INTERIM REPORT

8-21-79

Accession No. ______________

____

Contract Program or Project Title:

Subject of this Document: Supplement to Quick Look Report for LOFT LOCE L2-3

Type of Document: Quick Look Report

Author(s): D. L. Reeder

Date of Document: August 1979

Responsible NRC Individual and NRC Office or Division: G. D. McPherson

This document was prepared primarily for preliminary or internal use. It has not received full review and approval. Since there may be substantive changes, this document should not be considered final.

for Kay Rose

H. P. Pearson, Supervisor
Information Processing
EG&G Idaho

Prepared for
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

NRC Fin #A6048

INTERIM REPORT

977 316

NRC Research and Technical Assistance Report

7909190516

EG&G Idaho, Inc.

P. O. Box 1625
Idaho Falls, Idaho 83401

August 10, 1979

Mr. R. E. Tiller, Director
Reactor Operations & Programs Division
Idaho Operations Office- DOE
Idaho Falls, ID 83401

SUPPLEMENT TO QUICK LOOK REPORT (QLR) L2-3 - Kau-162-79

Ref: N. C. Kaufman ltr to R. E. Tiller, Kau-98-79, Quick Look Report for LOFT LOCE L2-3, May 18, 1979

Dear Mr. Tiller:

This letters transmits supplemental information to the Loss-of-Fluid Test (LOFT) Loss-of-Coolant Experiment (LOCE) L2-3 QLR. Information on the calculations submitted by the participants in the United States Standard Problem 10, LOFT LOCE L2-3 is included. The information and several calculated parameters are attached.

This information is intended to allow a cursory overview of the predictions and not to be an assessment of them. Both best estimate and evaluation model calculations are included.

Very truly yours,

N. C. Kaufman
Director, LOFT

DLR:mim

Attachment:
As stated

977 317

cc: H. D. Axtell, EW&EB
S. Banerjee, McMaster Univ.
R. W. Barber, DSE, DOE-HQ (2)
G. L. Bennet, NRC-HQ
C. H. Berlinger, NRC-HQ
W. Binner, IfR (4)
W. W. Bixby, DOE-ID
J. Block, Creare
K. J. Brinkmann, ECN (4)
G. F. Brockett, ITI
R. W. Brodsky, DOE-HQ
D. M. Chapin, MPR
P. Y. Chen, NRC-HQ
R. Denning, BCL
S. Fabic, NRC-HQ
T. Fernandez, EPRI
M. Firnhaber, GfR
R. F. Fraley, ACRS
K. P. Galbraith, NSE
D. Godard, ODE
P. Griffith, MIT
M. D. Houston, NRC-HQ
J. Jackson, LASL
W. J. Johnson, NRC-HQ
W. Kato, BNL
S. Kellman, W
N. N. Kondic, NRC-HQ
R. T. Lahey, RPI
R. R. Landry, NRC-HQ
A. J. Levine, GE
S. Levine, NRC
W. Loewenstein, EPRI
P. A. Lottes, ANL
D. Lummerzheim, BfFuT
G. Markoczy, SFIfFR (4)
R. J. Mattson, NRC-HQ
F. Mayinger, LuIfV
G. D. McPherson, RSR, NRC-HQ (2)
M. Meerbaum, B&W
G. Menzel, CE
C. Moser, EI
T. E. Murley, NRC-HQ
P. E. Norian, NRC-HQ
T. H. Novak, NRC-HQ
F. Odar, NRC-HQ
A. Olsen, Risø (4)
G. Owsley, Exxon
Dr. Pfeiffer, GfR (10)
D. Primeau, AECL
Z. R. Rosztoczy, NRC-HQ
M. Shiba, JAERI
T. M. Su, NRC-HQ
K. Taketani, JAERI (4)
R. L. Tedesco, NRC-HQ
D. G. Thomas, ORNL
L. S. Tong, NRC-HQ
D. Trent, PNL
B. Washburn, DOE-HQ
K. R. Wichman, NRC-HQ
K. A. Williams, LASL
R. W. Kiehn, EG&G Idaho (w/o Attach)

318

~~977 337~~

bcc: M. Akimoto
E. C. Anderson
V. T. Berta VTB
L. A. Cook
G. A. Dinneen
L. D. Goodrich
J. C. Haire
D. J. Hanson
R. O. Haroldsen
H. Henze
G. W. Johnsen
M. J. Johnson
S. T. Kelppe (3)
T. K. Larson
G. D. Lassahn
L. P. Leach
P. E. MacDonald
O. R. Meyer
N. L. Norman
D. J. Olson
V. H. Ransom
D. L. Reeder DLR
G. Reiger
R. E. Rice
M. L. Russell
T. K. Samuels
P. J. Schally (3)
R. W. Shumway
D. M. Snider
D. T. Sparks
W. A. Spencer
M. L. Stanley
L. H. Sullivan
K. C. Sumpter
T. Sudoh (2)
D. J. Varacalle
G. H. Weimann (2)
R. D. Wesley
L. L. Wheat
J. E. Wilkins
L. Winters (2)
Central File (w/o Attach)
N. C. Kaufman File (2)

S. A. Naff SAN by JRW

077 319

This attachment summarizes the pretest calculations of LOFT nuclear Loss-of-Coolant Experiment (LOCE) L2-3 and is intended to supplement information supplied in QLR-L2-3[1]. LOCE L2-3 was designated United States Standard Problem 10 by the Nuclear Regulatory Commission (NRC) and pretest calculations were performed by several official participants and other groups. The organizations making calculations, the computer codes used, and a brief summary of results are included.

LOCE L2-3 was conducted in the LOFT facility[2] on May 12, 1979, from initial primary coolant and reactor maximum linear heat generation rate conditions typical of those in a generic nuclear power plant at normal operating conditions. The data gathered during the experiment are valuable for assessment of the calculational capability and inherent conservatism in the computer codes used for best estimate and evaluation model analysis of nuclear reactor systems.

Calculations have been received from the following organizations: Combustion Engineering (CE)[3], Exxon Nuclear Company (ENC)[4,5], Intermountain Technology Incorporated for the Electric Power Research Institute (ITI/EPRI)[6], Idaho National Engineering Laboratory LOFT Program (LOFT)[7], Los Alamos Scientific Laboratory Reactor Safety (LASL)[8,9], and the NRC Division of System Safety (NRC/DSS)[10]. A listing of all participants and the computer codes used are given in Table I. It should be noted that ENC and the NRC/DSS performed evaluation model calculations; whereas, the other participants made best estimate calculations.

The options used in the calculations regarding break flow modeling and accumulator gas expansion can make significant differences in the results. These options are listed in Tables II and III. The chronology of events measured and calculated by the participants is given in Table IV. Some participants did not supply all the event times.

Figures 1 through 25 show the calculated hot fuel rod cladding temperatures at four axial locations. Due to differences in fuel rod nodalization, some participants did not have four different temperatures for the four locations. The highest measured cladding temperatures are shown in Figures 26 through 29[11] for comparison.

TABLE I

Participant	Codes Used
Combustion Engineering	FATES - Fuel initial conditions CEFLASH - Blowdown hydraulics STRIKIN - Blowdown and refill fuel rod heat transfer
	RELBOT MXTEMP Refill Hydraulics CREARE
	TARP Reflood fuel rod heat transfer THERM
Exxon Nuclear Company	ENC WREMIIA PWR ECCS Evaluation Model
Intermountain Technology Incorporated for the Electric Power Research Institute	RETRAN[12]
INEL/LOFT	FRAP-S3[13] Fuel initial conditions RELAP4/MOD6 (MODIFIED)[7,14]
LASL	TRAC - PIA[15]
	TRAC - PIA with the Iloeje[16] ΔT_{min} correlation
NRC/DSS	WREM package GAPCON fuel initial conditions RELAP4/MOD5/NRC blowdown thermal hydraulics

TABLE II

BREAK FLOW MODELING

Participant	Fluid Condition	Model[a]	Discharge Coefficient
Combustion Engineering	Subcooled	HF	0.6
	Saturated	HEM	0.9
	Superheated	MB	0.9
Exxon Nuclear Company	Subcooled	HF	1.0
	Saturated	M	1.0
Intermountain Technology Incorporated for Electric Power Research Institute	Subcooled	HF	0.75
	Saturated	HEM	1.0
INEL/LOFT	Subcooled	HF	0.848
	Saturated	HEM	0.848
LASL	N/A	N/A	N/A
NRC/DSS	Subcooled	HF	1.0
	Saturated	M	1.0

a HF - Henry Fauske
HEM - Homogeneous Equilibrium Model
MB - Murdock Bauman
M - Moody

<u>TABLE III</u>

ACCUMULATOR POLYTROPIC GAS CONSTANT

Participant	Constant
Combustion Engineering	1.2
Exxon Nuclear Company	1.0
Intermountain Technology Incorporated for Electric Power Research Insitute	1.0
INEL/LOFT	1.4
LASL	1.4
NRC/DSS	1.4

977 324

TABLE IV

MEASURED AND CALCULATED CHRONOLOGY OF EVENTS

Event	Data	RELAP4/ MOD6	TRAC-PIA	TRAC-PIA+ Iloeje	CE	ITI/ EPRI	NRC/ DSS	ENC
LOCE initiated	0	0	0	0	0	0	0	0
End of SCBD[a]	0.05	--	--	--	--	0.05	--	--
First DNB[b]	0.96	0.5	0.25	0.5	0.5	1.0	1.5	--
End of SCBF[c]	3.0	4	--	--	--	4.4	--	--
PCT[d] occurrence	4.95	4.5	40.0	5.0	6	15.5	36	45.9
First core-wide rewet	8	70	--	10	--	--	--	--
HPIS[e] initiation	14	15.2	14	--	--	12	--	11.24
Pressurizer empty	14	15	17	--	--	12.5	--	--
Accumulator iniation	16	15.6	19.5	--	15.2	15.0	--	12.08
LPIS[f] initiation	29	28	31	--	--	--	--	16.15
Accumulator flow ended	45	59	57	--	51.6	--	--	50.53
Core reflooded	55	70	--	--	--	--	--	--

a. SCBD - Subcooled blowdown.
b. DNB - Departure from nucleate boiling.
c. SCBF - Subcooled break flow.
d. PCT - Peak cladding temperature.
e. HPIS - High-pressure injection system.
f. LPIS - Low-pressure injection system.

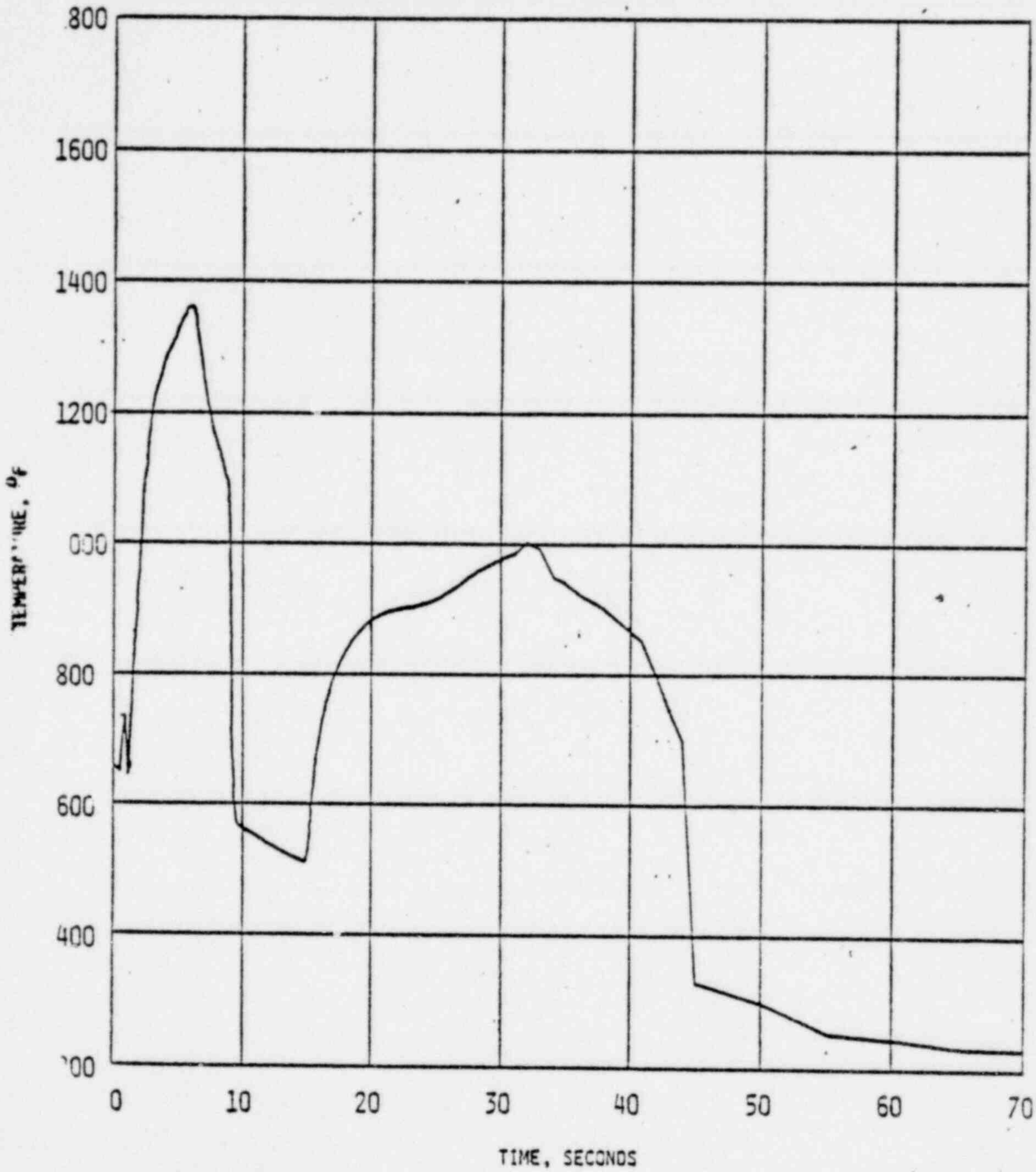

Fig. 1 CE hot rod cladding temperature at 0.381-m elevation.

