

September 10, 1986

Docket No. 50-271

LICENSEE: VERMONT YANKEE NUCLEAR POWER CORPORATION

FACILITY: VERMONT YANKEE ATOMIC POWER STATION

SUBJECT: JULY 29, 1986 MEETING WITH VERMONT YANKEE NUCLEAR POWER
CORPORATION (VYNPC) TO DISCUSS REVIEW OF THE RELAP 5YA CODE

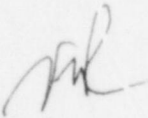
On July 29, 1986, a meeting was held at the NRC Headquarters at Bethesda, Maryland to discuss the review of the RELAP 5YA computer code for LOCA analysis at Vermont Yankee. Enclosure 1 is the list of the individuals that attended the meeting. Enclosure 2 is the proposed meeting agenda offered by the licensee. Enclosure 3 is a handout of the slides presented by the licensee at the meeting.

The following is a summary of significant items discussed:

1. VY LOCA Licensing Analysis Method
2. VY LOCA Sample Problems
3. NRC-EG&E Technical Review Questions
4. Acceptance of R5YA EM Heat Transfer
5. Method for Quantifying Margin of Conservatism (Appendix K, Item II.5)

Original signed by

Vernon L. Rooney, Project Manager
BWR Project Directorate #2
Division of BWR Licensing

BWR#2 
V Rooney;eh
9/3/86

8609250088 860910
PDR ADOCK 05000271
P PDR

Mr. R. W. Capstick
Vermont Yankee Nuclear Power Corporation
Vermont Yankee Nuclear Power Station

cc:

Mr. J. G. Weigand
President & Chief Executive Officer
Vermont Yankee Nuclear Power Corp.
R. D. 5, Box 169
Ferry Road
Brattleboro, Vermont 05301

Mr. Donald Hunter, Vice President
Vermont Yankee Nuclear Power Corp.
1671 Worcester Road
Framingham, Massachusetts 01701

New England Coalition on
Nuclear Pollution
Hill and Dale Farm
R. D. 2, Box 223
Putney, Vermont 05346

Mr. Walter Zaluzny
Chairman, Board of Selectman
Post Office Box 116
Vernon, Vermont 05345

J. P. Pelletier, Plant Manager
Vermont Yankee Nuclear Power Corp.
Post Office Box 157
Vernon, Vermont 05354

Raymond N. McCandless
Vermont Division of Occupational
& Radiological Health
Administration Building
10 Baldwin Street
Montpelier, Vermont 05602

Honorable John J. Easton
Attorney General
State of Vermont
109 State Street
Montpelier, Vermont 05602

John A. Ritscher, Esquire
Ropes & Gray
225 Franklin Street
Boston, Massachusetts 02110

W. P. Murphy, Vice President &
Manager of Operations
Vermont Yankee Nuclear Power Corp.
R. D. 5, Box 169
Ferry Road
Brattleboro, Vermont 05301

Mr. Gerald Tarrant, Commissioner
Vermont Department of Public Service
120 State Street
Montpelier, Vermont 05602

Public Service Board
State of Vermont
120 State Street
Montpelier, Vermont 05602

Vermont Yankee Decommissioning
Alliance
Box 53
Montpelier, Vermont 05602-0053

Resident Inspector
U. S. Nuclear Regulatory Commission
Post Office Box 176
Vernon, Vermont 05354

Vermont Public Interest
Research Group, Inc.
43 State Street
Montpelier, Vermont 05602

Thomas A. Murley
Regional Administrator
Region I Office
U. S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pennsylvania 19406

MEETING SUMMARY DISTRIBUTION

Licensee: Yankee Atomic Electric Company

*Copies also sent to those people on service (cc) list for subject plant(s).

Docket File

NRC PDR
L PDR
BBD-2 Rdg
DMuller
HAbelson
OGC-MNBB 9604
EJordan
BGrimes
ACRS-10
PWheatly
WHodges
TCollins
CGraves
VRooney

List of Meeting Attendees
July 29, 1986

<u>Name</u>	<u>Organization</u>
T. Fernandez	Yankee Atomic Electric Co.
H. Da Silva	Yankee Atomic Electric Co.
K. St. John	Yankee Atomic Electric Co.
A. Husain	Yankee Atomic Electric Co.
W. Hodges	NRC/DBL/RSB
T. Collins	NRC/DBL/RSB
C. Graves	NRC/DBL/RSB
H. Ableson	NRC/DBL/BWR#2
P. Wheatly	EG&G/NRC Consultant
J. Jones	EG&G/NRC Consultant

AGENDA

<u>TIME</u>	<u>TOPIC</u>	
8:45- 8:50	MEETING OBJECTIVES & AGENDA	RTF
	<u>VY LOCA LICENSING ANALYSIS METHOD</u>	
8:50- 9:00	o OVERVIEW	RTF
9:00- 9:20	o RELAP5YA CODE & ASSESSMENT	RTF
9:20-10:00	o TLTA LBLOCA TEST 6425/R2	HCdS
10:00-11:00	VY NSSS MODEL	RTF
11:00-11:15	VY HC MODEL	RTF
11:15-11:45	VY EM HEAT TRANSFER	RTF

LUNCH

<u>LBLOCA SAMPLE PROBLEMS</u>	
	RTF

1:00-1:40	o CASE EA	
1:40-1:50	o CASE EB	
1:50-2:20	o CASE BA	
2:20-3:00	SBLOCA SAMPLE PROBLEM	HCdS
3:00-4:00	METHOD FOR QUANTIFYING CONSERVATIVE MARGIN	
4:00-4:30	MEETING SUMMARY	ALL

RTF-2
7/29/86

VY LOCA LICENSING ANALYSIS PLAN

GOALS

1. OBTAIN SER ON BWR LOCA LICENSING ANALYSIS METHOD BY DECEMBER 1986.
2. APPLY METHOD FOR VY HIGH ENERGY BUNDLE PROGRAM TO OBTAIN SER FOR CYCLE 14 (STARTUP 11/1/88).

MAJOR MILESTONES

1. COMPLETE RESPONSE TO 197 NRC QUESTIONS ON RELAP5YA CODE BY SEPTEMBER 30, 1985.
2. COMPLETE RESPONSE TO 39 ADDITIONAL NRC QUESTIONS ON RELAP5YA CODE BY DECEMBER 31, 1985.
3. OBTAIN SER ON RELAP5YA CODE BY MARCH 31, 1986.
4. SUBMIT VY LOCA SAMPLE PROBLEMS TO NRC BY JUNE 30, 1986.
5. OBTAIN SER ON BWR LOCA METHOD FROM NRC BY DECEMBER 31, 1986.
6. SUBMIT VY LOCA LICENSING ANALYSIS BY DECEMBER 31, 1987.
7. OBTAIN SER ON VY LOCA ANALYSIS FROM NRC PRIOR TO STARTUP OF CYCLE 14 (NOVEMBER 1988).

RTF
7/29/86

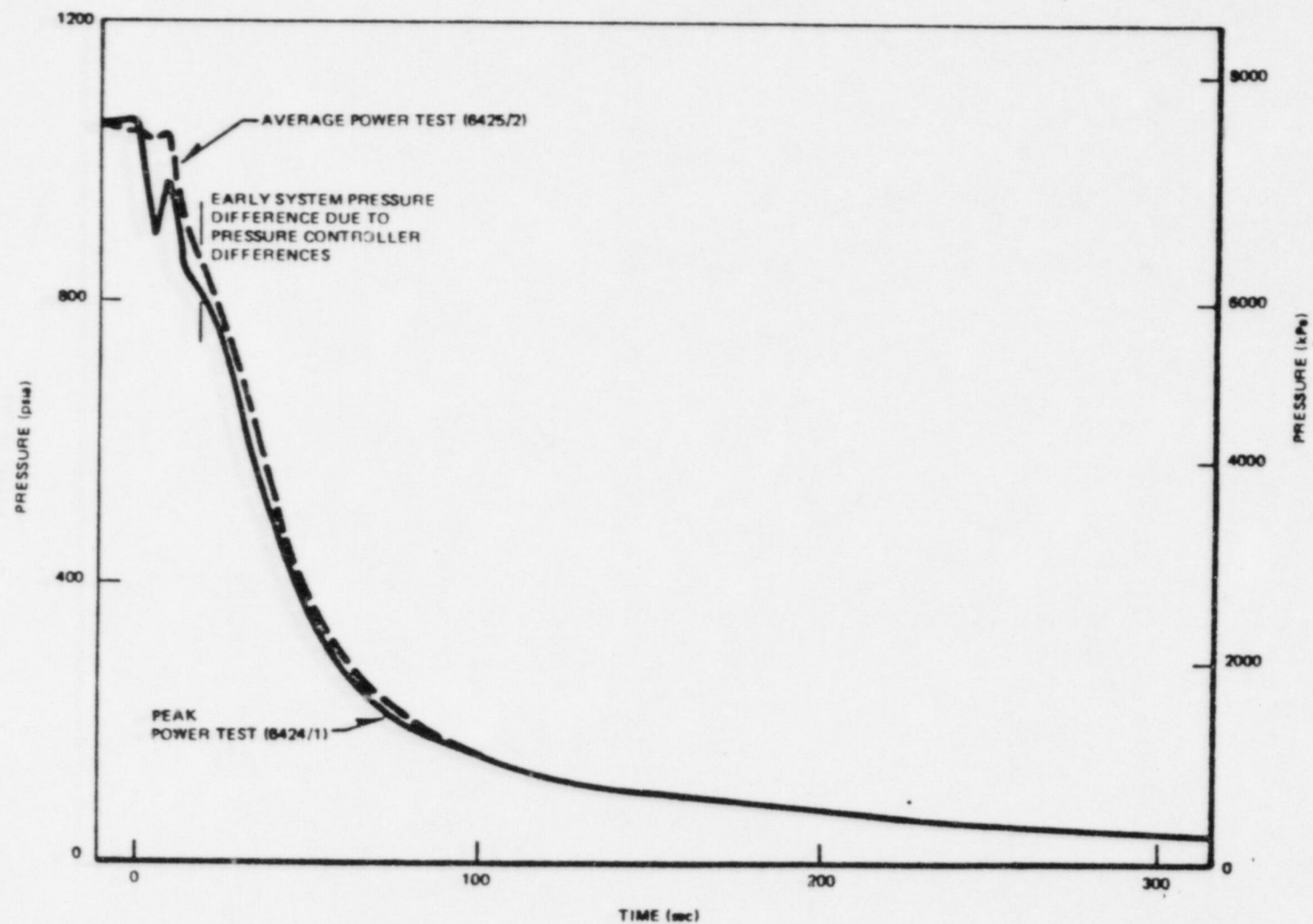


Figure 3-41. Comparison of System Pressure Responses for Average ECC Tests with Average Power (6425/2) and Peak Power (6424/1)

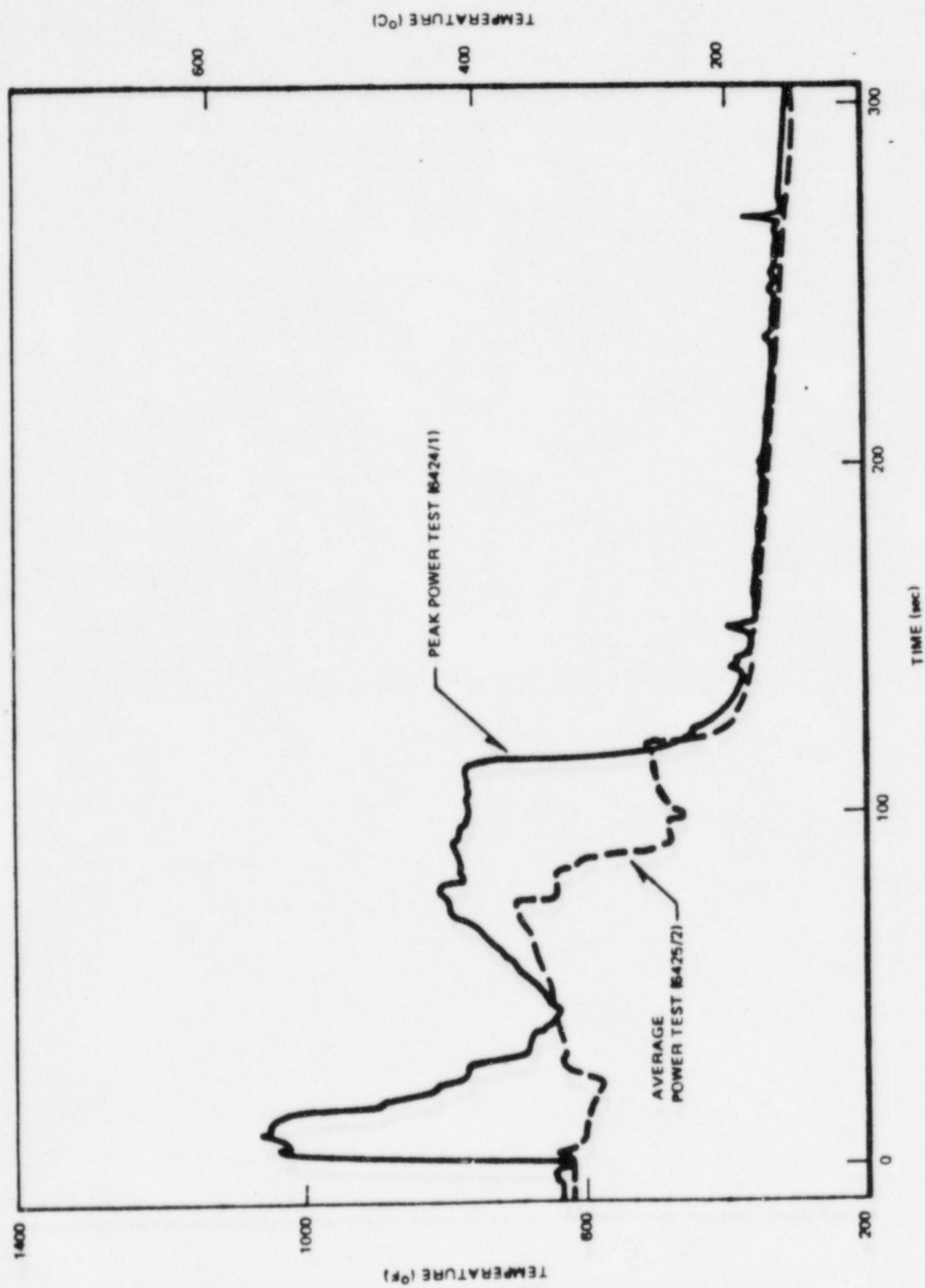


Figure 3-46. Comparison of Peak Cladding Temperature Responses for Average ECC Tests with Average Power (6425/2) and with Peak Power (6424/1)

VY LOCA LICENSING ANALYSIS SCHEDULE

TASK	1985				1986				1987				1988			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q

1. RELAP5YA QUESTIONS/ANSWERS

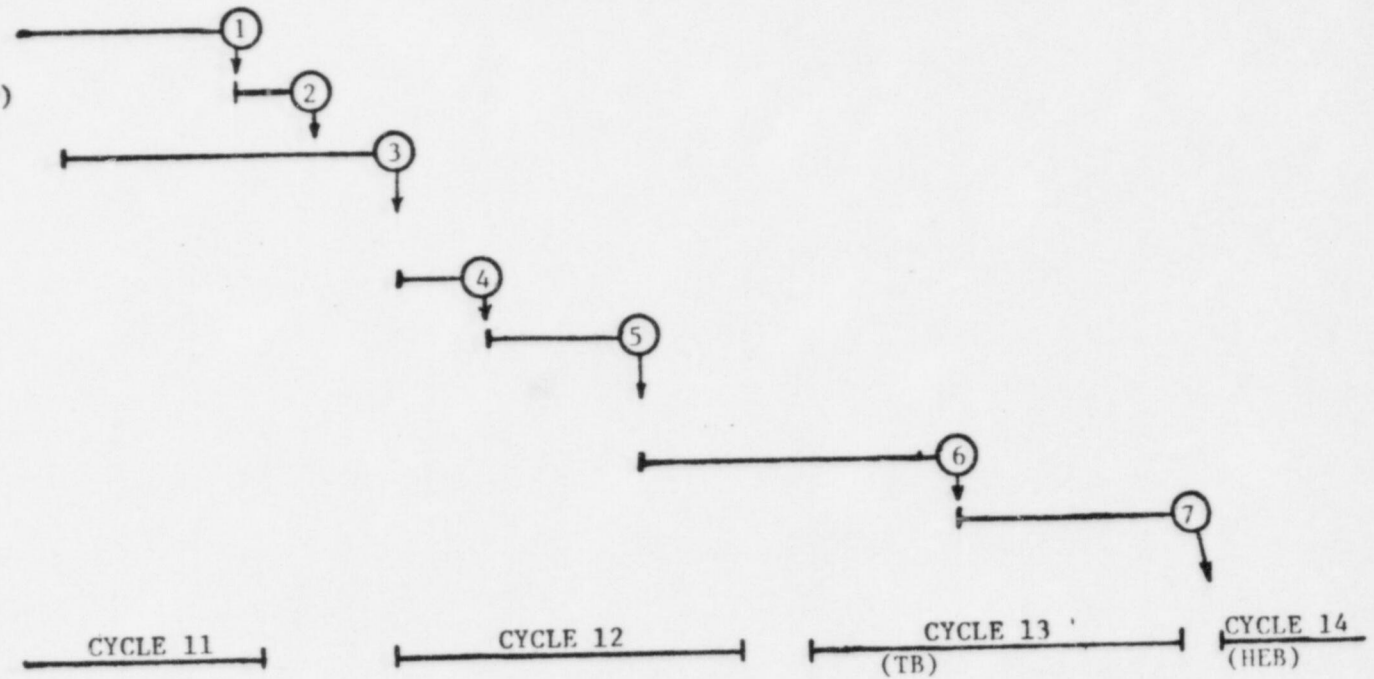
- General Questions (197)
- Additional Questions (39)
- NRC Review

2. VY LOCA SAMPLE PROBLEMS

- YAEC Perform
- NRC Review

3. VY LOCA ANALYSES

- YAEC Perform
- NRC Review



VY PROJECTED OPERATION:

CYCLE 11

CYCLE 12

CYCLE 13
(TB)

CYCLE 14
(HEB)

RTF
7/29/86

BWR LOCA LICENSING ANALYSIS METHOD

OBJECTIVE: PROVIDE CYCLE INDEPENDENT LOCA ANALYSES THAT COMPLY WITH 10 CFR 50.46 AND APPENDIX K.

