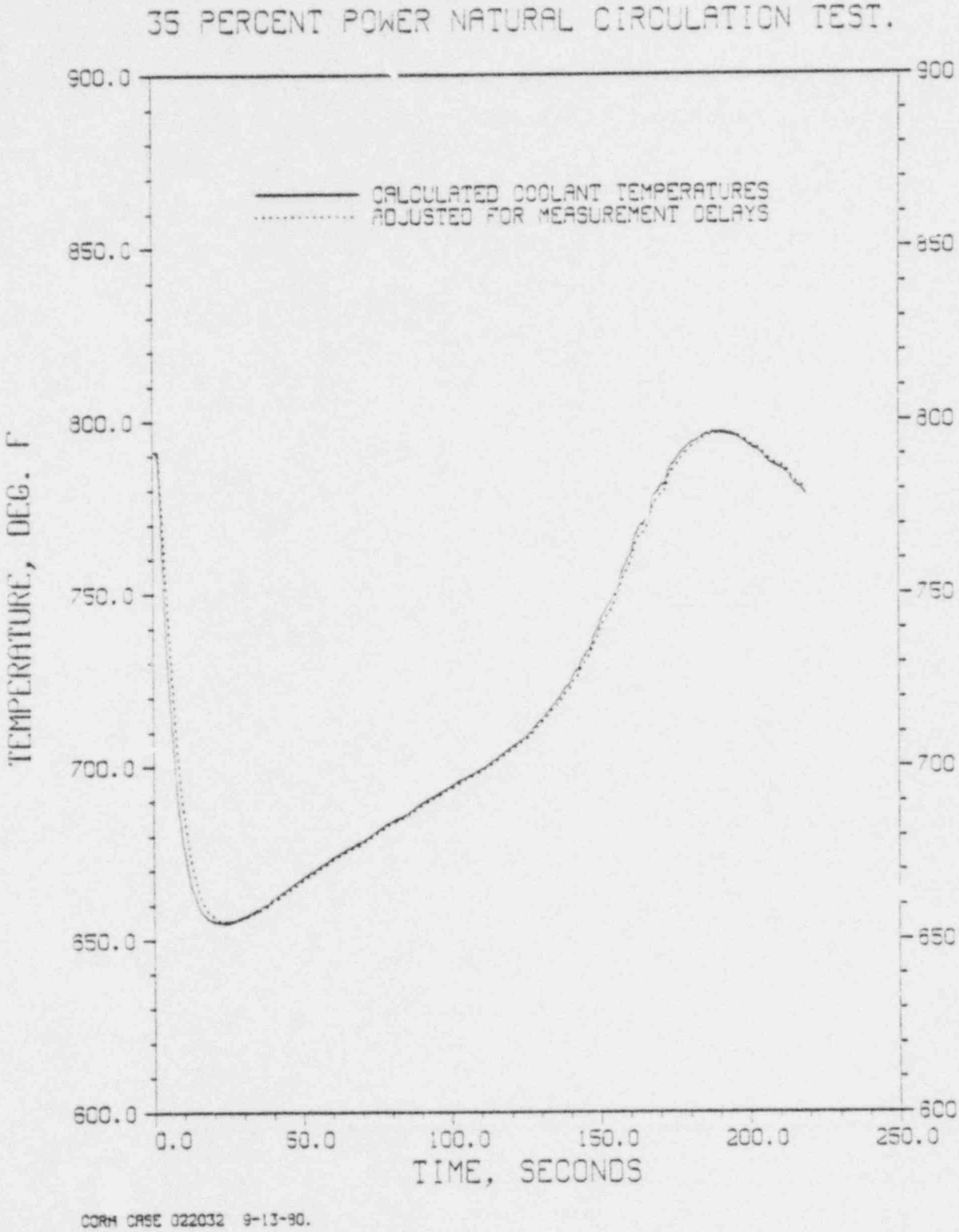

Figure 4.10 Calculated Row 2 FOTA Top of Pins Coolant Temperatures for T/C TX1035 on Pin 9, 3.

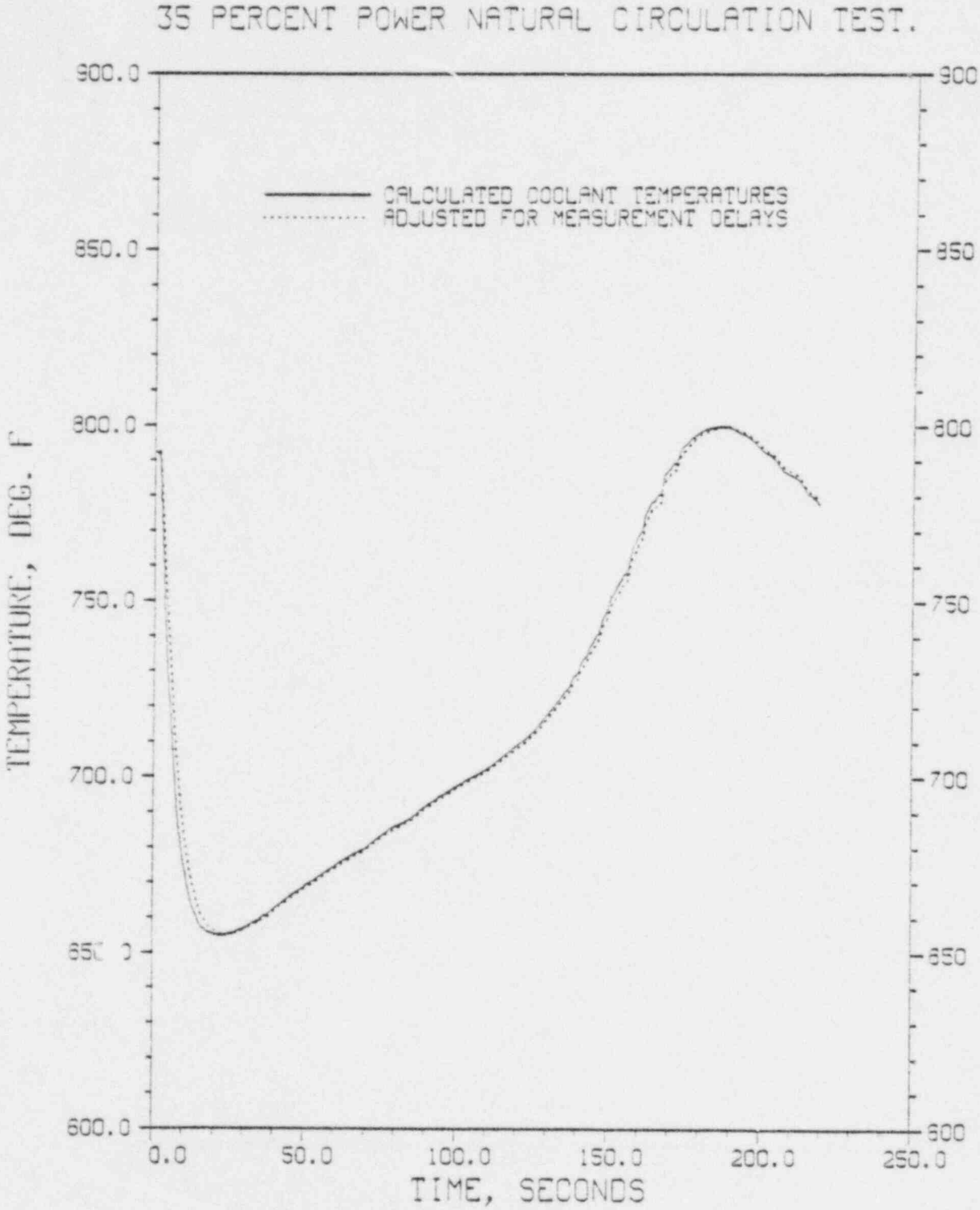

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Figure 4.11 Calculated Row 2 FOTA Top of Pins Coolant Temperatures for T/C TX1039 on Pin 9, 5.

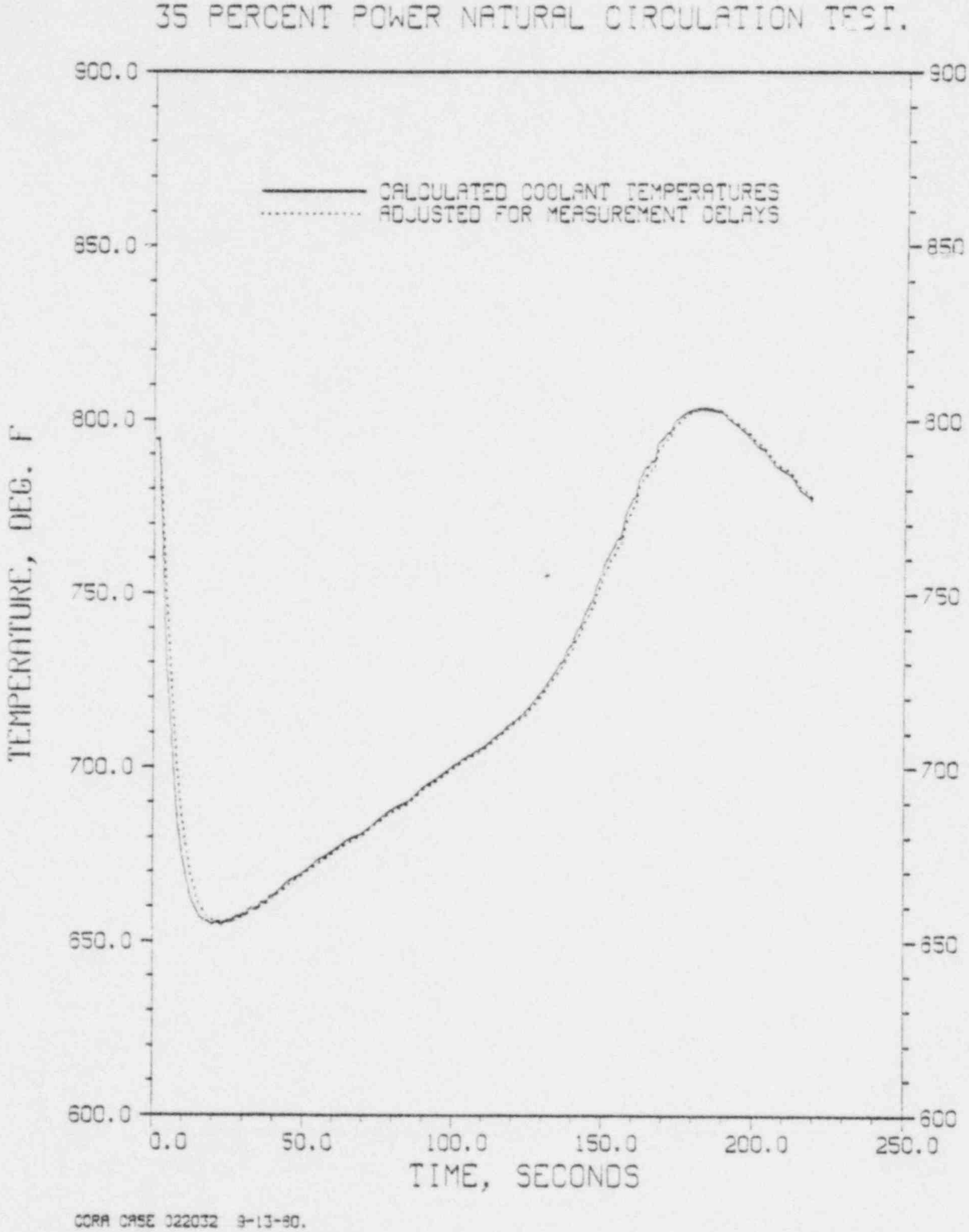

Figure 4.12 Calculated Row 2 FOTA Top of Pins Coolant Temperatures for T/C TX1041 on Pin 10, 8.

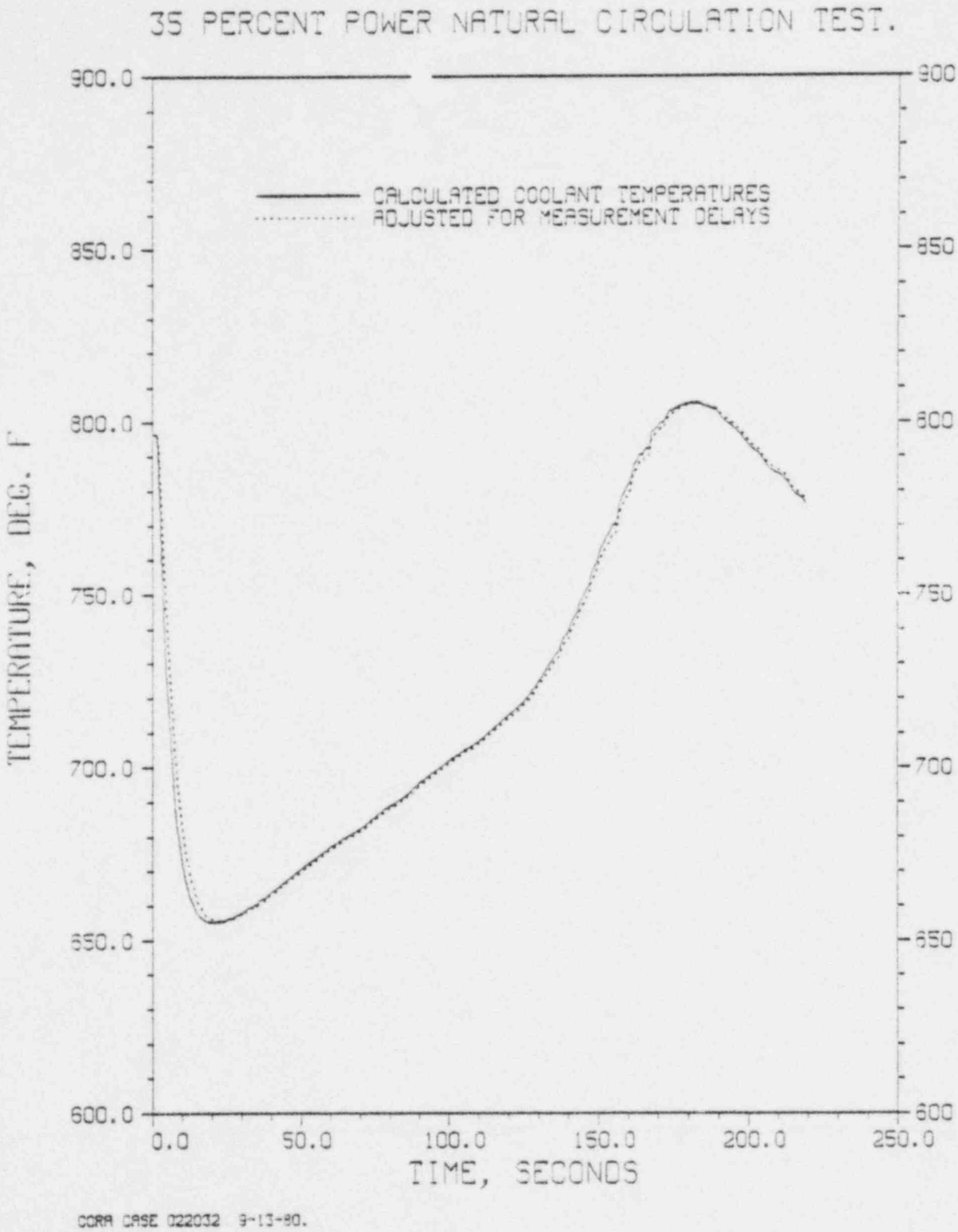

Figure 4.13 Calculated Row 2 FOTA Top of Pins Coolant Temperatures for T/C TX1010 on Pin 9, 13.

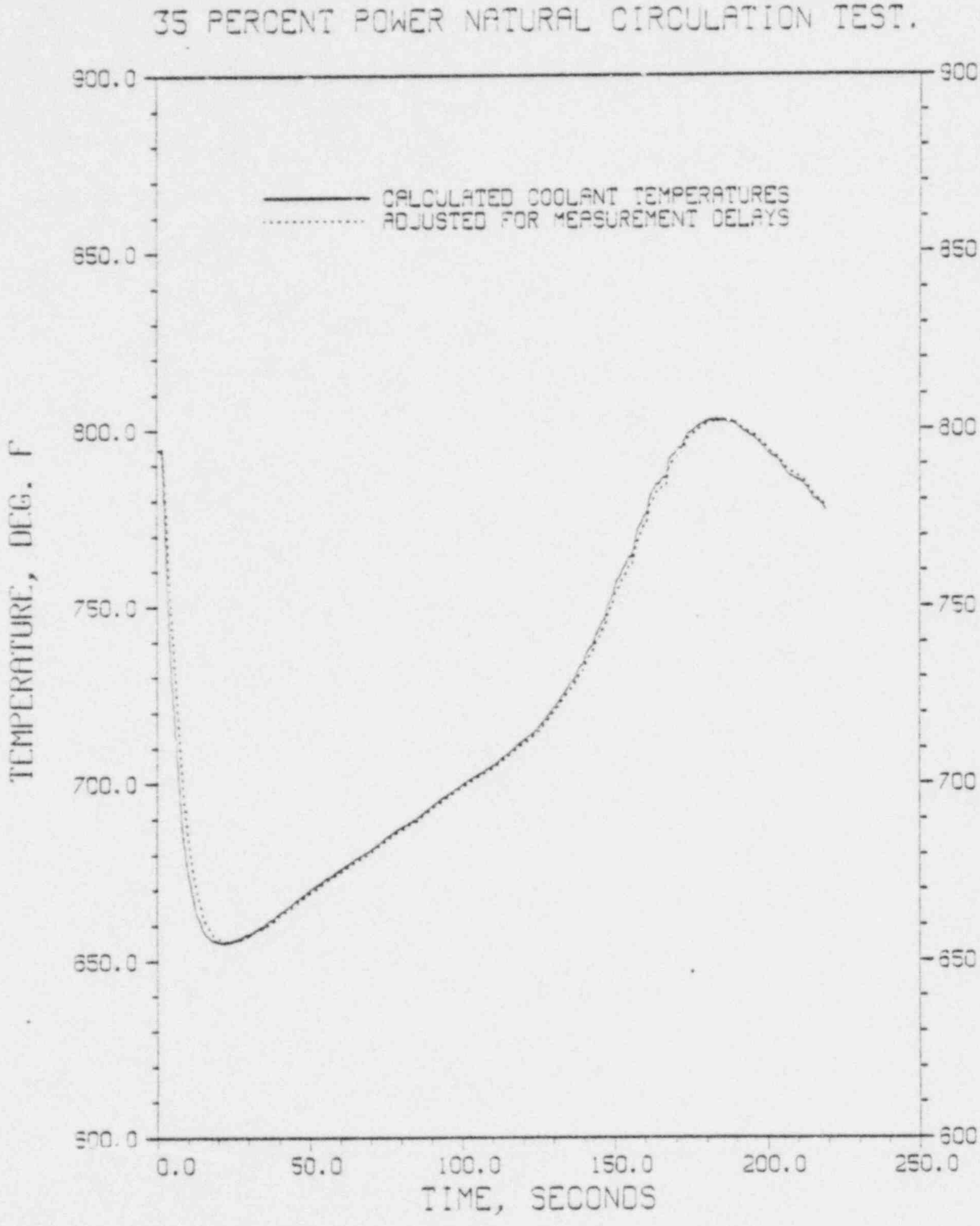

Figure 4.14 Calculated Row 2 FOTA Instrument Stalk Coolant Temperatures at T/C Location.