977 326

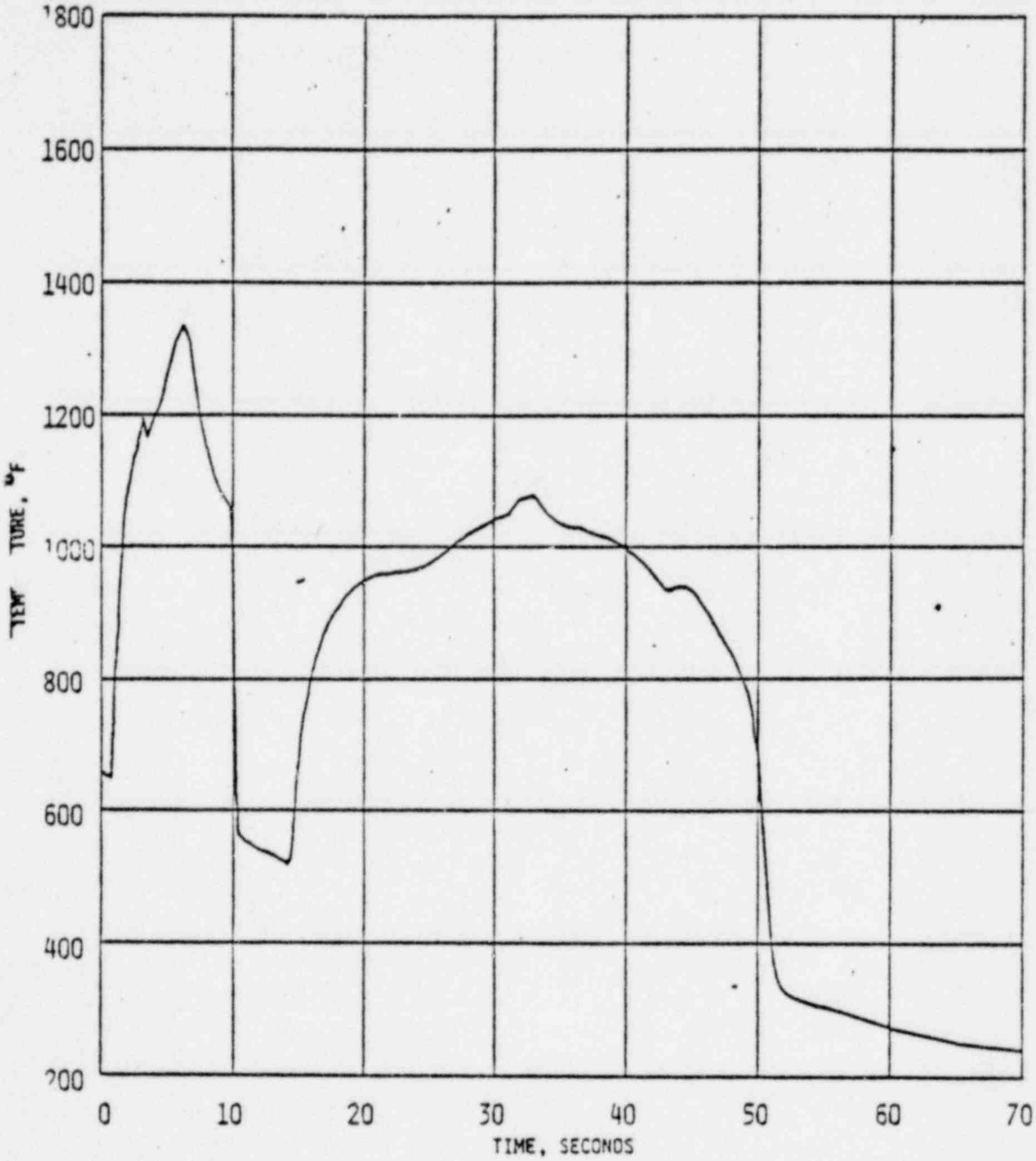

Fig. 2 CE hot rod cladding temperature at 0.533-m elevation.

977 327

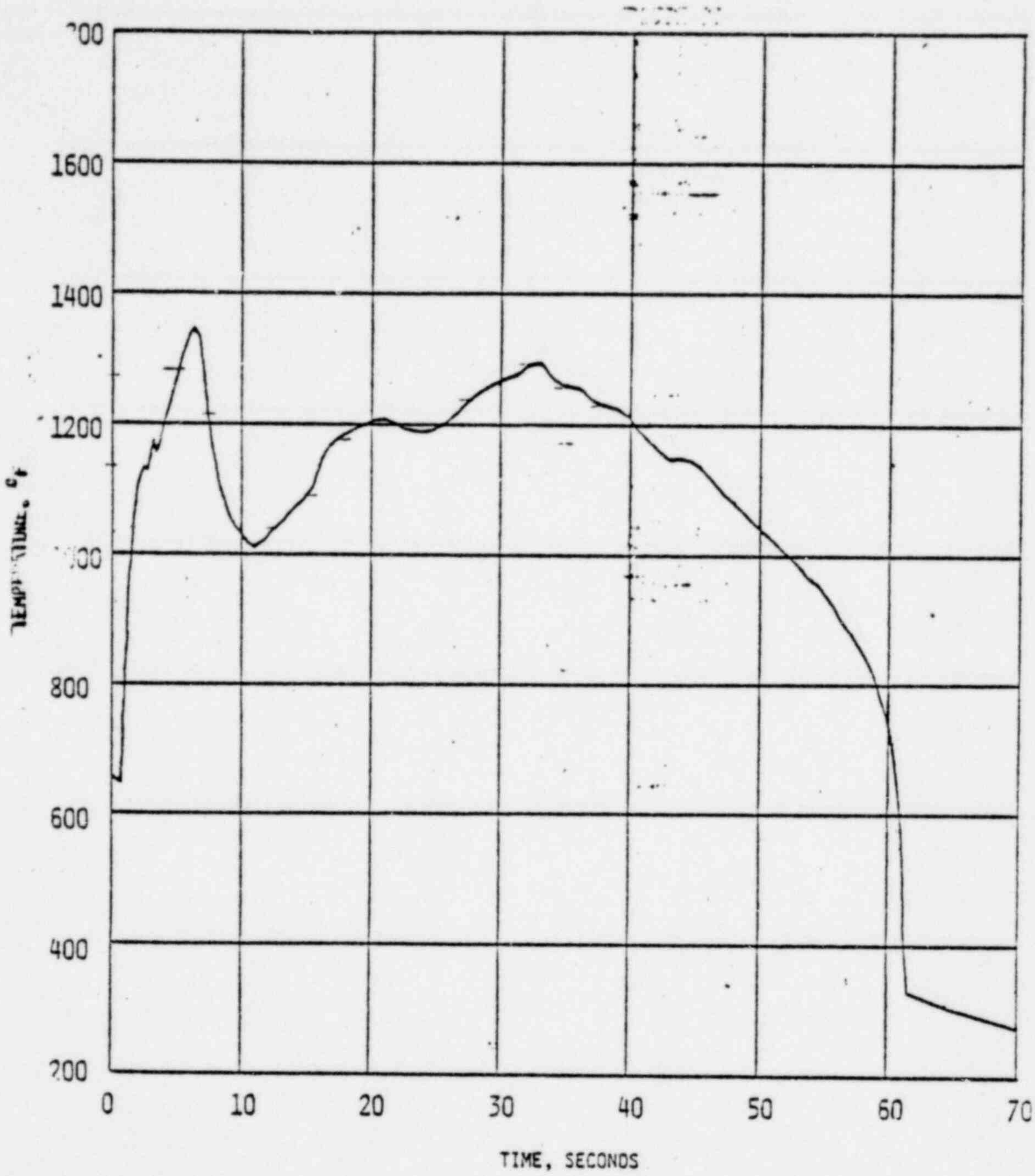

Fig. 3 CE hot rod cladding temperature at 0.762-m elevation.

POOR ORIGINAL

977 328

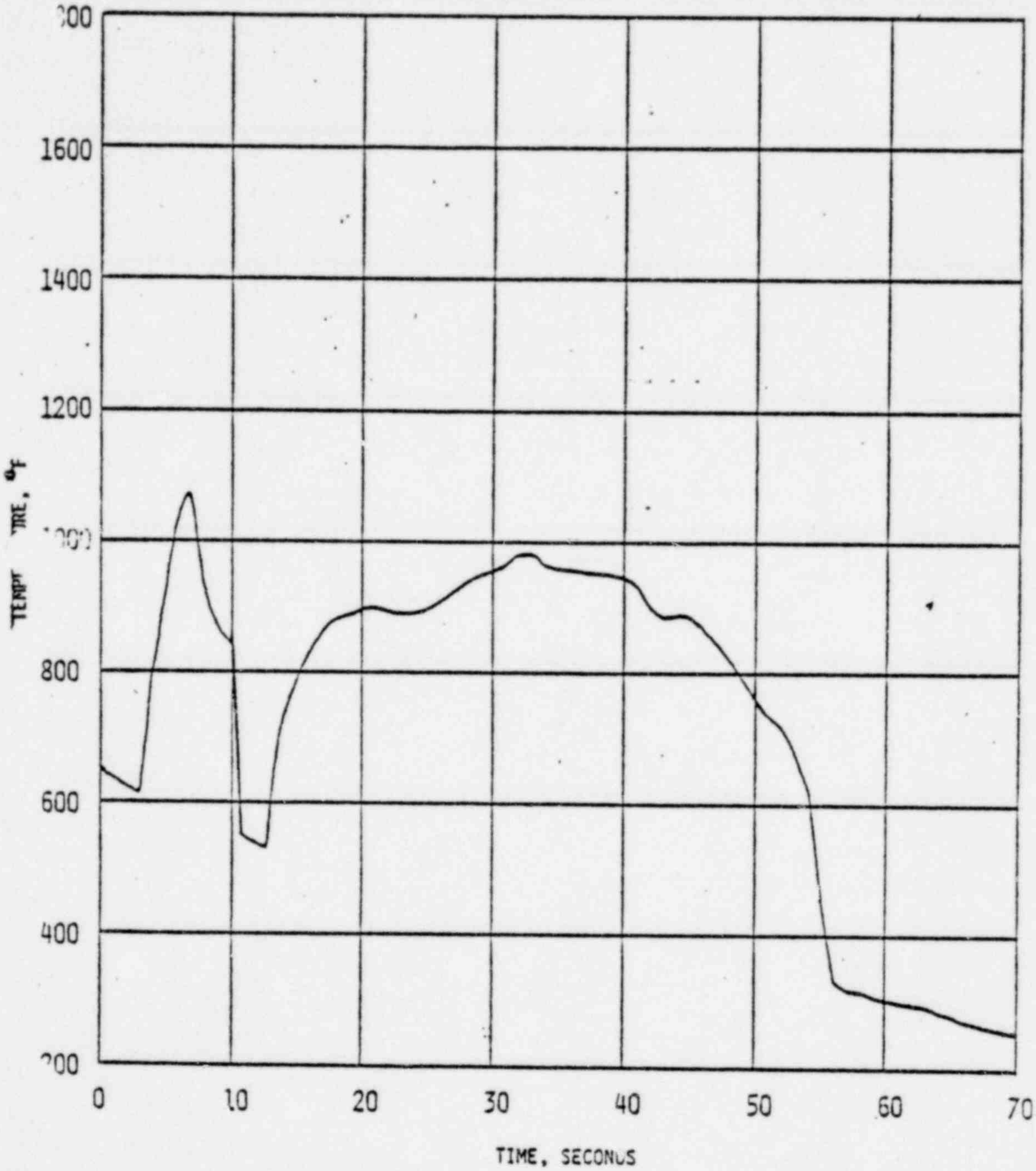

Fig. 4 CE hot rod cladding temperature at 0.991-m elevation.

POOR ORIGINAL

977 329

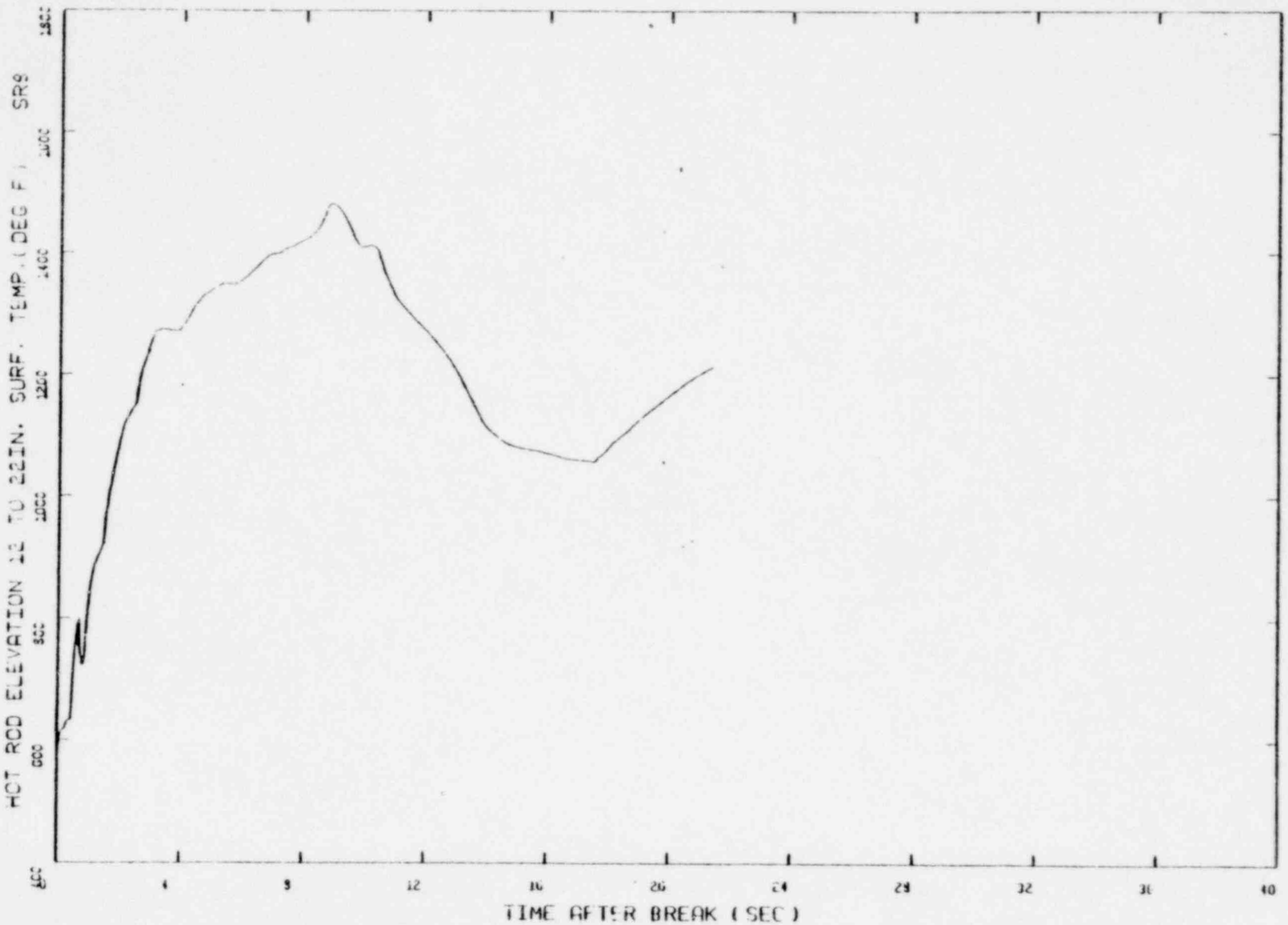

Fig. 5 ENC hot rod cladding temperature from 0.305- to 0.559-m elevations.