INPUT DATA

- PLANT DRAWINGS, TECHNICAL SPECIFICATIONS, PERFORMANCE DATA
- SIMULATE CODE - CORE AXIAL & RADIAL POWER DISTRIBUTIONS
MODERATOR, FUEL AND SCRAM REACTIVITY
TABLES
- FIBWR CODE - INITIAL CORE AND BYPASS FLOW DISTRIBUTION
- CASMO CODE - ROD POWER DISTRIBUTION WITHIN PEAK BUNDLE
- FROSSTEY CODE - INITIAL FUEL ROD PARAMETERS
- ACTIVATE APPENDIX K EVALUATION MODEL OPTIONS

STEADY STATE INITIALIZATION - RELAP5YA CODE

- NSSS EM INITIALIZATION MODEL - ACCELERATED STARTUP TRANSIENT FROM
HOT STAGNANT CONDITIONS TO STEADY
STATE

ACCIDENT ANALYSES - RELAP5YA CODE

- LOCA EM SYSTEM MODEL - INTEGRAL ANALYSIS OF ENTIRE ACCIDENT
- LOCA EM HOT CHANNEL MODEL - RUN FOR MORE DETAILED ANALYSIS (WHEN
NECESSARY) USING SYSTEM TRANSIENT
RESULTS AS BOUNDARY CONDITIONS ACROSS
BUNDLE

BWR LOCA LICENSING ANALYSIS METHOD

OUTPUT DATA FOR REPORTS

1. GRAPHS

- DBA STEAM DOME PRESSURE HISTORY
- DBA WIDE RANGE ("INNER SHROUD") LEVEL HISTORY, OR
- DBA VESSEL MASS INVENTORY HISTORY
- DBA CORE FLOW HISTORY
- DBA ECCS FLOW HISTORIES
- DBA PEAK CLADDING TEMPERATURE HISTORY
- DBA HEAT TRANSFER COEFFICIENT HISTORY

2. SUMMARY TABLES

- DBA SIGNIFICANT EVENT TIMES
- PEAK CLADDING TEMPERATURE VS BREAK SPECTRUM
- MAPLHGR, PCT, % OXIDATION, %H₂ RELEASE VS BURNUP

RELAP5 CODE SUMMARY

ADVANCED HYDRODYNAMIC MODEL

- Two-fluid, Nonhomogeneous, Nonequilibrium
- 1D with Multi-D Approximations
- Noncondensable Gas & Dissolved Boron Allowed
- 8 Governing Differential Equations
 - 4 CONT; 2 MOMENTA; 1 Mix ENERGY, 1 Mix State
- 8 Primary Variables (ρ_m , ρ_B , X_s , X_N , V_g , V_f , U_m , P)
- Constitutive and Process Models
 - r_g , C_r , FI , FW , K , G_{CRIT} , Q

RELAP5 CODE SUMMARY

COMPONENTS

- INTERNAL VOLUMES AND JUNCTIONS
 - SNGLVOL, SNGLJUN, BRANCH, PIPE, ANNULUS
- ACCUMULATOR*
- SEPARATOR
- CENTRIFUGAL PUMP
- JET PUMP*
- VALVES (Trip, Check, Inertial, Motor, Servo)
- Generalized TRIP and CONTROL SYSTEM
- FUEL BEHAVIOR*
- Boundary Conditions: TMDPVOL, TMDPJUN
- Heat Structures

RTF-6

7/29/86

RELAP5YA Model Development Tasks

	<u>Analysis Requirement</u>
A. <u>Hydrodynamic Models</u>	
1. Interphase Drag	BE, EM
2. Moody Two-Phase Critical Flow	EM
3. Jet Pump	BE, EM
B. <u>Heat Transfer Models</u>	
1. Forced Convective Boiling	BE, EM
2. Critical Heat Flux	BE, EM
3. Rewet and Quench	BE, EM
4. Multi-Surface Radiation	BE, EM
5. Heat Transfer Logic Options	EM
C. <u>Fuel Behavior Models</u>	
1. Internal Gas Pressure	BE, EM
2. Rod Deformation and Rupture	BE, EM
3. Transient Gap Conductance	BE, EM
4. Zircaloy-Water Reactions	EM

Separate Effect Tests for RELAP5YA Model Assessment

Hydrodynamic Models

Interphase Drag

4

1

Frigg Loop Tests
GE Level Swell Test

Two-Phase Critical Flow

7

1

Parametric Calculations
Marviken Test

Jet Pump

233

2

1/6 Scale EG&G SS Tests
1/6 Scale Blowdown Tests
VY Jet Pump M-N Curve

Accumulator

1

1

Maine Yankee Test
LOFT L3-1 Test

Heat Transfer Models

Forced Convective Boiling

3

Bennett Tests

Critical Heat Flux

5

4

3

Columbia Tests
GE Nine Rod Tests
ORNL THTF Tests

Radiation

2

4

Analytical Solutions
Parametric Calculations

EM Logic Options

9

Parametric Calculations

Fuel Behavior Models

Metal-Water Reaction

1

Analytical Solution

All Models

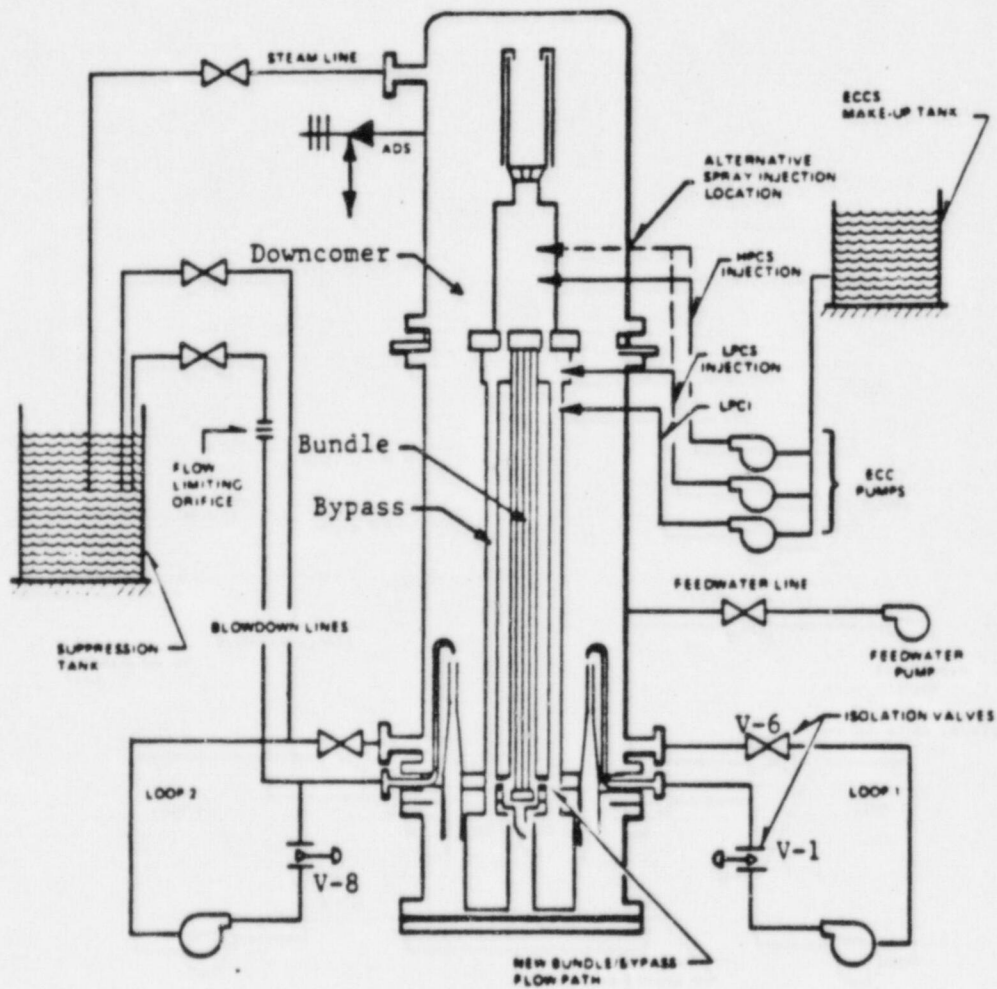
1

TOODEE2-EM Run

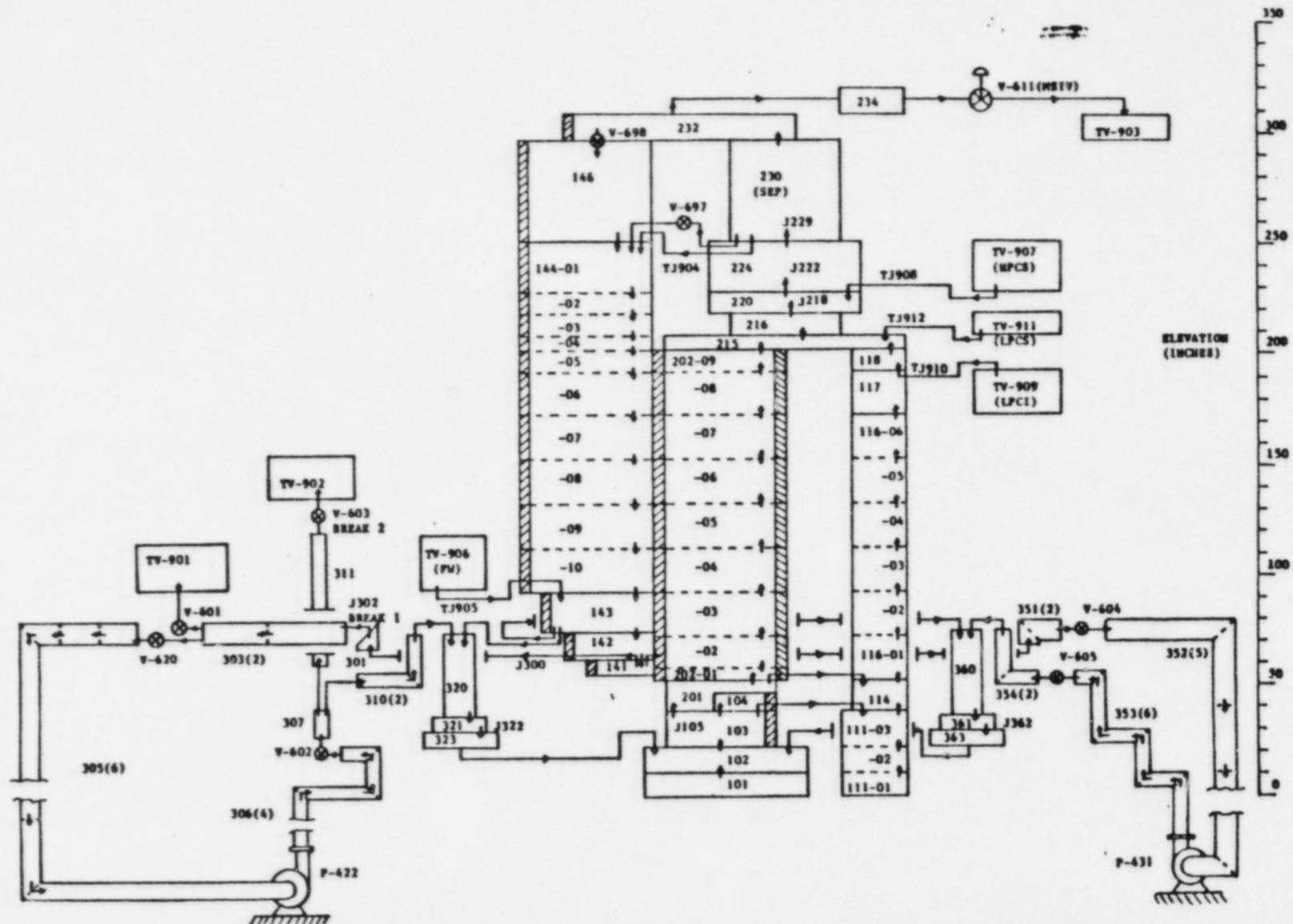
Integral Tests for RELAP5YA Code Assessment

	<u>Reference</u>
<u>Thermal-Hydraulic Test Facility (ORNL-NRC)</u>	
3 Steady-State Film Boiling Tests	1-4
1 Transient Film Boiling Test	1-4
1 Quasi Steady-State Boiloff Test	1-4
2 Reflood Tests	1-4
<u>Two Loop Test Apparatus (GE-EPRI-NRC)</u>	
Large Break With ECCS, Test 6425/2	1-4, 1-10
Large Break Without ECCS, Test 6426/1	1-4
Small Break With Degraded ECCS, Test 6323/1	1-4, 1-10
System Boiloff With Recovery, Test 6441/6	1-4
<u>LOFT (EG&G-NRC)</u>	
Small Break With Pumps On, Test L3-6	1-4, 1-9
Severe Core Transient With Pumps Tripped, Test L8-1	1-4
Small Break With Pumps Off, Test L3-1	1-9
<u>Semiscale Test Facility (EG&G-NRC)</u>	
Single-Phase, Two-Phase, and Reflux Modes of Natural Circulation, Test Series S-NC-2	1-9
<u>Yankee Plant (YAEC)</u>	
Reactor Coolant Pump Trip Test	1-7

RTF-9
7/29/86



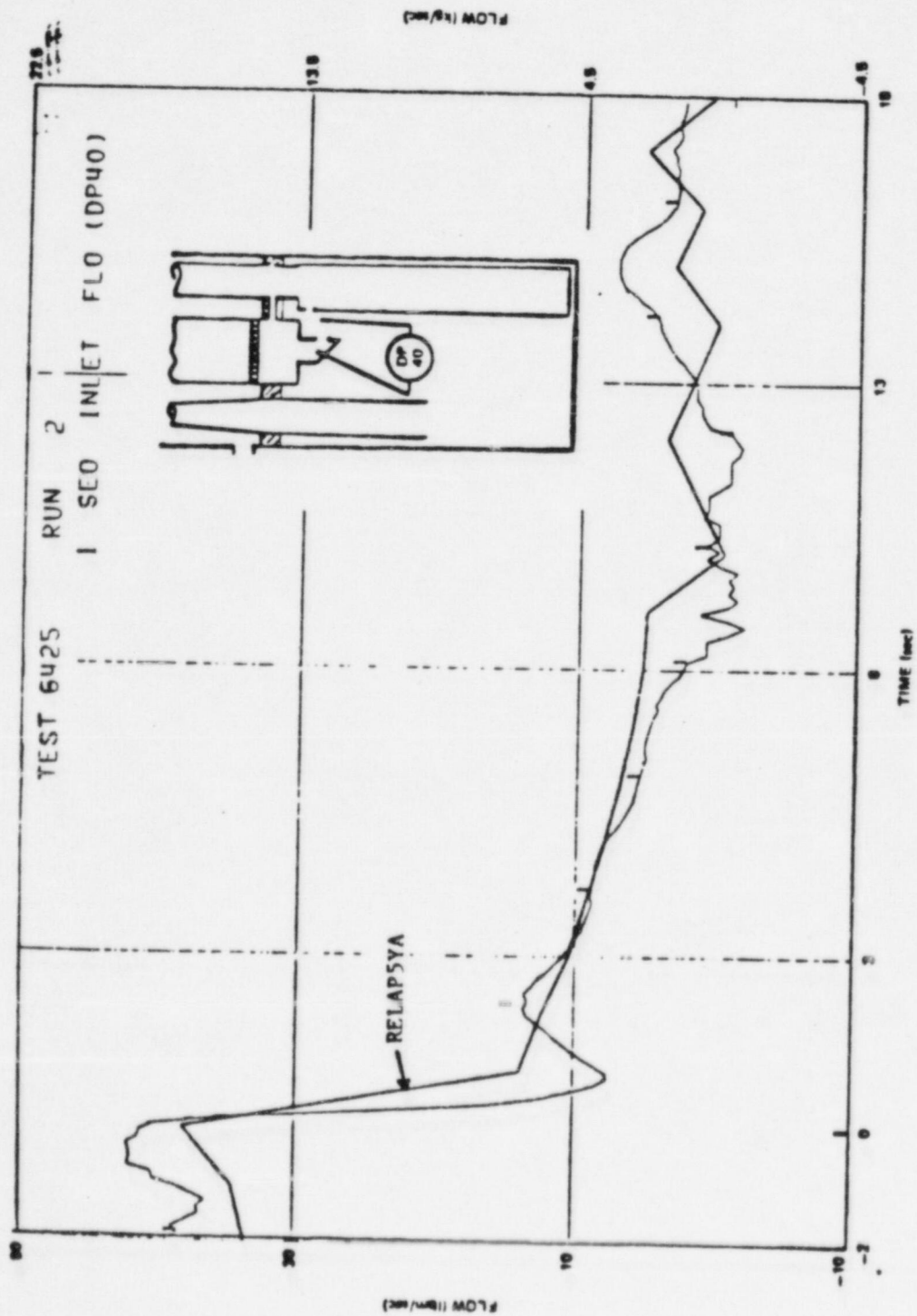
Schematic of TLTA-5A Configuration



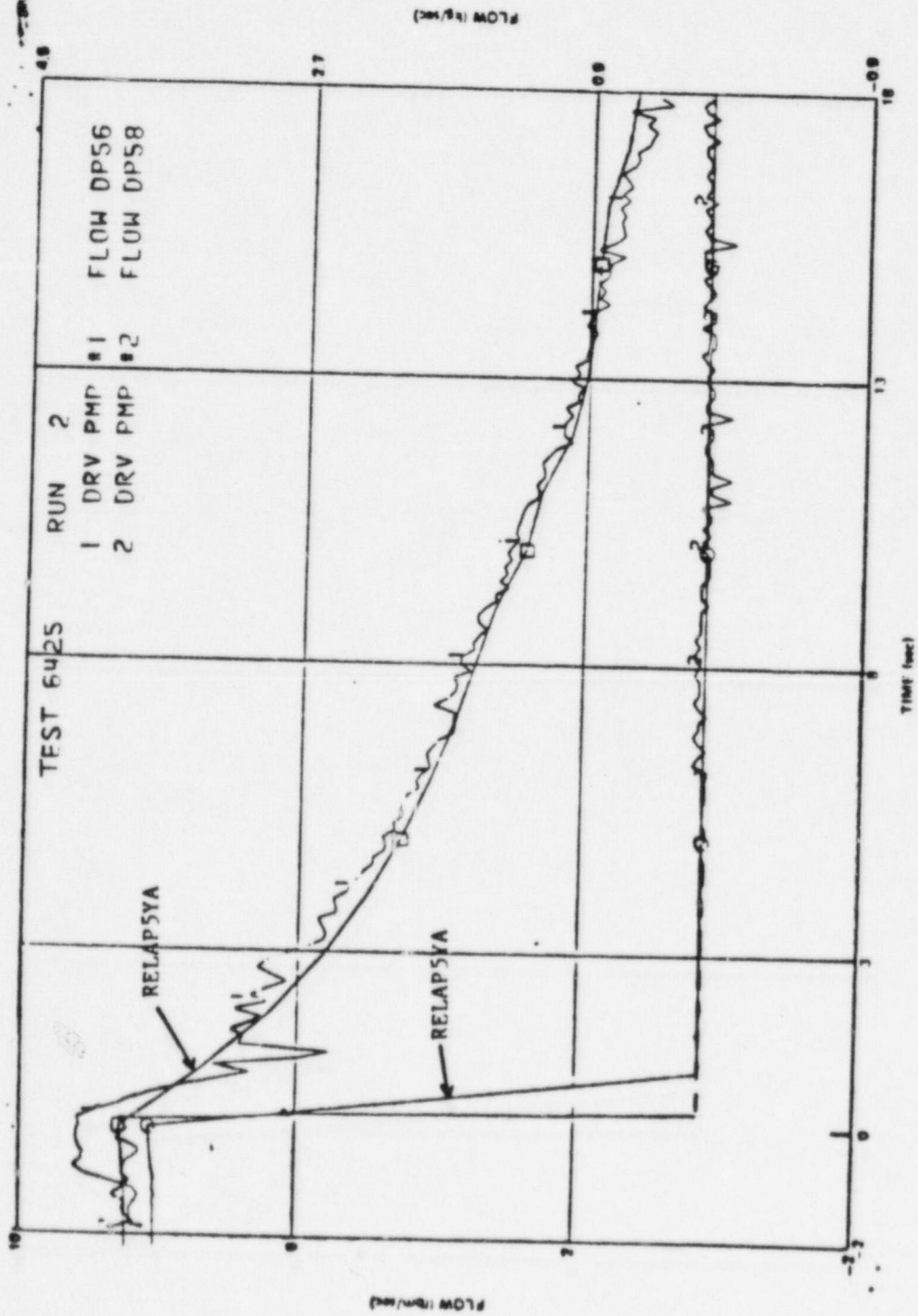
RELAP5YA Nodalization for TLTA Test 6425/2

Comparison of Calculated and Measured Initial
Conditions for TLTA Test 6425/2

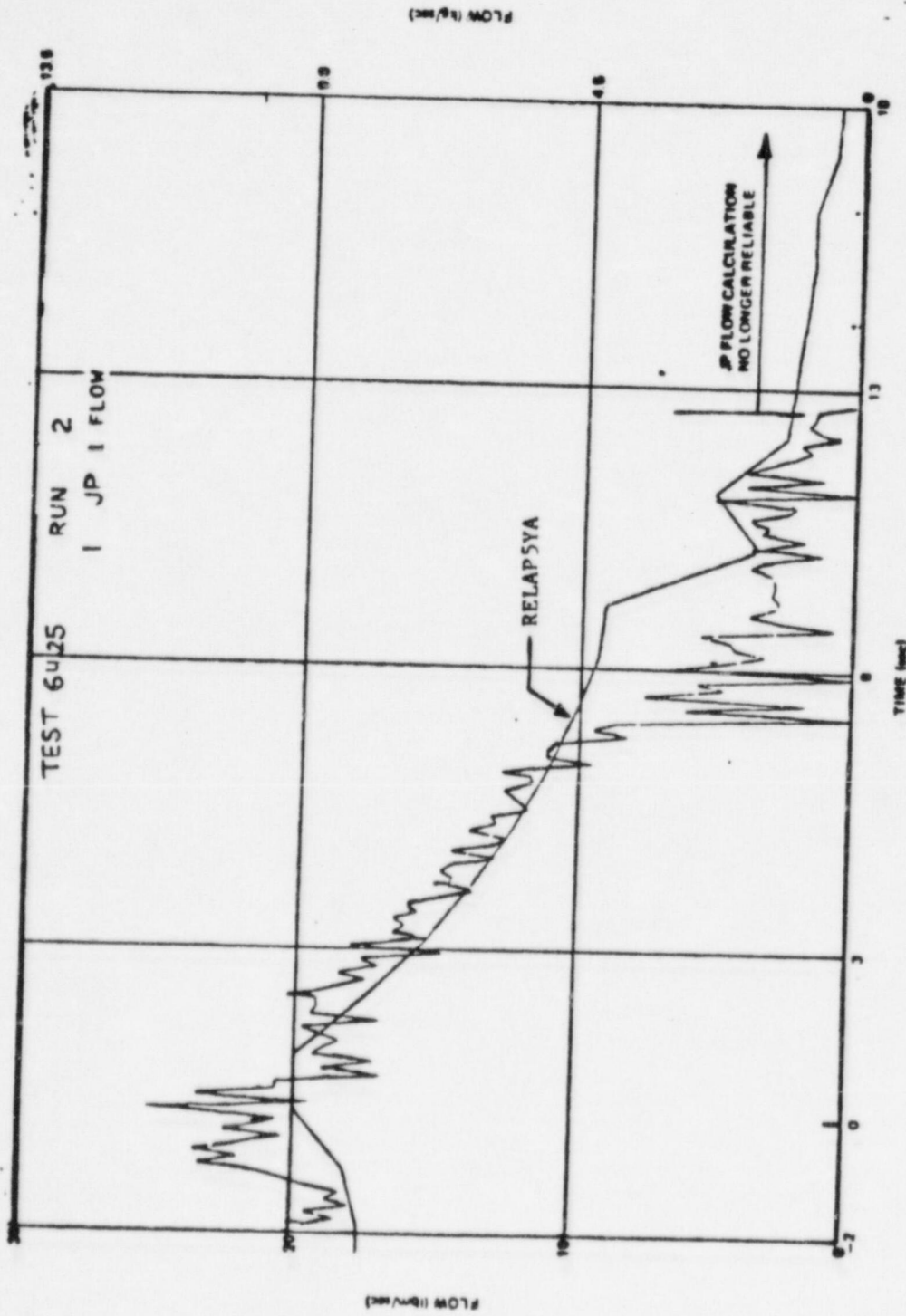
<u>Parameter</u>	<u>Data</u>	<u>SS Initiation at 2 MW</u>	<u>Initial Conditions</u>
Bundle Power (MW)	5.05 $\pm$ 0.03	2.0	5.06
Steam Dome Pressure (psi)	1044 $\pm$ 5	1043.8	1044.2
Lower Plenum Enthalpy (Btu/lbm)	528 $\pm$ 5	521	526.1
Initial Water Level (inches)	73 $\pm$ 6	76	77.6
Feedwater Enthalpy (Btu/lbm)	41 $\pm$ 2	42.9	42.9
Bundle Pressure Drop (psid)	17 $\pm$ 2	11.0	16.3
Steam Flow (lbm/s)	6 $\pm$ 1	1.88	5.7
Feedwater Flow (lbm/s)	1.4 $\pm$ 0.3	1.84	1.4
Intact Loop Pump Flow (lbm)	9.1 $\pm$ 1	8.73	8.8
Broken Loop Pump Flow (lbm)	8.4 $\pm$ 1	8.3	8.4
Intact Loop Jet Pump (lbm)	22 $\pm$ 2	18.1	20.0
Broken Loop Jet Pump (lbm)	20 $\pm$ 2	16.4	18.4
Bundle Inlet Flow (lbm)	39 $\pm$ 5	31.1	34.1
Lower Plenum Pressure (psi)	1071 $\pm$ 5	1061.5	1070.1