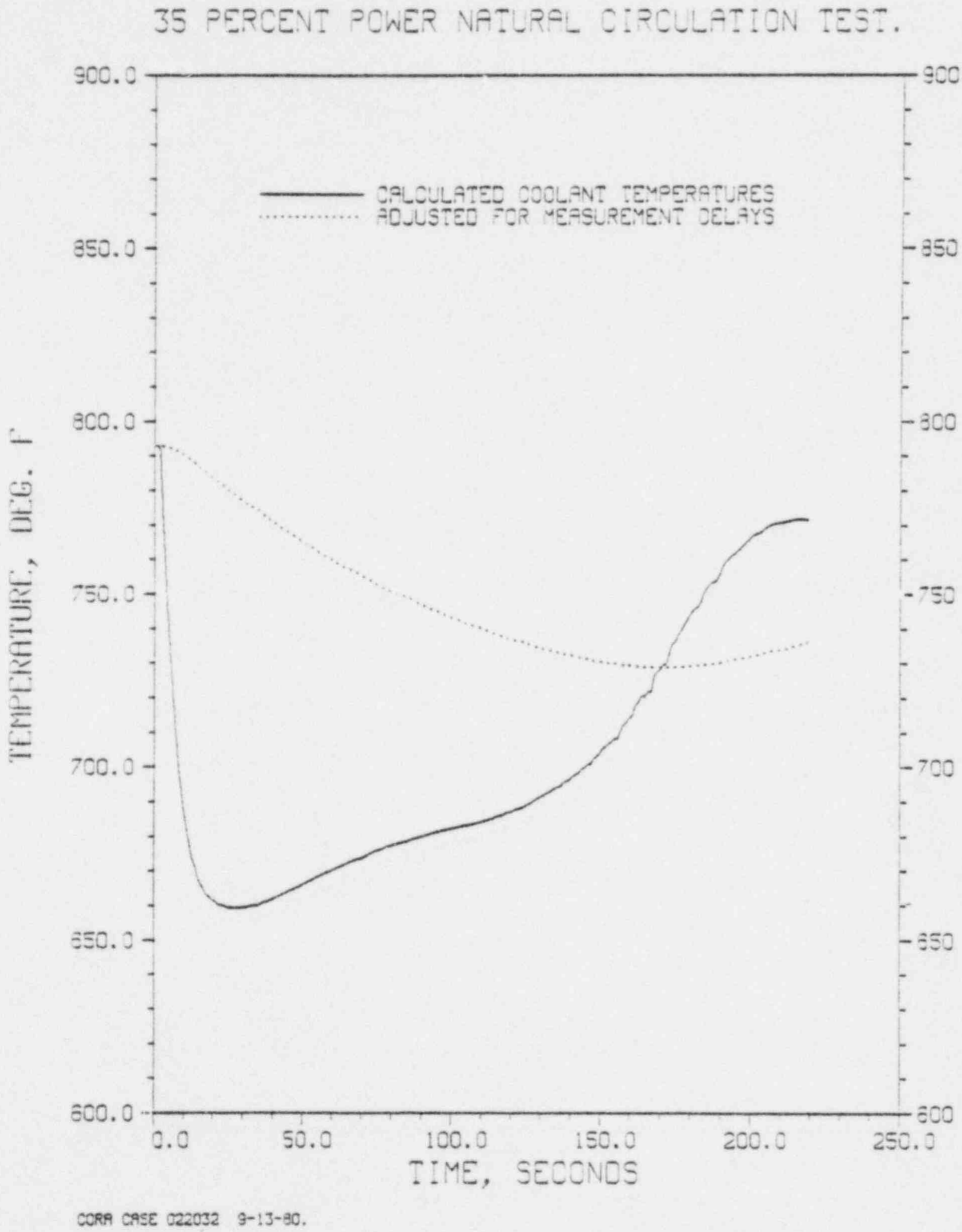

Figure 4.15 Calculated Row 2 FOTA Average Coolant Temperatures at Top of Fuel.

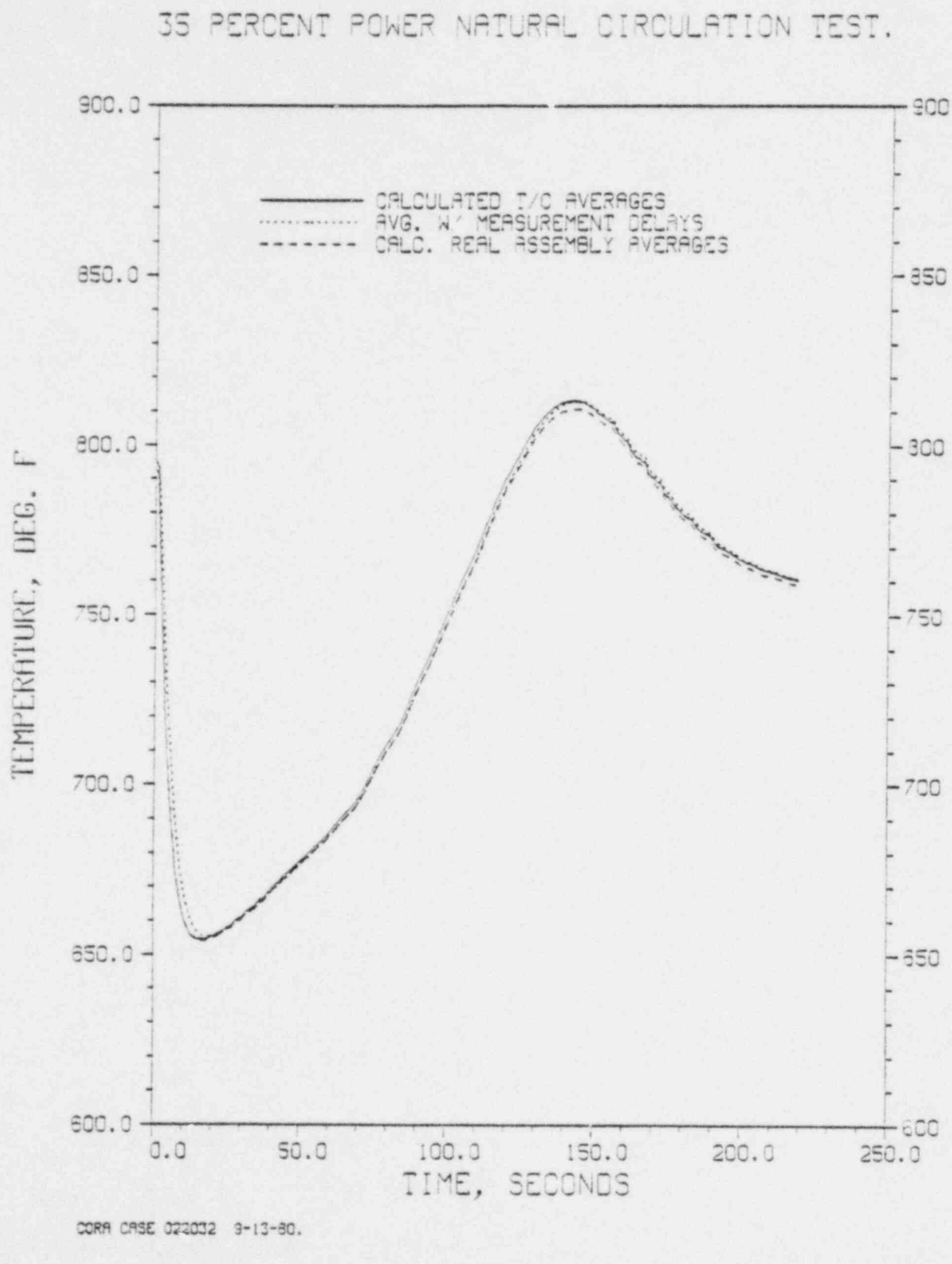

Figure 4.16 Calculated Row 2 FOTA Average Coolant Temperatures at Top of Pins.

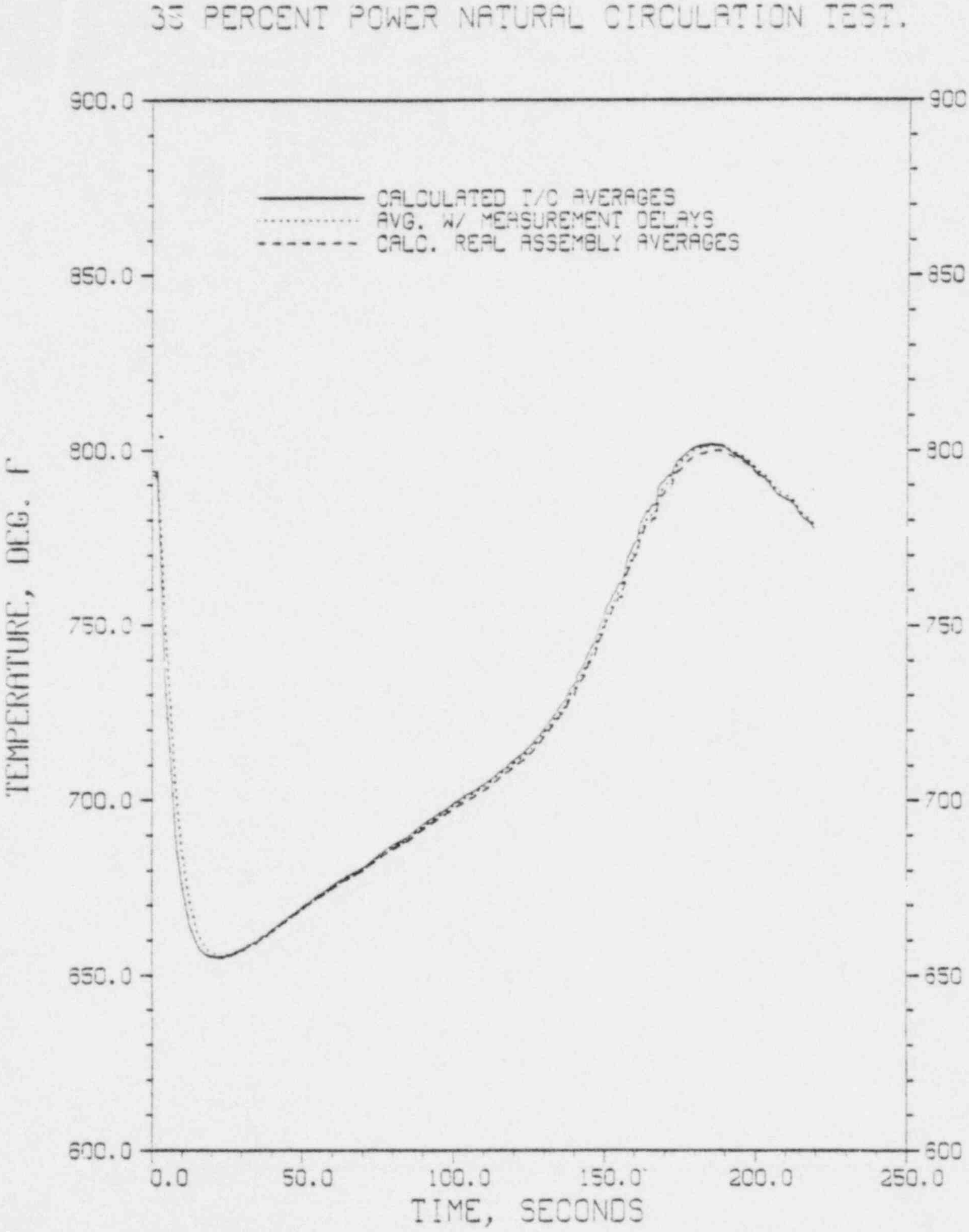

Figure 4.17 Calculated Row 2 FOTA Normalized Assembly Coolant Flow Rates.

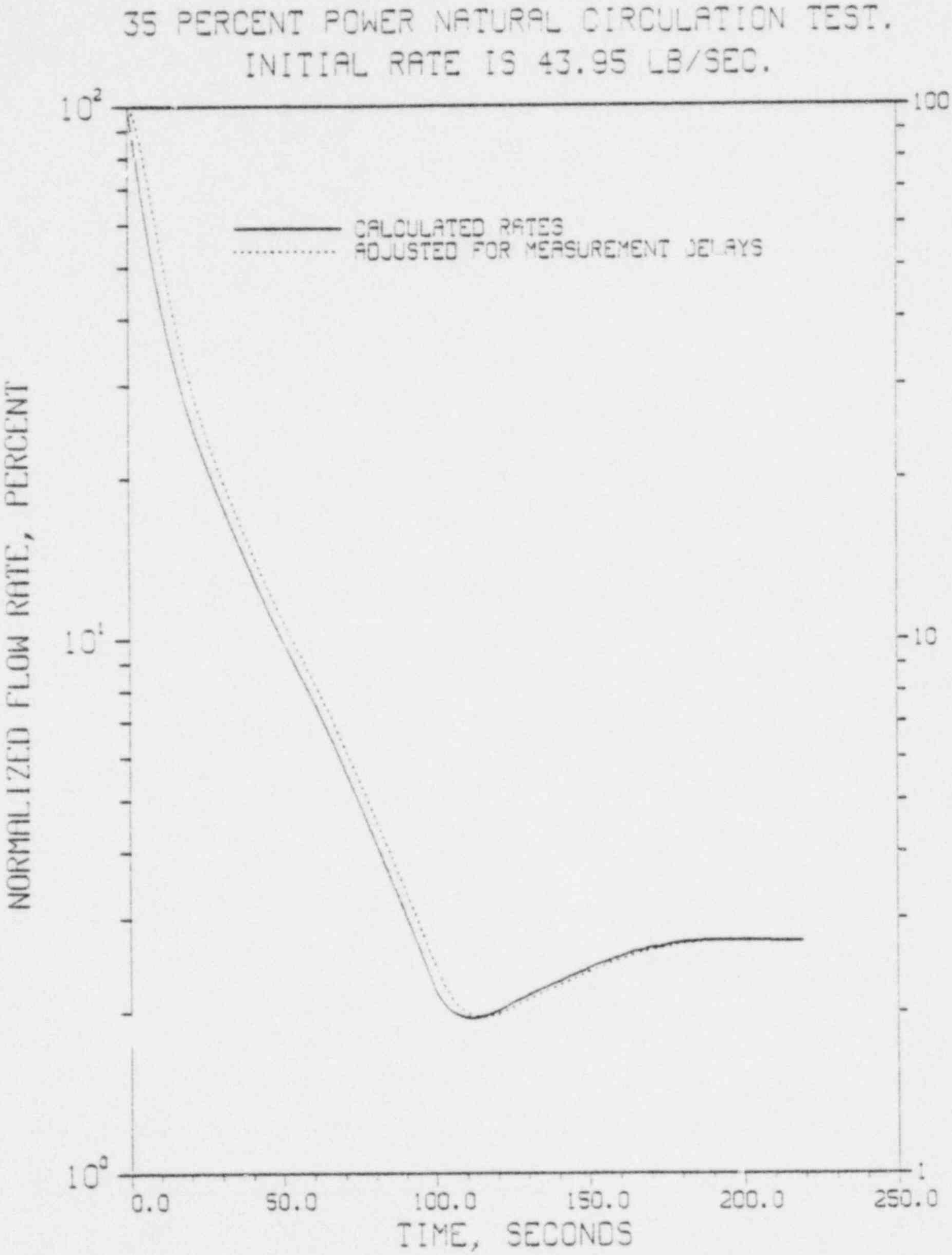

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Figure 4.18 Calculated Row 6 FOTA Core Midplane Coolant Temperatures for T/C TX9002 on Pin 16, 10.

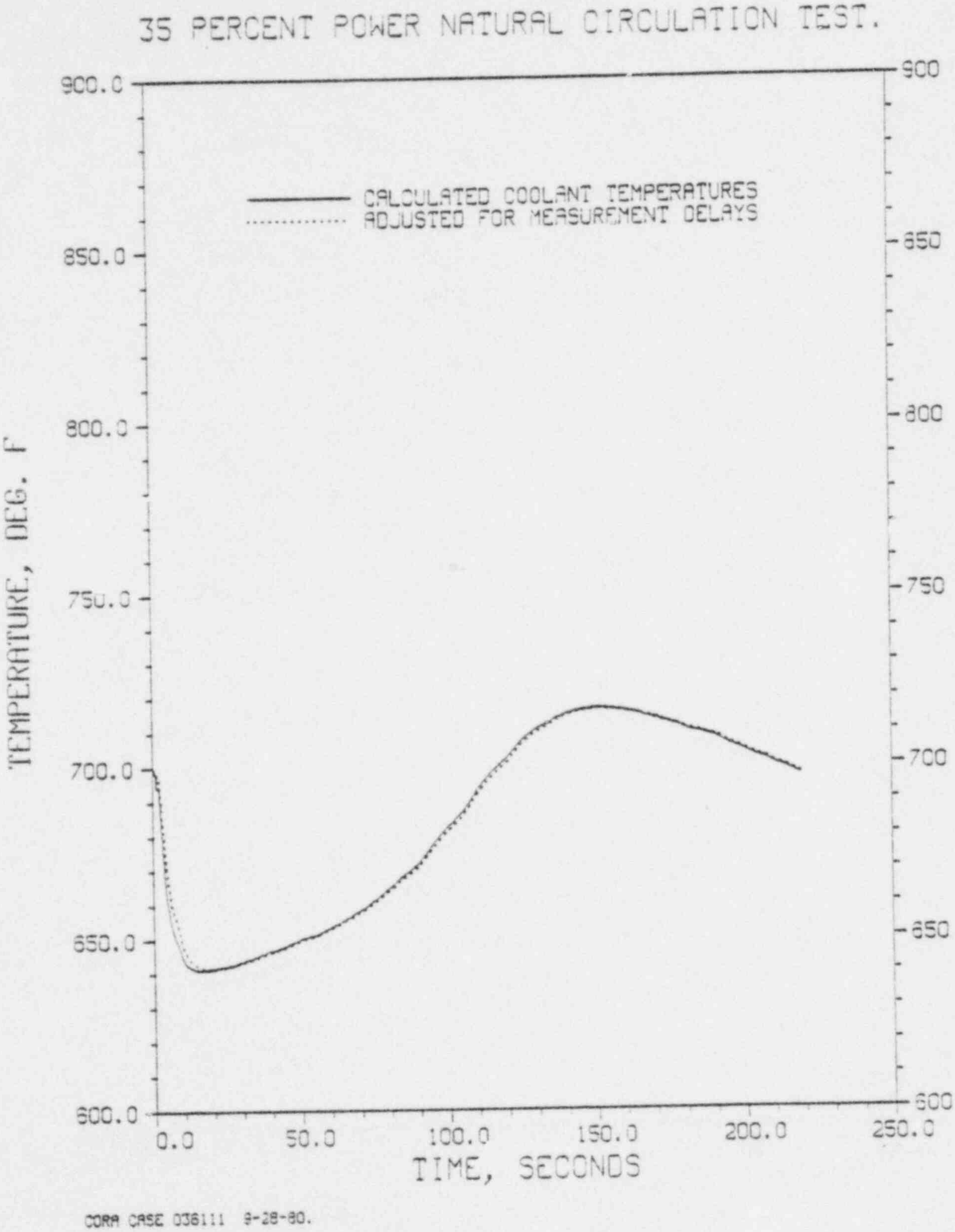

Figure 4.19 Calculated Row 6 FOTA Core Midplane Coolant Temperatures for T/C TX9039 on Pin 8, 8.