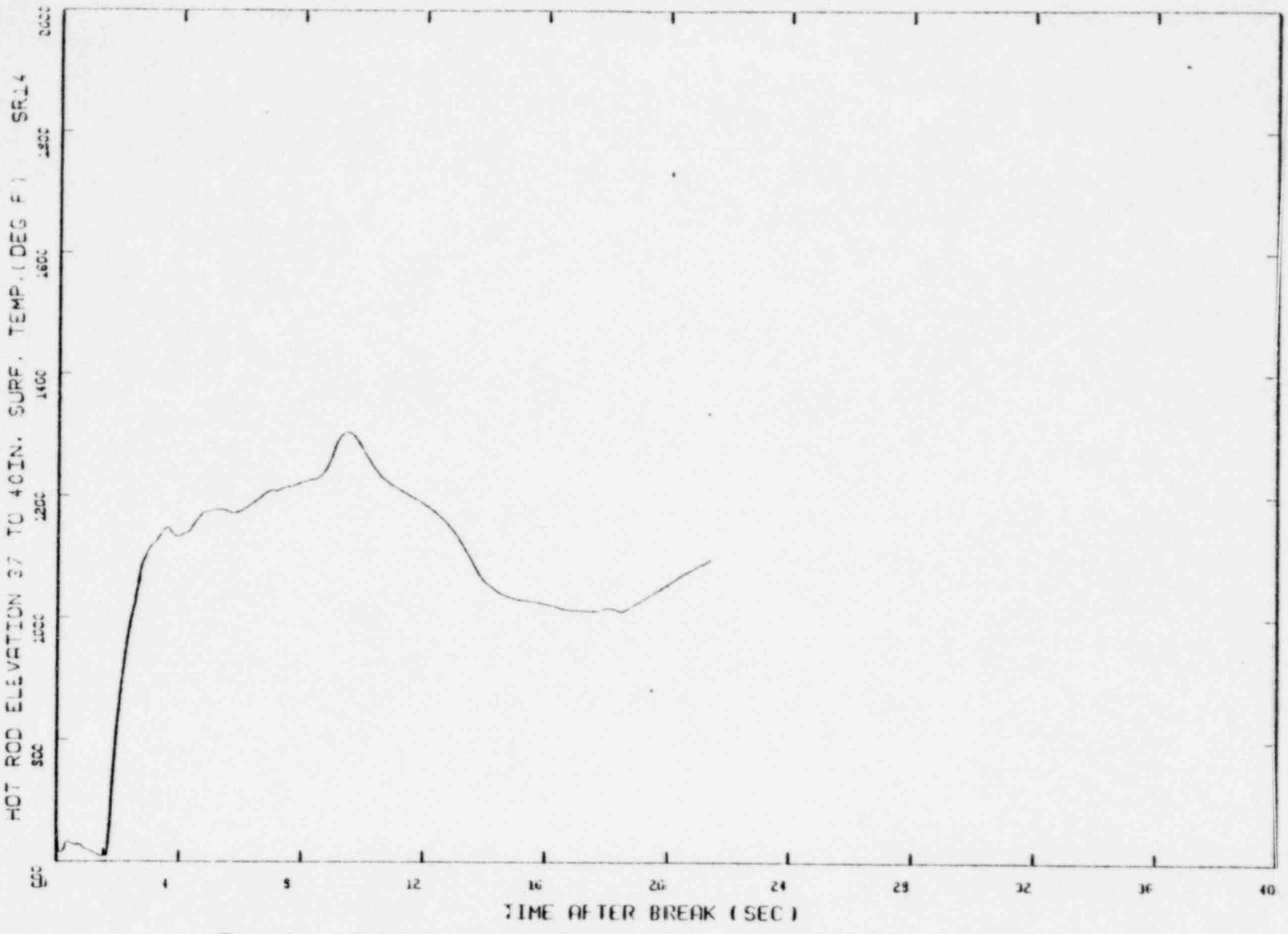

Fig. 6 ENC hot rod cladding temperature from 0.711- to 0.787-m elevations.

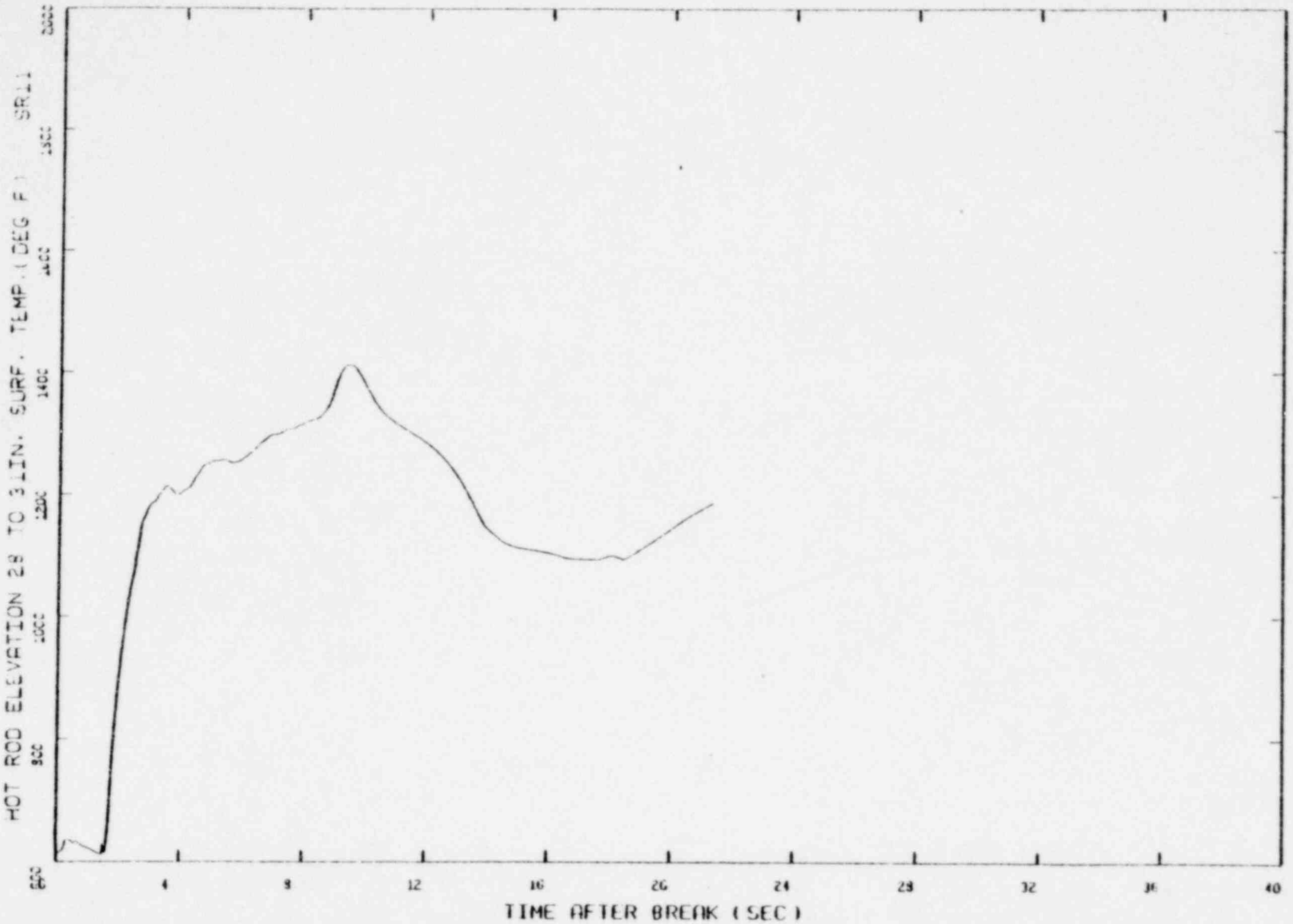

Fig. 7 ENC hot rod cladding temperature from 0.940- to 1.016-m elevations.

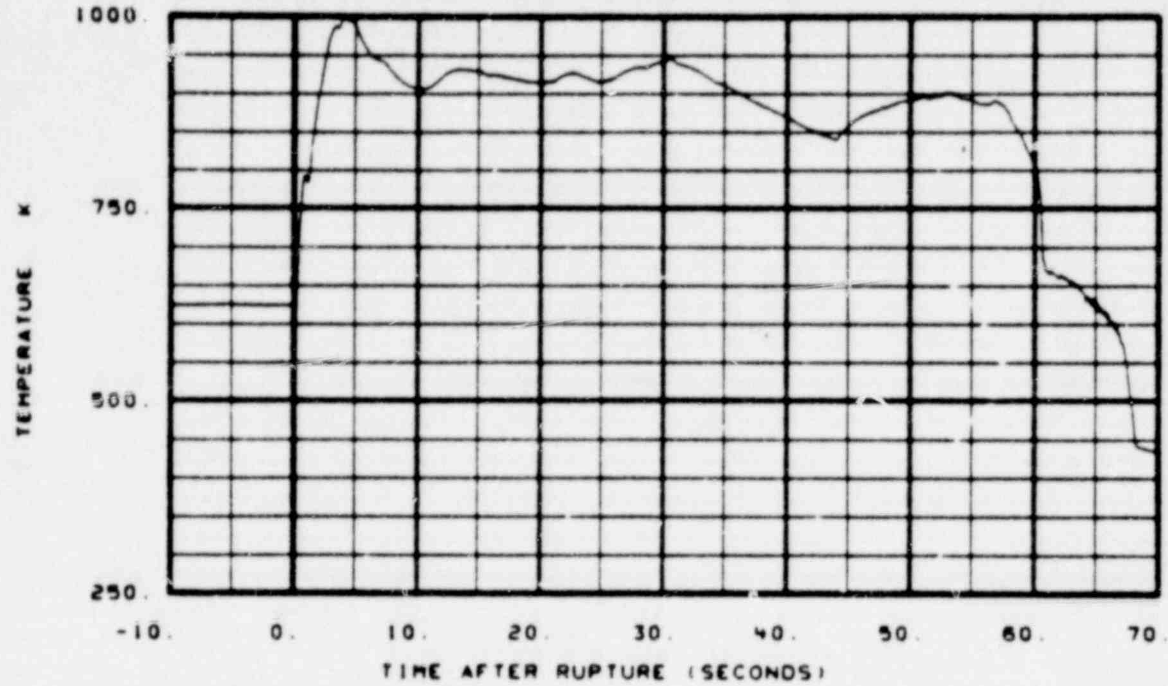

Fig. 8 LOFT hot rod cladding temperature at 0.381-m elevation.

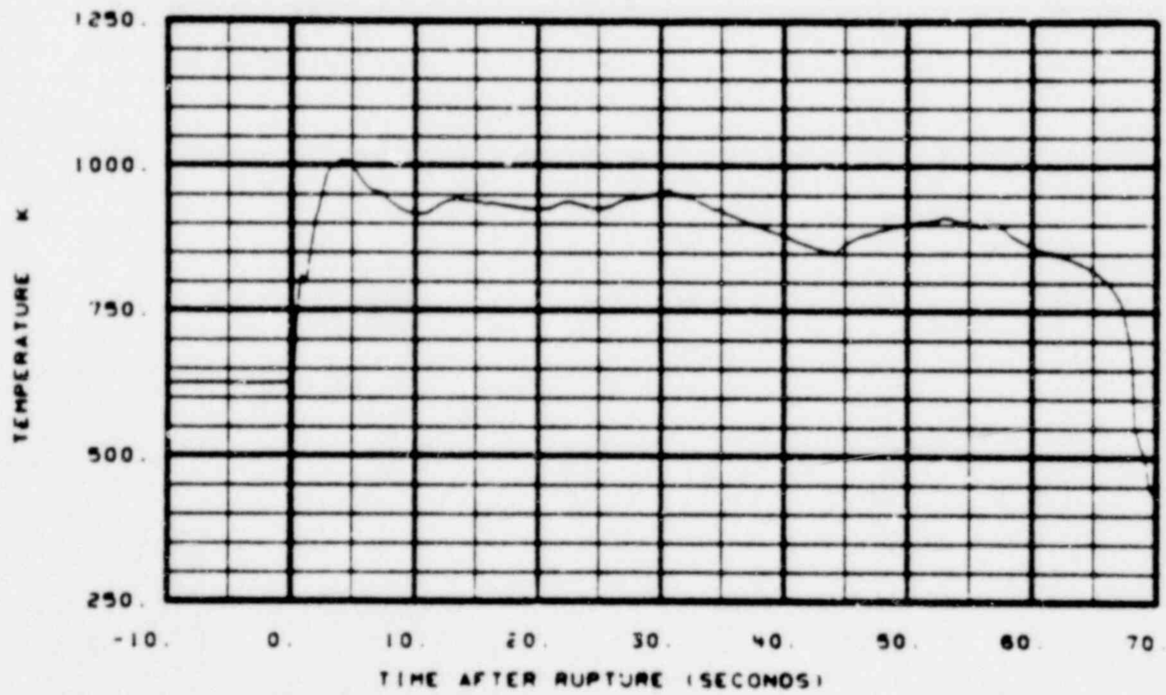

Fig. 9 LOFT hot rod cladding temperature at 0.533-m elevation.

POOR ORIGINAL

977 333

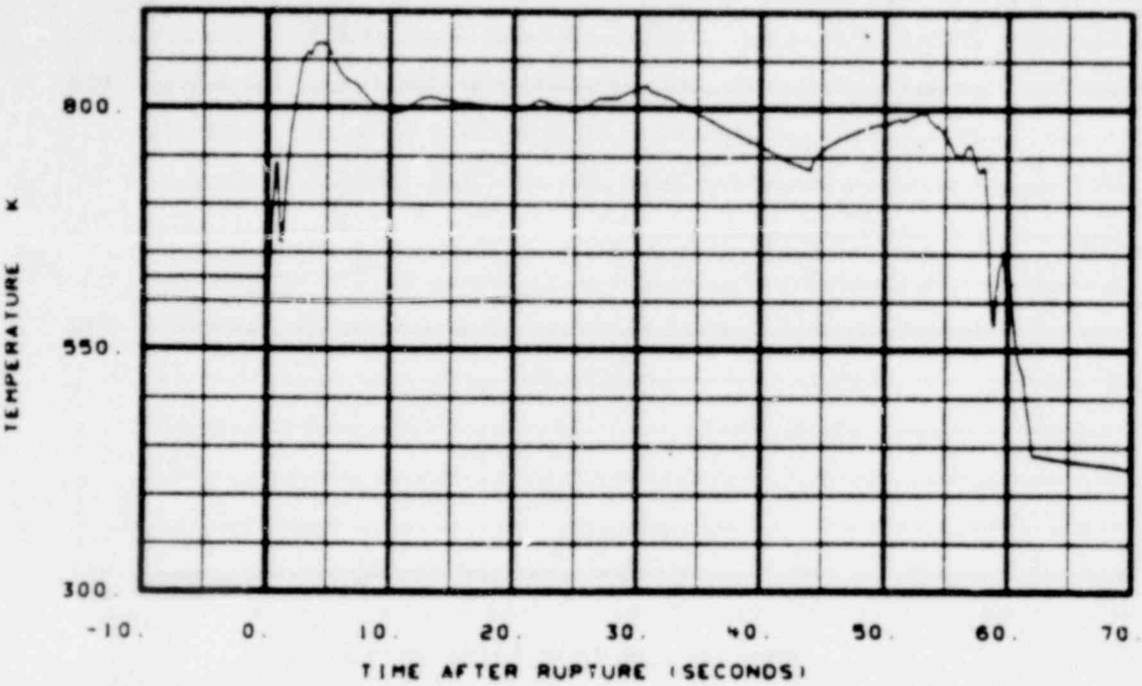

Fig. 10 LOFT hot rod cladding temperature at 0.762-m elevation.