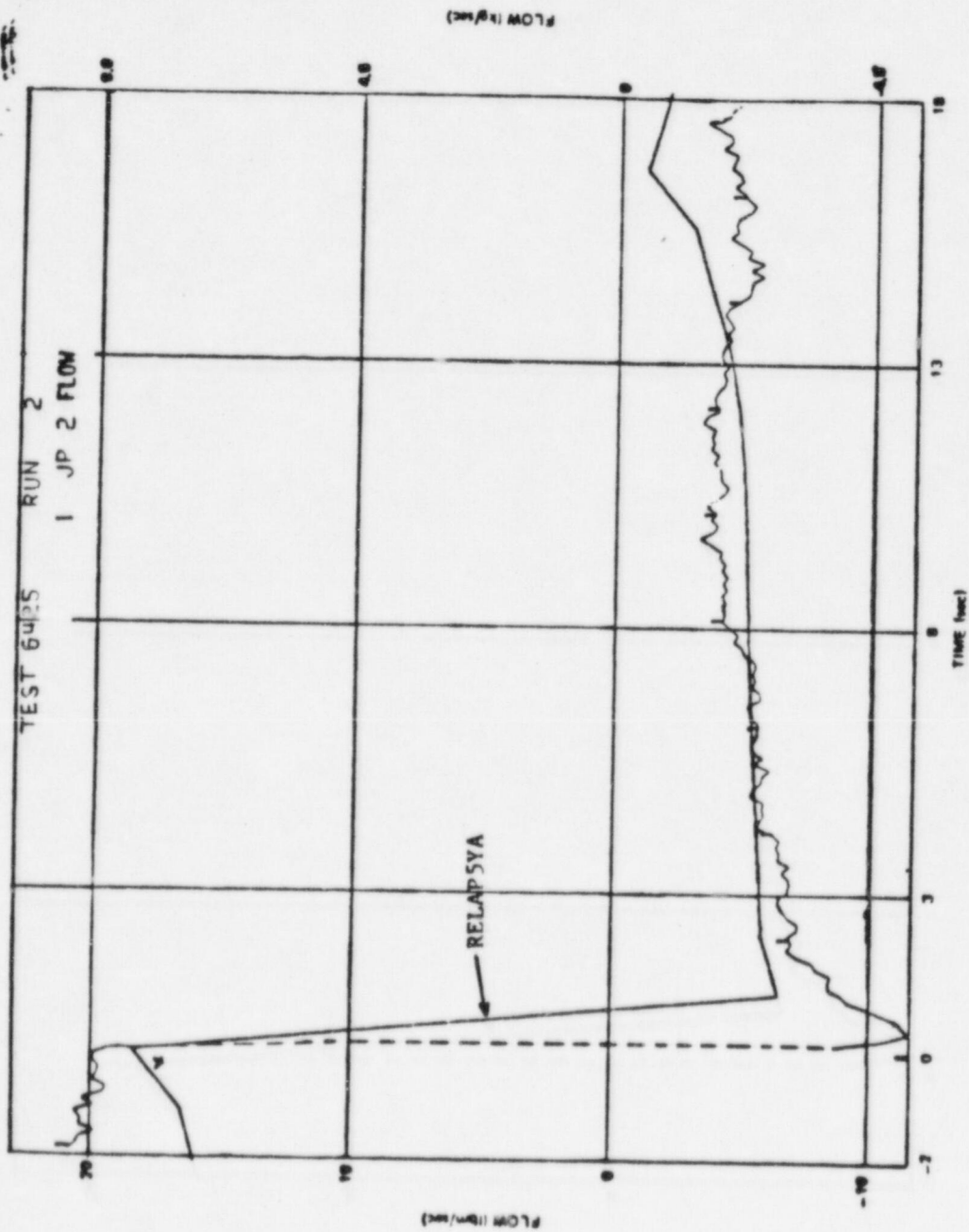
Bundle Inlet Side Entry Orifice Mass Flow Rate