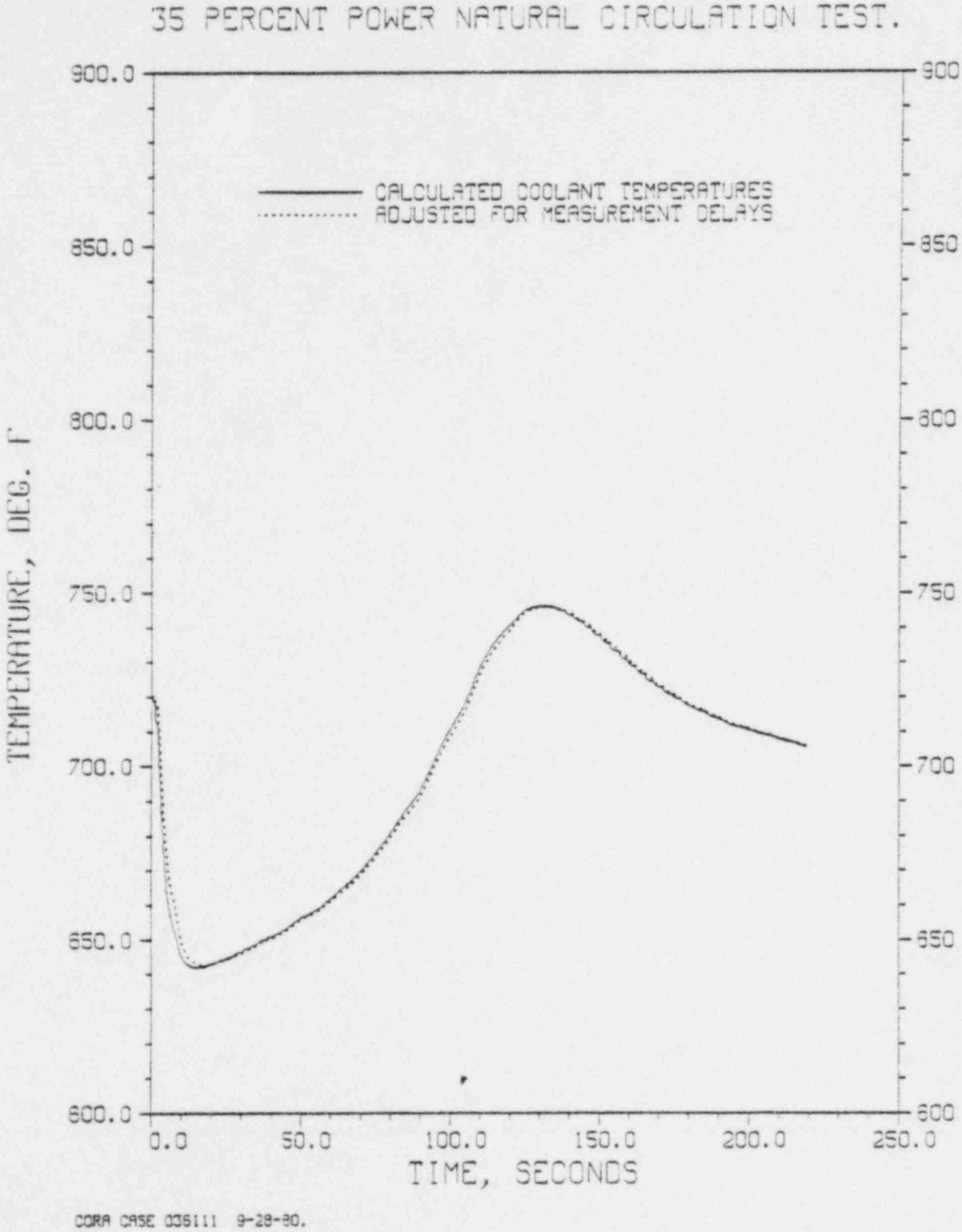

Figure 4.20 Calculated Row 6 FOTA Core Midplane Coolant Temperatures for T/C TX9022 on Pin 2, 1.

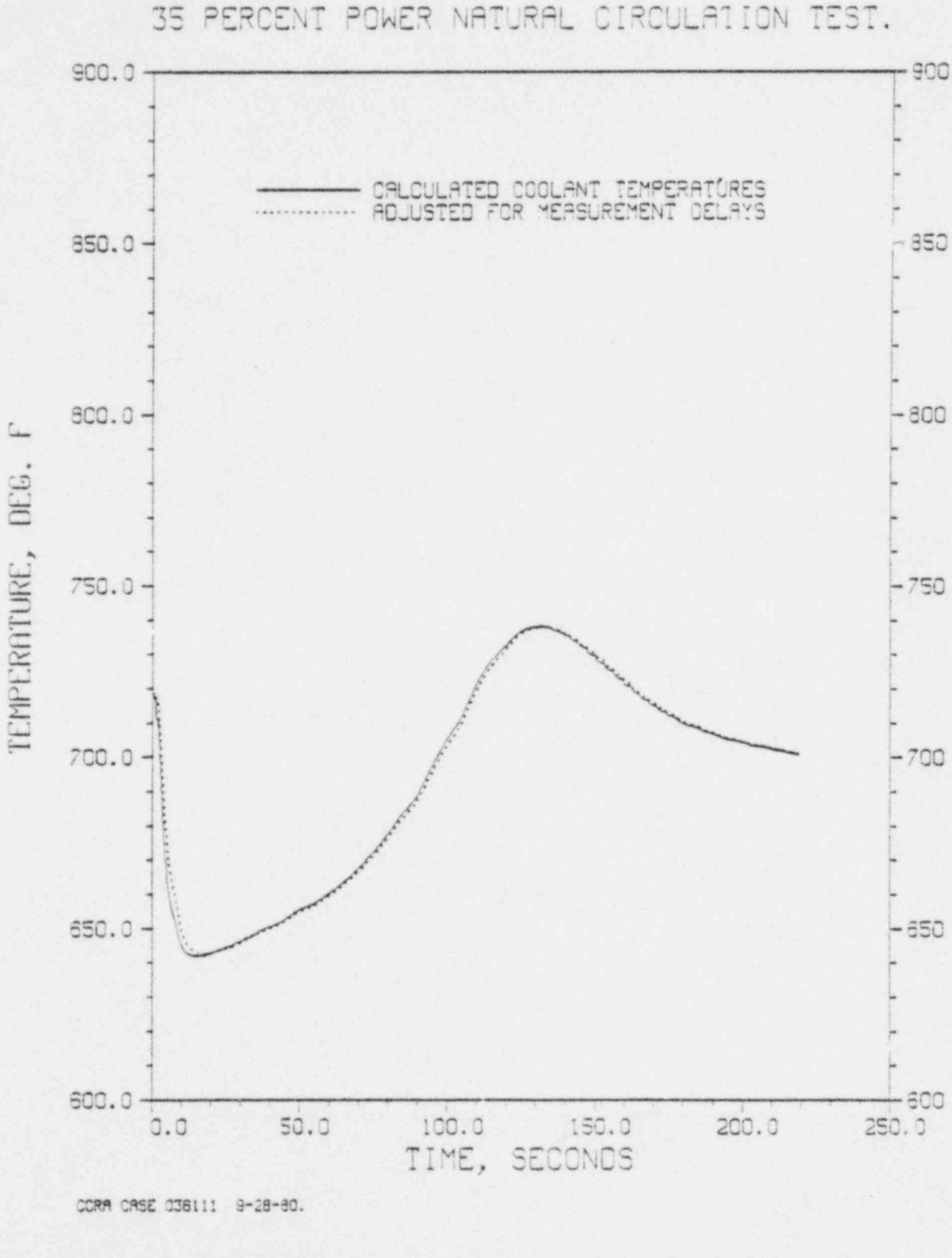

Figure 4.21 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9025 on Pin 1, 1.

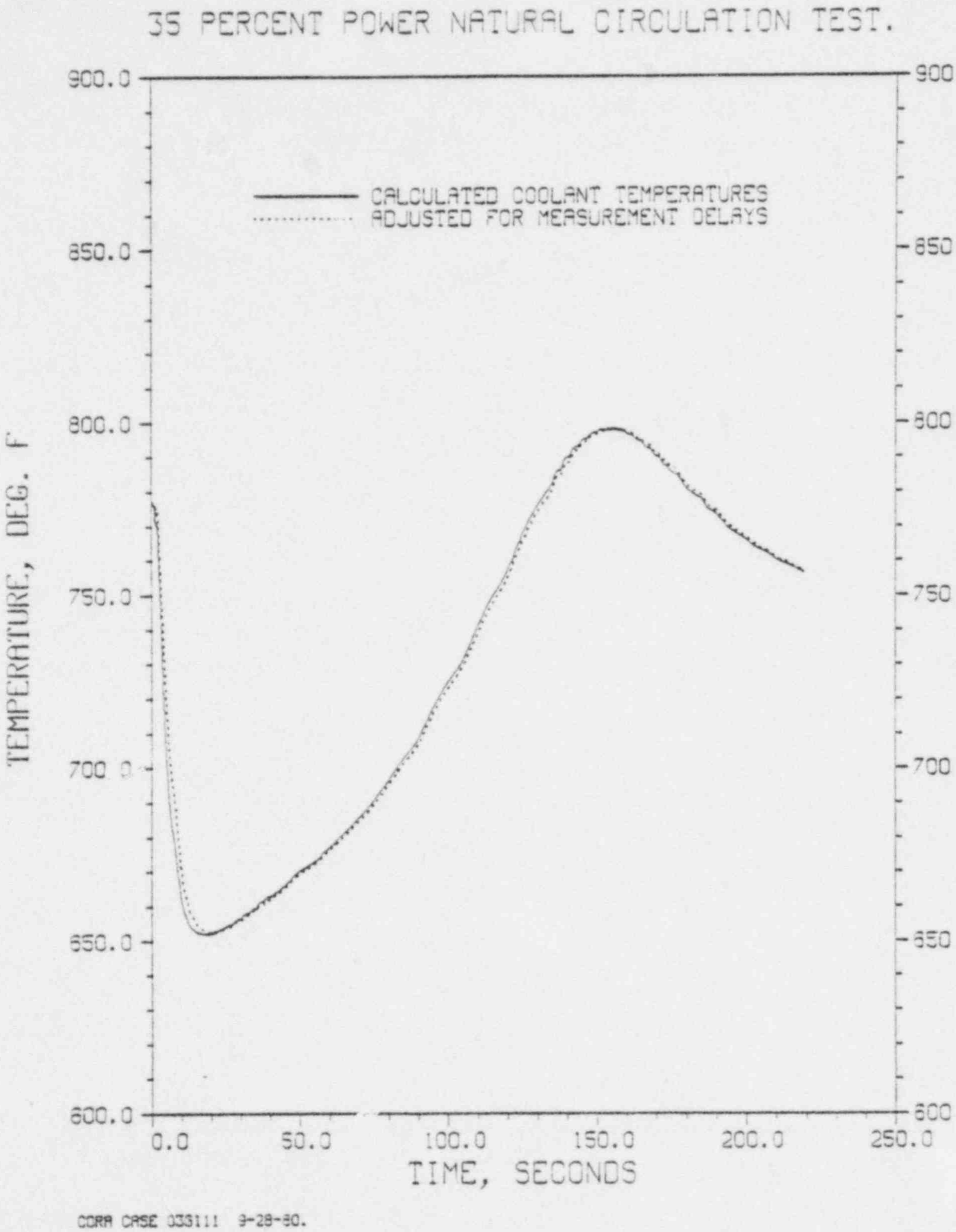

Figure 4.22 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9026 on Pin 2, 2.

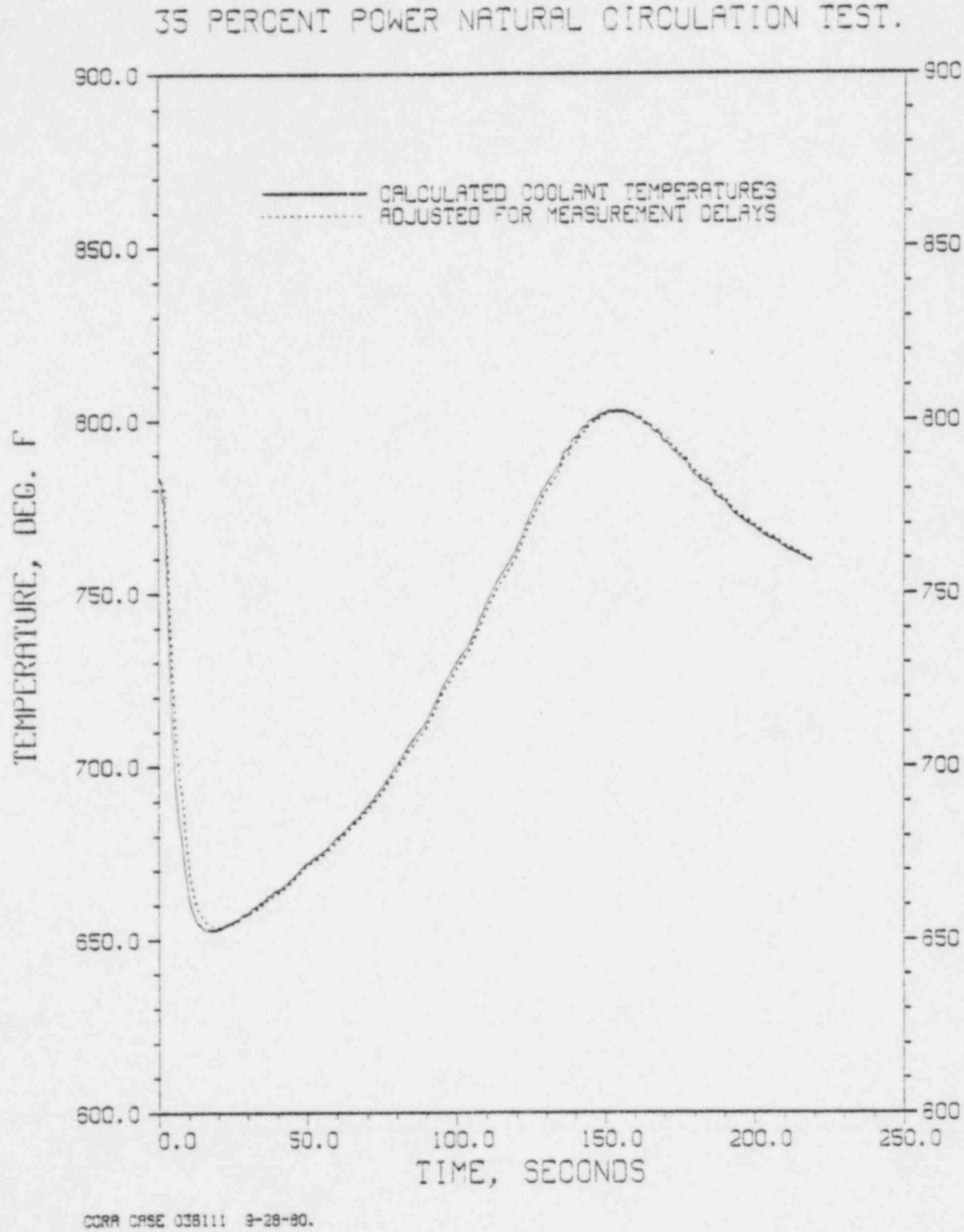

Figure 4.23 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9018 on Pin 4, 4.

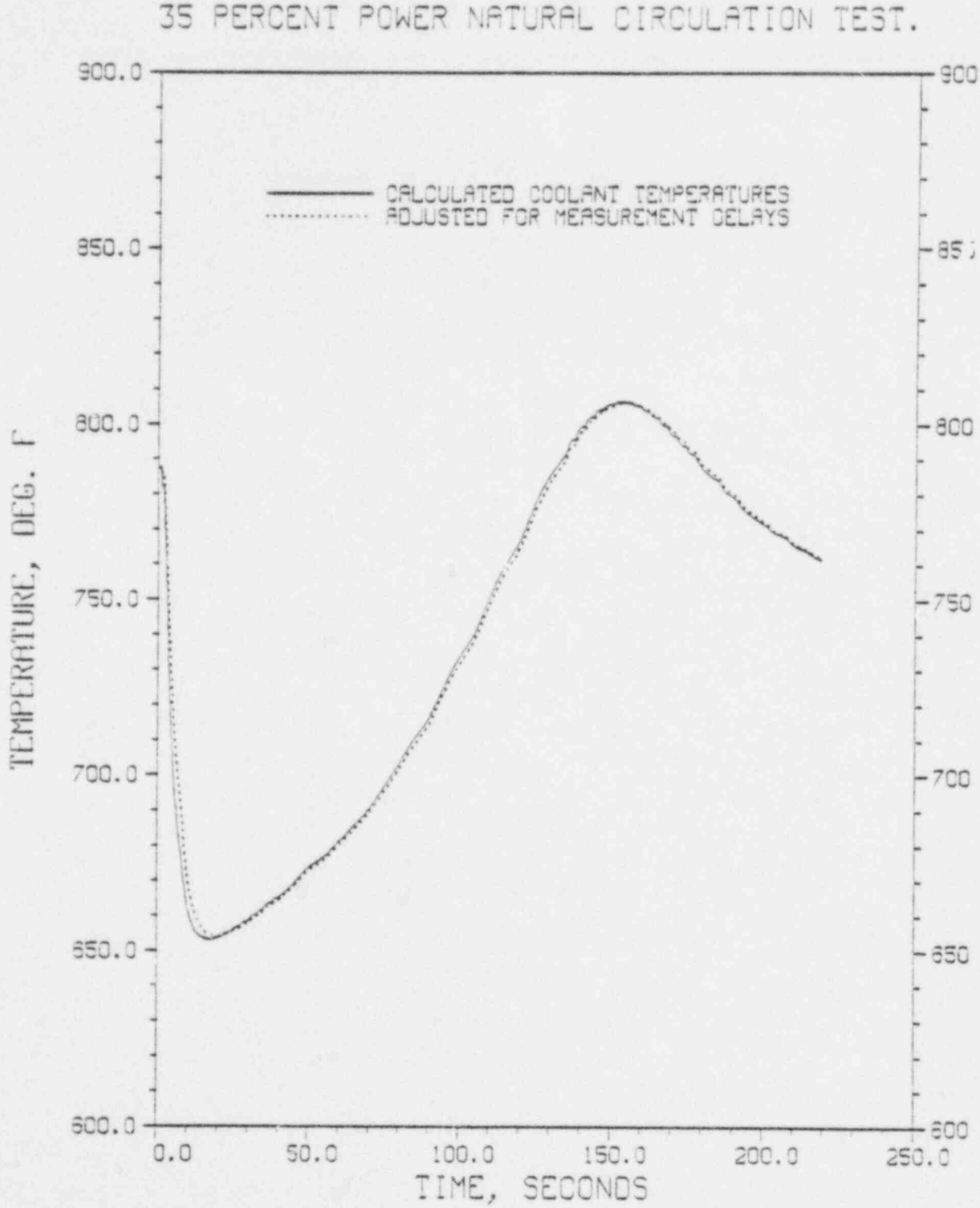

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Figure 4.24 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9009 on Pin 9, 9.