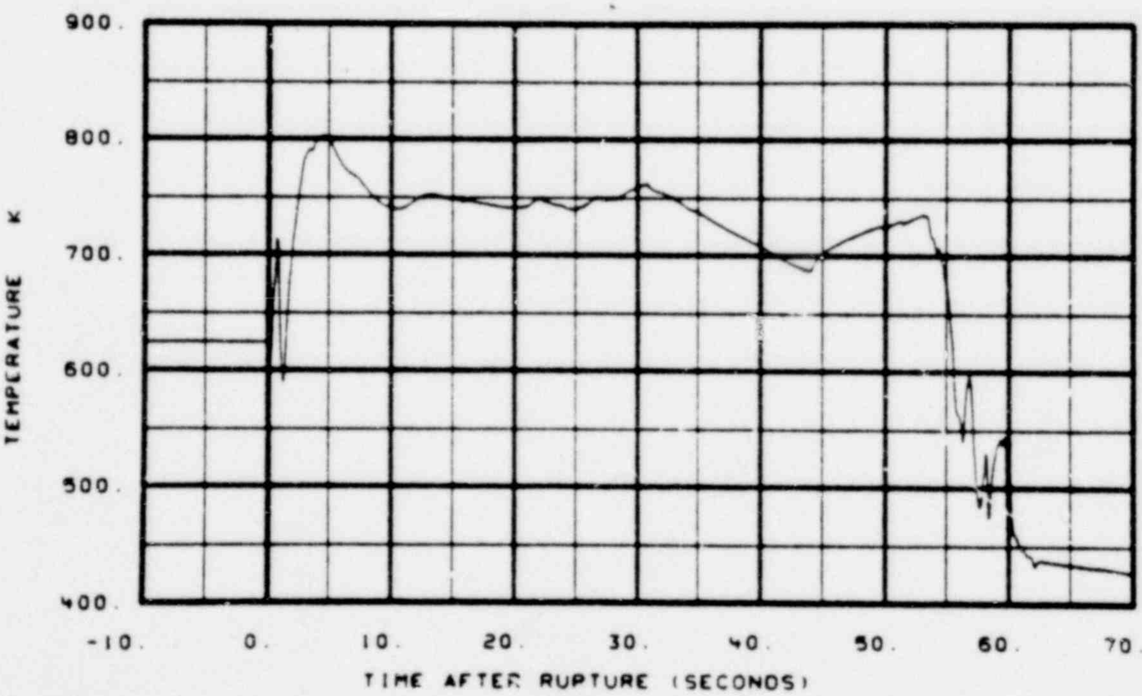

Fig. 11 LOFT hot rod cladding temperature at 0.991-m elevation.

POOR ORIGINAL

977 334

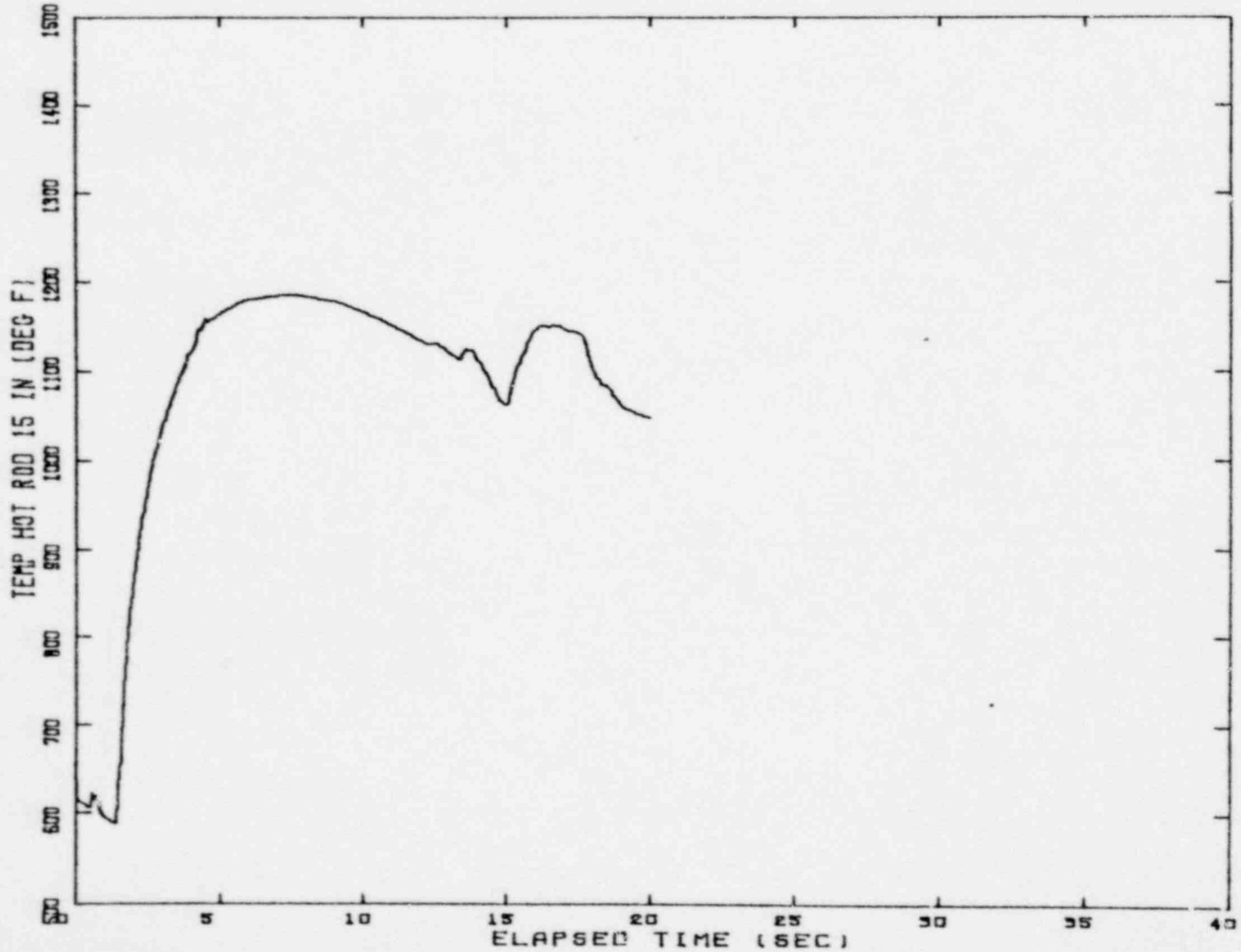

Fig. 12 ITI/EPRI hot rod cladding temperature at 0.381-m elevation.

977 335

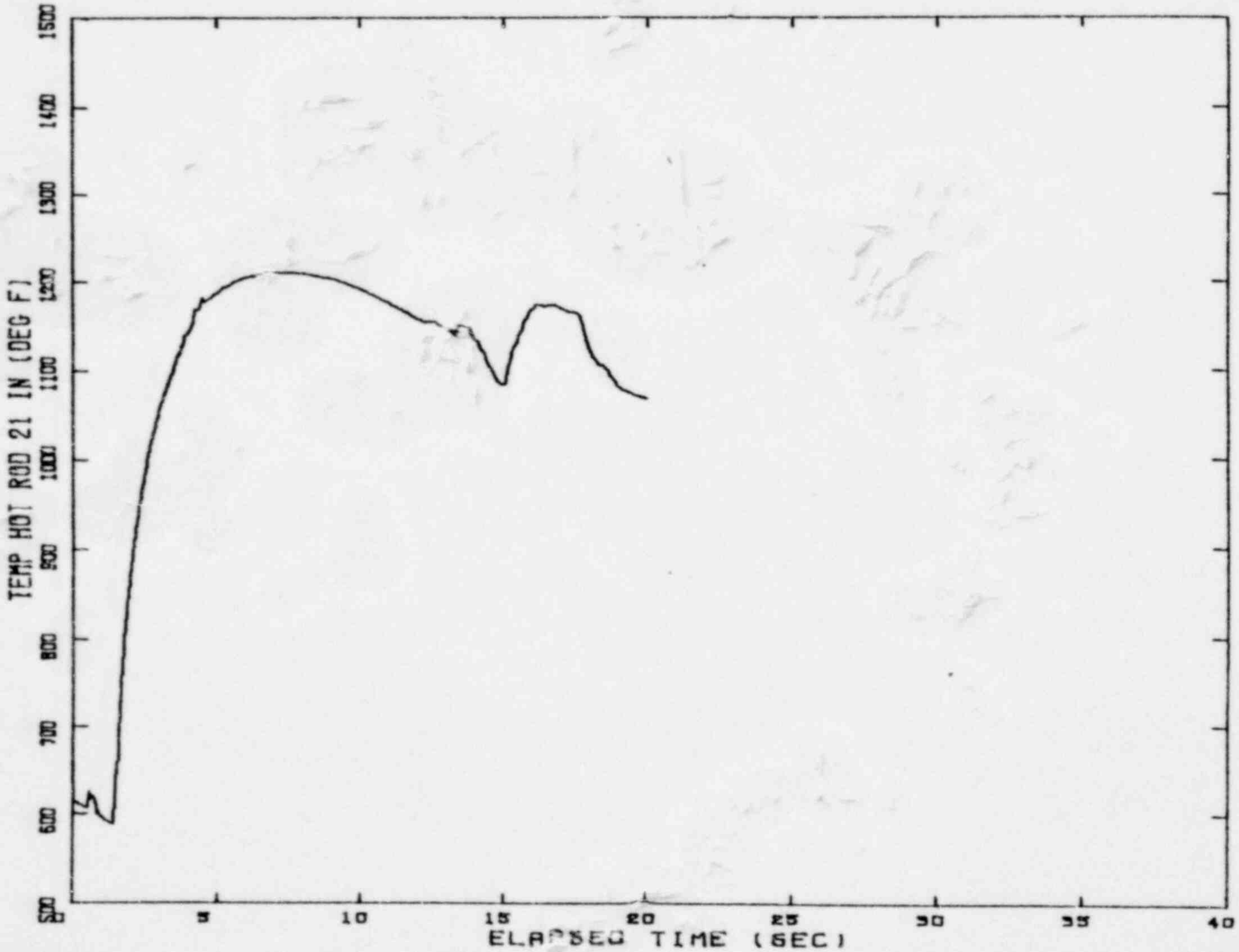

Fig. 13 ITI/EPRI hot rod cladding temperature at 0.533-m elevation.

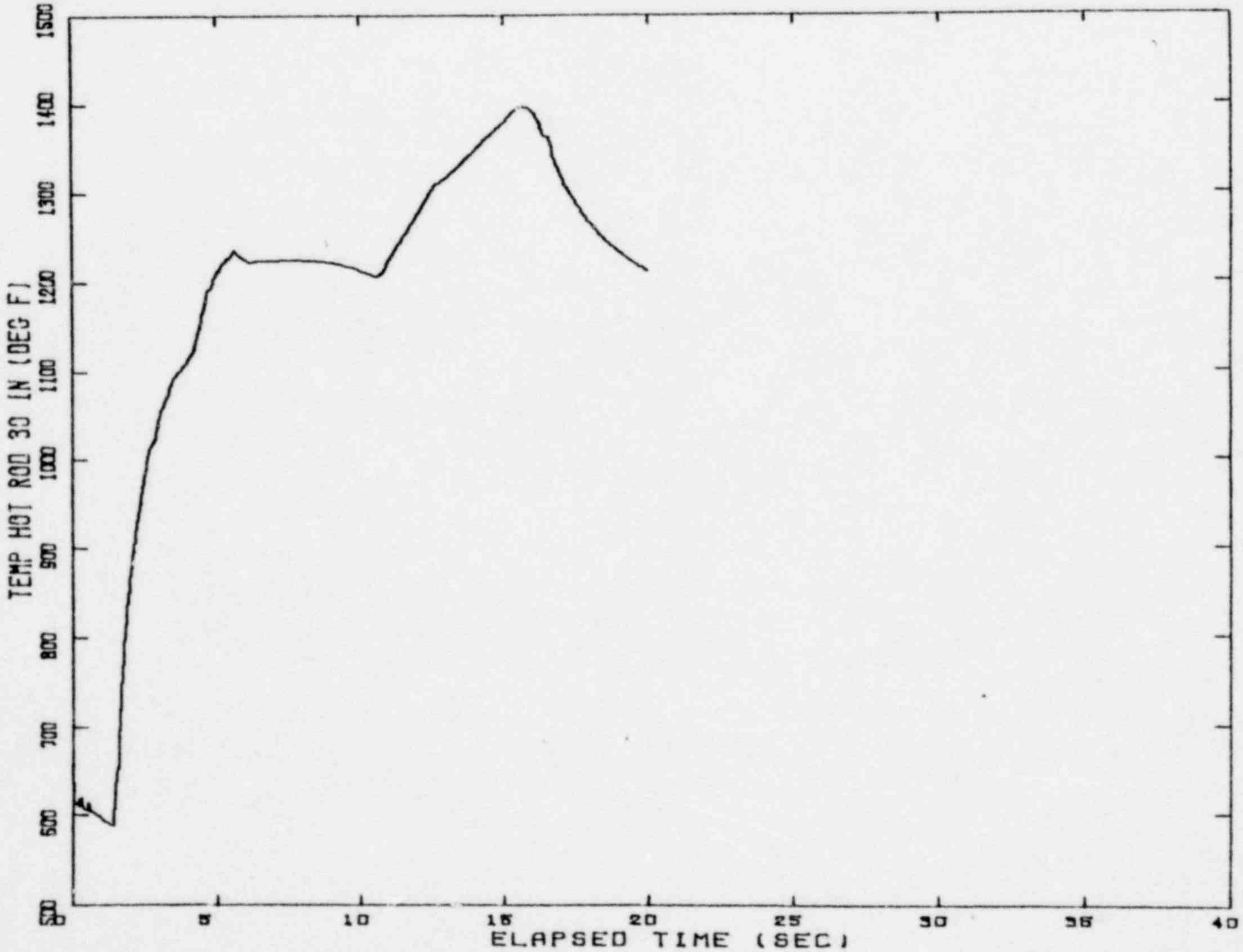

Fig. 14 ITI/EPRI hot rod cladding temperature at 0.762-m elevation.