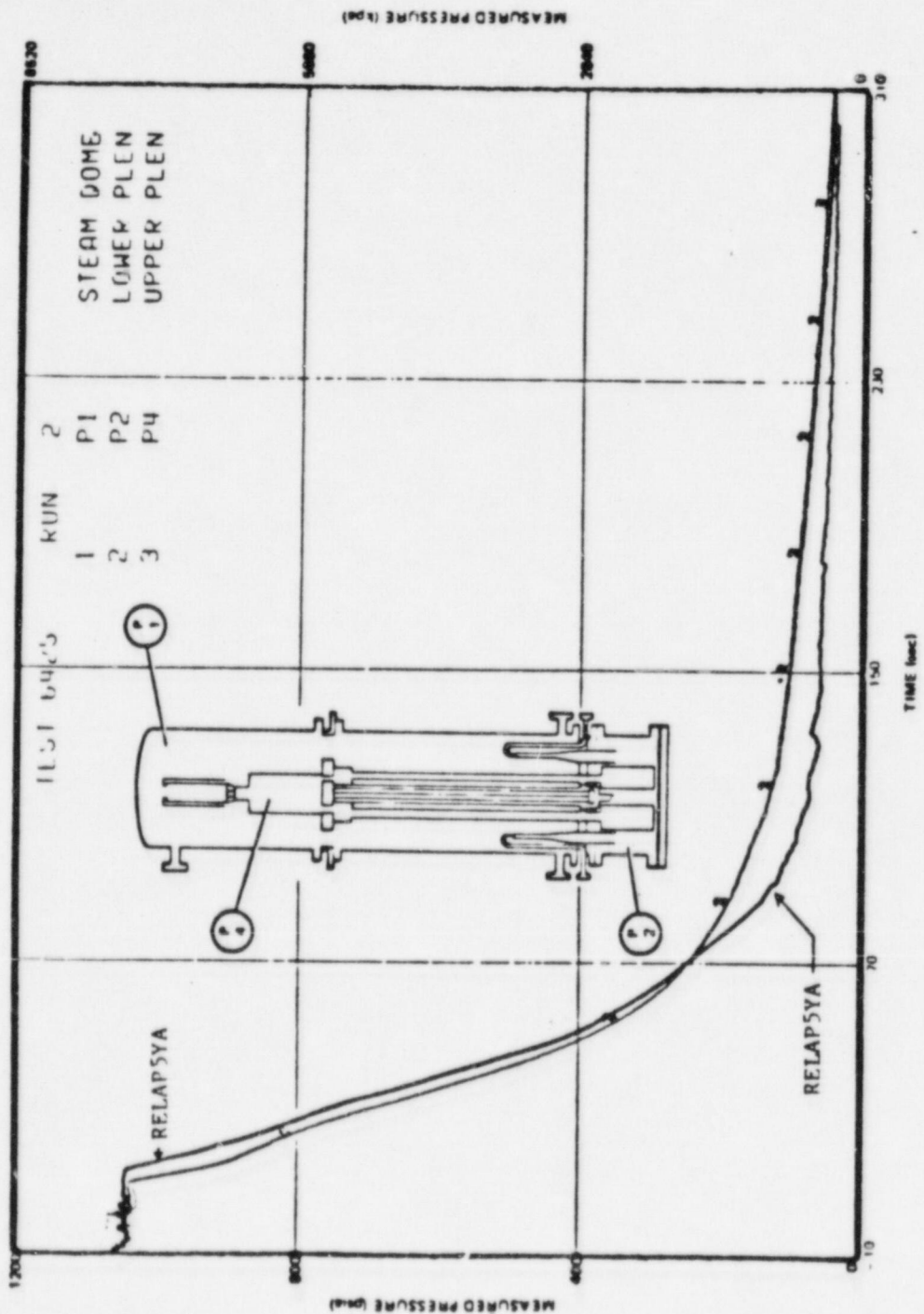
Recirculation Pump Mass Flow Rates



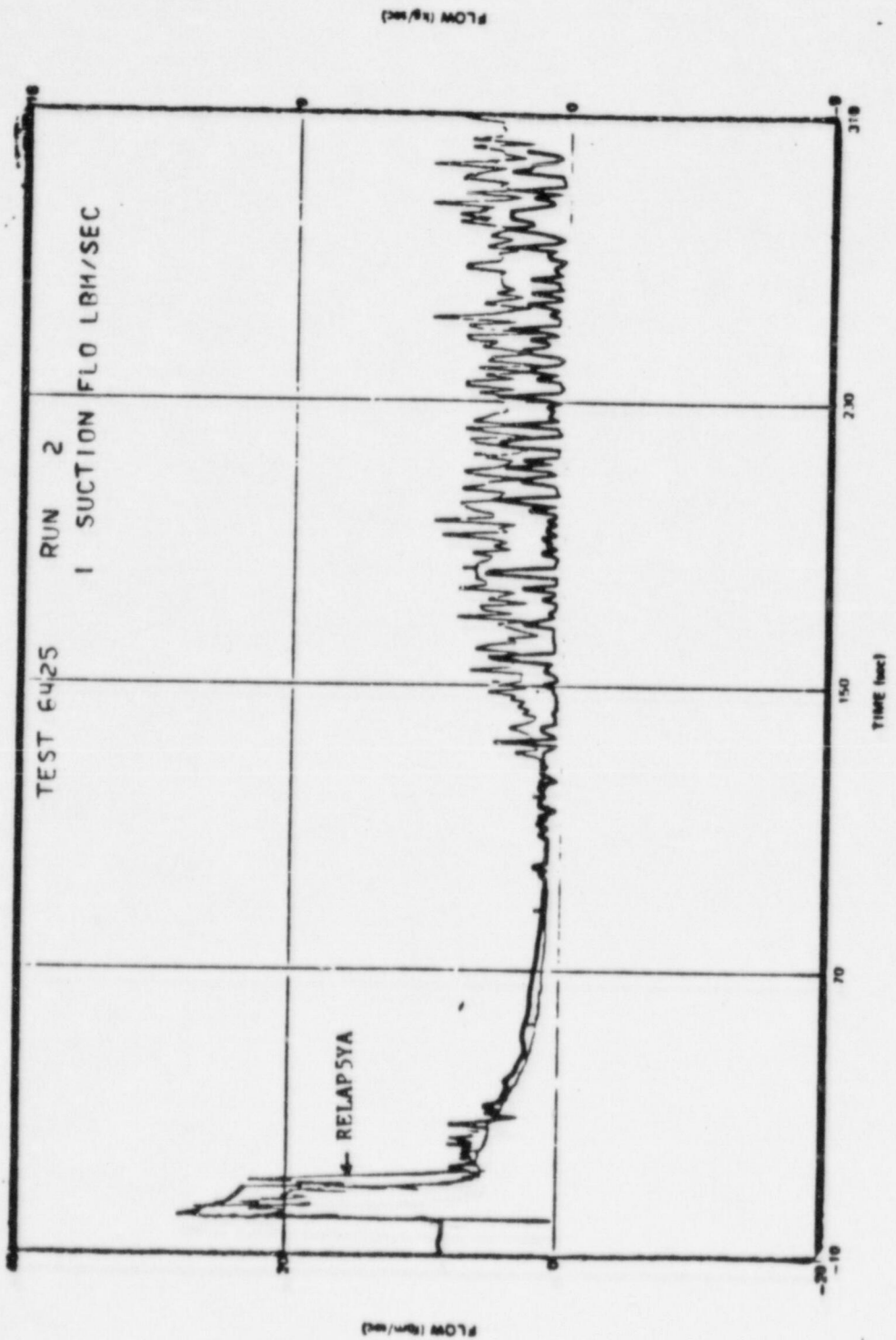
Intact Loop Jet Pump Mass Flow Rate



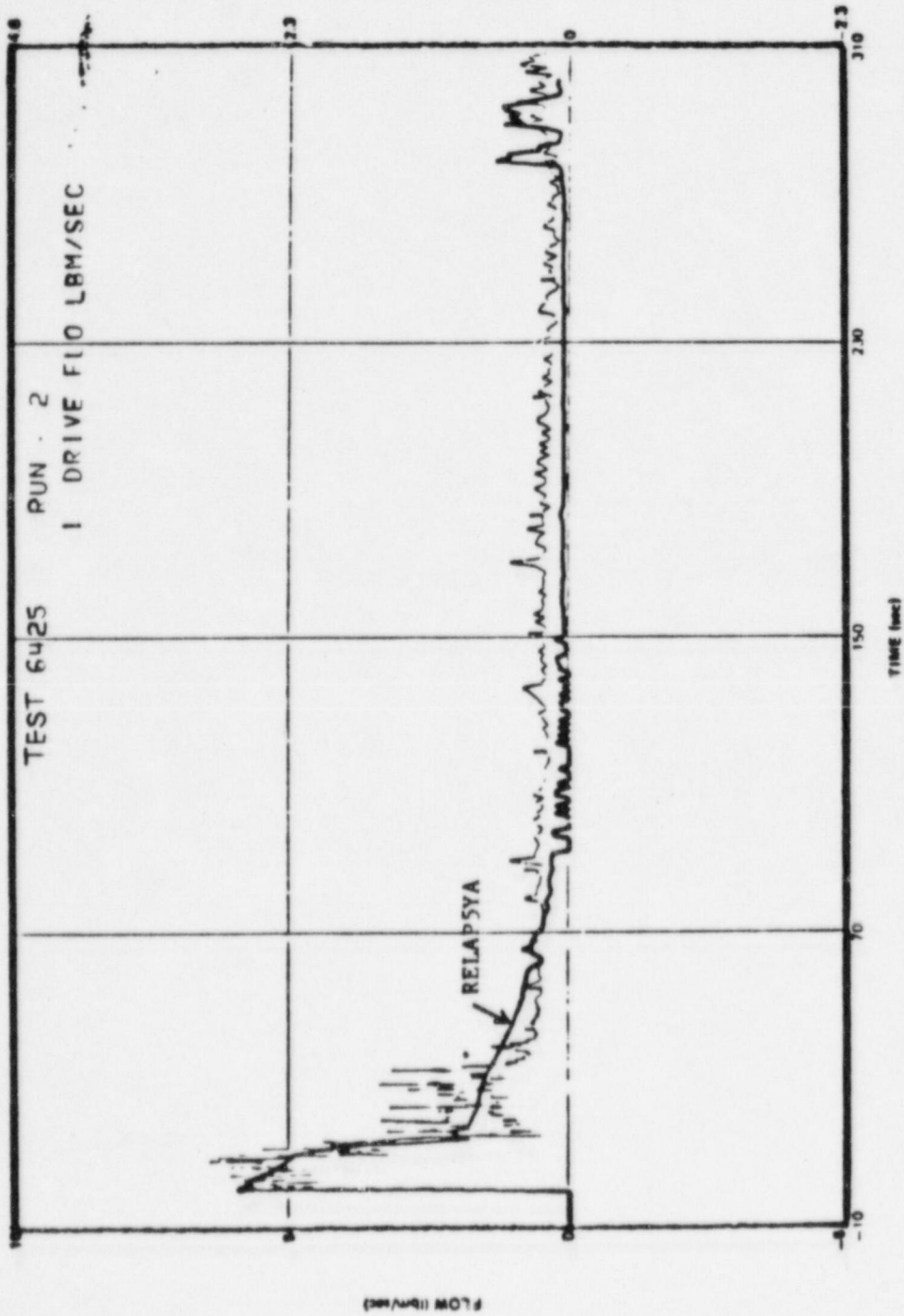
Broken Loop Jet Pump Mass Flow Rate



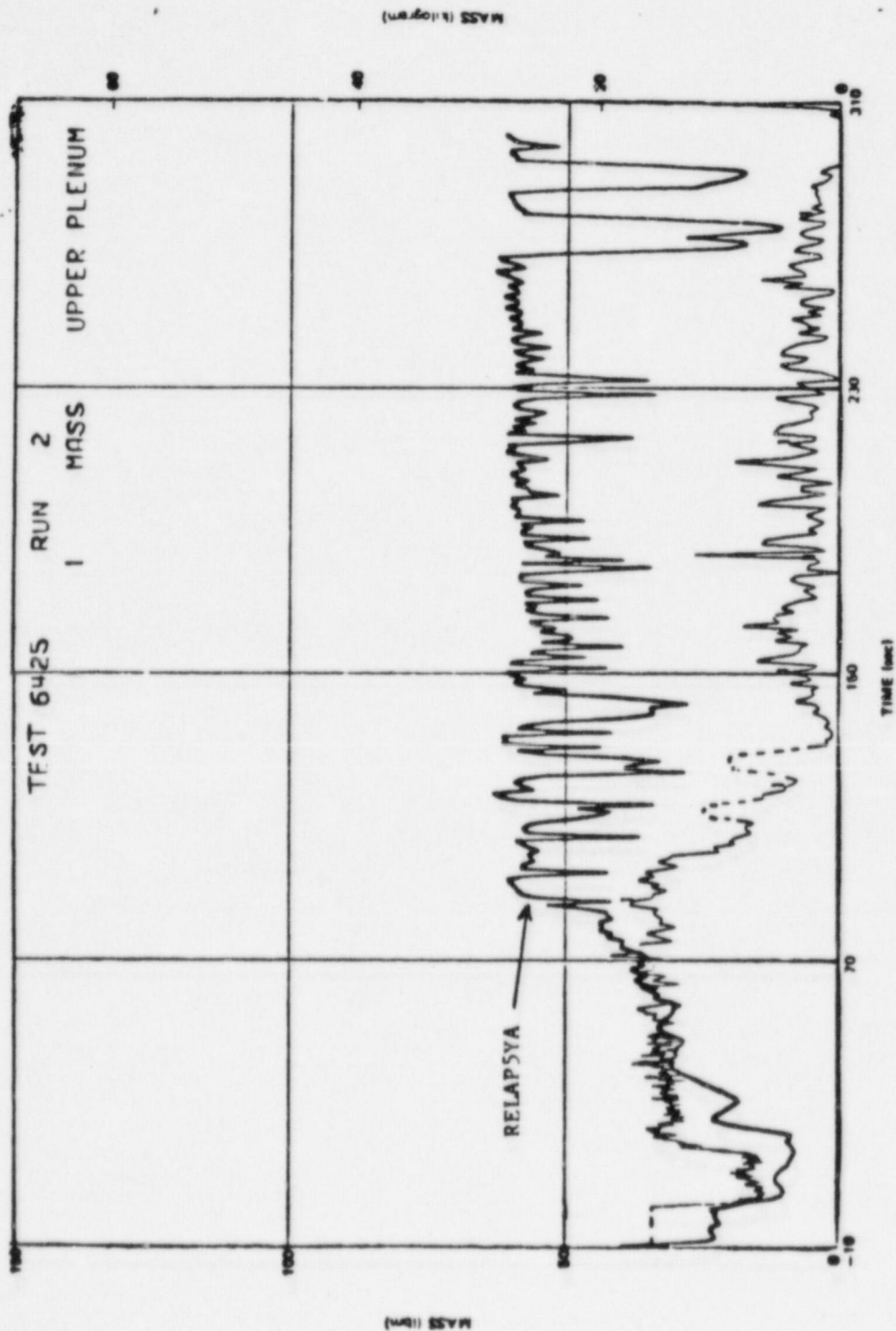
System Pressures



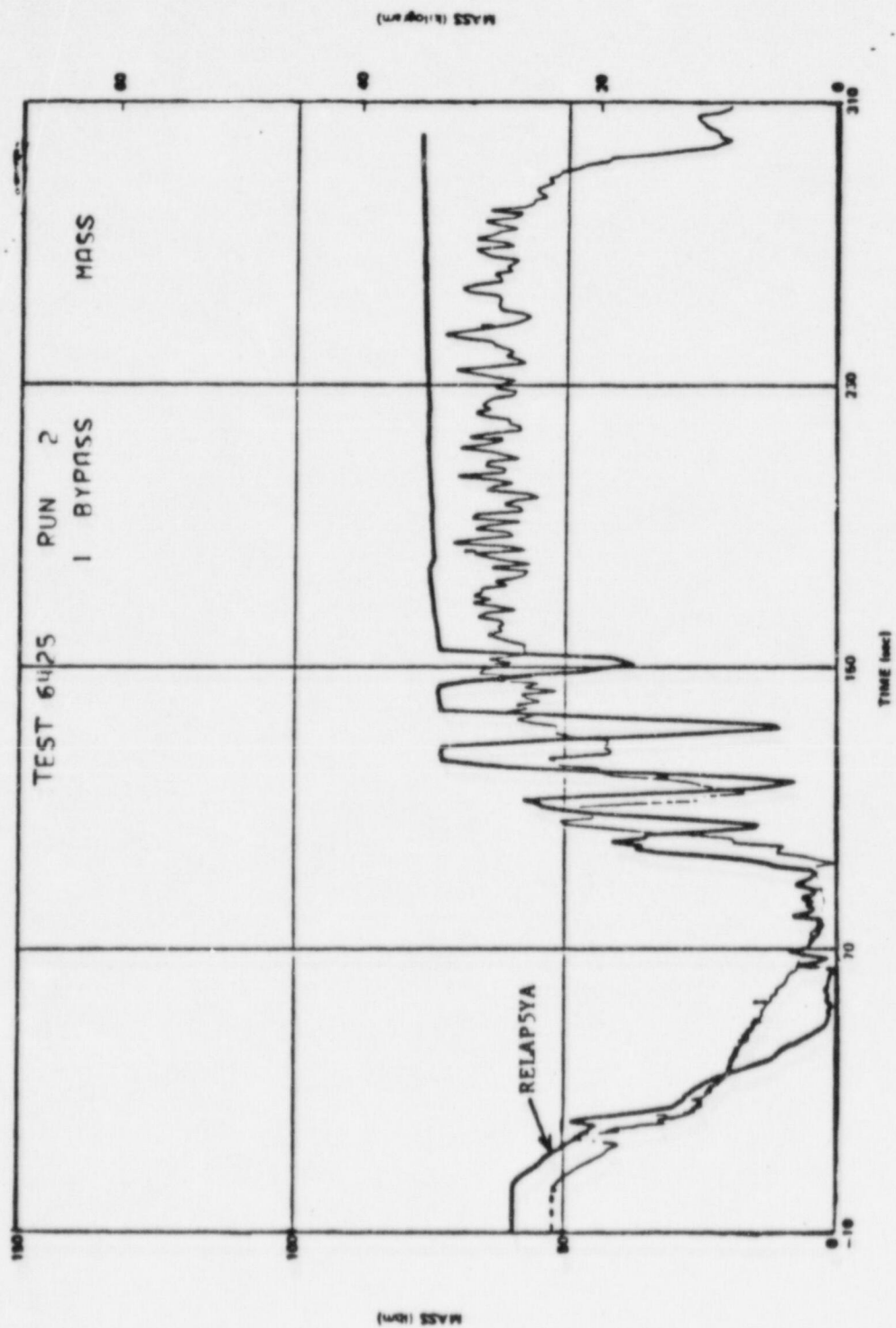
Suction Line Break Mass Flow Rate



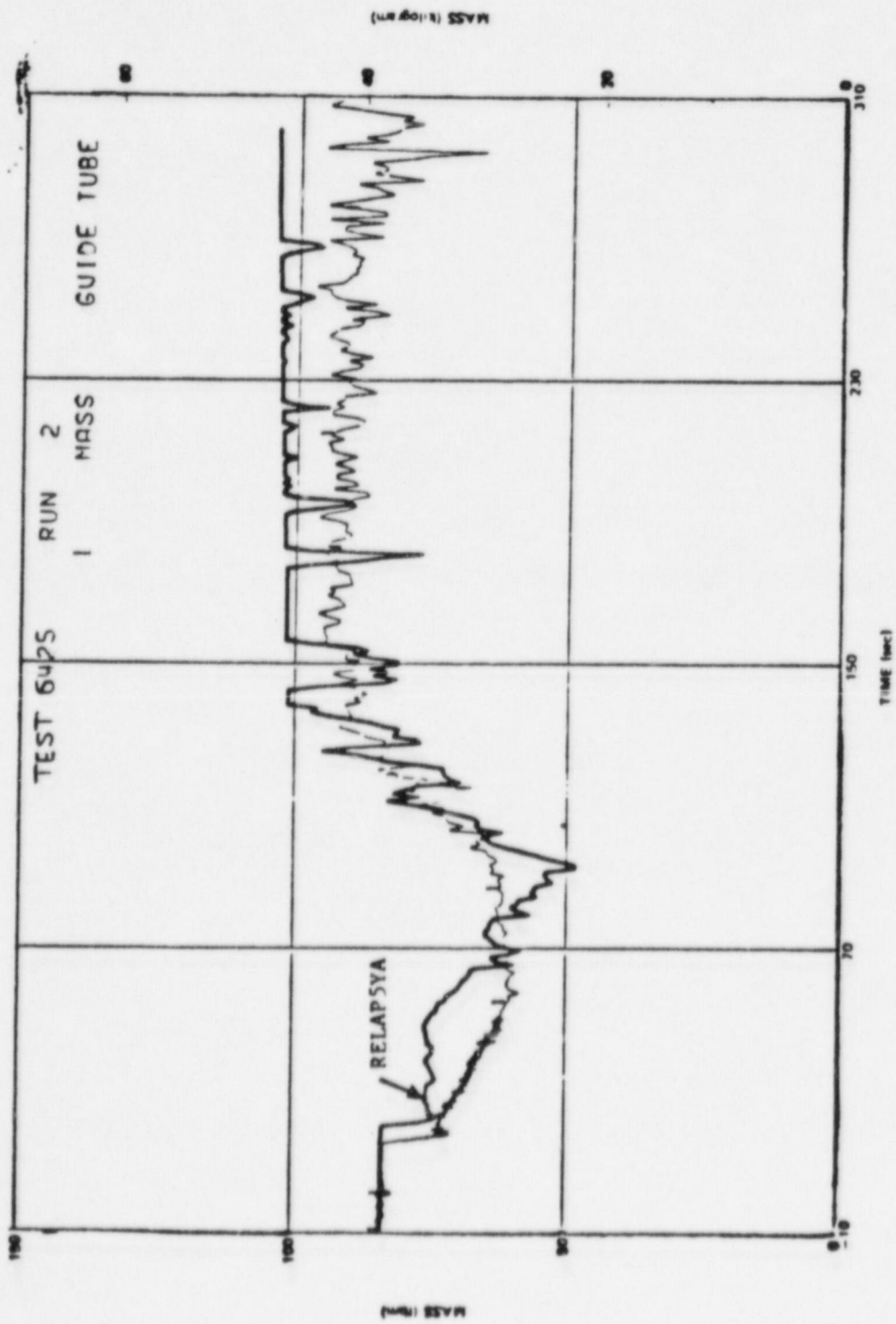
Drive Line Break Mass Flow Rate



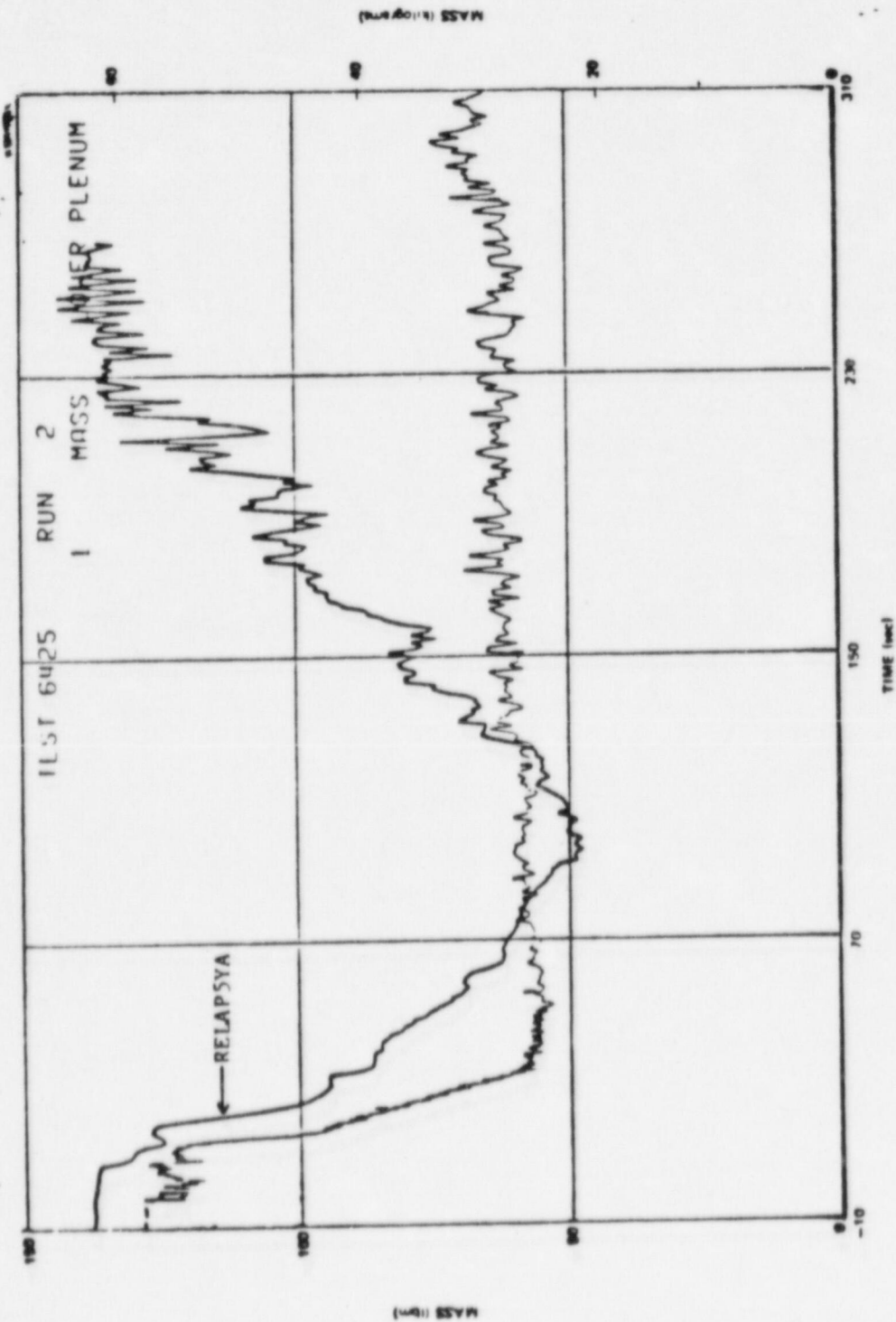
Upper Plenum Fluid Mass



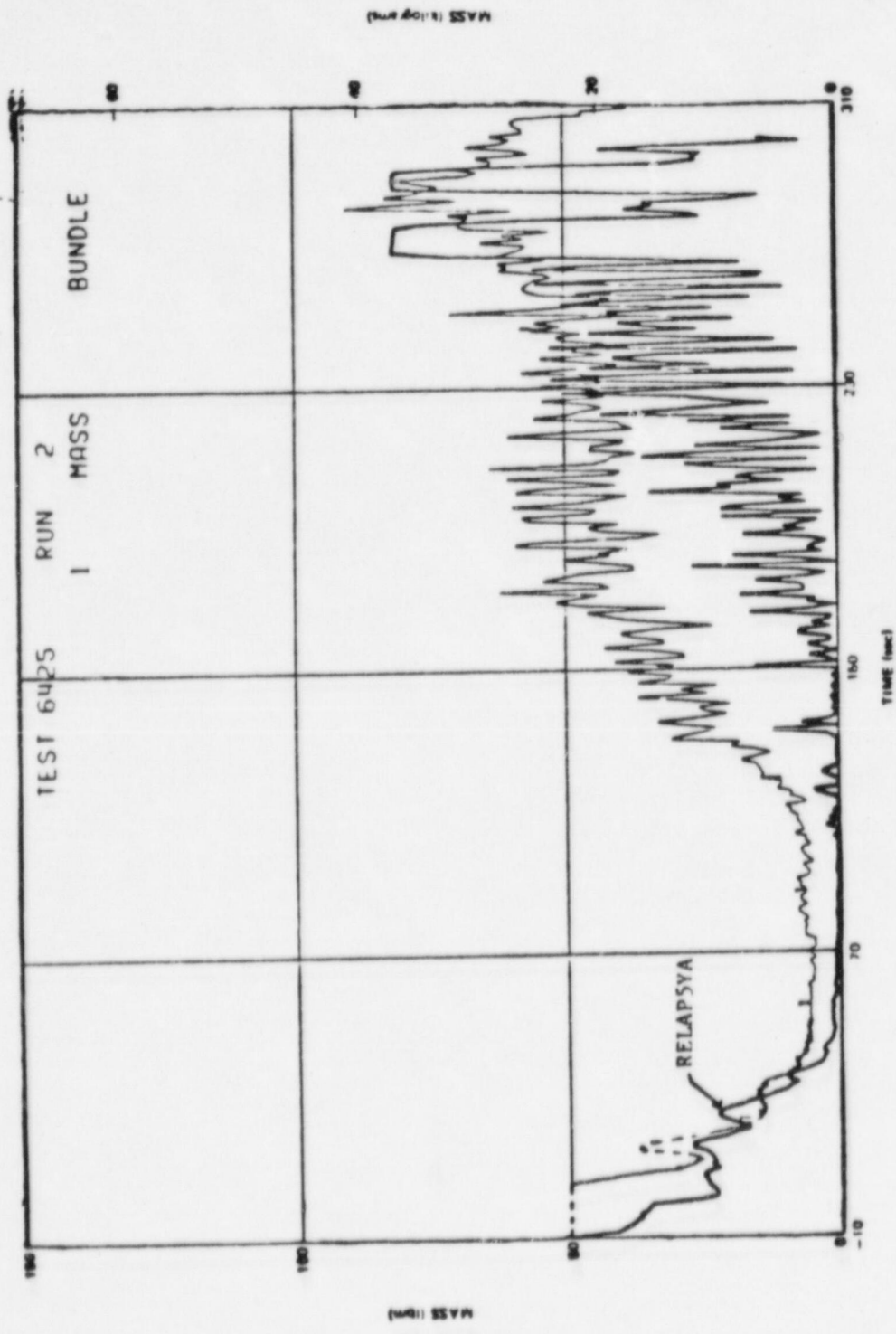
Bypass Fluid Mass



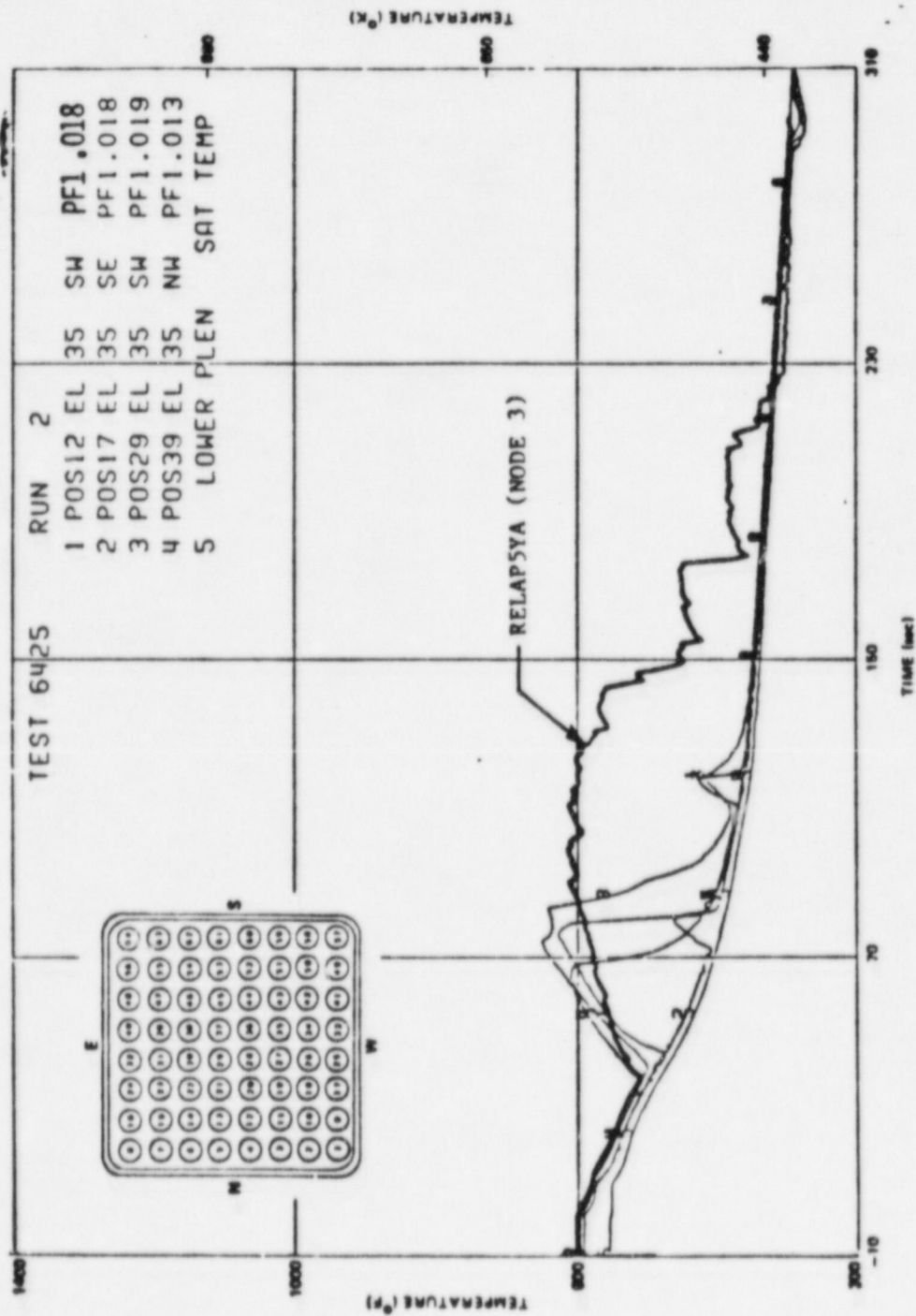
Guide Tube Fluid Mass



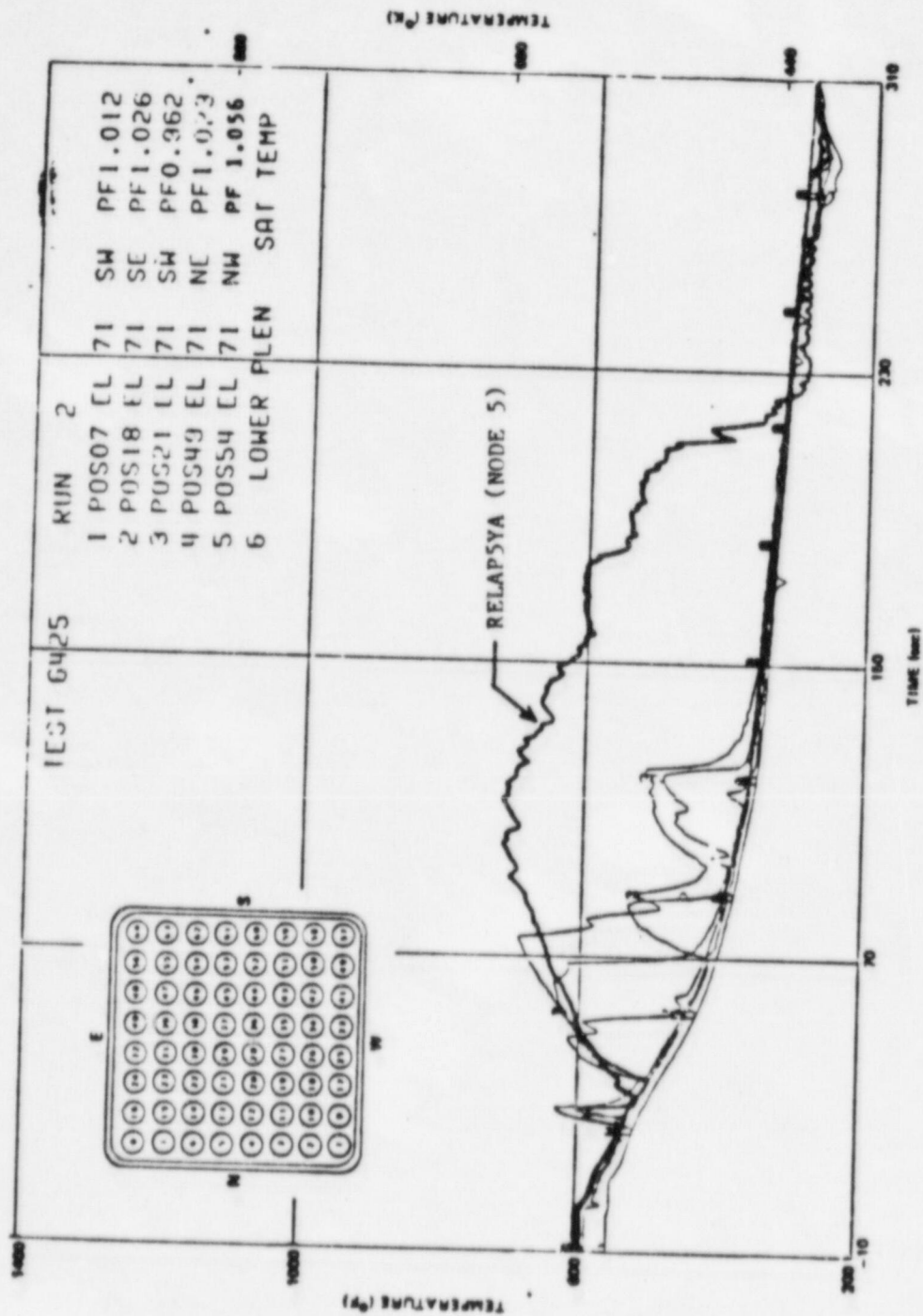