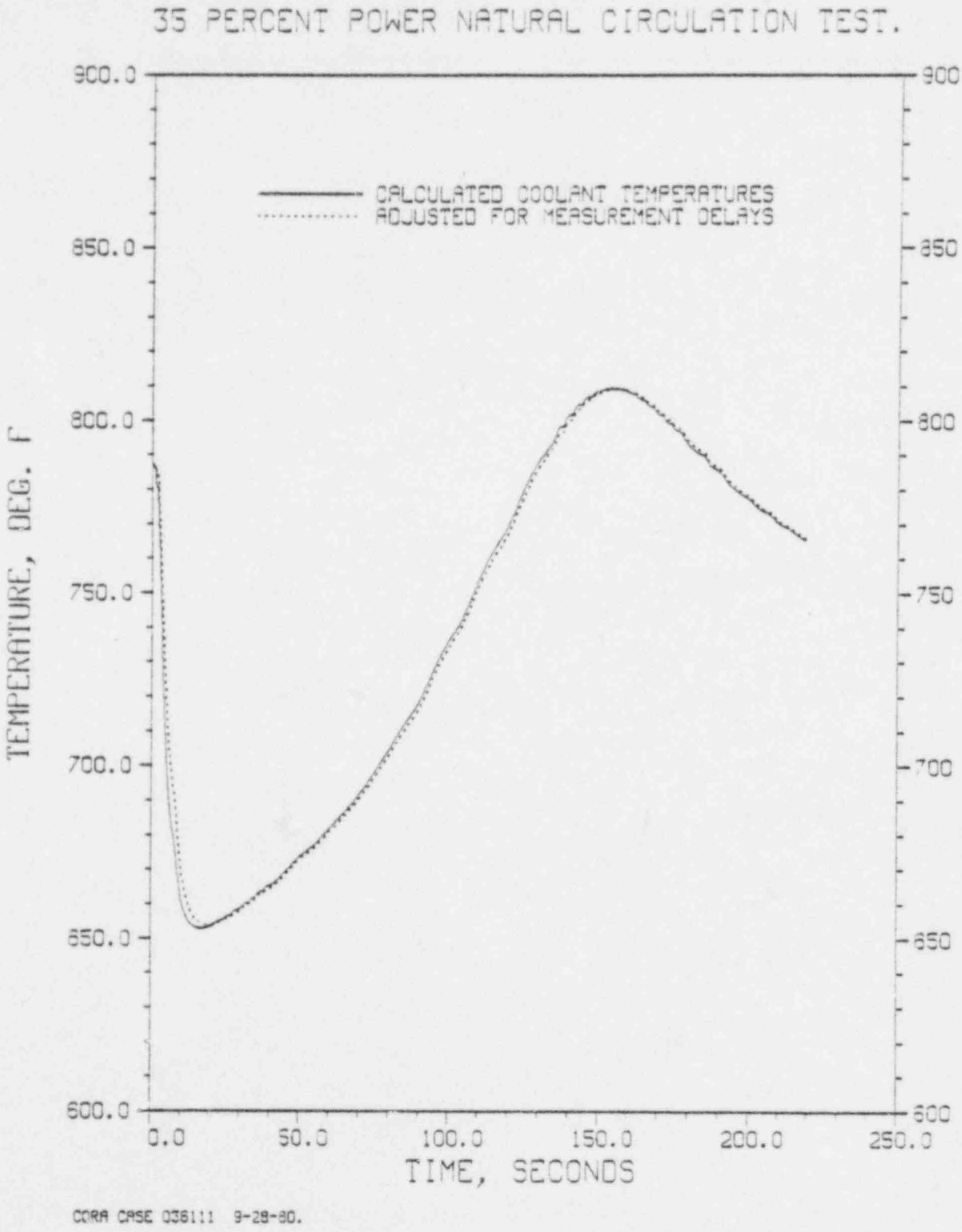

Figure 4.25 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9004 on Pin 14, 9.

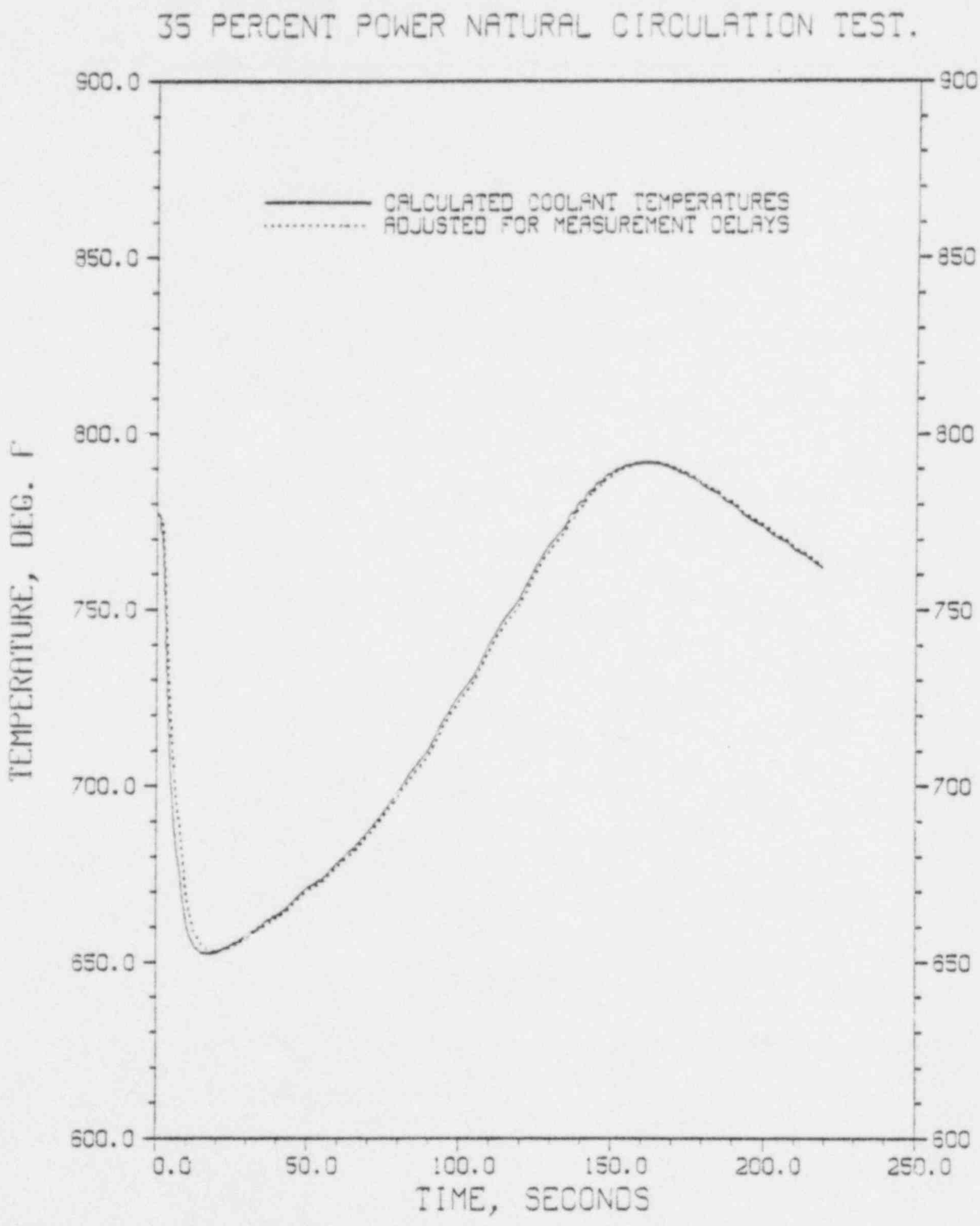

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Figure 4.26 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9003 on Pin 16, 9.

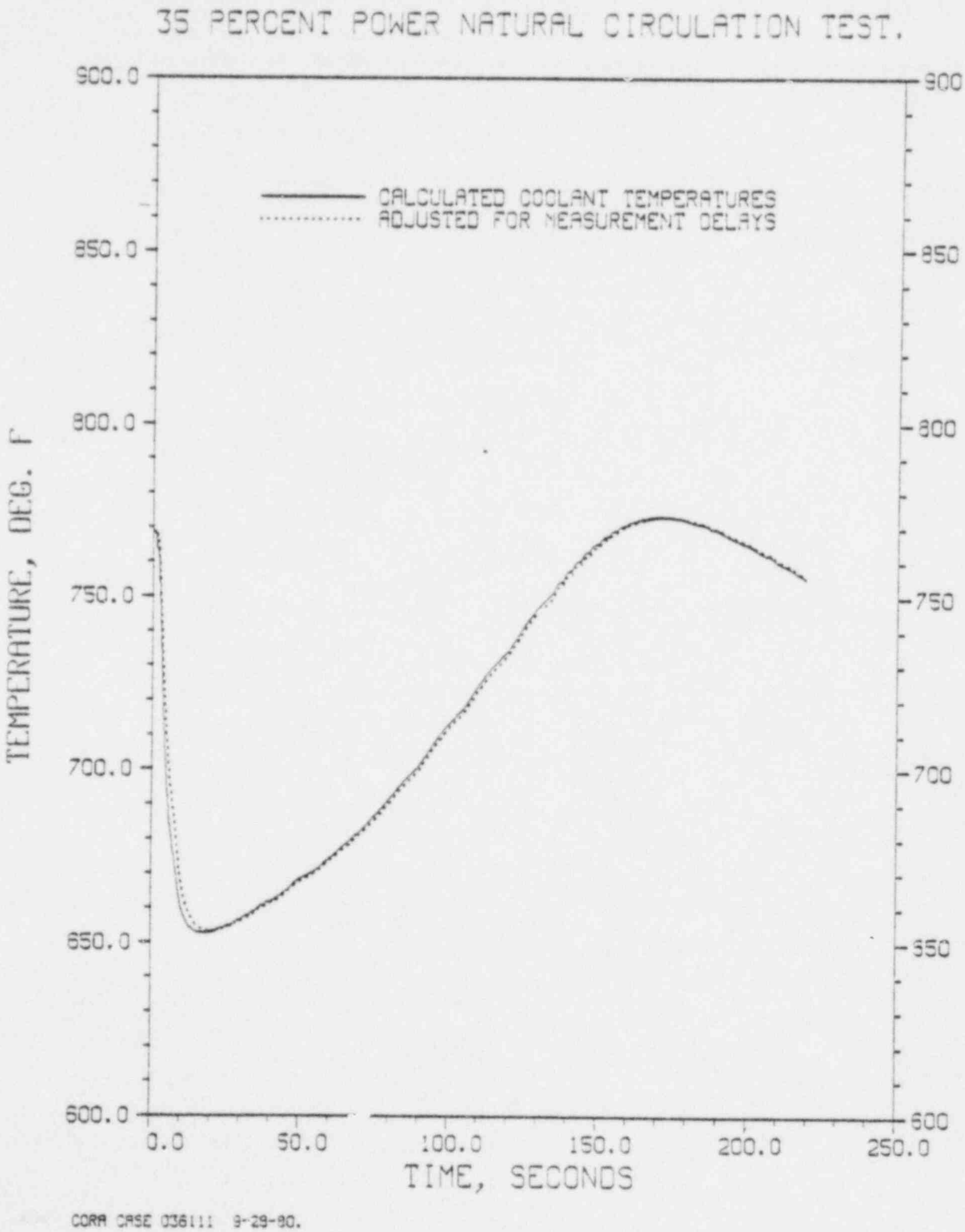

Figure 4.27 Calculated Row 6 FOTA Top of Fuel Coolant Temperatures for T/C TX9001 on Pin 17, 9.

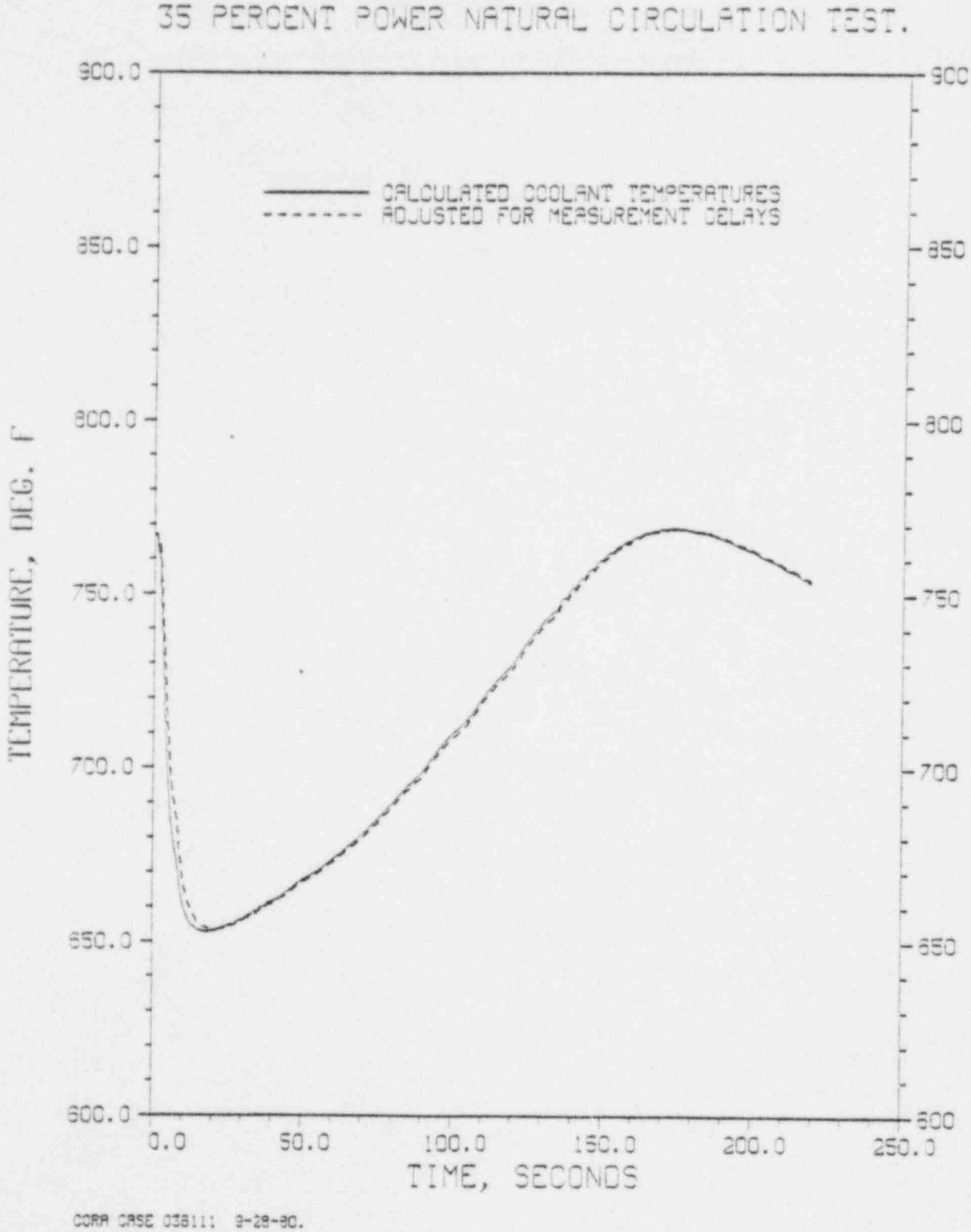

Figure 4.28 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9024 on Pin 1, 2.