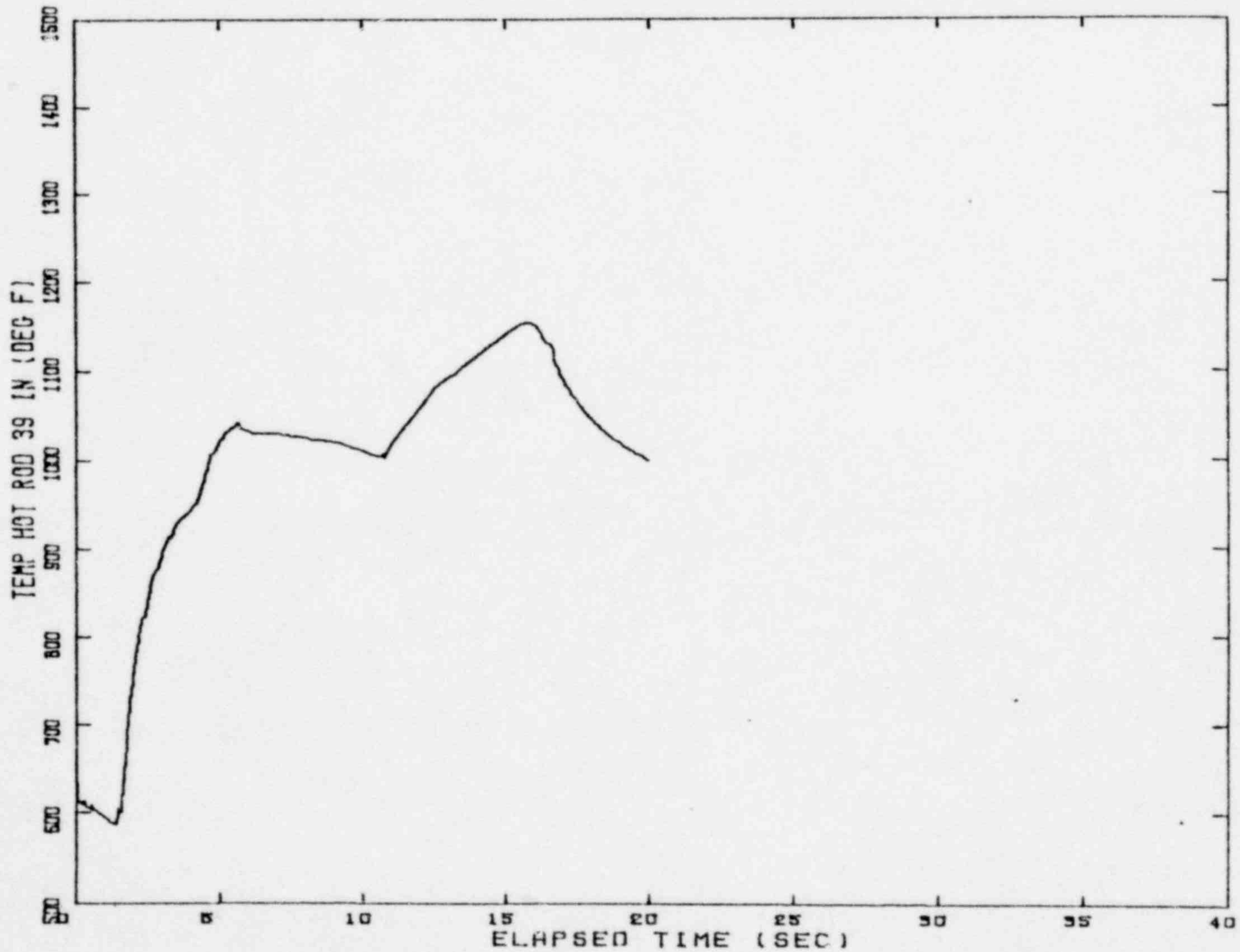

Fig. 15 ITI/EPRI hot rod cladding temperature at 0.991-m elevation.

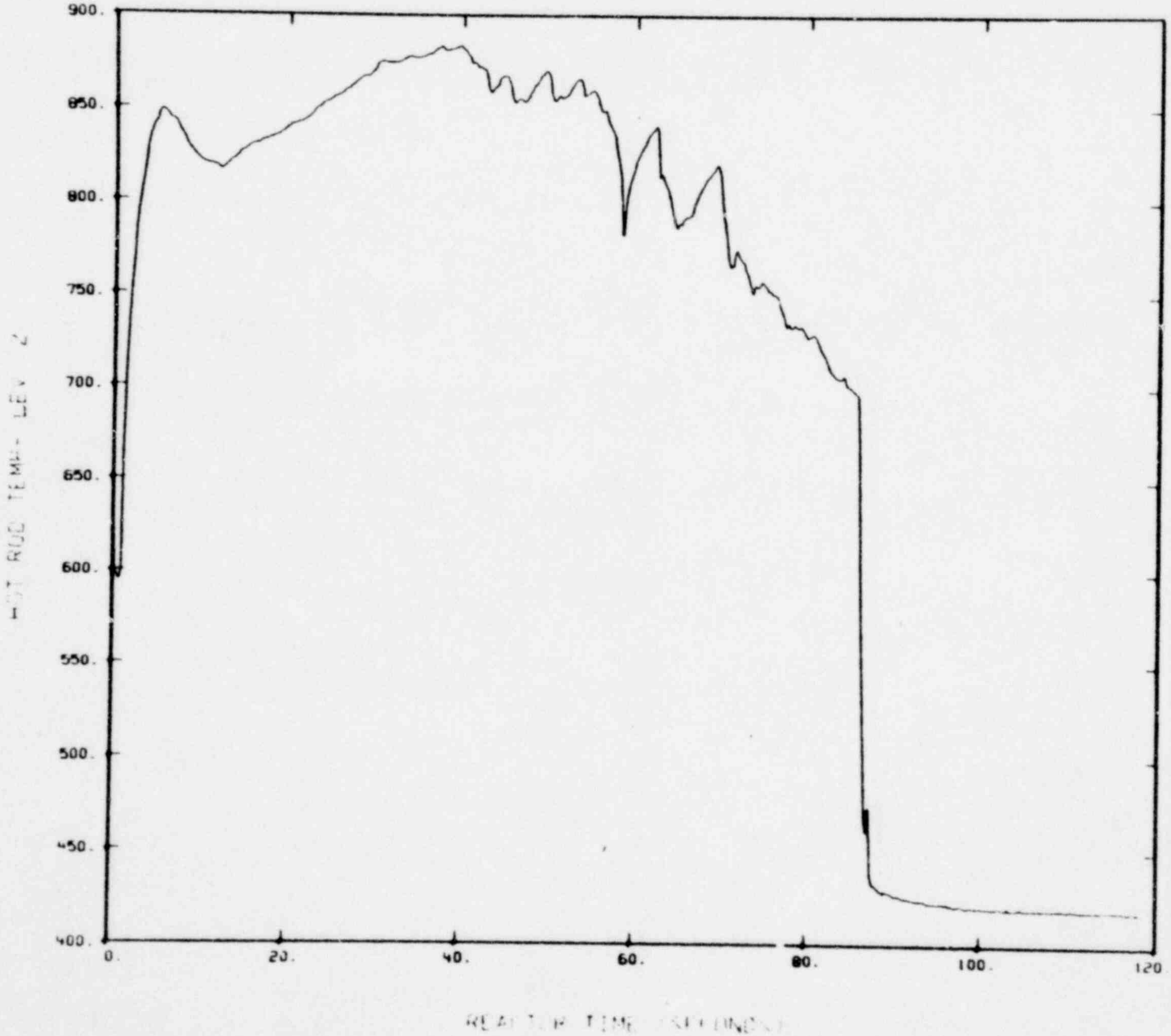

Fig. 16 TRAC-PIA hot rod cladding temperature at 0.381- and 0.533-m elevations.

977 340

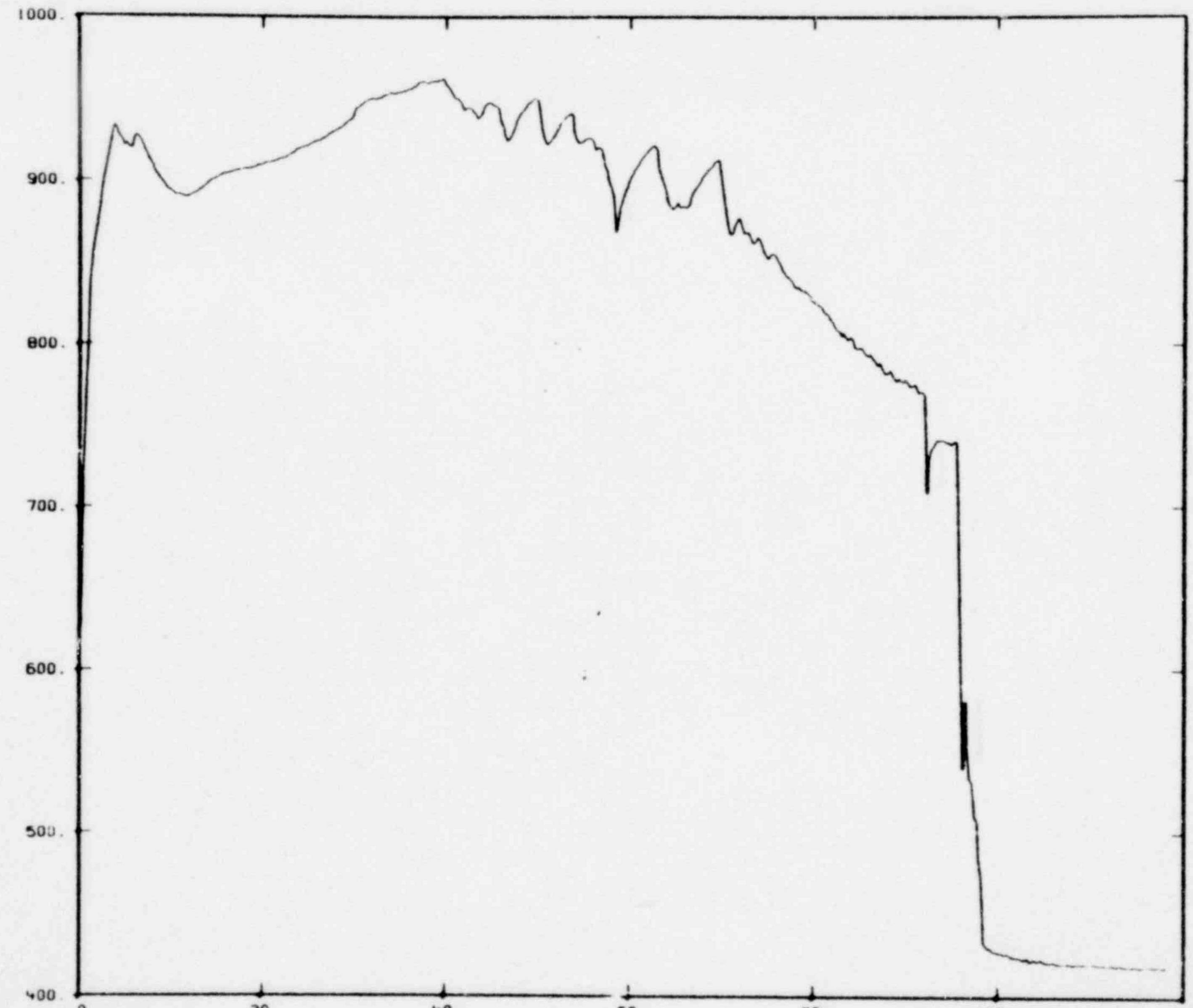

Fig. 17 TRAC-PIA hot rod cladding temperature at 0.762-m elevation.

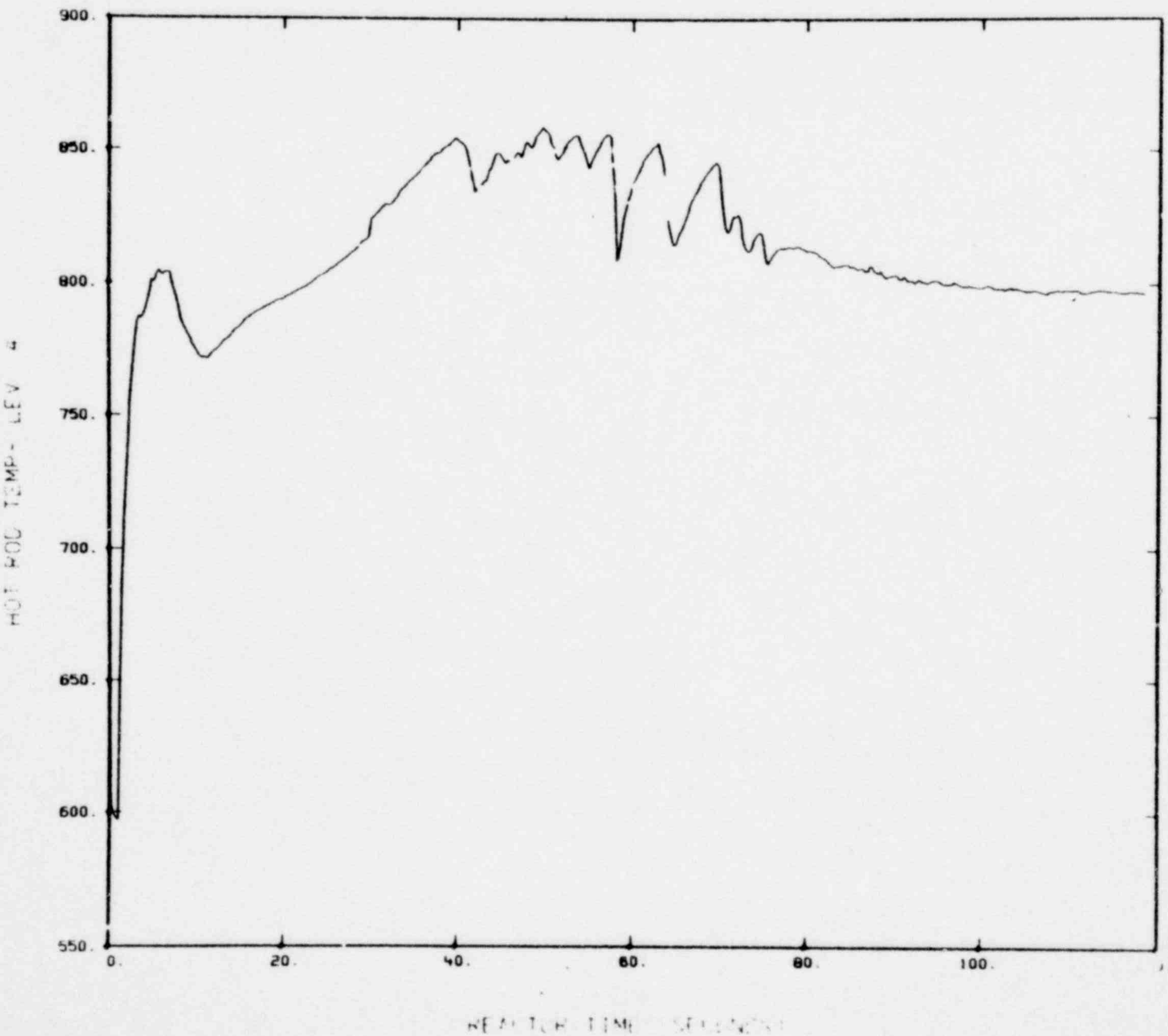

Fig. 18 TRAC-PIA hot rod cladding temperature at 0.991-m elevation.