Lower Plenum Fluid Mass



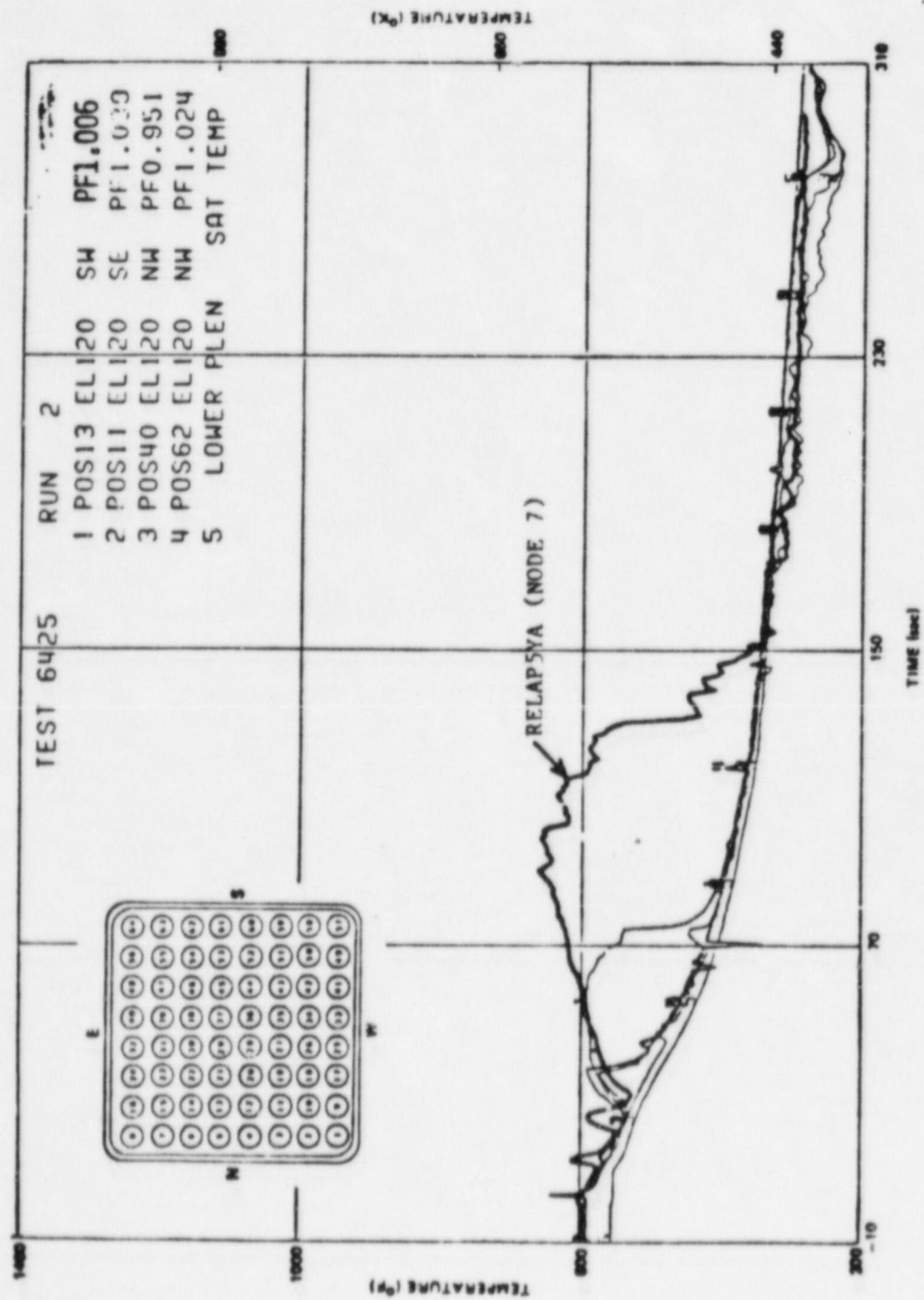
Bundle Fluid Mass



Inside Clad Temperature-Elevation 35 in.

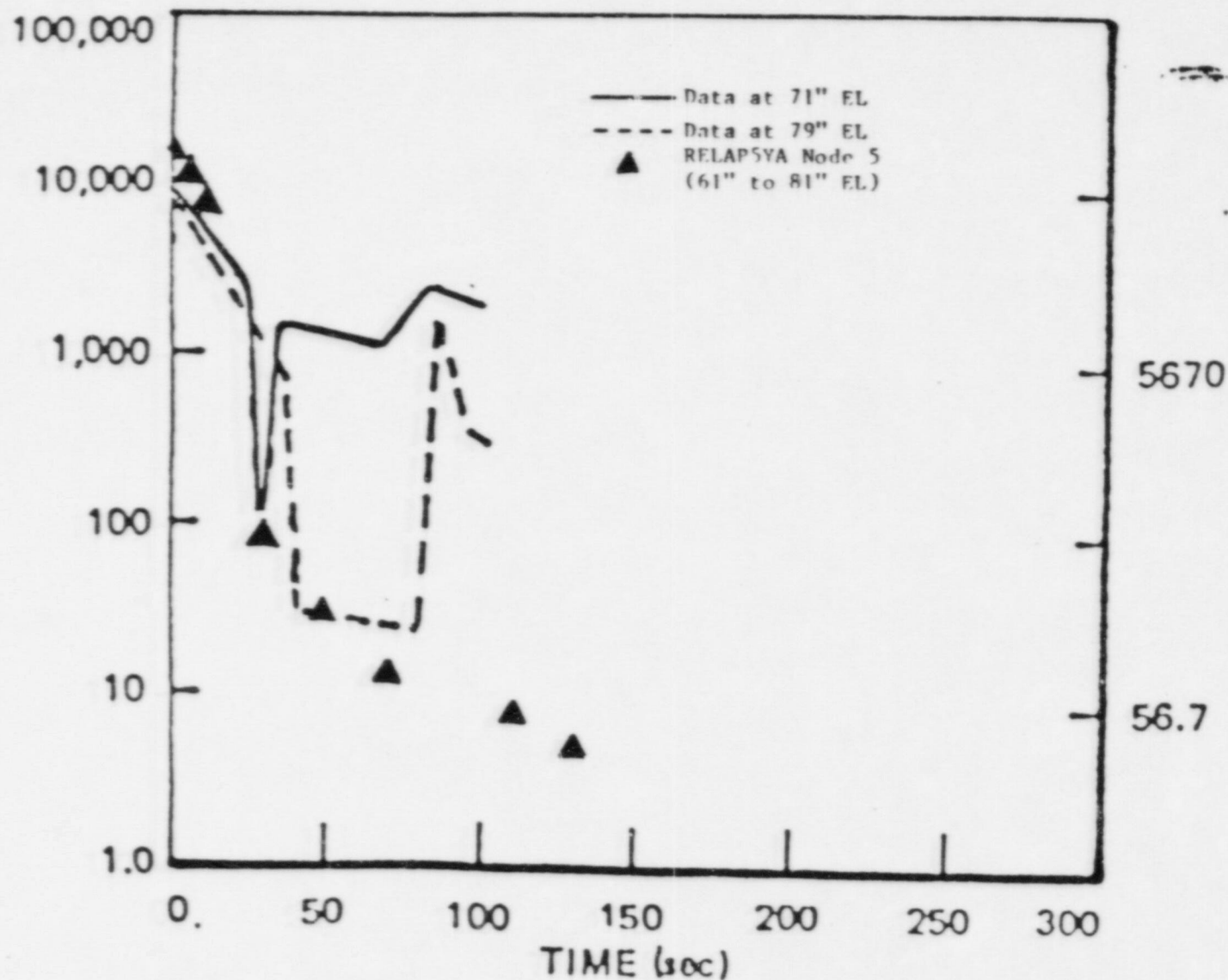


Inside Clad Temperature-Elevation 71 in.

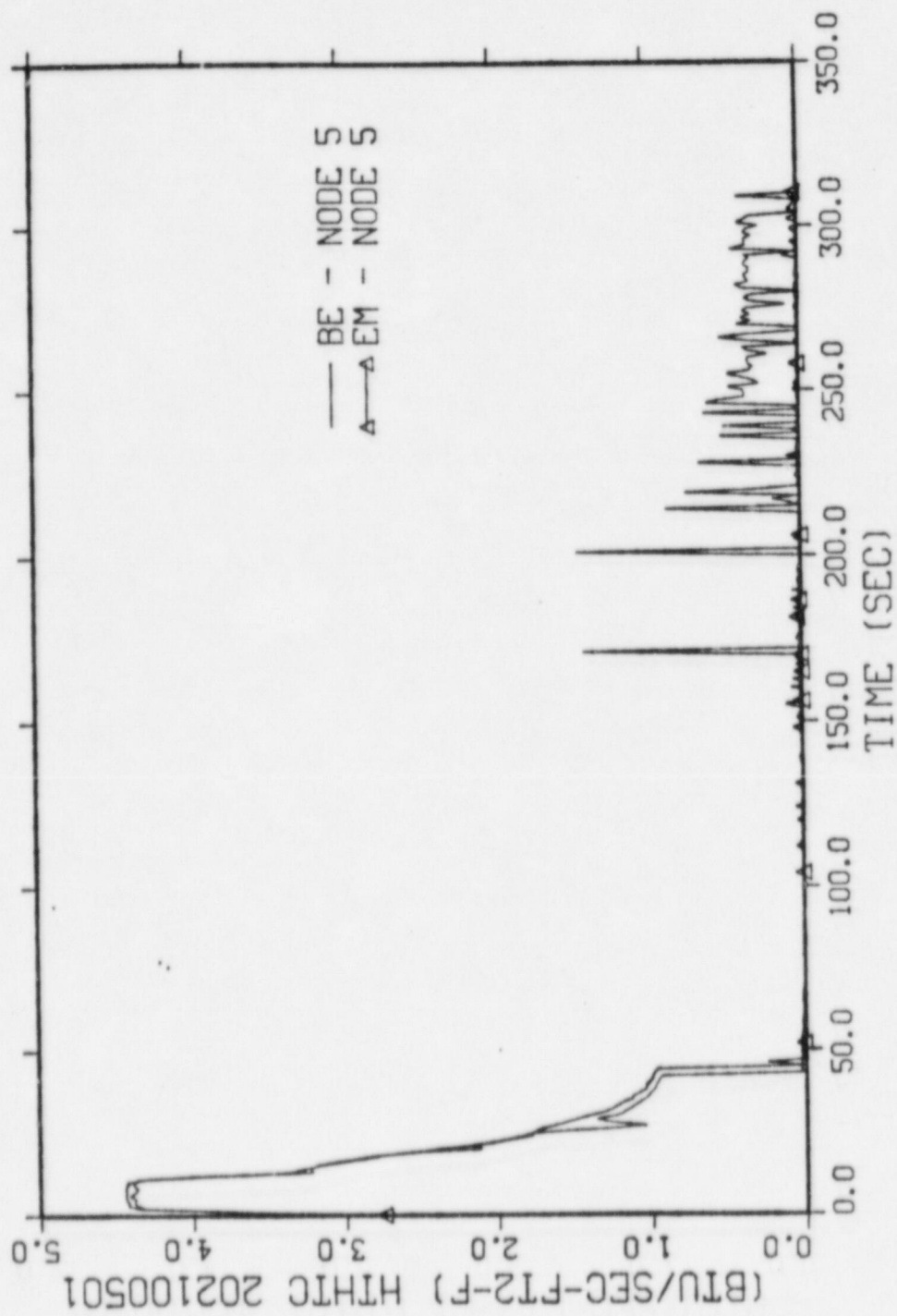


Inside Clad Temperature-Elevation 120 in.

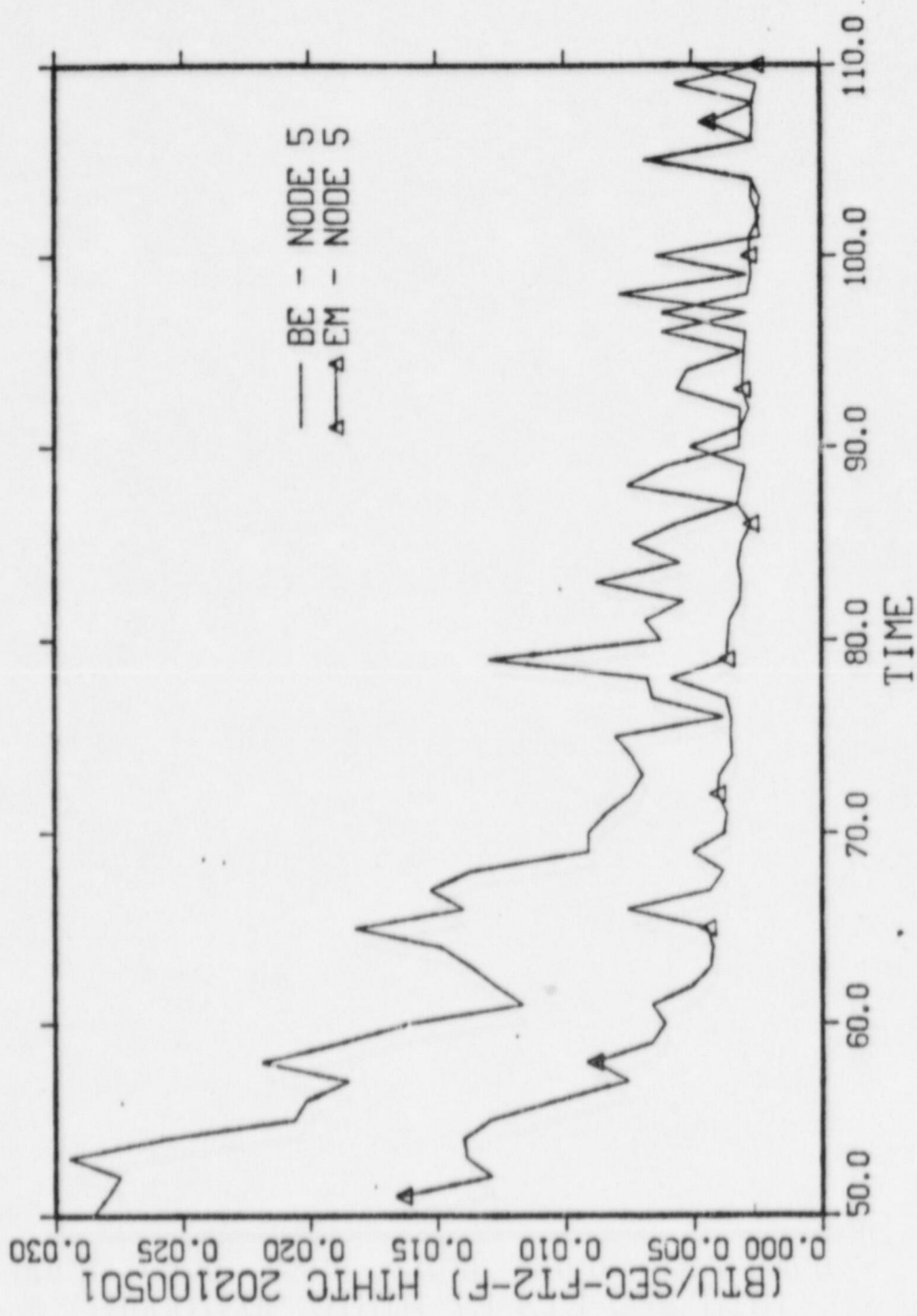
HEAT TRANSFER COEFFICIENT, BTU/HR-FT²-DEG.F.



Comparison of bundle heat transfer coefficients in RELAP5VA simulation of TLTA Test 6425/2 with data of TLTA Test 64-2/3.



TLTA LARGE BREAK TEST 6425/2



TLTA LARGE BREAK TEST 6425/2

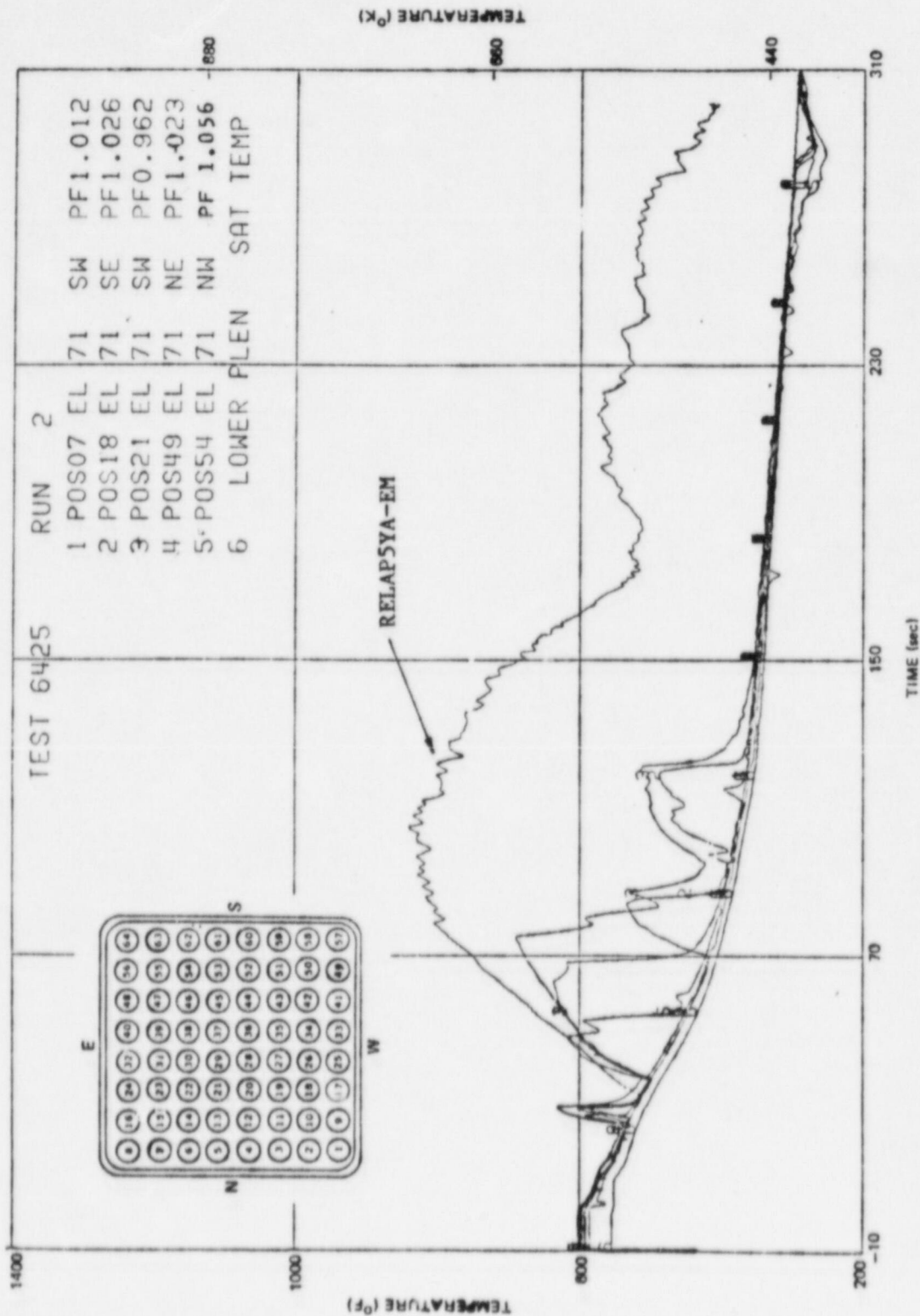


Figure J-91. Inside Clad Temperature-Elevation 71 in.