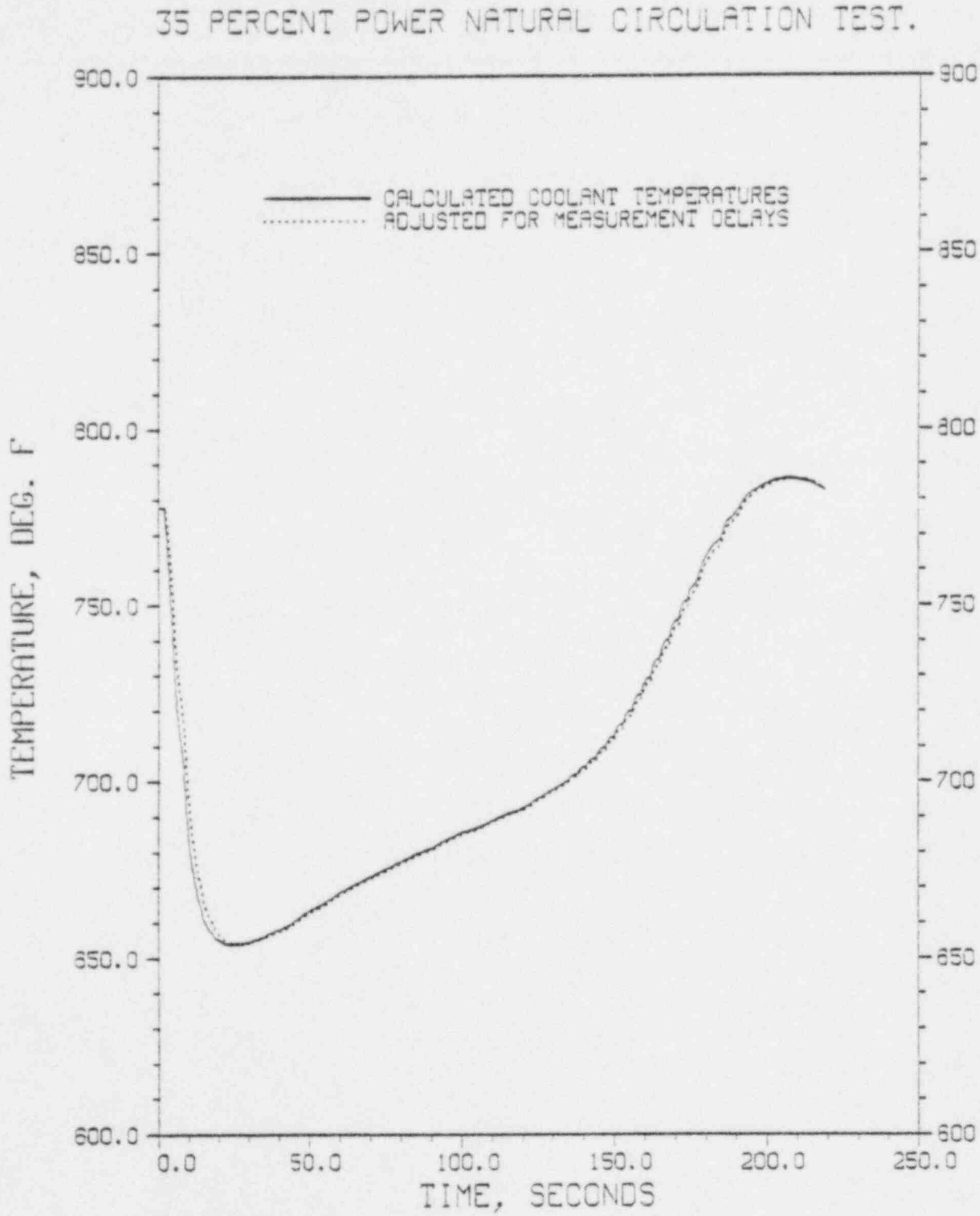

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Figure 4.29 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9019 on Pin 3, 3.

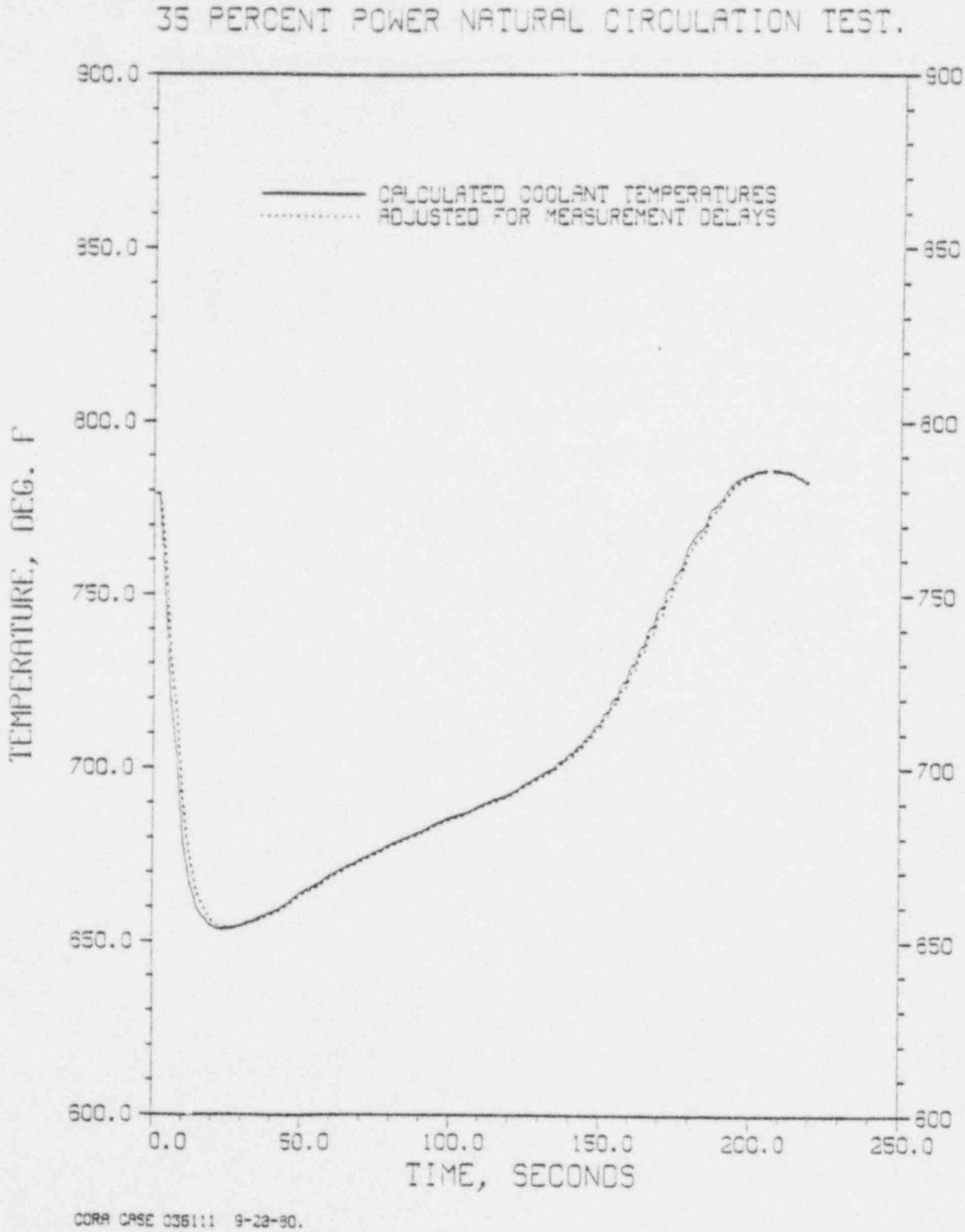


Figure 4.30 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9017 on Pin 5, 5.

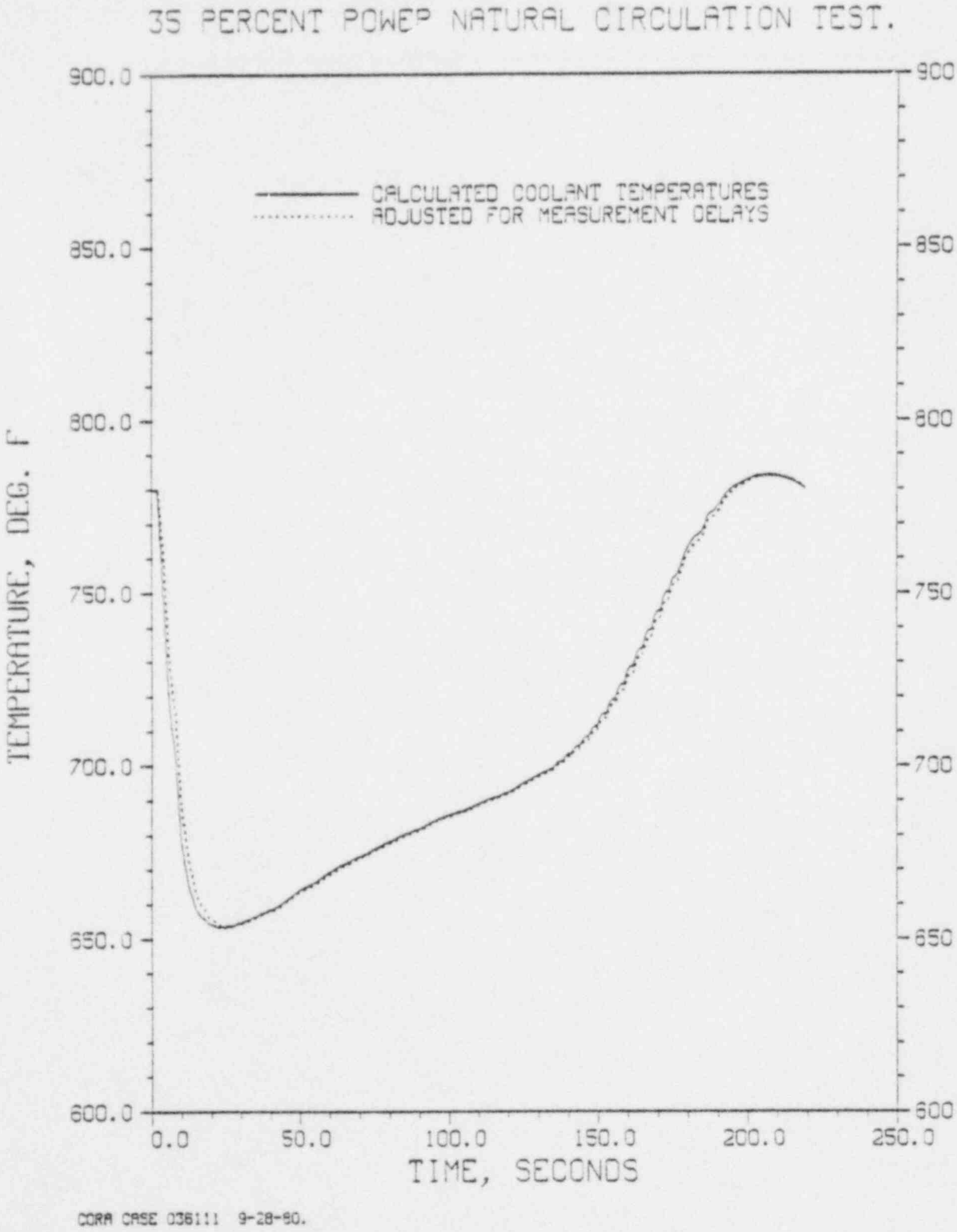


Figure 4.31 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9012 on Pin 10, 9.

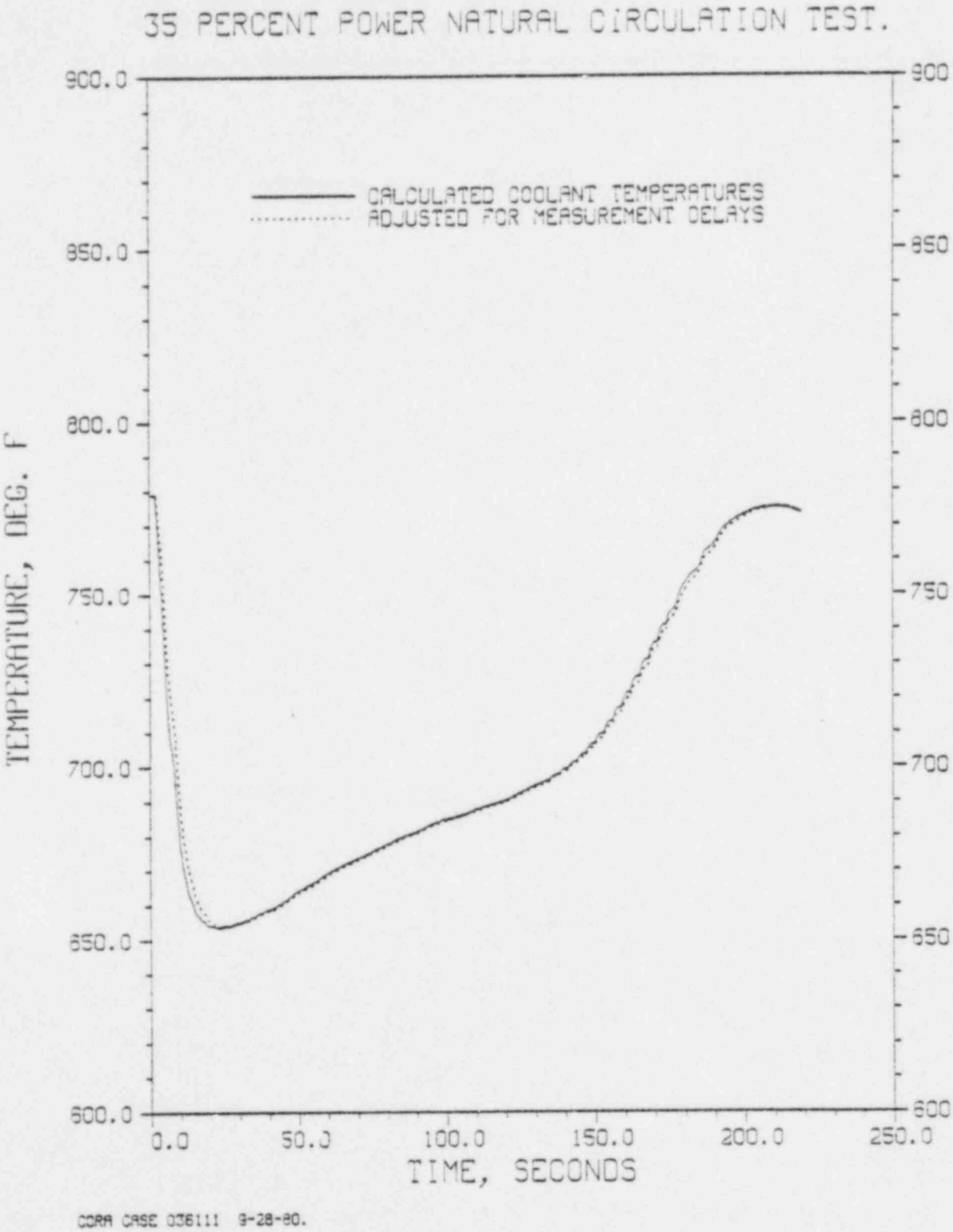


Figure 4.32 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9044 on Pin 17, 8.

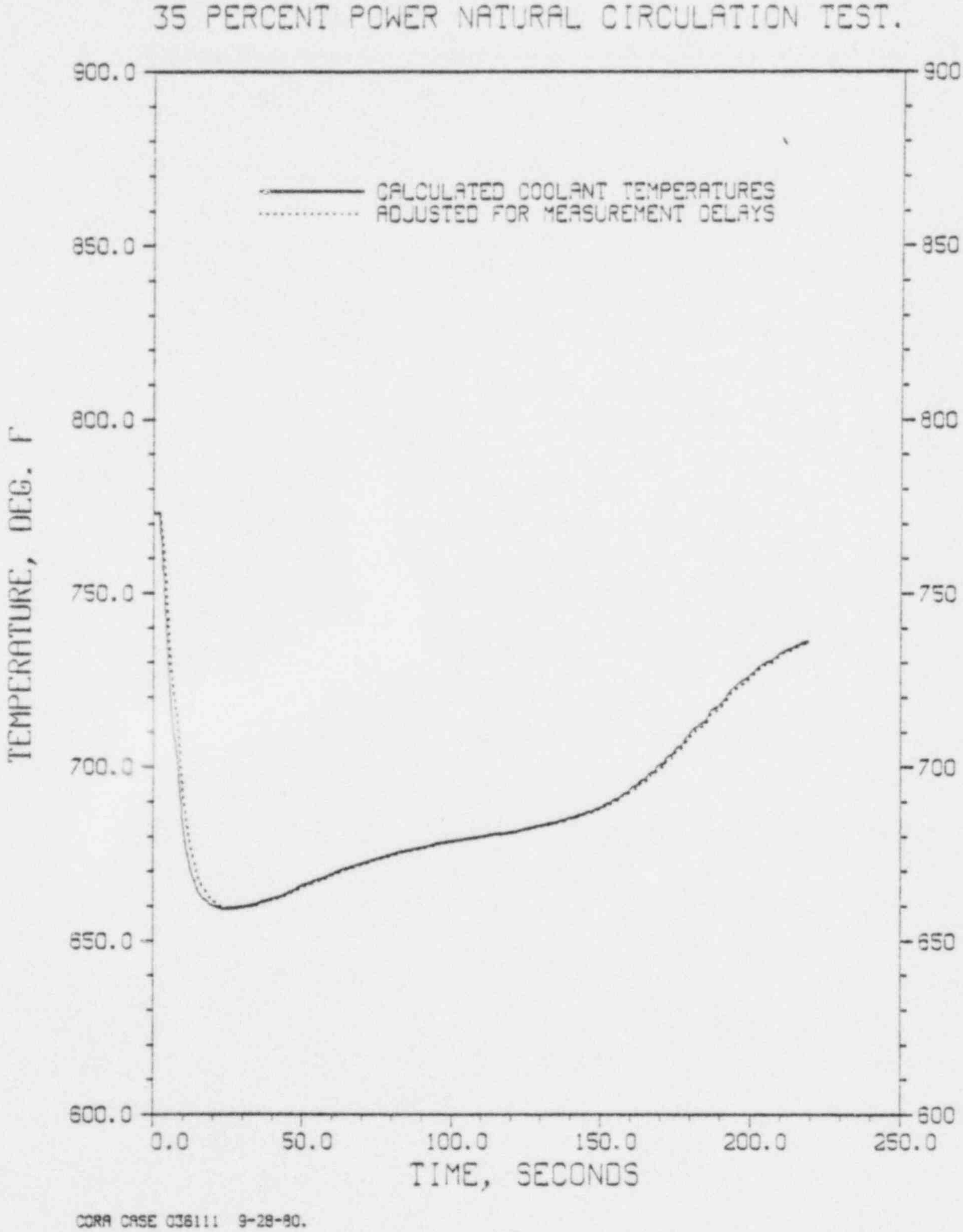


Figure 4.33 Calculated Row 6 FOTA Top of Pins Coolant Temperatures for T/C TX9041 on Pin 13, 9.