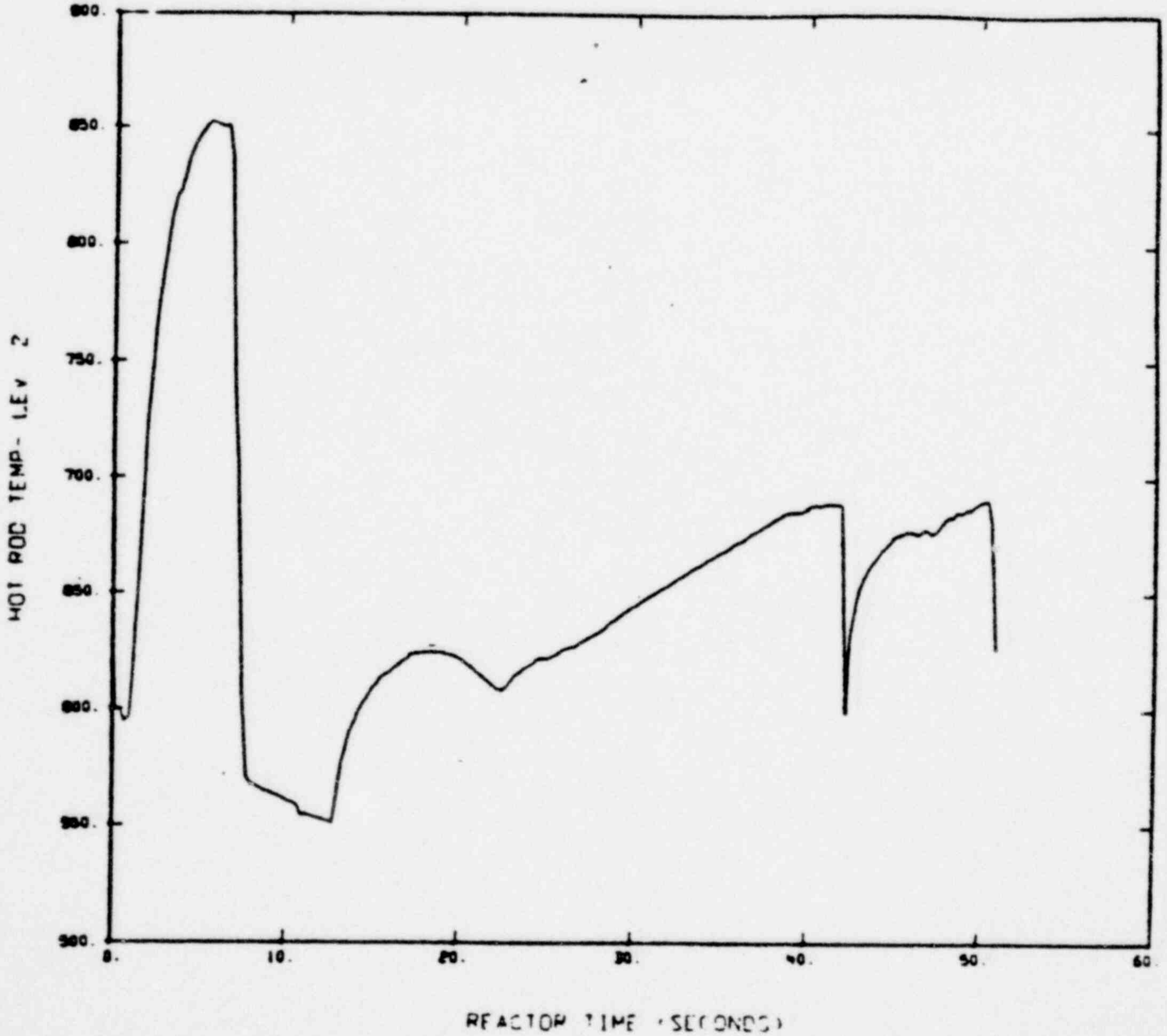

Fig. 19 TRAC-PIA + Iloeje hot rod cladding temperature at 0.381- and 0.533-m elevations.

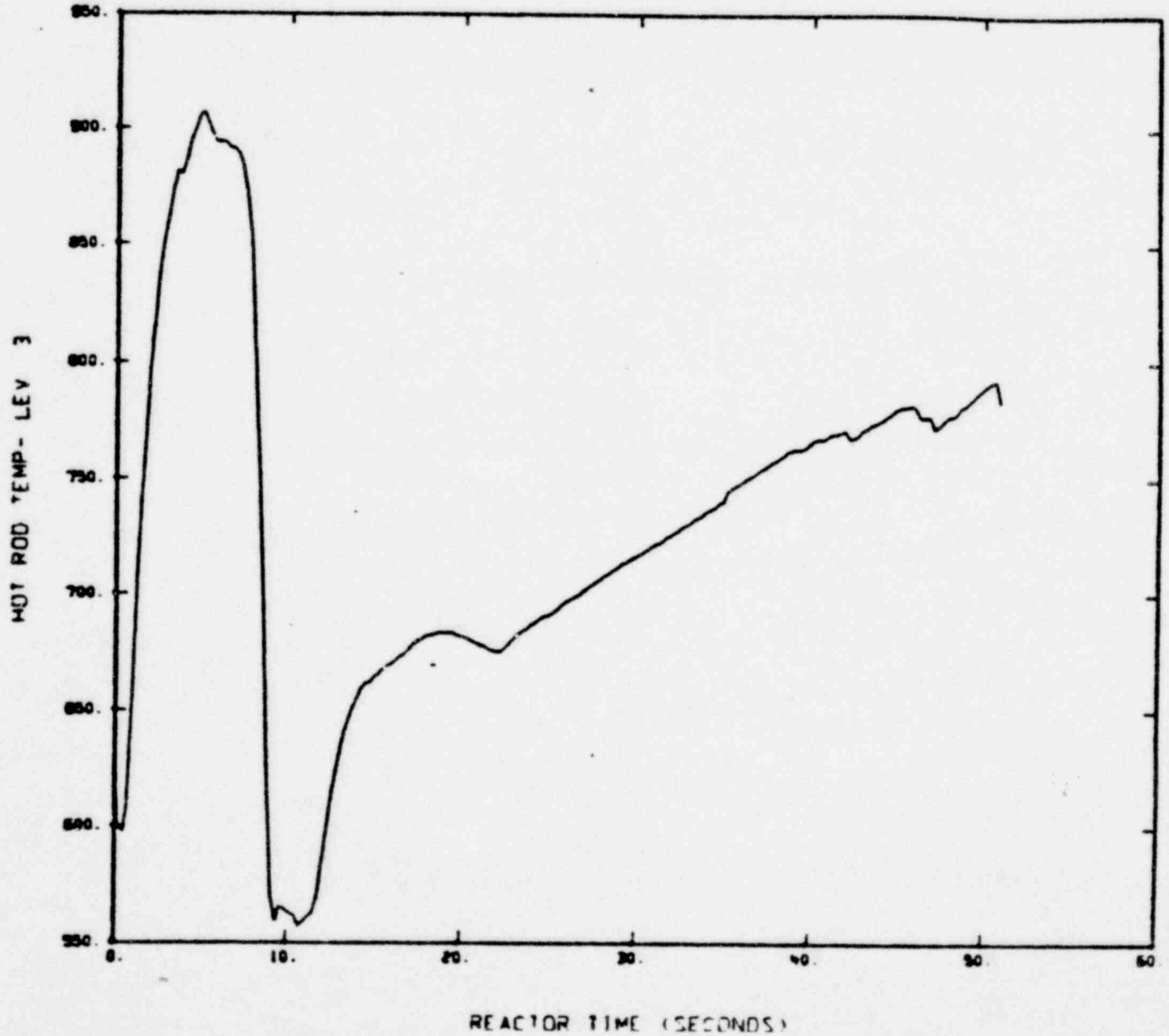

Fig. 20 TRAC-PIA + Iloeje hot rod cladding temperature at 0.762-m elevation.

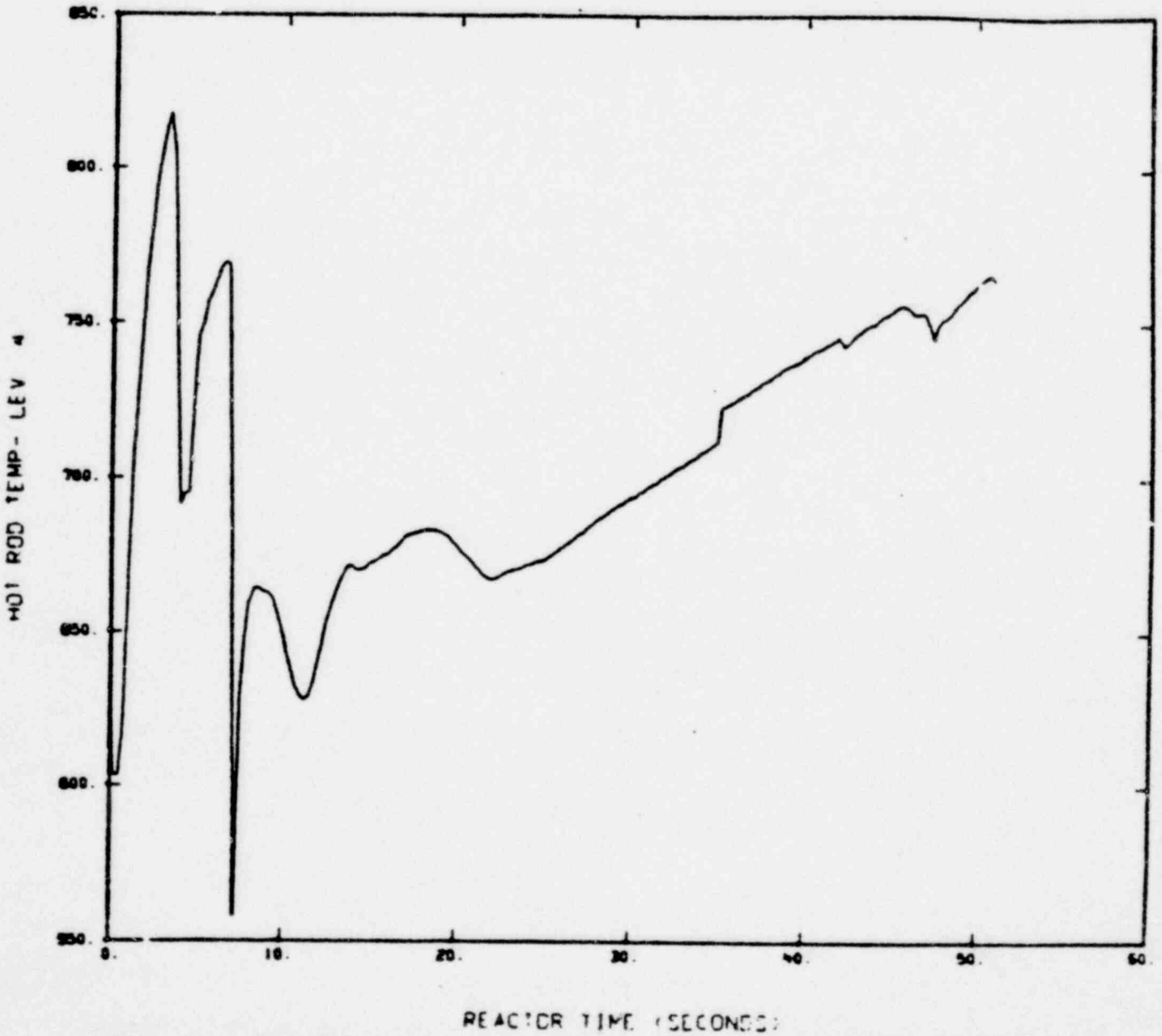

Fig. 21 TRAC-PIA + Iloeje hot rod cladding temperature at 0.991-m elevation.

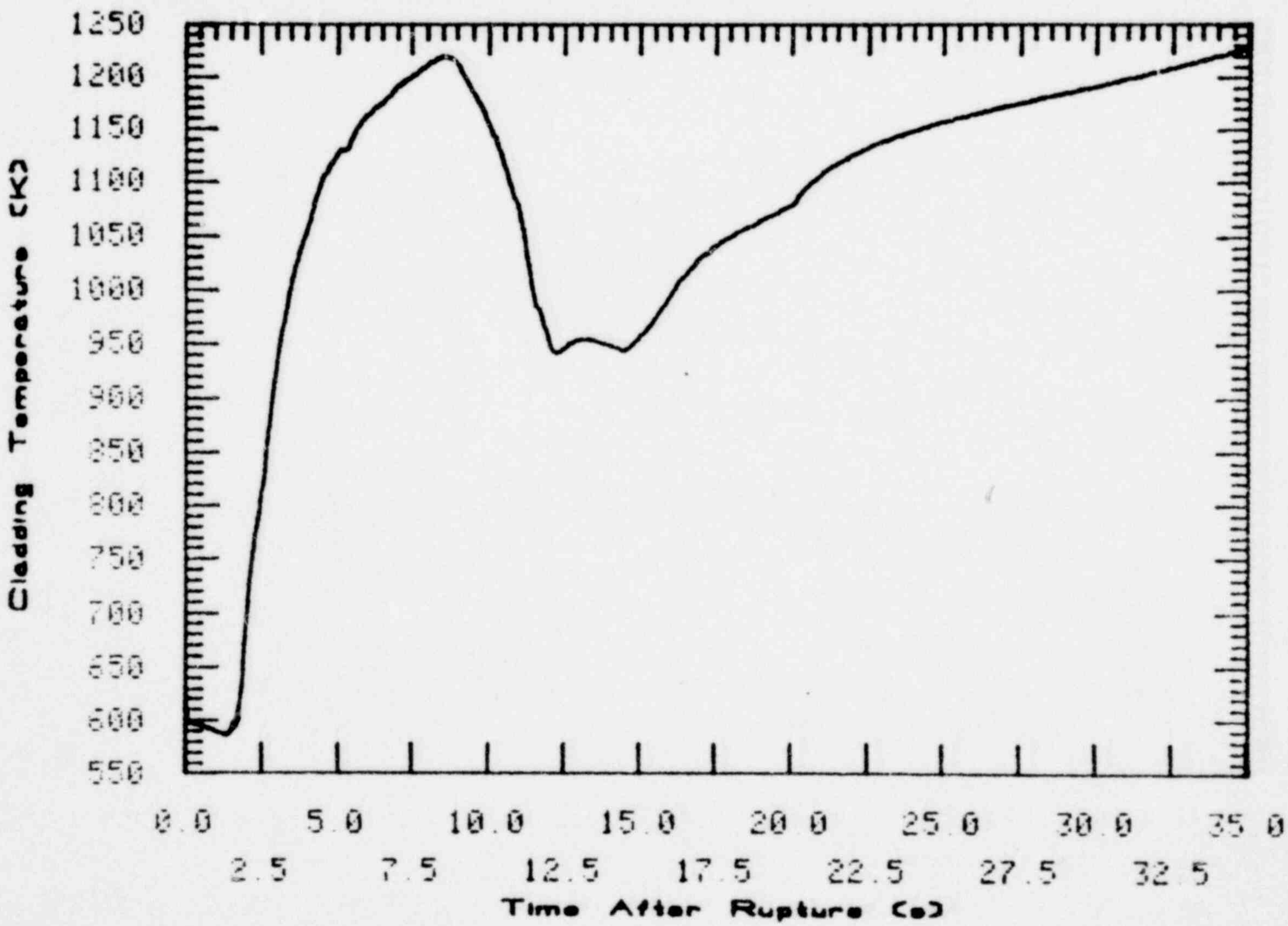

Fig. 22 NRC/DSS hot rod cladding temperature at 0.381-m elevation.