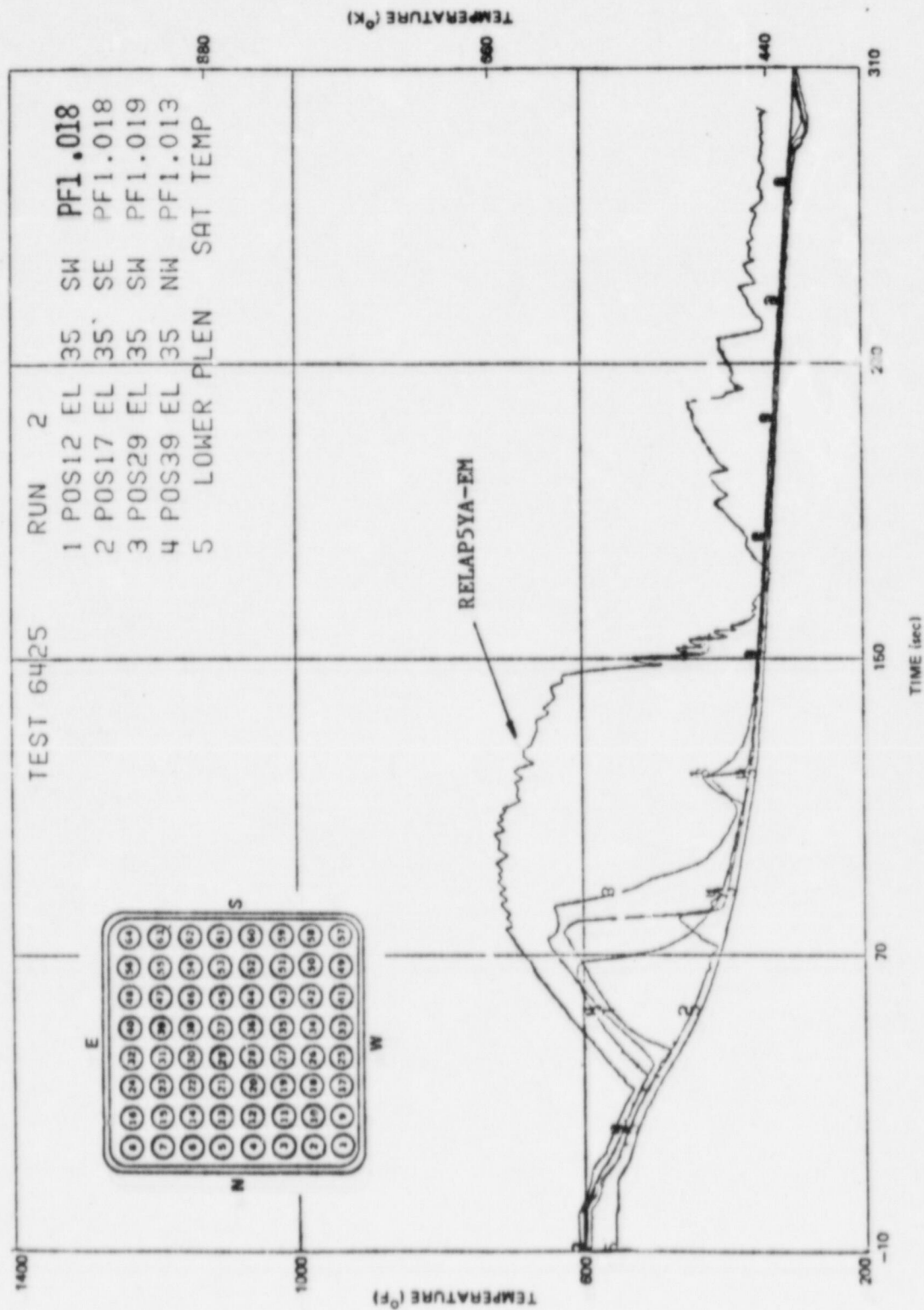


Figure J-95. Inside Clad Temperature-Elevation 35 in.

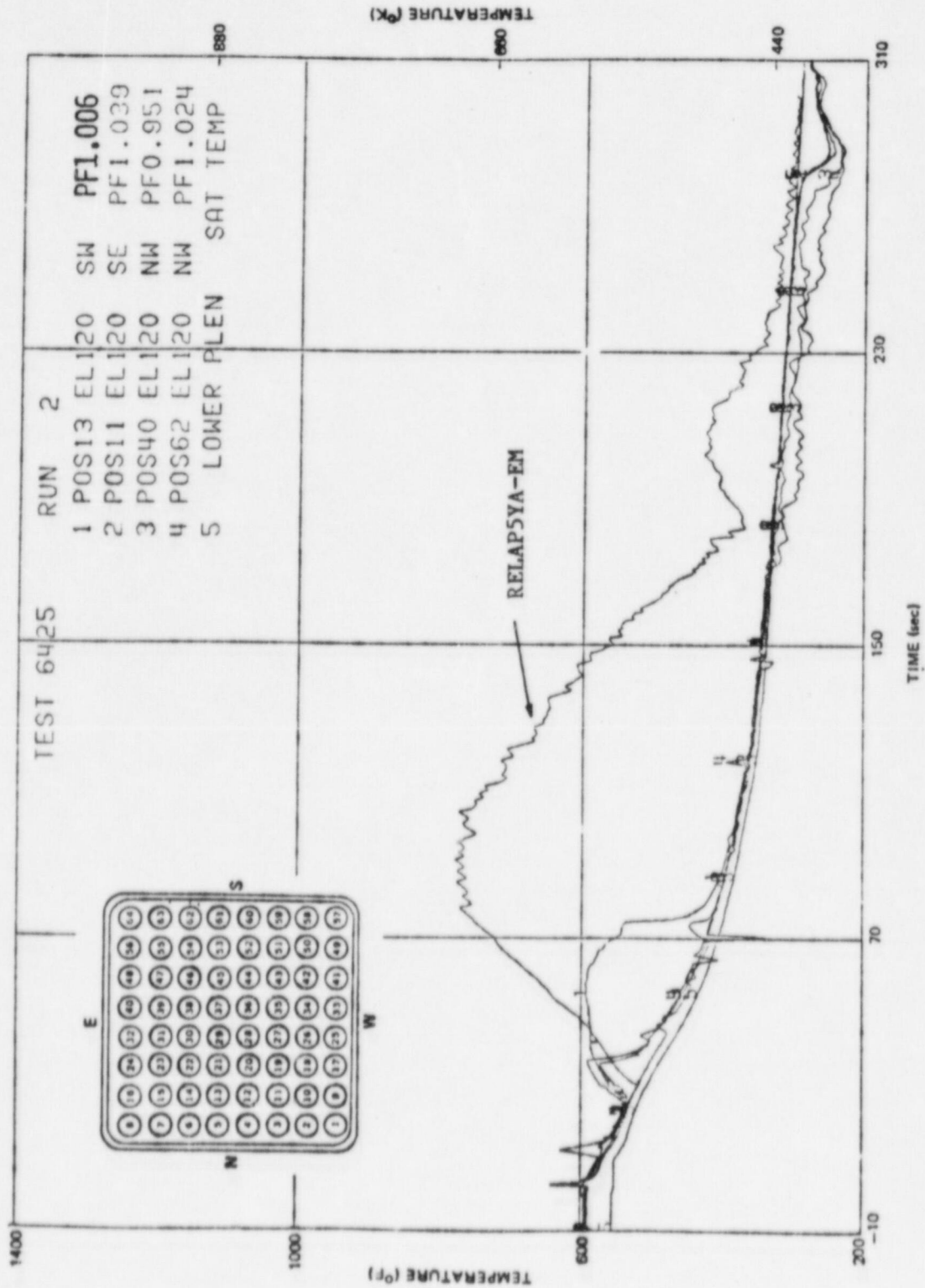


Figure J-83. Inside Clad Temperature-Elevation 120 in.

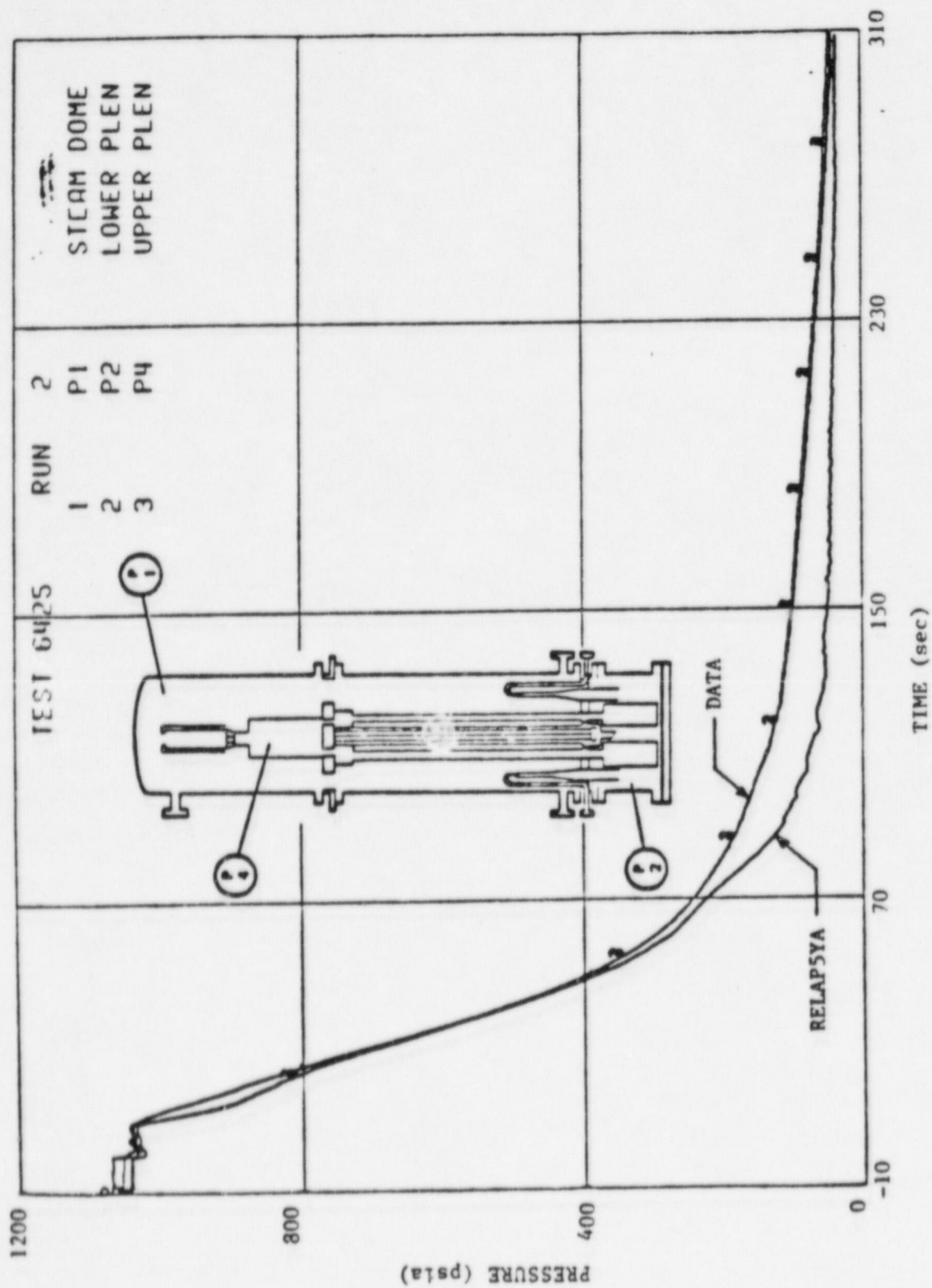


Figure 5.2-17: Comparison of system pressure response in TLTA
Test 6425/2 to RELAP5YA EM calculation

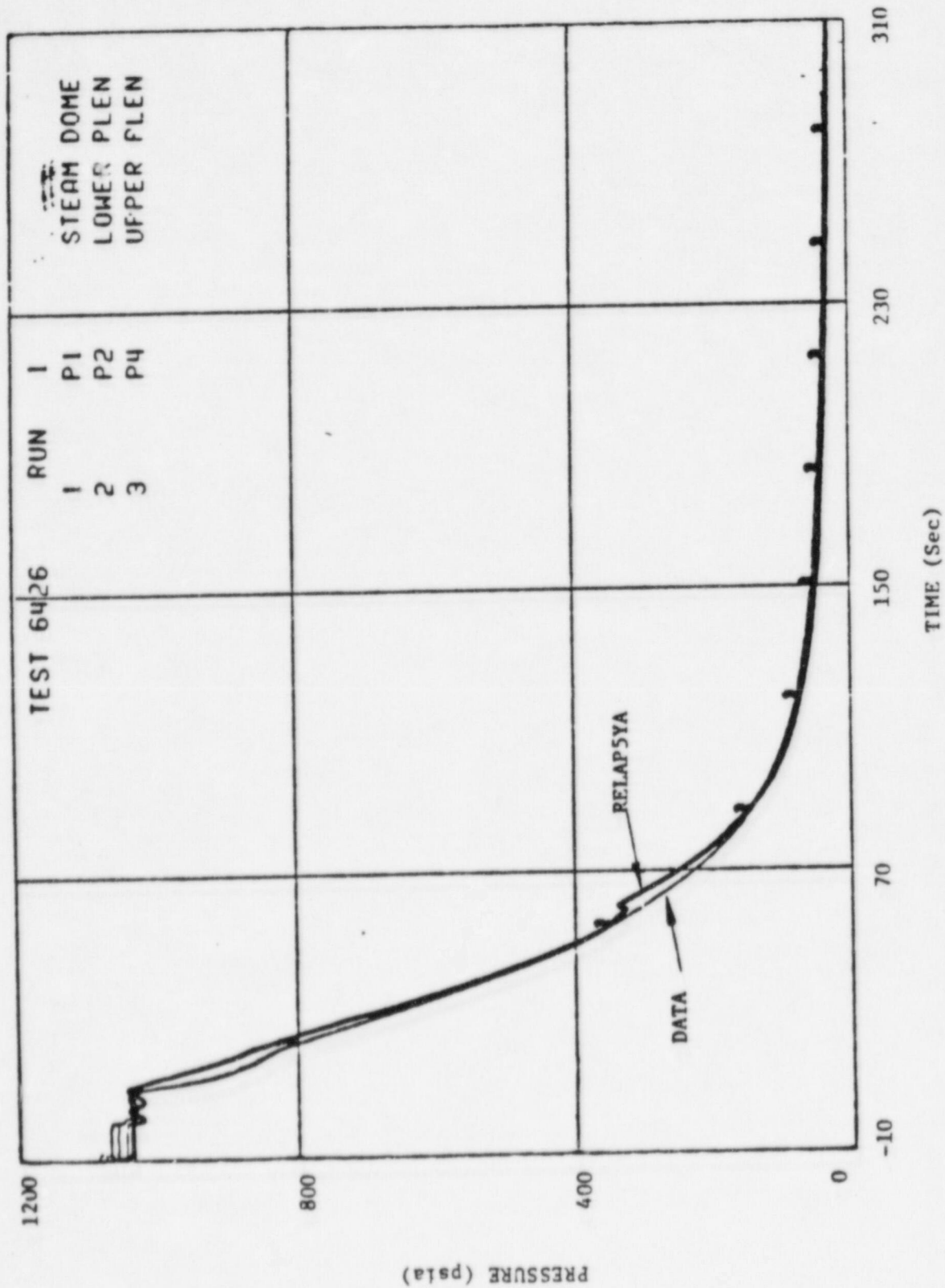


Figure 5.2-25: Comparison of System Pressure Response in TLTA Test 6426/1 to RELAP5YA Calculation

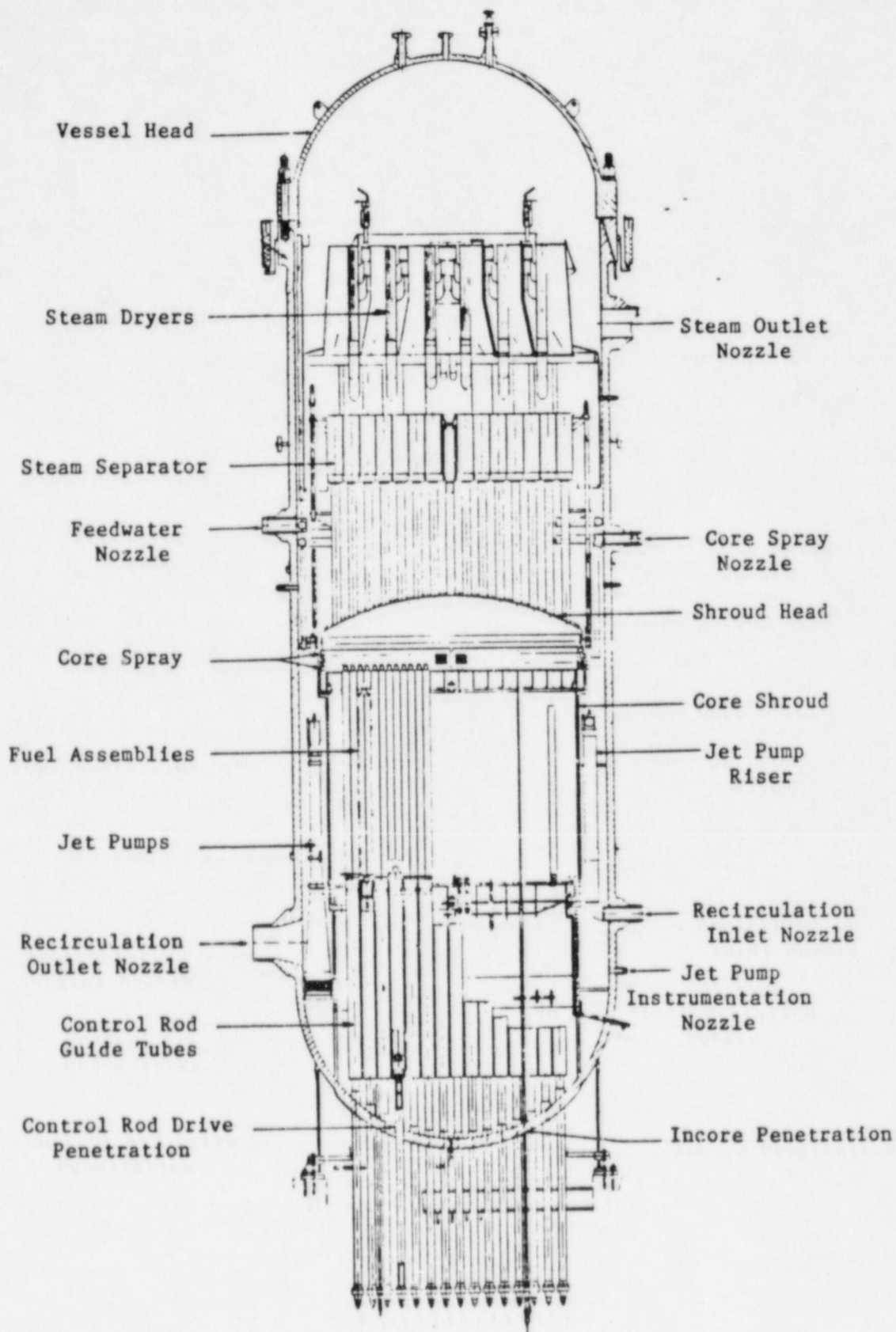


Figure 1.2-1: Vermont Yankee Reactor Vessel

TABLE 1.2.1Vermont Yankee Operating Conditions

		<u>Rated</u>	<u>Design</u>
Core Power	(MWt)	1,593	1,664
Vessel Pressure	(psia)	1,020	1,035
Vessel Water Level	(inches) ^a	512	512
Feedwater Temperature	(°F)	372	376
Feedwater Flow	(MLBM/hr) ^b	6.40	6.72
Recirculation Loop Flow (each of two loops)	(MLBM/hr)	12.3	12.3
Control Rod Drive Flow	(MLBM/hr)	0.03	0.03
Core Flow	(MLBM/hr)	48.0	48.0
Main Steam Line Flow (four combined lines)	(MLBM/hr)	6.43	6.75