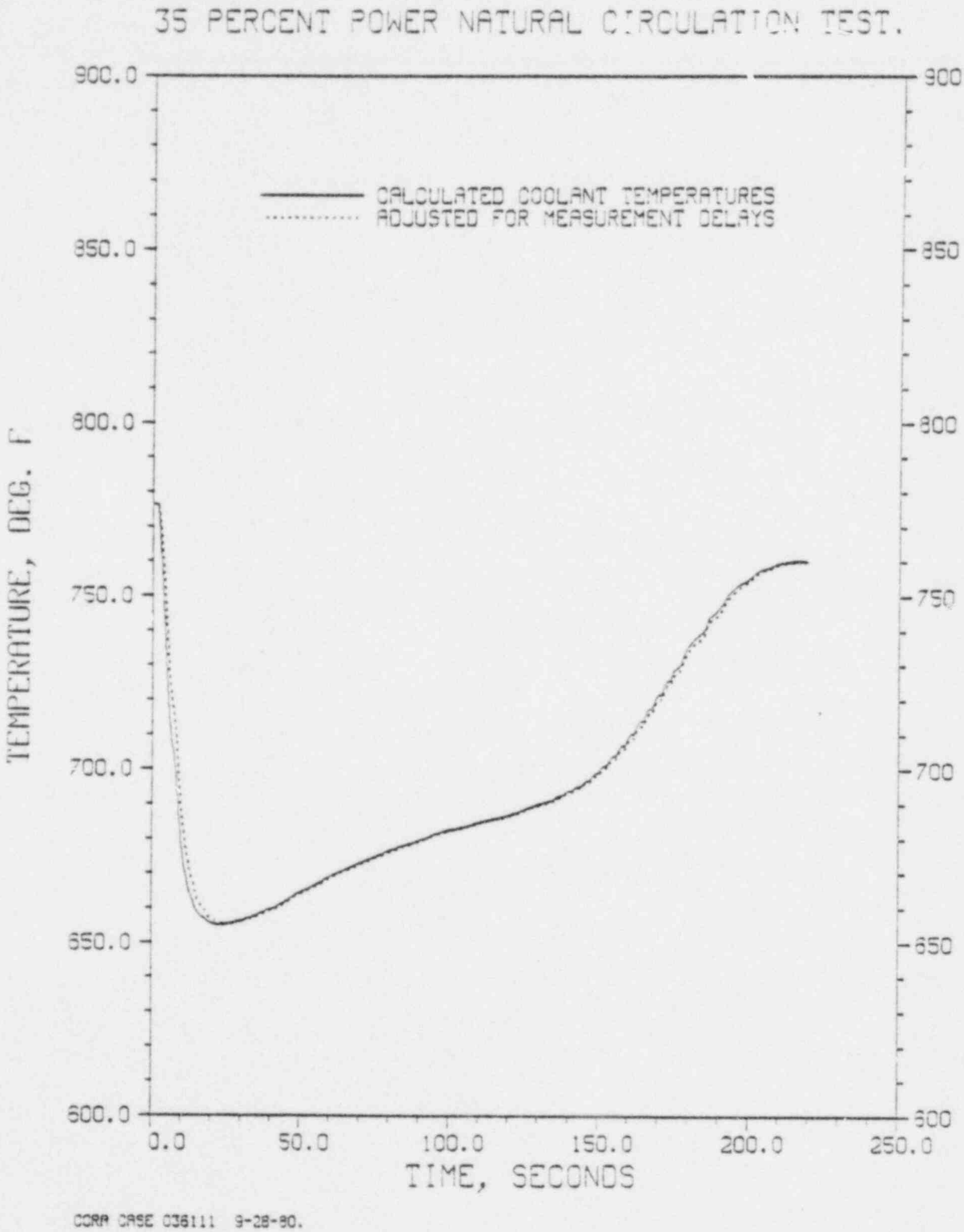


Figure 4.34 Calculated Row 6 FOTA Instrument Stalk Coolant Temperatures at T/C Location.

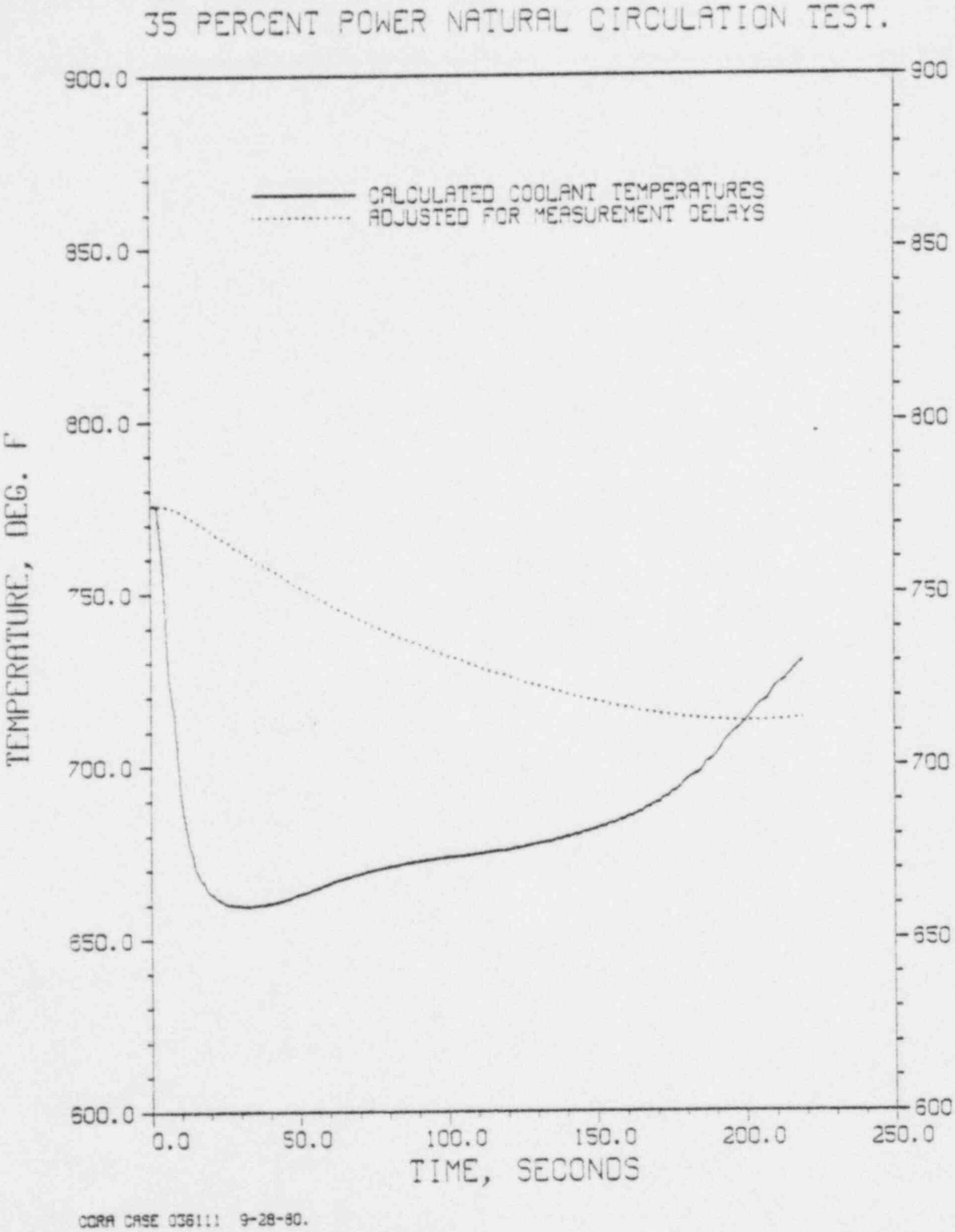


Figure 4.35 Calculated Row 6 FOTA Average Coolant Temperatures at Top of Fuel.

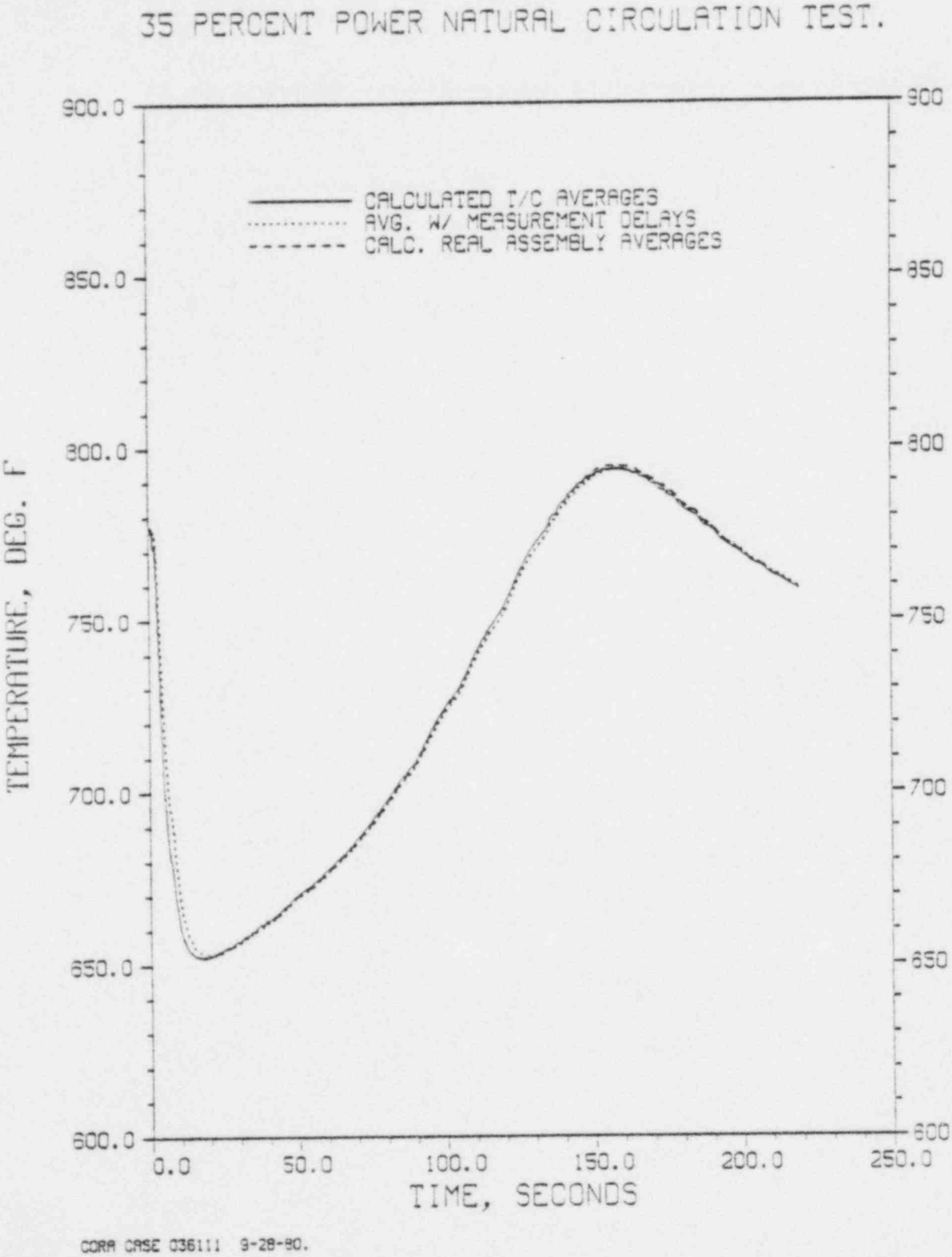


Figure 4.36 Calculated Row 6 FOTA Average Coolant Temperatures at Top of Pins.

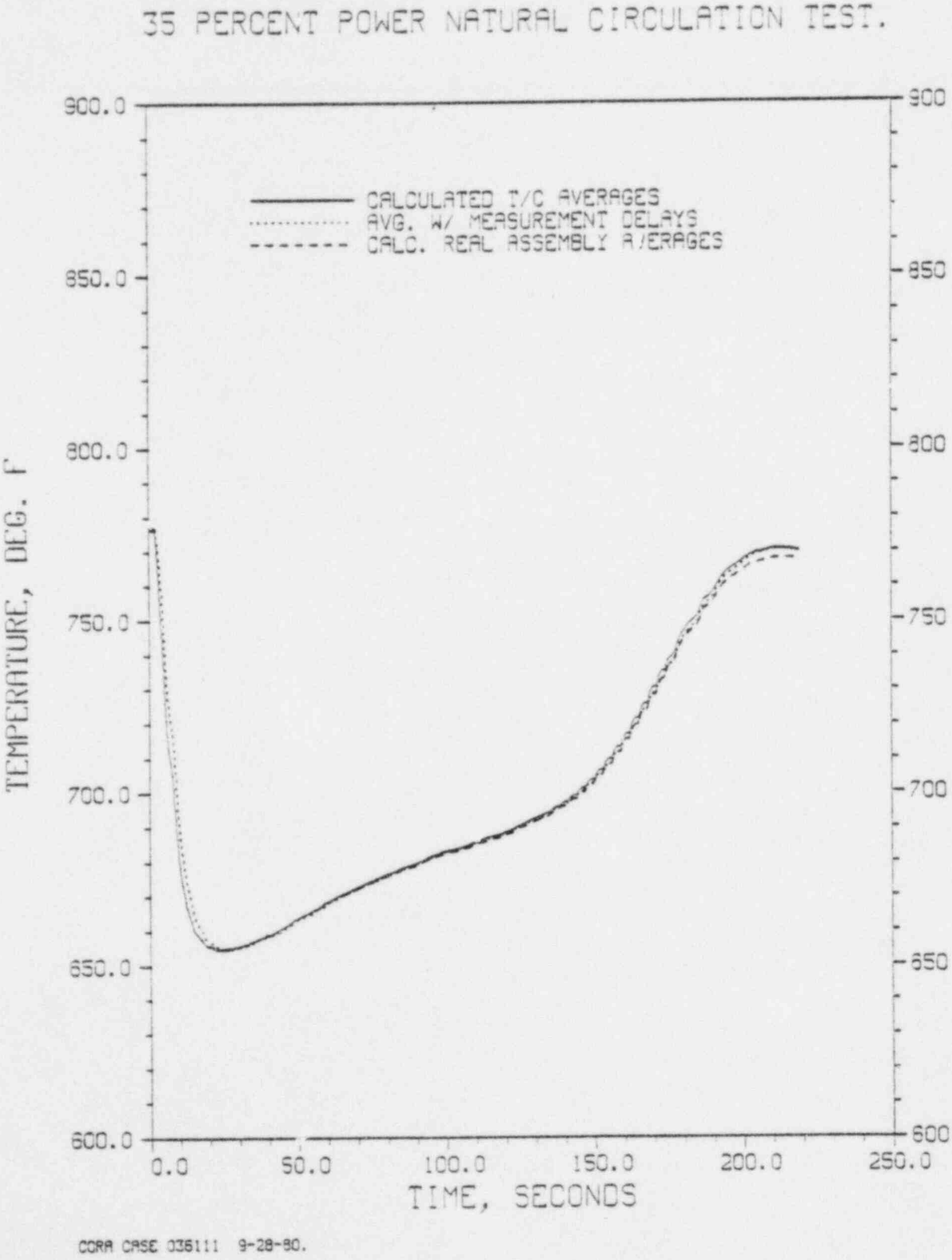
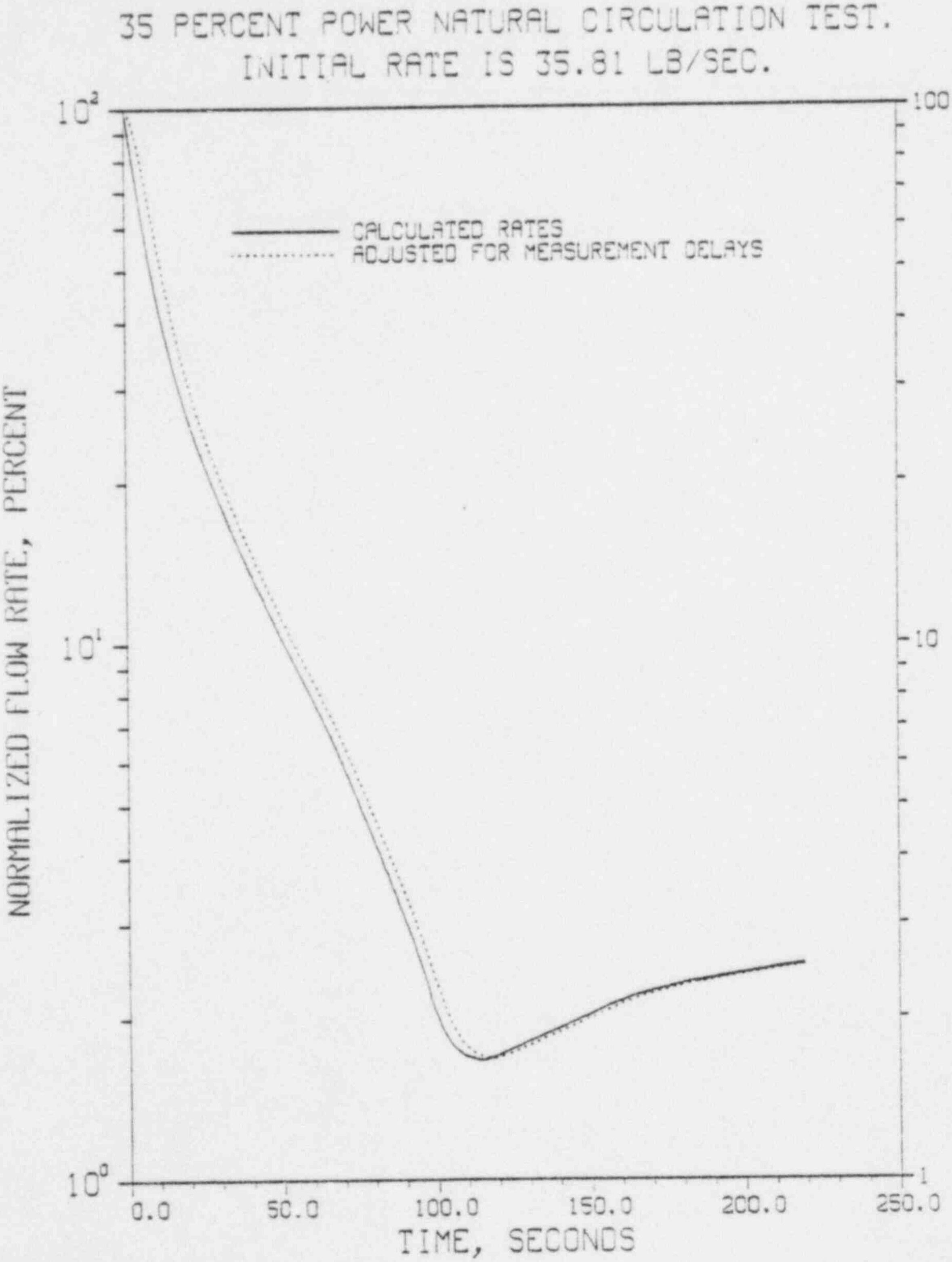


Figure 4.37 Calculated Row 6 FOTA Normalized Assembly Coolant Flow Rates.