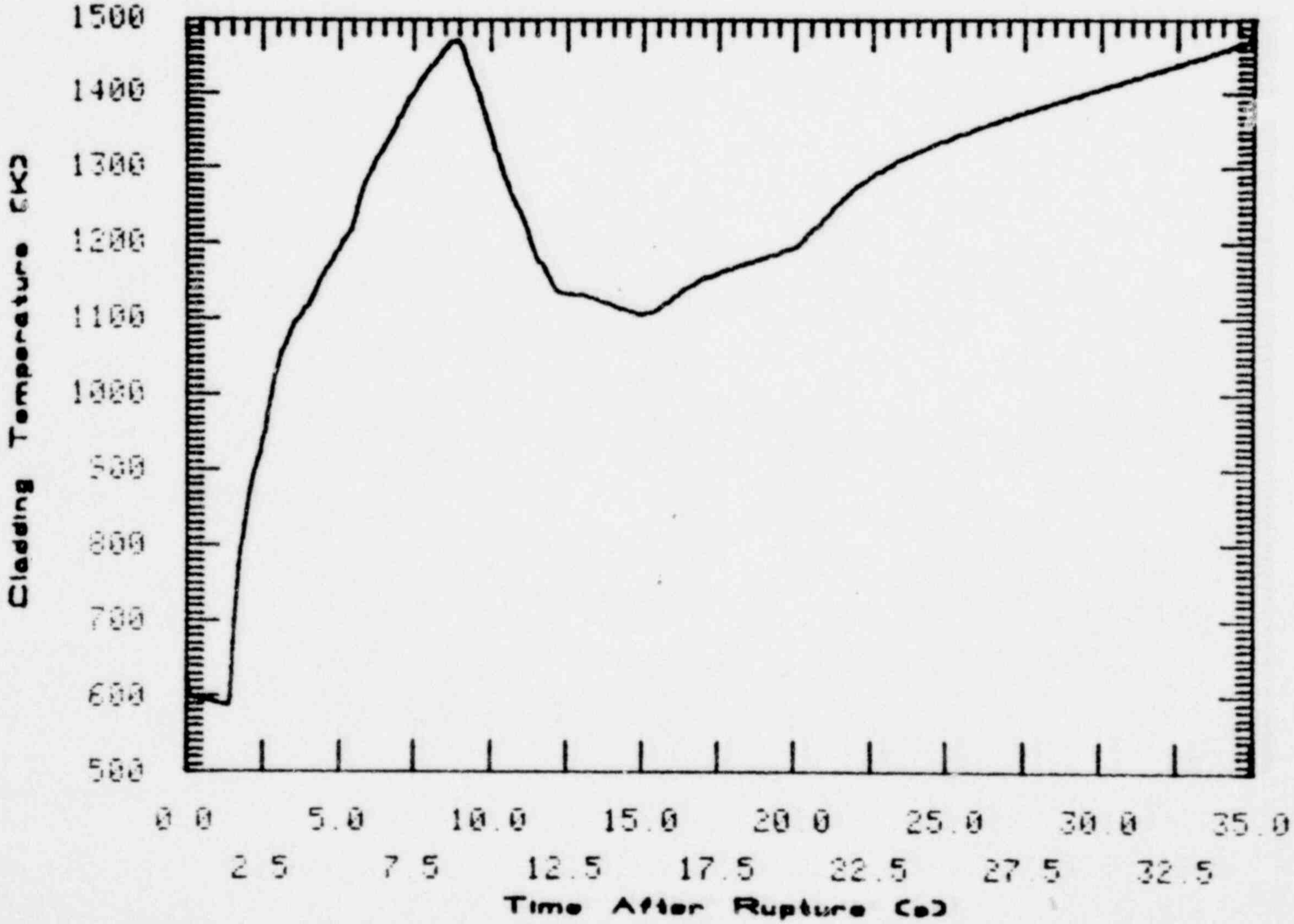

Fig. 23 NRC/DSS hot rod cladding temperature at 0.533-m elevation.

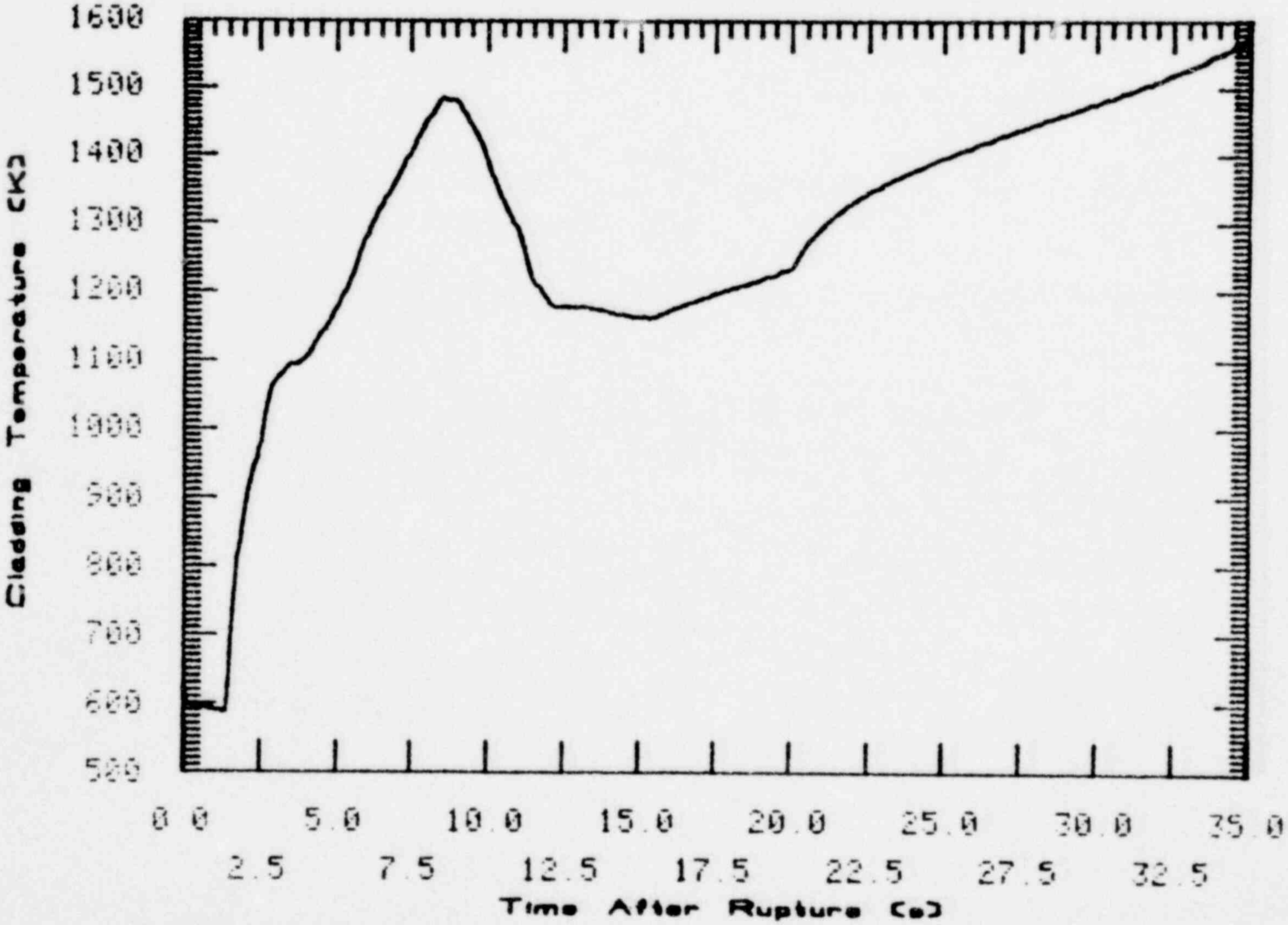

Fig. 24 NRC/DSS hot rod cladding temperature at 0.762-m elevation.

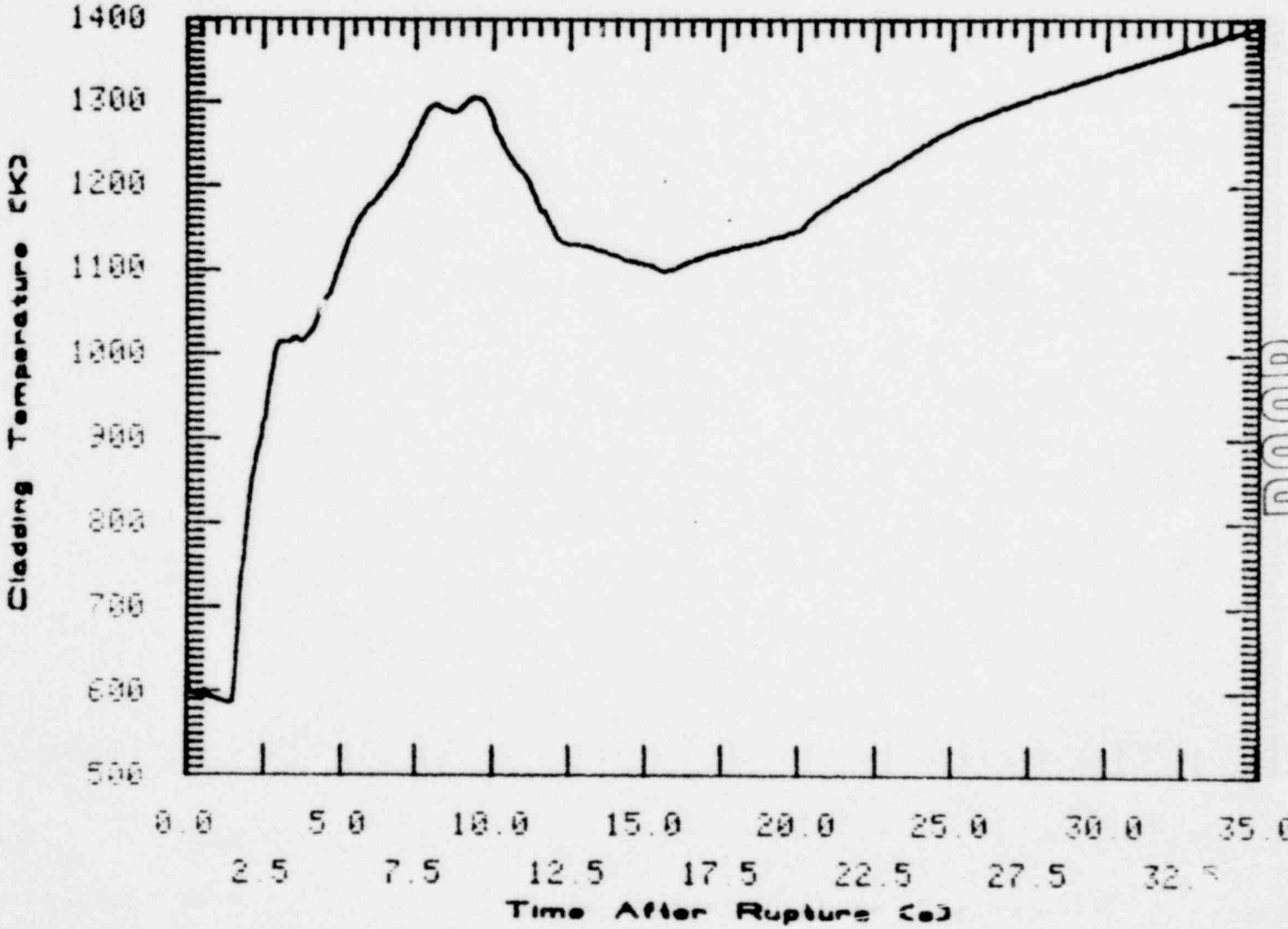

Fig. 25 NRC/DSS hot rod cladding temperature at 0.991-m elevation.

POOR ORIGINAL

977 348

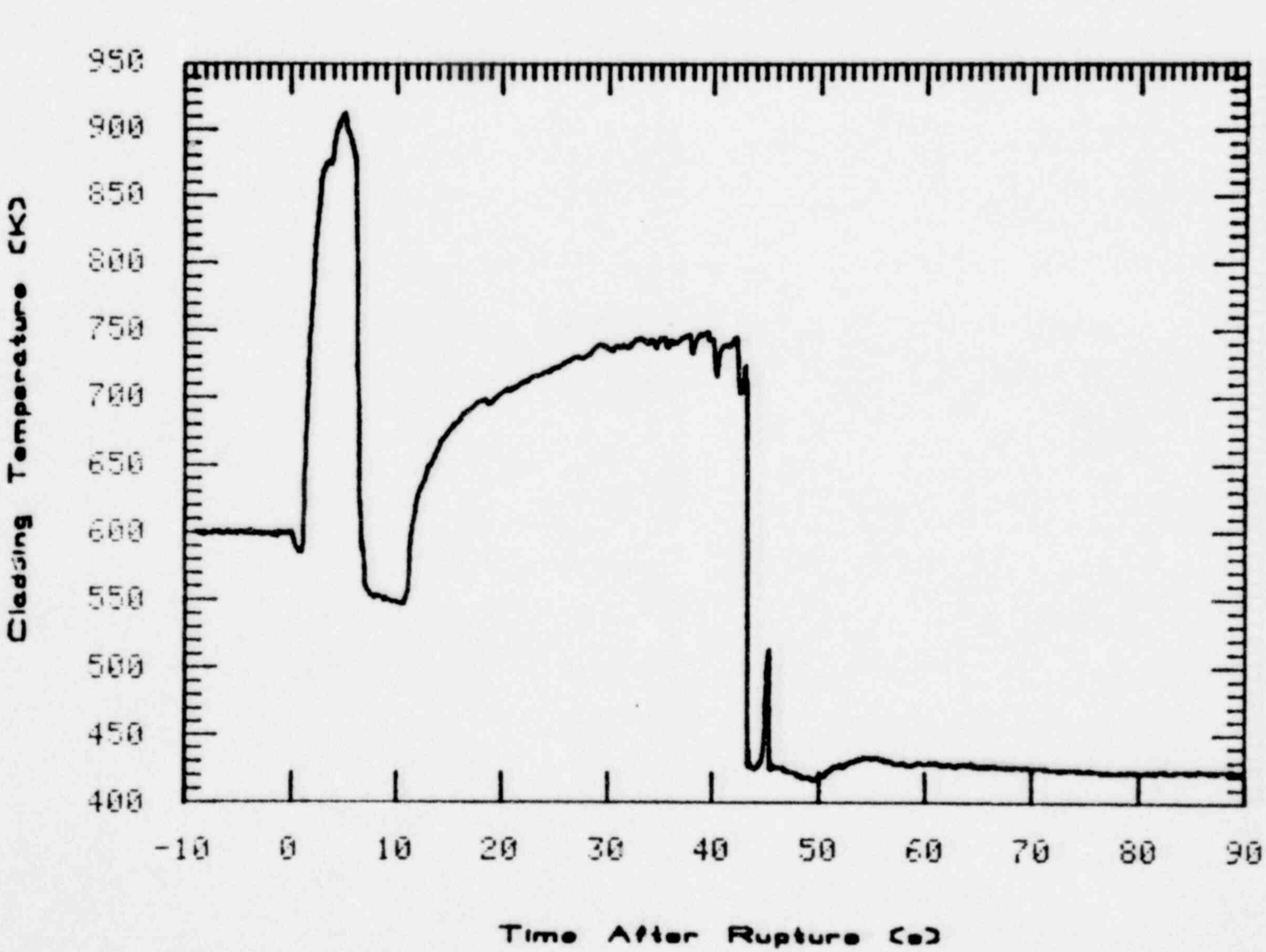

Fig. 26 LOCE L2-3 hottest measured cladding temperature at 0.381-m elevation.