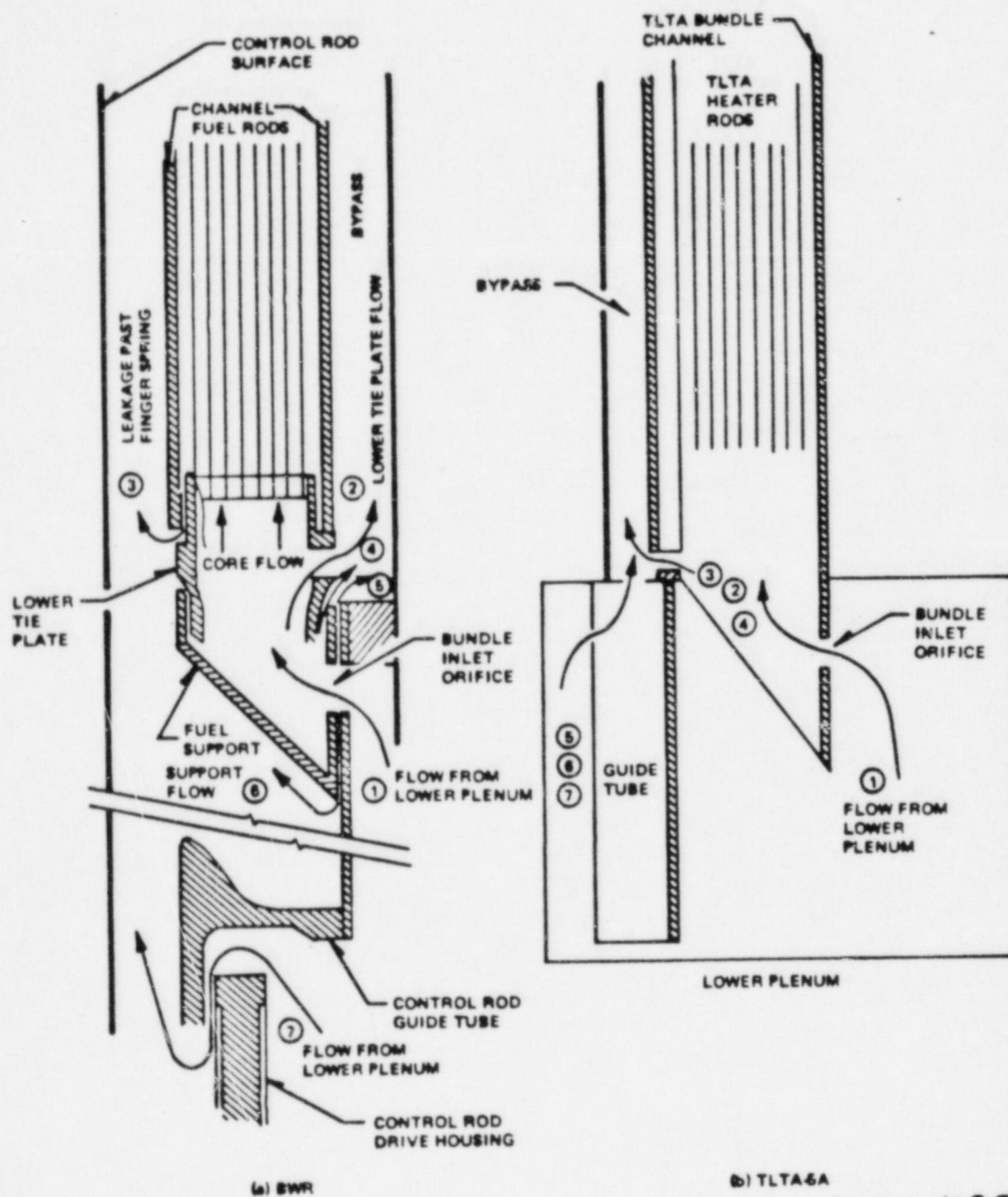
NOTES:

- a. Inches above the top of the lower reactor vessel invert.
- b. Million pounds mass per hour.

TABLE 2.1.1

Vermont Yankee NSSS Nodalization Summary

Region or System	Nodalization Diagram Numbers	Number of Volumes		Number of Junctions		Number of Heat Structures	
		Active	TMDPVOL	Active	TMDPJUN	Active	Passive
<u>Reactor Pressure Vessel</u>							
Lower Plenum	002 to 012	6	0	10	0	0	6
Control Rod Guide Tubes	022 to 024-5	6	0	6	0	0	6
Core Bypass	100 to 102-9	10	0	10	0	0	10
Core Fuel Assemblies							
116 Peripheral Low Power	120 to 122-9	10	0	11	0	9	10
248 Central Average Power	140 to 142-9	10	0	11	0	9	10
4 Central High Power	160 to 162-9	10	0	11	0	9	10
Upper Plenum	206 to 208	2	0	2	0	0	2
Standpipes and Separators	210 to 228	3	3	5	2	0	3
Intermediate Steam	232	1	0	2	0	0	0
Steam Dryer Assembly	234	1	0	1	0	0	1
Steam Dome	240	1	0	1	0	0	1
Downcomer	250 to 290	15	0	14	0	0	13
<u>Other Systems</u>							
Recirculation Loop A	302 to 338-1	12	0	12	0	0	12
Jet Pump Bank A	340 to 342-3	4	0	6	0	0	4
Recirculation Loop B	352 to 388-1	12	0	12	0	0	12
Jet Pump Bank B	390 to 392-3	4	0	6	0	0	4
Feedwater Lines	400 to 402-3	3	1	3	1	0	0
Main Steam Lines	540 to 550	6	1	7	0	0	5
Steam Relief and Supply	551 to 571	0	1	6	1	0	0
Containment	614 to 663	0	8	0	0	0	0
ECCS	700 to 763	2	4	2	4	0	0
DEG Break	801 to 802	0	0	2	0	0	0
TOTALS		118	18	140	8	27	109



Similar to YY NSSS except
path ⑦ is separate

Figure 2-5. Flow Paths at Inlet Region of a BWR Fuel Bundle and the TLTA Simulation

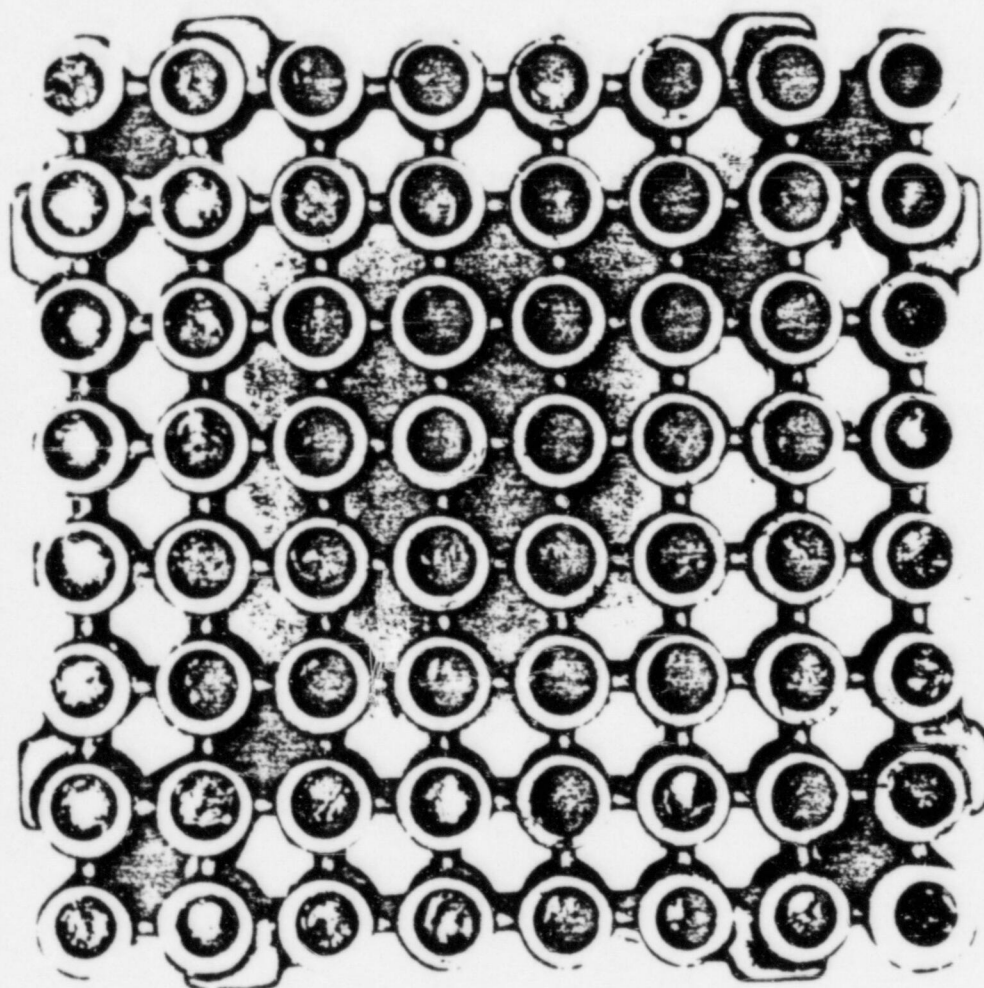


Figure 1. Bottom view of a prototypical 8 X 8 BWR fuel bundle upper tieplate.

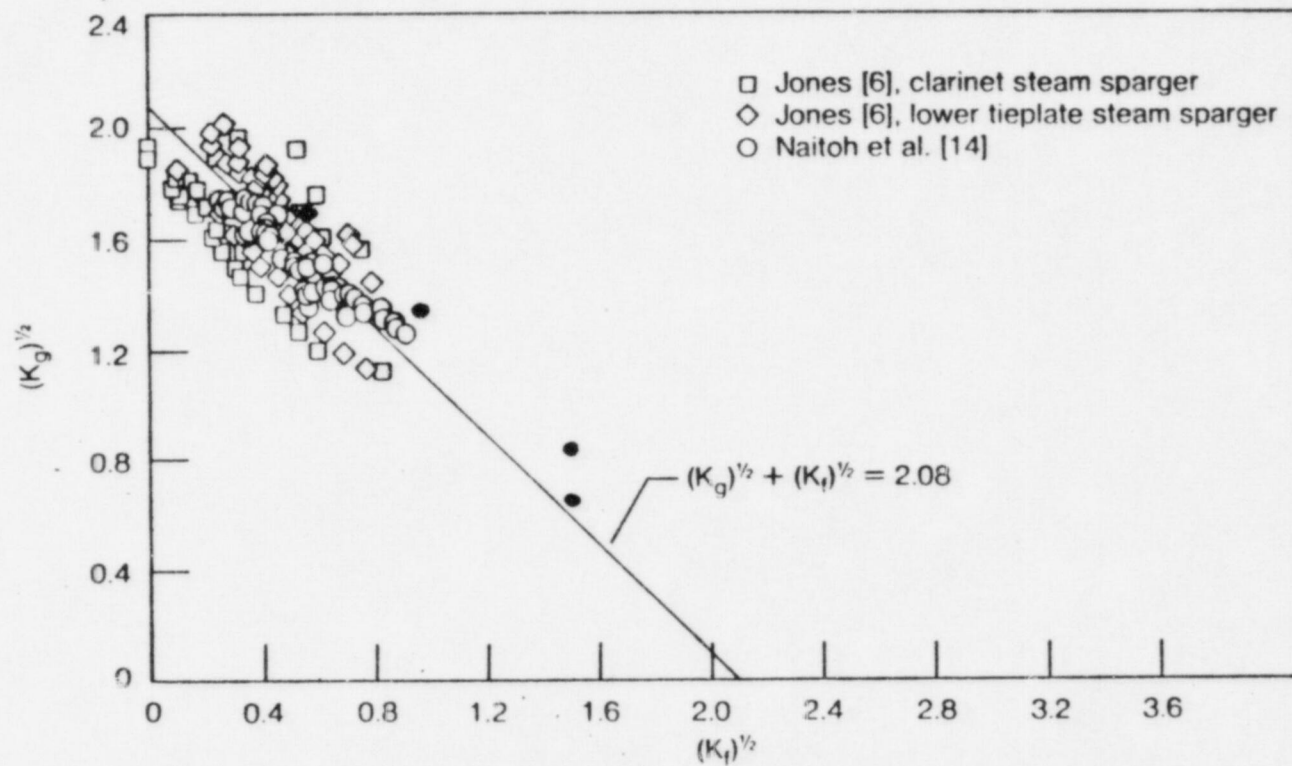


Figure 5. Comparison of data of Jones [6] with data of Naitoh et al. [14] for flooding at a 8×8 tieplate in a simulated BWR fuel bundle.

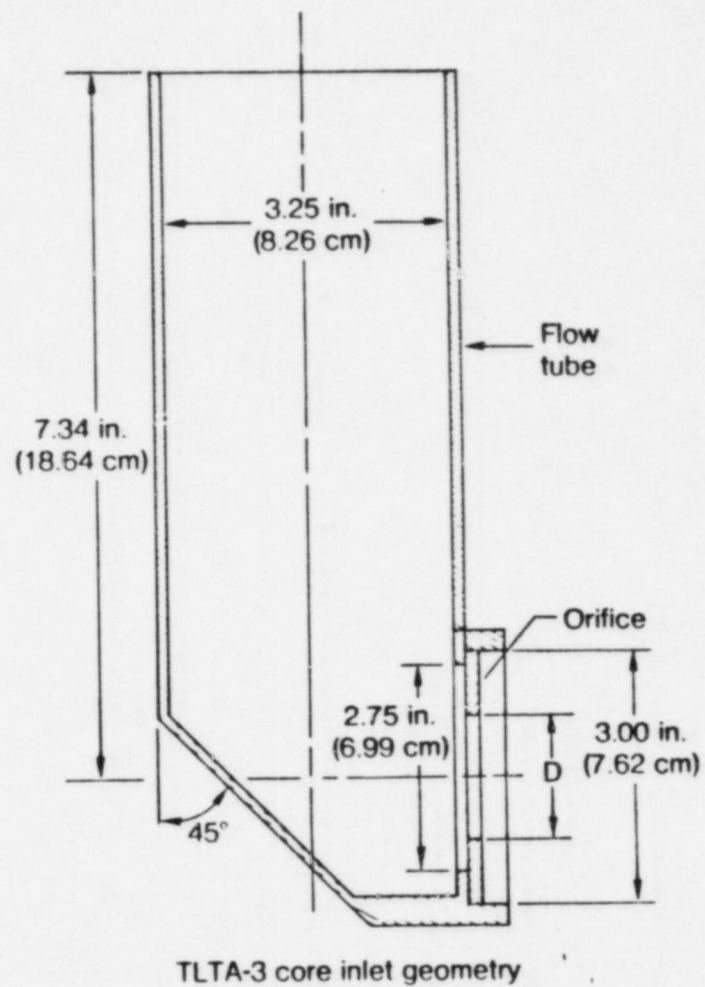
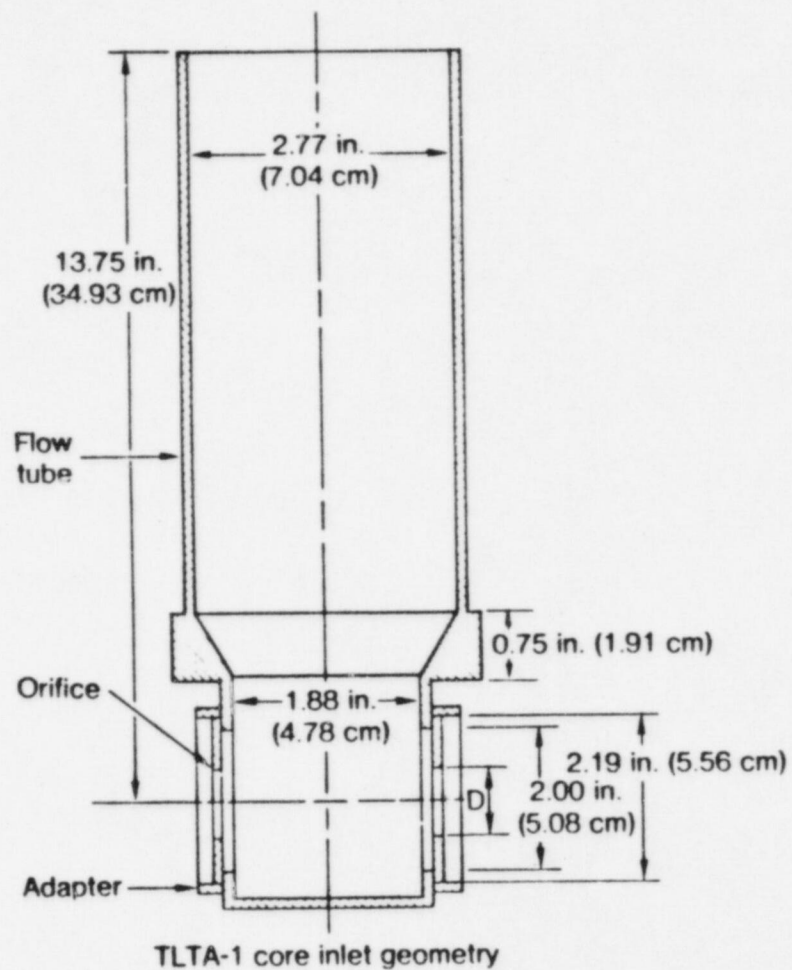


Figure 6. Schematic of TLTA (two-loop test apparatus) core inlet side-entry orifices. (Reference 13)

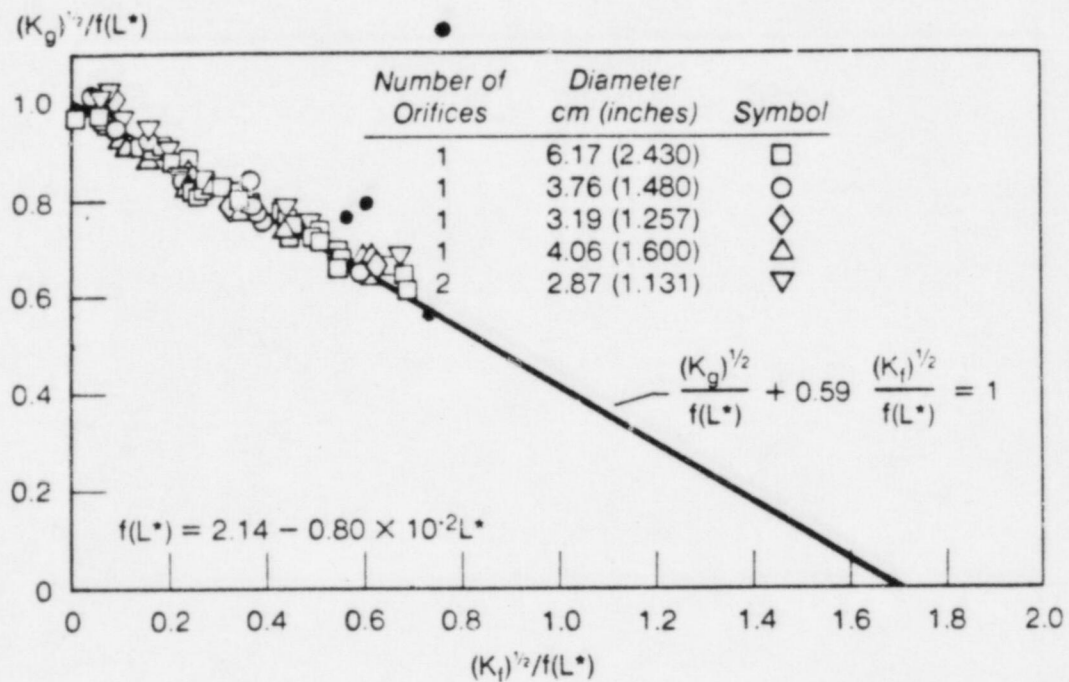


Figure 9. Correlation of flooding data from simulated BWR bottom side-entry orifices.