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APPENDIX A

PROBLEM FORCING BOUNDARY CONDITIONS

APPENDIX A

PROBLEM FORCING BOUNDARY CONDITIONS

1. Reactor power, fraction of initial power, versus time, seconds.

A. POWER(N),N = 1,11

.10000000+001	.11882810+000	.76517727-001	.62205535-001	.52289713-001
.41739254-001	.31744737-001	.25915141-001	.23182508-001	.21556137-001
.20567590-001				

B. TIME(N),N = 1,11

.00000000	.14999994+001	.30057768+001	.60139387+001	.10508129+002
.22586862+002	.54013217+002	.10053909+003	.14705246+003	.19356263+003
.23359128+003				

2. Core inlet coolant pressure fraction of initial, versus time, seconds[1].

A. PRESSURE(N),N = 1,139

.10000000E+01	.99406918E+00	.98584161E+00	.97765152E+00	.96950000E+00
.95332272E+00	.93730656E+00	.92935494E+00	.91356238E+00	.90572587E+00
.89016552E+00	.88244638E+00	.86712411E+00	.81386987E+00	.76518899E+00
.72216034E+00	.67789095E+00	.63526457E+00	.59431291E+00	.55510867E+00
.53139422E+00	.50959775E+00	.48444111E+00	.45975711E+00	.44002219E+00
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.35080113E+00	.34082033E+00	.33271513E+00	.32383209E+00	.31518254E+00
.30760954E+00	.29940545E+00	.29226512E+00	.28657442E+00	.28146013E+00
.27583618E+00	.27093228E+00	.26553224E+00	.26069103E+00	.25706958E+00
.25270552E+00	.24926142E+00	.24592090E+00	.24261989E+00	.23916371E+00
.23652005E+00	.23405307E+00	.23102249E+00	.22864508E+00	.22630406E+00
.22385954E+00	.22204546E+00	.22002991E+00	.21769919E+00	.21596658E+00
.21425620E+00	.21273017E+00	.21116277E+00	.20978545E+00	.20808337E+00
.20674666E+00	.20542809E+00	.20412772E+00	.20291113E+00	.20180511E+00
.20043828E+00	.19614834E+00	.19231619E+00	.18929076E+00	.18671342E+00
.18397126E+00	.18203399E+00	.18000624E+00	.17836062E+00	.17095184E+00
.17560653E+00	.17444275E+00	.17339892E+00	.17238322E+00	.17151164E+00
.17067973E+00	.15955481E+00	.16821195E+00	.16762395E+00	.16685600E+00
.16616167E+00	.16559595E+00	.16508254E+00	.16465234E+00	.16429456E+00
.16398379E+00	.16372575E+00	.16349675E+00	.16330336E+00	.16320418E+00
.16313672E+00	.16303129E+00	.16306120E+00	.16304249E+00	.16303269E+00
.16303059E+00	.16303254E+00	.16303135E+00	.16303223E+00	.16303386E+00
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.16307397E+00	.16307898E+00	.16308601E+00	.16309274E+00	.16310221E+00
.16311078E+00	.16312045E+00	.16312866E+00	.16313930E+00	

(1) Initial pressure is 62.882 psig.

POOR ORIGINAL

B. TIME(N),N = 1,139

0.	.14000000E-01	.78000000E-01	.14200000E+00	.20600000E+00
.33400000E+00	.46200000E+06	.52600000E+00	.65400000E+00	.71800000E+00
.64600000E+00	.91000000E+00	.10300000E+01	.15000000E+01	.20247071E+01
.25047071E+01	.30167071E+01	.35207071E+01	.40407071E+01	.45527071E+01
.50487468E+01	.55012952E+01	.60443532E+01	.65874112E+01	.70399595E+01
.75377627E+01	.81033175E+01	.85748236E+01	.90423297E+01	.95116357E+01
.10098718E+02	.10505868E+02	.11001430E+02	.11529624E+02	.12057819E+02
.12527325E+02	.13055514E+02	.13545025E+02	.14032616E+02	.14502322E+02
.15030517E+02	.15500023E+02	.16048217E+02	.16512395E+02	.17014530E+02
.17601413E+02	.18070919E+02	.18540425E+02	.19009931E+02	.19508781E+02
.20031015E+02	.20500521E+02	.21007404E+02	.21556910E+02	.22020416E+02
.22525266E+02	.23004037E+02	.23532231E+02	.24152126E+02	.24621632E+02
.25091138E+02	.25516628E+02	.26039495E+02	.26529001E+02	.27115883E+02
.27585389E+02	.28054895E+02	.28544401E+02	.29046177E+02	.29515683E+02
.30102565E+02	.32114472E+02	.34247250E+02	.36185970E+02	.38023351E+02
.40264289E+02	.42105688E+02	.44232178E+02	.46186368E+02	.48096937E+02
.50120919E+02	.52075109E+02	.54038023E+02	.56114350E+02	.58068540E+02
.60075074E+02	.63034712E+02	.66107763E+02	.69091392E+02	.72059754E+02
.75139348E+02	.78027012E+02	.81069158E+02	.84098959E+02	.87051306E+02
.90087279E+02	.93027288E+02	.96018145E+02	.99158807E+02	.10204620E+03
.10505690E+03	.10807925E+03	.11119823E+03	.11408137E+03	.11704497E+03
.12000112E+03	.12325627E+03	.12602191E+03	.12910633E+03	.13226478E+03
.13502842E+03	.13818687E+03	.14112108E+03	.14410900E+03	.14709692E+03
.15004212E+03	.15303004E+03	.15600214E+03	.15905393E+03	.16204703E+03
.16511349E+03	.16821480E+03	.17105132E+03	.17404442E+03	.17703753E+03
.18003003E+03	.18308242E+03	.18610486E+03	.18907470E+03	.19246143E+03
.19504371E+03	.19802710E+03	.20109802E+03	.20400294E+03	.20703235E+03
.21022777E+03	.21338108E+03	.21632810E+03	.21915002E+03	

POOR ORIGINAL

3. Core inlet coolant temperature, °F, versus time, seconds.

A. TEMPERATURE(N),N = 1,39

.62795007+003	.62793380+003	.62791027+003	.62788915+003	.62786418+003
.62783810+003	.62780853+003	.62777815+003	.62774886+003	.62773240+003
.62770361+003	.62767363+003	.62764429+003	.62761775+003	.62759090+003
.62756561+003	.62754343+003	.62752160+003	.62750158+003	.62748453+003
.62746117+003	.62744166+003	.62742127+003	.62740372+003	.62738665+003
.62737007+003	.62735368+003	.62733719+003	.62731820+003	.62729995+003
.62728349+003	.62726640+003	.62724793+003	.62722919+003	.62720946+003
.62716921+003	.62716901+003	.62715108+003	.62713692+003	

B. TIME(N),N = 1,39

.00000000	.22586662+002	.27123791+002	.30131.14+002	.33159658+002
.36021444+002	.39070640+002	.42125728+002	.45004685+002	.46625173+002
.49507402+002	.52571125+002	.55635765+002	.58520680+002	.61586279+002
.64652122+002	.67537749+002	.70603799+002	.73669865+002	.76555544+002
.81064287+002	.85572796+002	.91523601+002	.99096673+002	.11261874+003
.12750245+003	.13966121+003	.15011707+003	.16057266+003	.16958603+003
.17715737+003	.18454860+003	.19212035+003	.19951213+003	.20706451+003
.21465728+003	.22205018+003	.22654189+003	.23359128+003	

4. Upper pool coolant temperature, °F, versus time, seconds.

A. TEMPERATURE(N),N = 1,36

.74632236+003	.74562684+003	.74491675+003	.74352667+003	.74239202+003
.74127502+003	.74020614+003	.73929605+003	.73843799+003	.73763123+003
.73667337+003	.73616131+003	.73549178+003	.73486163+003	.73433254+003
.73377030+003	.73329840+003	.73279740+003	.73193061+003	.73119910+003
.73050020+003	.72987215+003	.72923776+003	.72882304+003	.72835654+003
.72774708+003	.72721787+003	.72692801+003	.72614664+003	.72566400+003
.72516200+003	.72471841+003	.72443021+003	.72375915+003	.72326336+003
.72356509+003				

B. TIME(N),N = 1,36

.00000000	.60139387+001	.75579942+001	.90114989+001	.10508129+002
.12043899+002	.13615131+002	.15056800+002	.16522316+002	.18009727+002
.19517293+002	.21043464+002	.22596862+002	.24145937+002	.25542664+002
.27123791+002	.28536311+002	.30131814+002	.33159658+002	.36021444+002
.39070640+002	.42125728+002	.45004085+002	.48066099+002	.51129234+002
.55635765+002	.60143606+002	.66074923+002	.72046655+002	.79621511+002
.90081027+002	.10666917+003	.13004725+003	.15462382+003	.18454860+003
.23359128+003				

5. Upper pool coolant depth, feet above top of assembly ducts, versus time, seconds.

A. DEPTH(N),N = 1,38

.16041630+002	.16023393+002	.15962555+002	.15939823+002	.15903850+002
.15868353+002	.15837730+002	.15808937+002	.15782270+002	.15757994+002
.15738391+002	.15721081+002	.15706211+002	.15693924+002	.15684360+002
.15677608+002	.15673517+002	.15680098+002	.15686279+002	.15692353+002
.15699205+002	.15704933+002	.15710071+002	.15714933+002	.15720833+002
.15715452+002	.15720045+002	.15723813+002	.15720001+002	.15723725+002
.15727425+002	.15731241+002	.15734961+002	.15738792+002	.15742745+002
.15746824+002	.15750590+002	.15750967+002		

B. TIME(N),N = 1,38

.00000000	.14999994+001	.30057768+001	.45668484+001	.60139387+001
.75579942+001	.90114984+001	.10508129+002	.12043899+002	.13615131+002
.15056800+002	.16522316+002	.18069727+002	.19517293+002	.21043464+002
.22580862+002	.25542064+002	.28536311+002	.30131814+002	.31554690+002
.33159658+002	.34589371+002	.36061444+002	.37634635+002	.40507736+002
.52571125+002	.67537749+002	.73609865+002	.85572796+002	.96031466+002
.10210179+003	.13208950+003	.17102818+003	.19067809+003	.20113475+003
.21303451+003	.22854189+003	.23359128+003		

APPENDIX B

FOTA THERMOCOUPLE LOCATIONS AND CORA FOTA MODEL

The following 7 figures are taken from Reference (1).

Figure B.1 Row 2 FOTA Thermocouple Radial Positions for Core Midplane Axial Locations

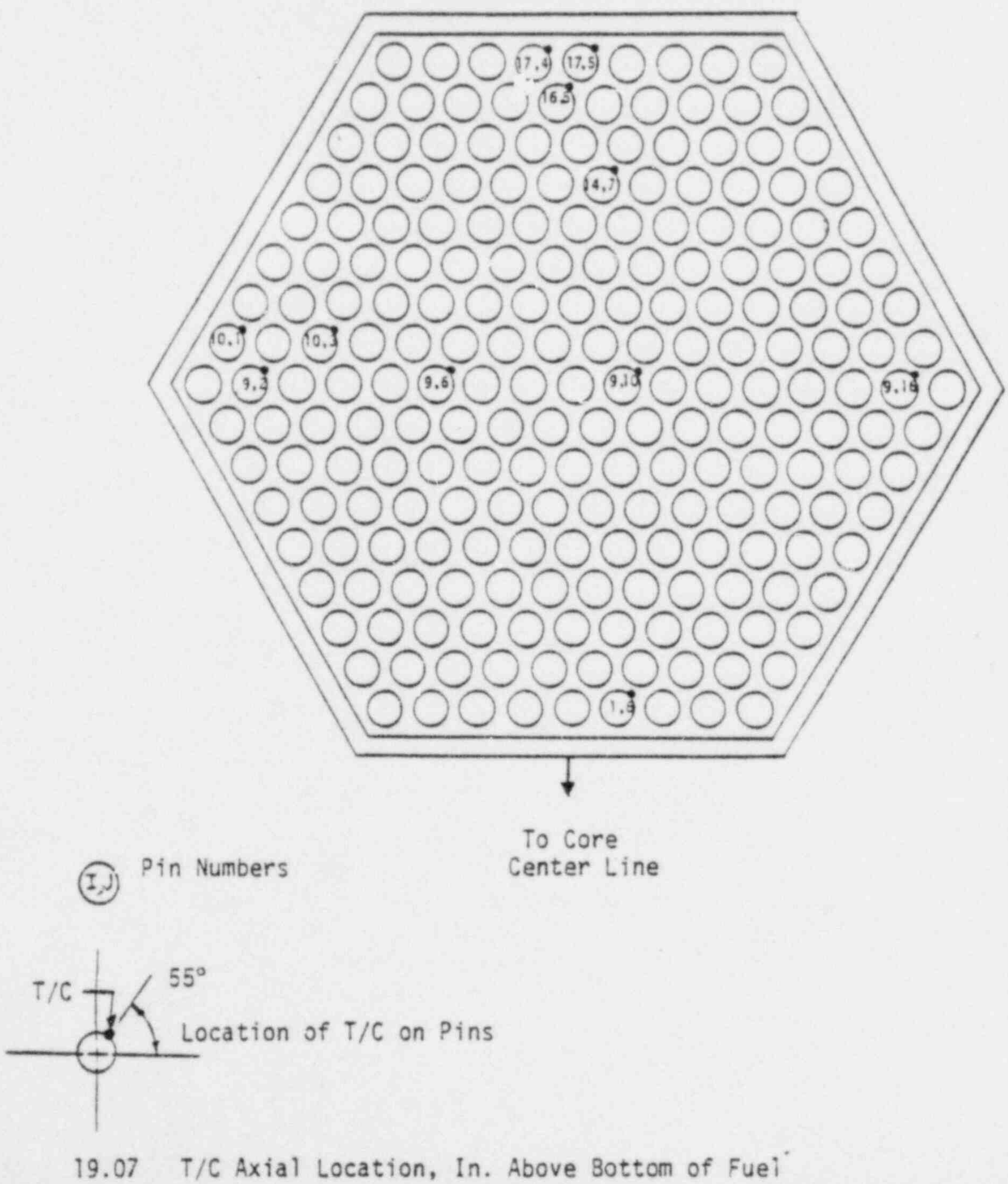
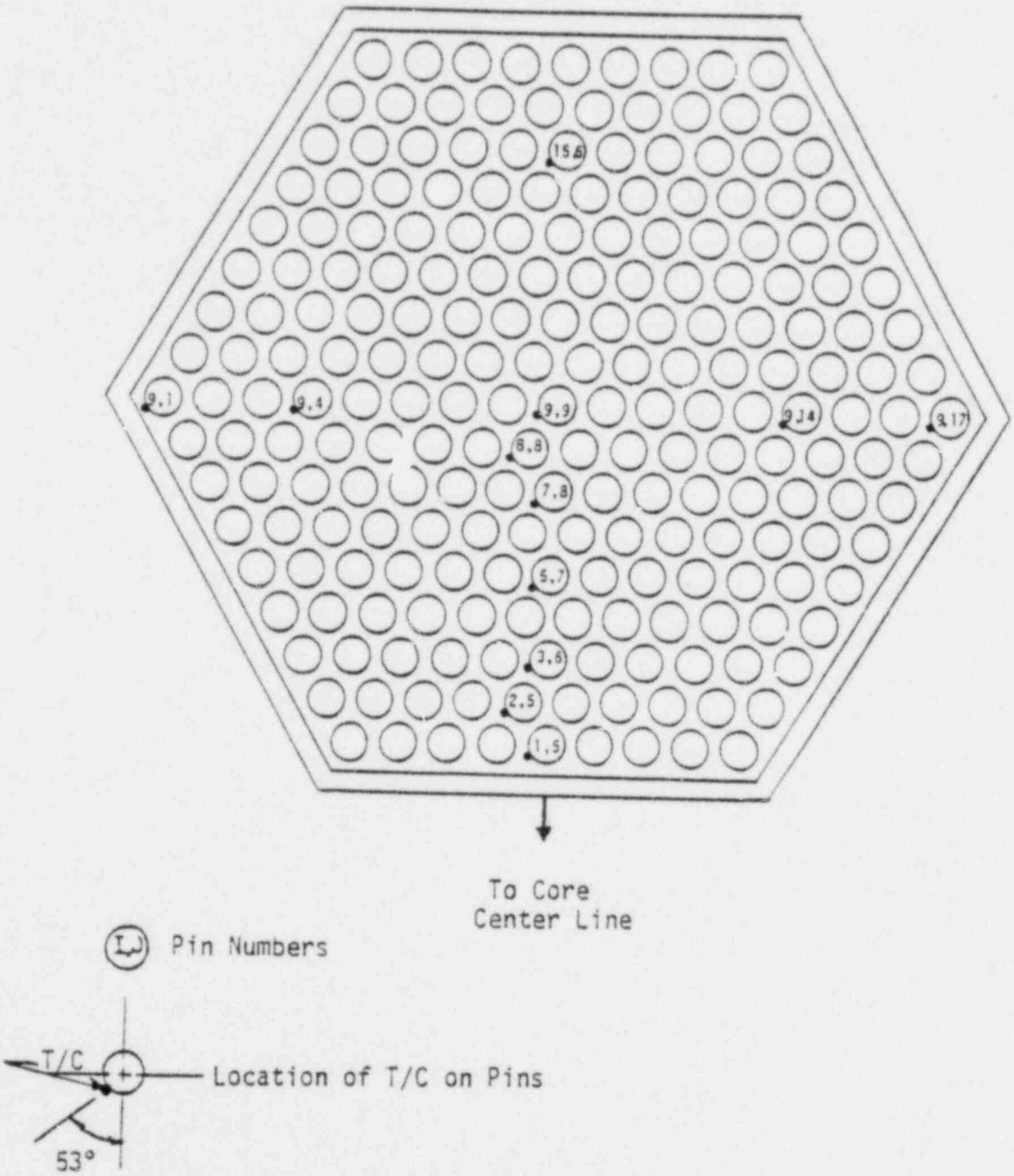
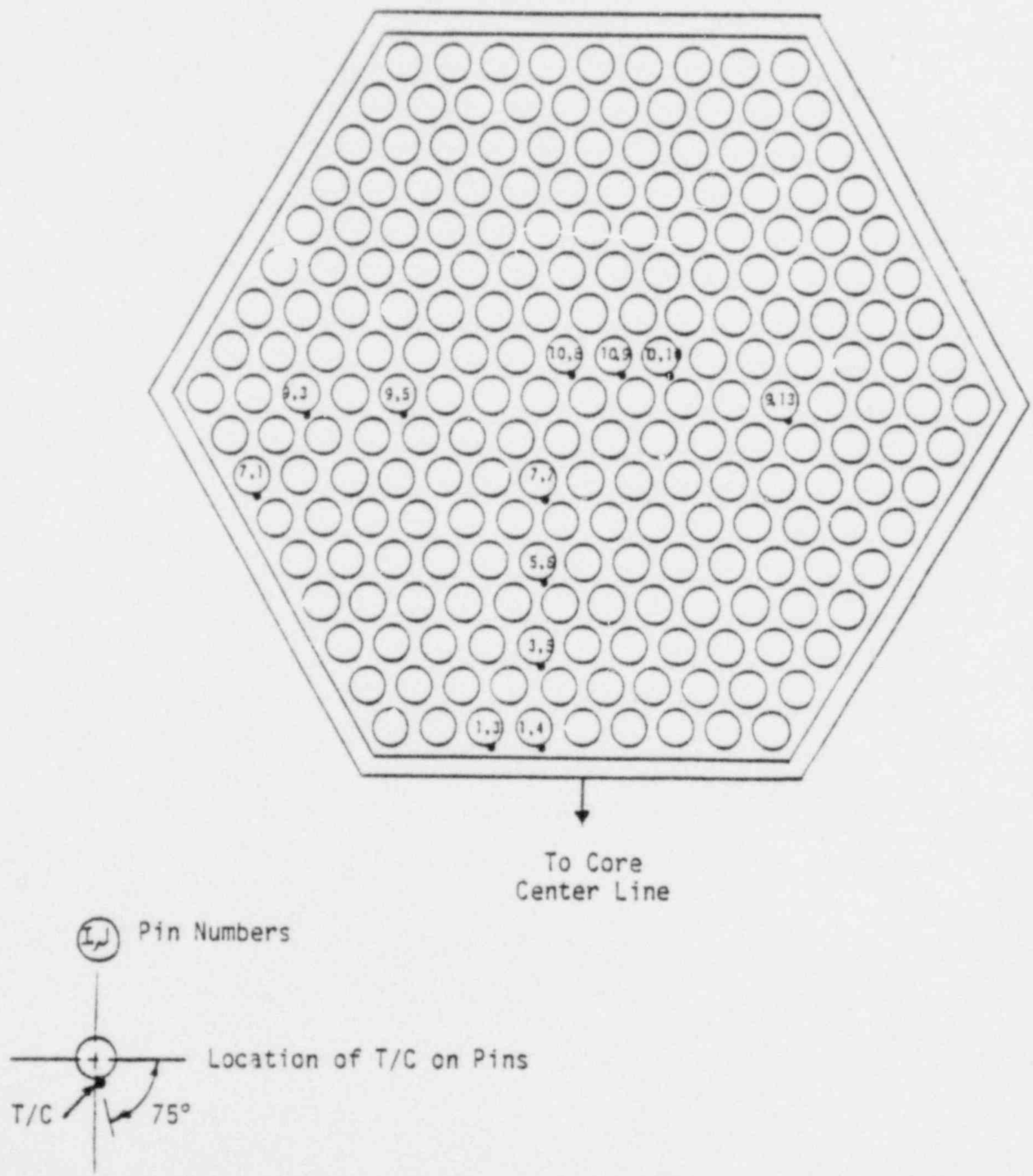