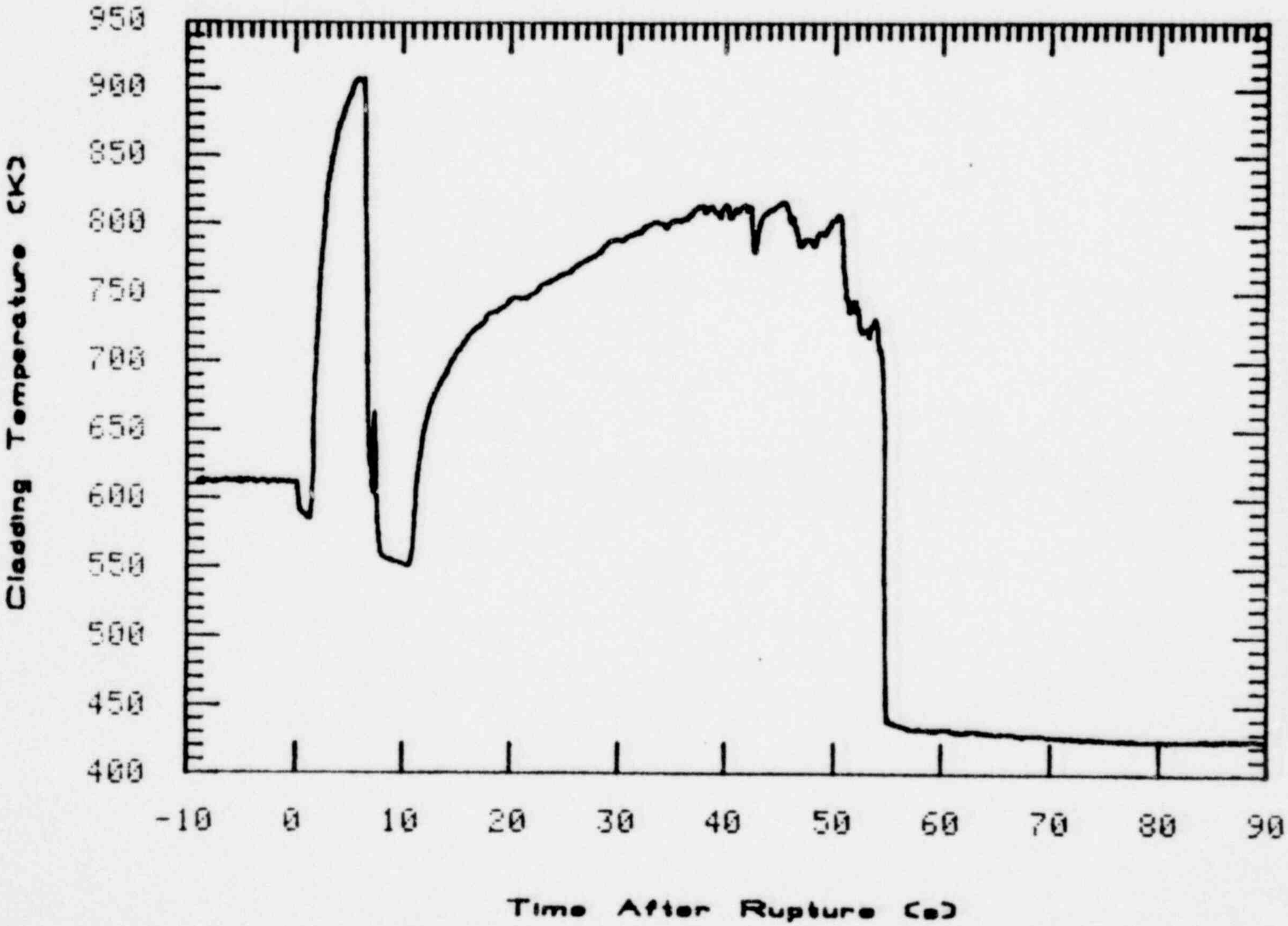

Fig. 27 LOCE L2-3 hottest measured cladding temperature at 0.533-m elevation.

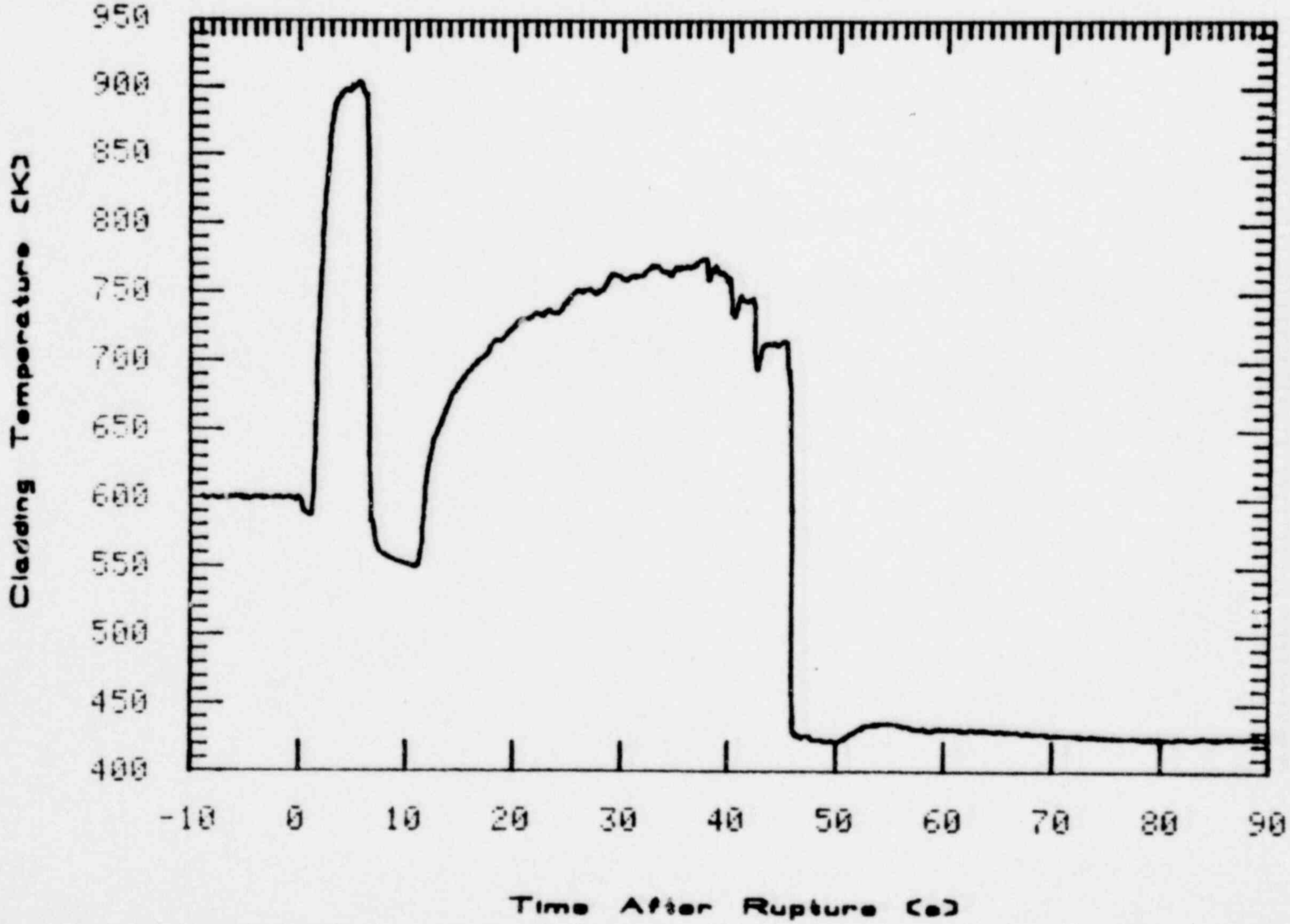

Fig. 28 LOCE L2-3 hottest measured cladding temperature at 0.762-m elevation.

POOR ORIGINAL

977 351

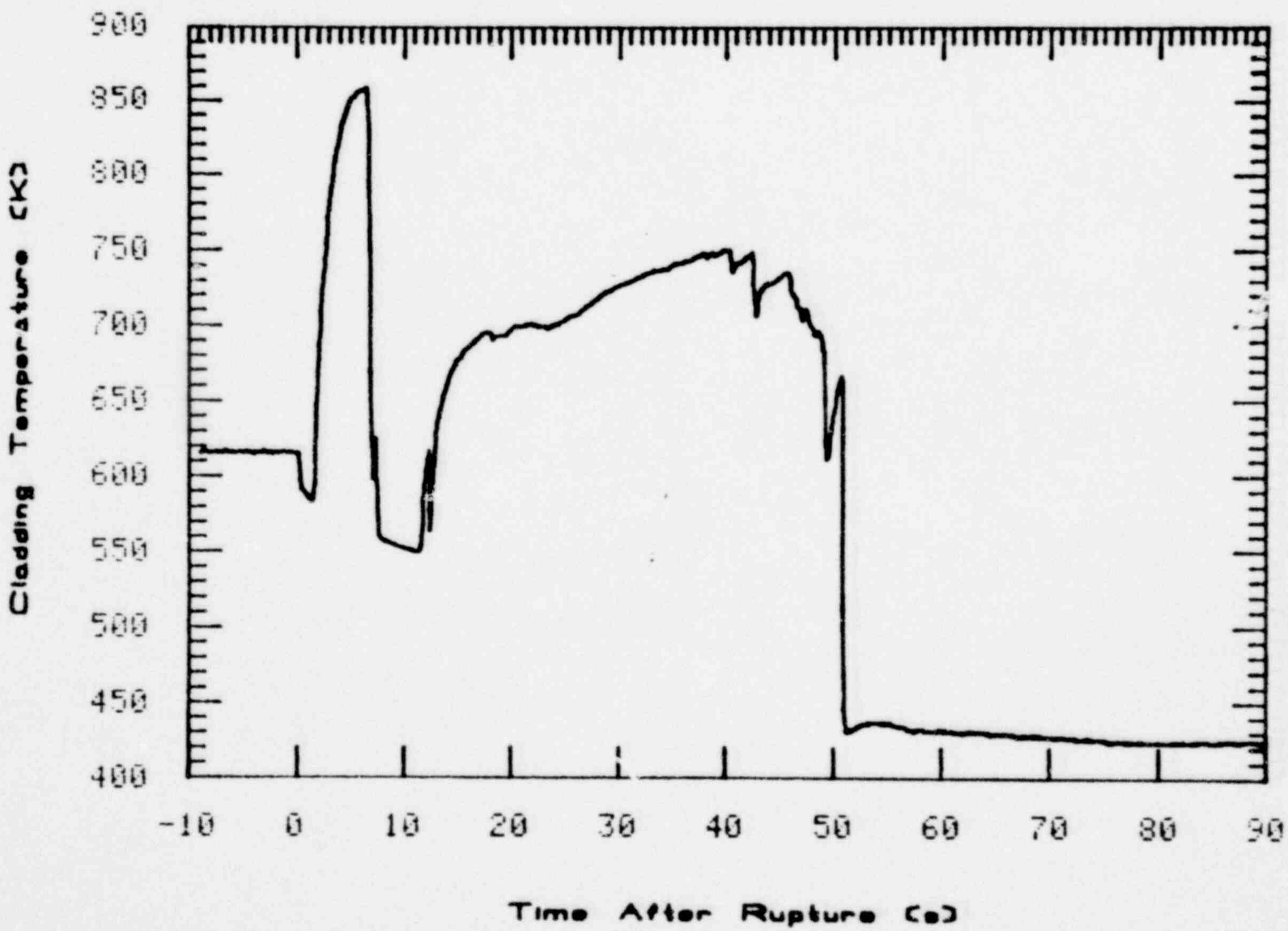

Fig. 29 LOCE L2-3 hottest measured cladding temperature at 0.991-m elevation.

977 352

POOR ORIGINAL

REFERENCES

1. D. L. Reeder, Quick Look Report on LOFT Nuclear Experiment L2-3, QLR-L2-3 (May 1979).

2. D. L. Reeder, LOFT System and Test Description (5.5-ft Nuclear Core 1 LOCEs), NUREG/CR-0247, TREE-1208 (July 1978).

3. Combustion Engineering, Best Estimate Pre-Test Analysis of LOFT Test L2-3, LD-79-029 (May 1979).

4. Letter, G. F. Owsley, Exxon Nuclear Company to Dr. R. J. Mattson, NRC, "Exxon Nuclear Company Prediction of LOFT Experiment L2-3" (April 30, 1979).

5. Letter, G. F. Owsley, Exxon Nuclear Company to Dr. R. J. Mattson, NRC, "Supplemental Information on Exxon Nuclear Prediction of LOFT Experiment L2-3" (May 17, 1979).

6. J. C. Wells et al, Pretest RETRAN Analysis for LOFT Test L2-3 (Standard Problem #10), ITI-I-4016 (May 7, 1979).

7. E. J. Kee and W. H. Grush, Best Estimate Prediction for LOFT Nuclear Experiment L2-3, EP-L2-3 (April 1979).

8. A. C. Peterson and K. A. Williams, TRAC-P1A Pretest Prediction of LOFT Nuclear Test L2-3, Los Alamos Scientific Laboratory Report LA-UR-79-1134 (May 1979).

9. Letter, K. A. Williams, Los Alamos Scientific Laboratory to Dr. L. Shotkin, NRC, "Pretest Prediction for LOFT L2-3 Using TRAC-P1A+Iloeje" (May 2, 1979).

10. Memorandum, Z. R. Rosztoczy, NRC, to R. Mattson, NRC, "WREM-LOFT Pretest EM Predictions" (May 11, 1979).

11. P. G. Prassinos et al, Experiment Data Report for LOFT Power Ascension Experiment L2-3, NUREG/CR-0792, TREE-13_3 (July 1979).

12. Energy Incorporated, RETRAN - A Program for One Dimensional Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems Volume I: Equations and Numerics, ERRI CCM-5 (December 1978).

13. J. A. Dearian et al, FRAP-S3 Analytical Models and Input Manual - FRAP-S3 A Computer Code for the Steady-State Analysis of Oxide Fuel Rods, Volume 1, TFBP-TR-164 (October 1977).

14. EG&G Idaho, Inc., RELAP4/MOD6 - A Computer Program for Transient Thermal-Hydraulic Analysis of Nuclear Reactors and Related Systems - User's Manual, CDAP-TR-003 (January 1978).

15. Los Alamos Scientific Laboratory, TRAC-P1A: An Advanced Best Estimate Computing Program for PWR LOCA Analysis, Vol. I, LA-7777-MS, NUREG/CR-0665 (April 1979).

16. O. C. Iloeje et al, "An Investigation of the Collapse and Surface Rewet in Film Boiling in Forced Vertical Flow", 73-WA/HT-20, ASME Winter Annual Meeting (November 1973).