Figure B.2 Row 2 FOTA Thermocouple Radial Positions for Top of Fuel Axial Locations



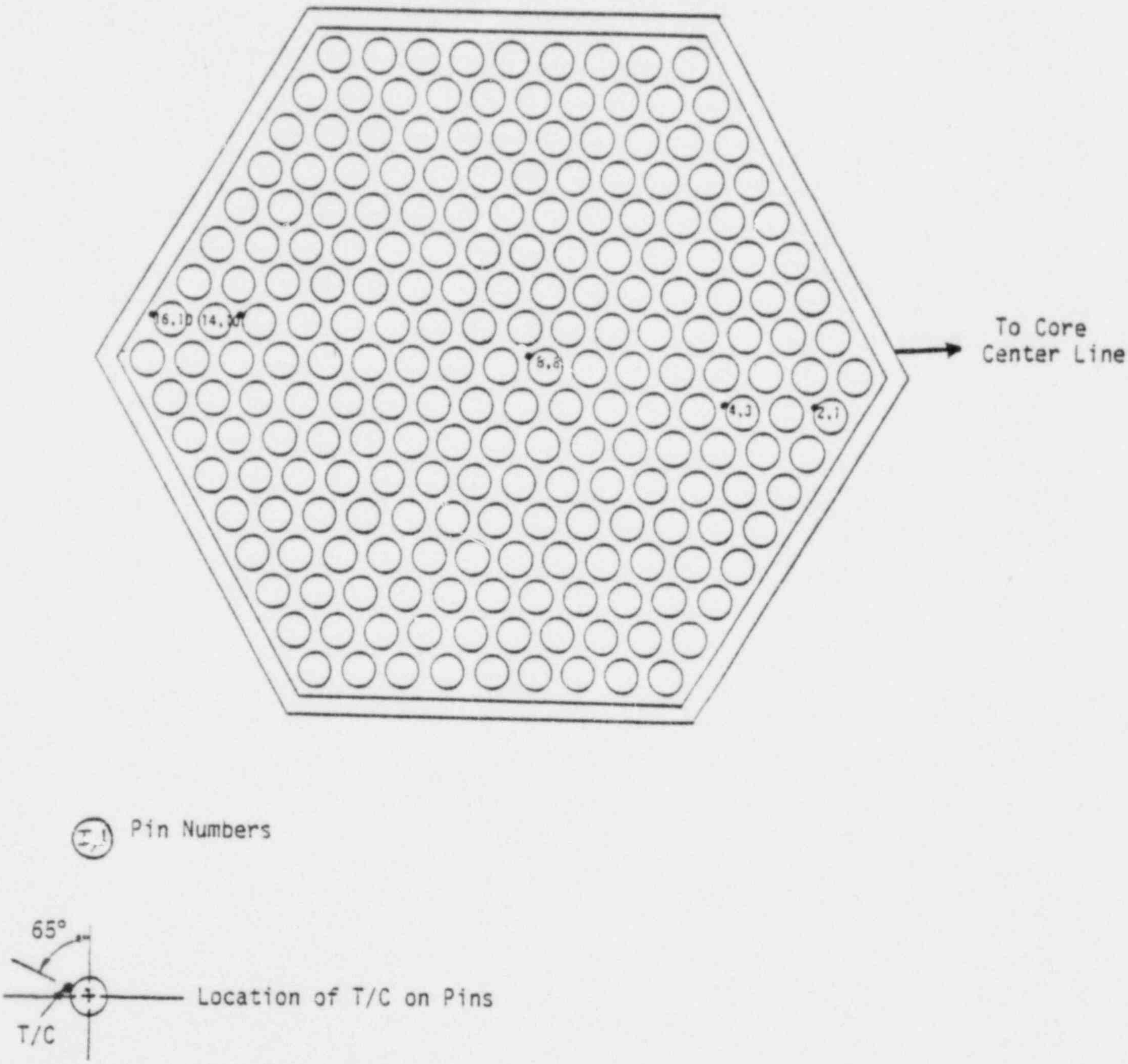
37 - T/C Axial Location, In. Above Bottom of Fuel

Figure B.3 Row 2 FOTA Thermocouple Radial Positions for Top of Pins Axial Locations



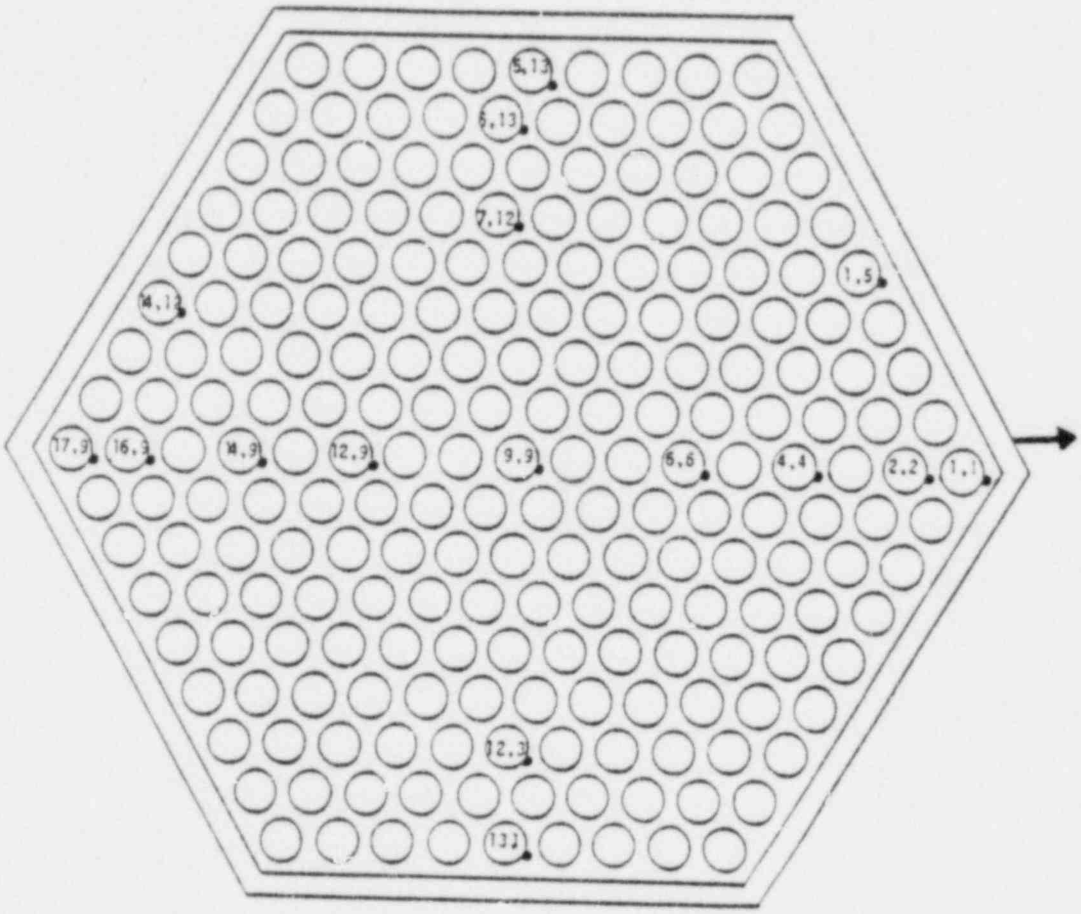
82.76 T/C Axial Location, In. Above Bottom of Fuel

Figure B.4 Row 6 FOTA Thermocouple Radial Positions for Core Midplane Axial Locations



19.07 T/C Axial Locations, In. Above Bottom of Fuel

Figure B.5 Row 6 FOTA Thermocouple Radial Positions for Top of Fuel Axial Locations



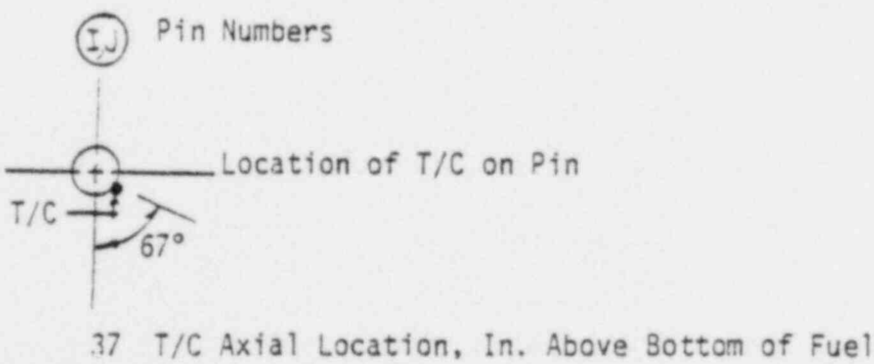
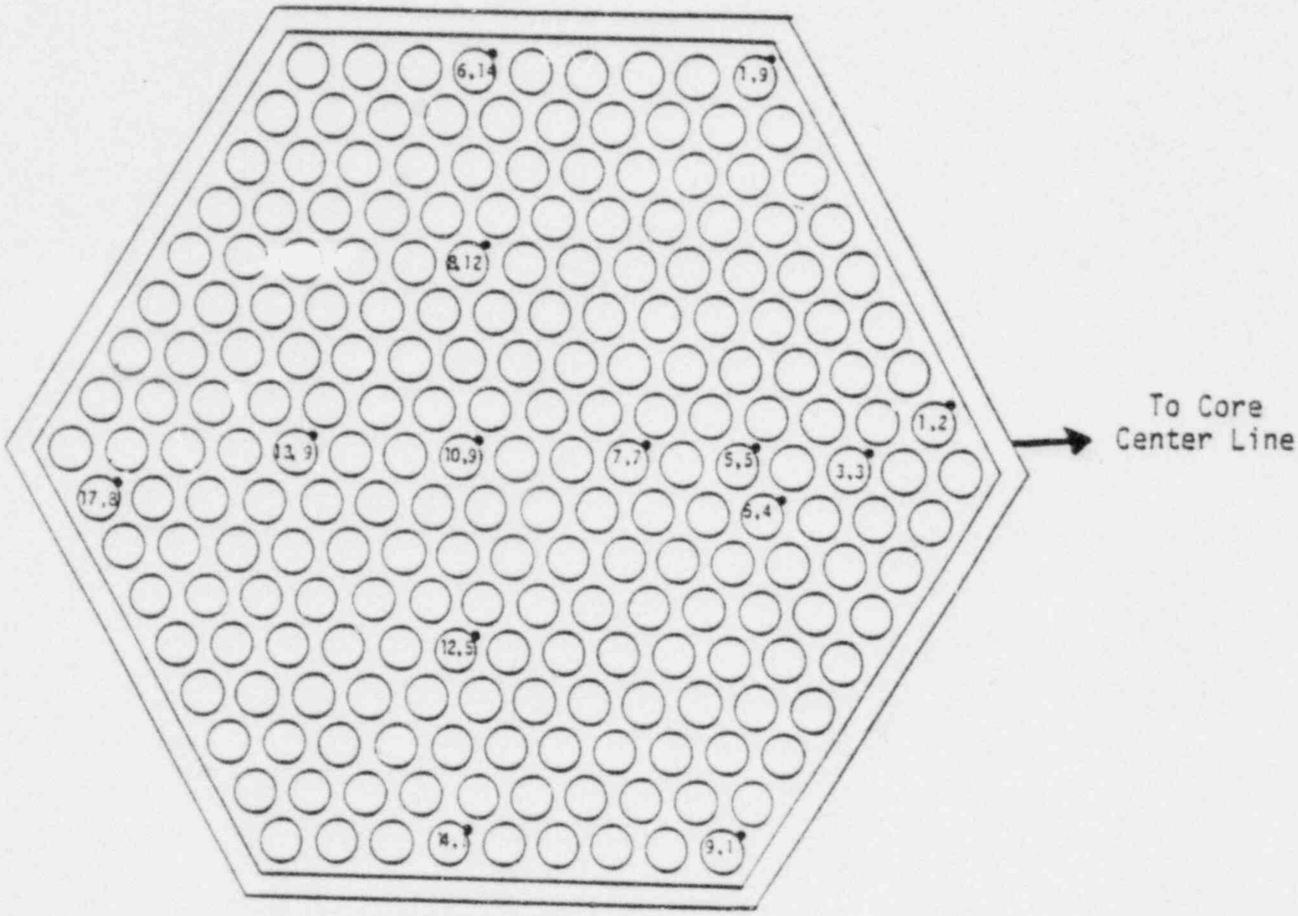
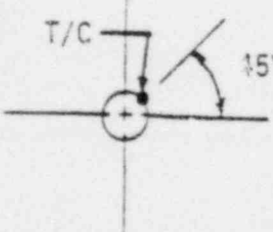


Figure B.6 Row 6 FOTA Thermocouple Radial Positions for Top of Pins Axial Locations



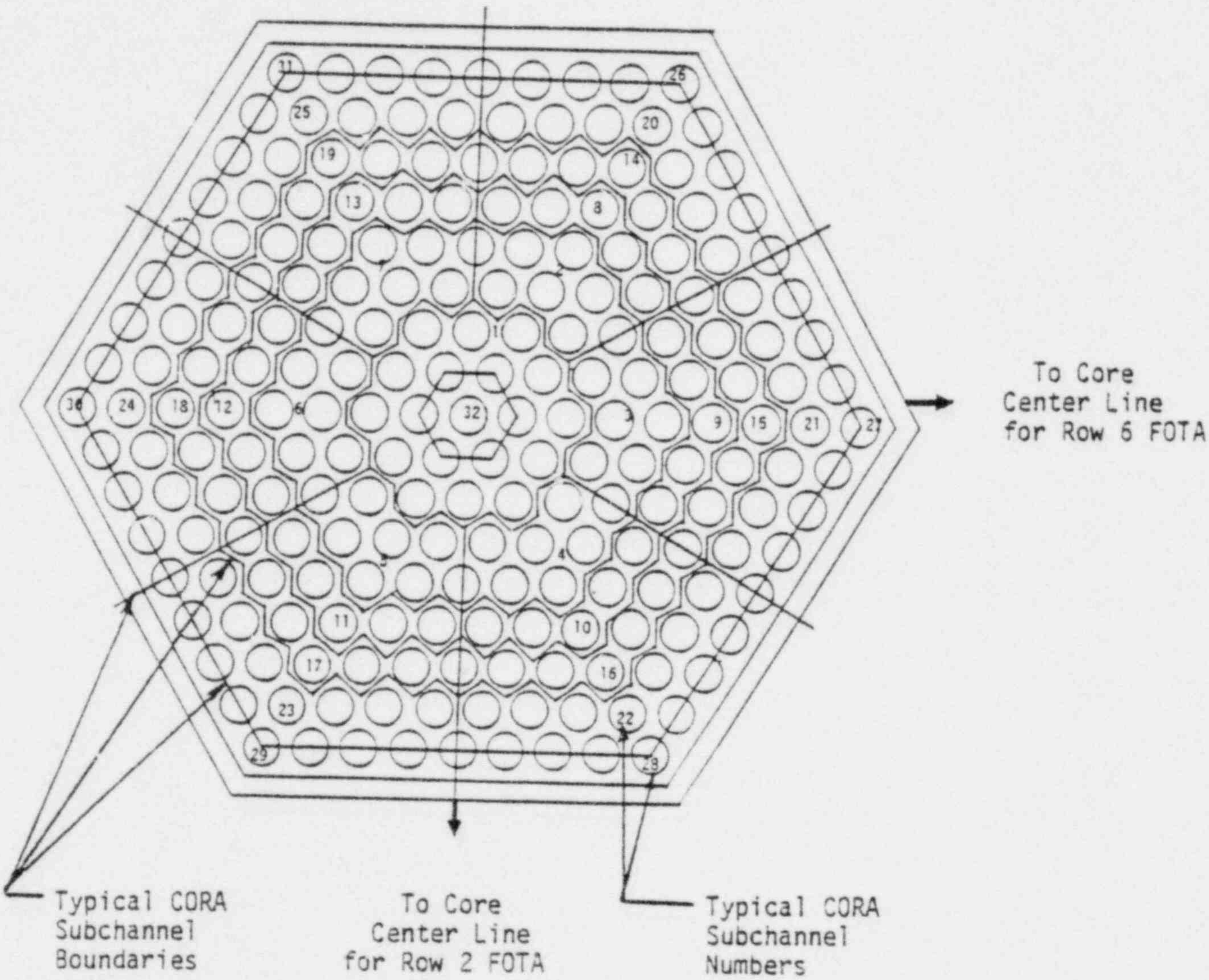
(I,J) Pin Numbers



Location of T/C on Pin

82.76 T/C Axial Location, In. Above Bottom of Fuel

Figure B.7 CORA Modeling for the Rows 2 and 6 FOTA Assemblies



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