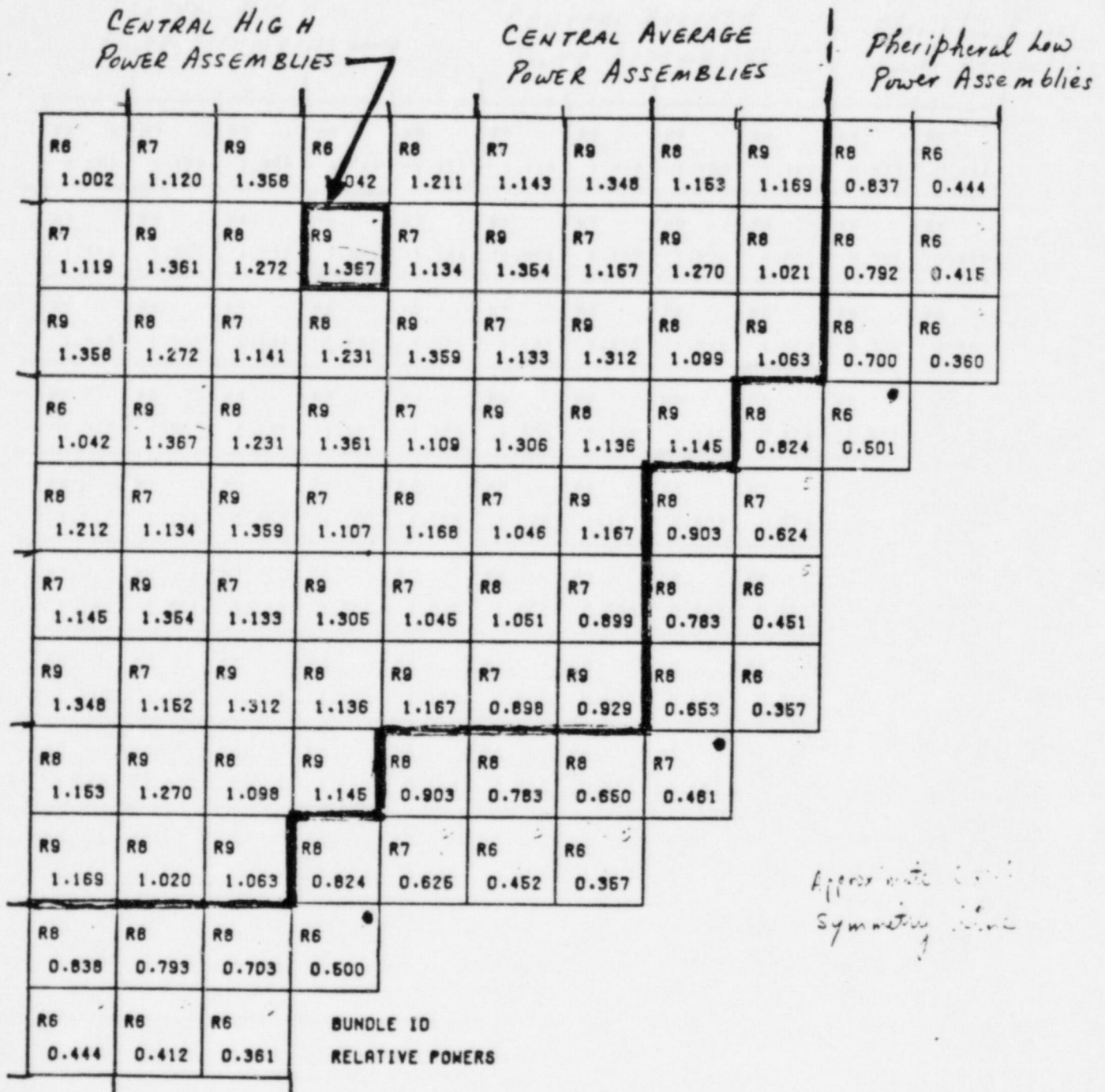


FIGURE 5.1.1

VY CYCLE 10 HALING DEPLETION EOC BUNDLE AVERAGE RELATIVE POWERS

From: V.Y. Cycle 10 Core Performance Analysis (January 1983) - YAEC-1342

RELAP5YA INPUT for VERMONT YANKEE MODEL.
FLUID VOLUMES

4/5/83
108

RTF

66b

JET PUMPS

The bank of 10 jet pumps on each recirculation Loop will be modeled as one jet pump each. The major portion of the throat region is modeled with the JETPMP component. The remaining volumes are modeled with SNGLVOL and SNGLTUBE.

From APED-5752;
(see WED-BWR File).

ID DRIVE NOZZLE = 3.1045" /
w/ 32 RMS

THROAT FINISH = 24 RMS (μ m)

Diffuser Finish = 63 RMS (μ m)

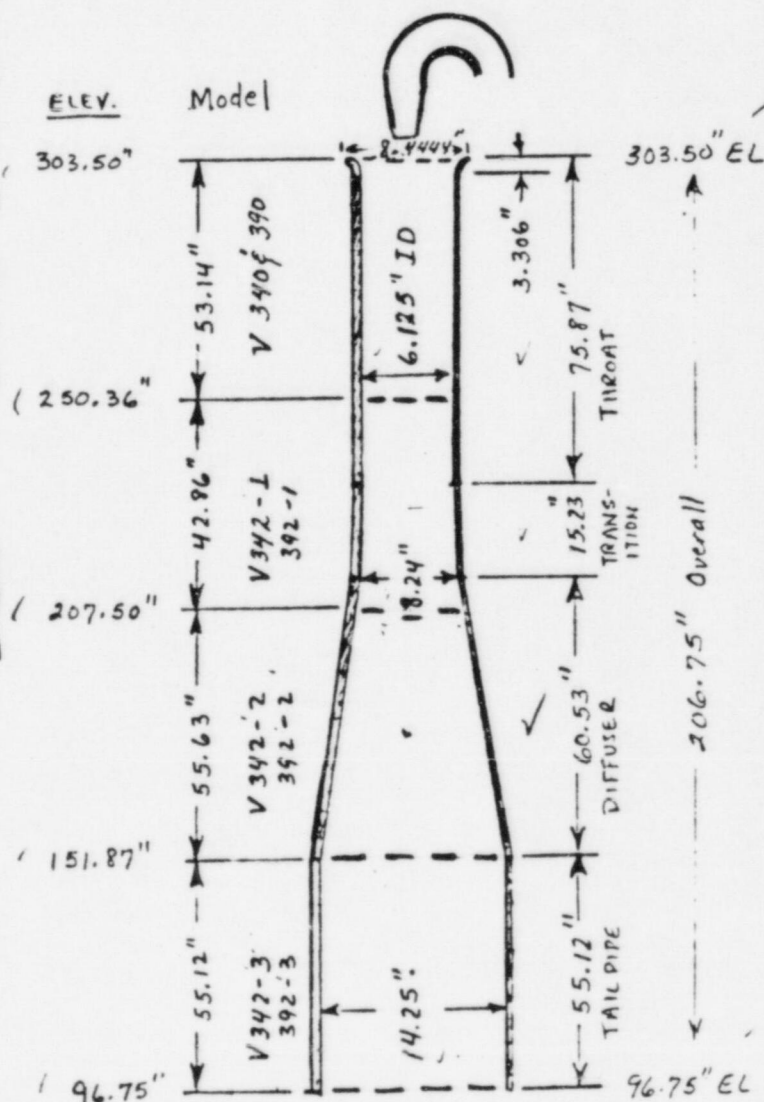
From VYNPS-FSAR,
page 4.3-10, Table 4.3-1

Throat Diameter = 6.125"
Diffuser Exit = 14.25"

From GE Dwg 719-E-113;

ID Suction Inlet = 8.4444"
(scaled dimension),

From Dwg 719-E-113;



5/8/86

RTF

Comparison of EG&G 1/6 Scale Jet Pump to 1 VY Jet Pump

Geometrical Parameters	EG&G Jet Pump	VY Jet Pump	SCALE FACTOR
Drive Nozzle Bend Diameter (D4)	1.196"	6.125"	5.12
Drive Nozzle Exit Diameter (D3)	0.566"	3.11835"	5.51
Equivalent Downcomer Diameter (D5) per Jet Pump	10.126"	24.799"	2.48
Suction Nozzle Lip Diameter (D2)	1.154"	8.4444"	7.32
THROAT DIAMETER AT FRUSTUM Base (D6)	1.3004"	7.0234"	5.40
THROAT DIAMETER (D1)	1.143"	6.125"	5.36
Length Drive Nozzle Convergence (L1)	2.337"	9.4916"	4.06
Length Drive Nozzle Exit to Straight Portion of Throat (Z _{DN} & L _D)	0.622"	3.3852"	5.44
Angle of Frustum Surface (φ) for Suction Area	24.838°	25.869°	1.042
cos(φ)	0.9075	0.8998	0.992
Throat Length (L2)	14.965"	91.10"	6.09
Diffuser Length (L3)	16.844"	60.53"	3.59 ✓
Tailpipe Length (L4)	2.281"	55.12"	24.16 ✓
Tailpipe Diameter (D7)	2.830"	14.25"	5.04

CONCLUSION: Most critical parameters are reasonably scaled ~ 5.47 except L3 & L4

5/8/86

COMPARISON OF JET PUMP LOSS FACTORS

RTF

PARAMETER	VY JET PUMP	EG&G JET PUMP	TLTA JET PUMP
SCALE (ID_{TN})	1/1	1/5.4	1/6.7

POS. DRIVE

FDK1:	K_{AS}	0.04129	0.040	0.0367
FDK2:	K_{DN}	0.1174	0.080	0.0922
FDK3:	$(1-K_{SA})$	0.8733	0.920	0.8877
FDK4:	K_{SA}	0.1268	0.080	0.1123
FDK5:	K_{SH}	0.6400	0.640	0.6430
FDK6:	$\cos \phi$	0.8998	0.9075	0.9300

NEG. DRIVE

RDK1:	K_{TA}	0.9000	0.7964	0.9441
RDK2:	K_{ND}	0.2441	0.1795	0.1900
RDK3:	K_{TN}	1.0000	1.0000	1.0000
RDK4:	K_{AT}	0.4695	0.4940	0.4976
RDK5:	K_{AN}	1.0	1.1	1.1

STEADY STATE MODEL ASSESMENT

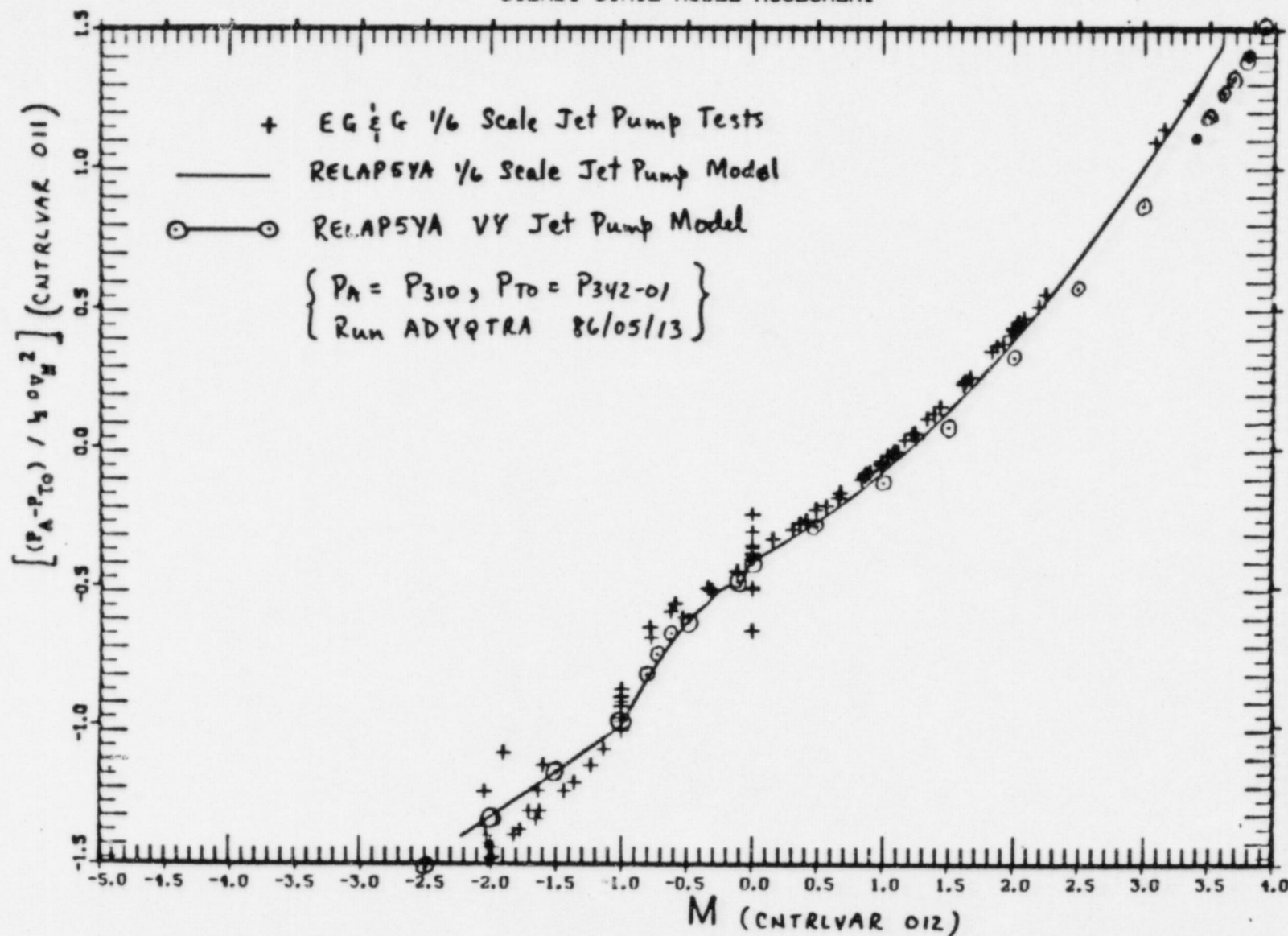


Figure II. 1.1
Positive Drive; Normalized Pressure Difference versus M
(Suction Plenum to Throat)

RTF
5/13/86

STEADY STATE MODEL ASSESMENT

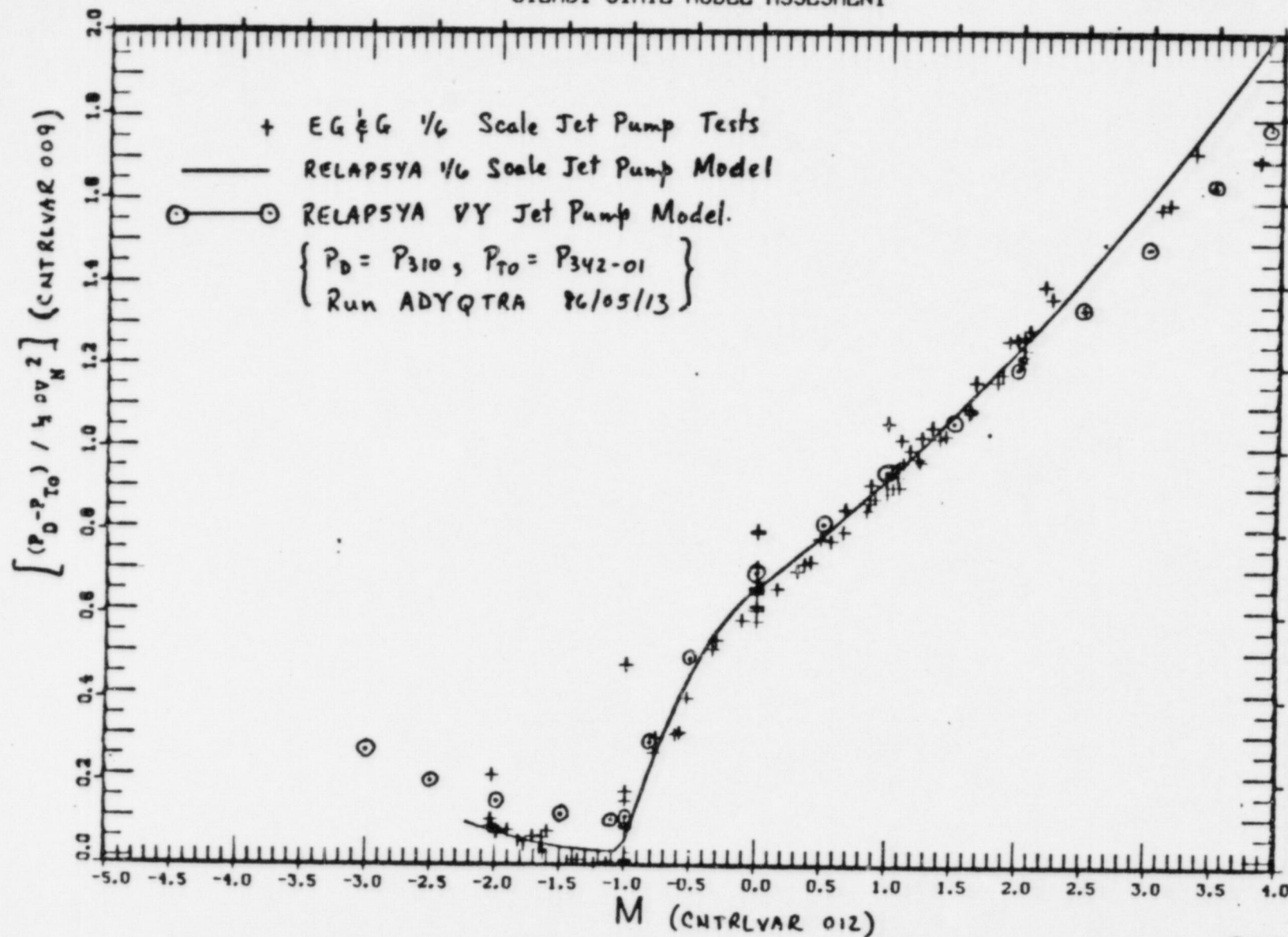


Figure II. 1.2
Positive Drive; Normalized Pressure Difference versus M
(Drive Line to Throat)

RTF
5/13/86

-6-

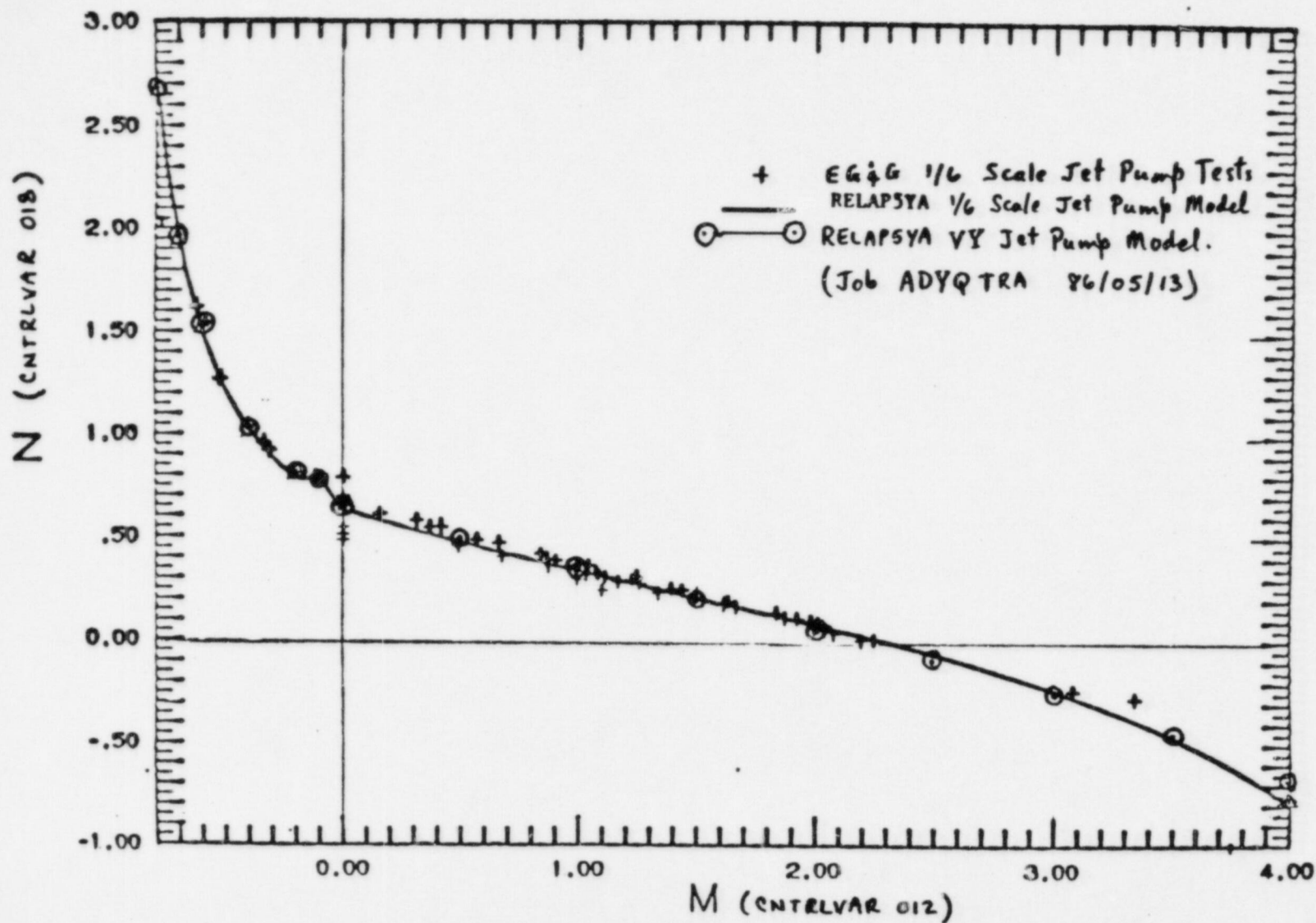


Figure 11-1.3
Positive Drive; N versus M

RTF
5/13/86

STEADY STATE MODEL ASSESMENT

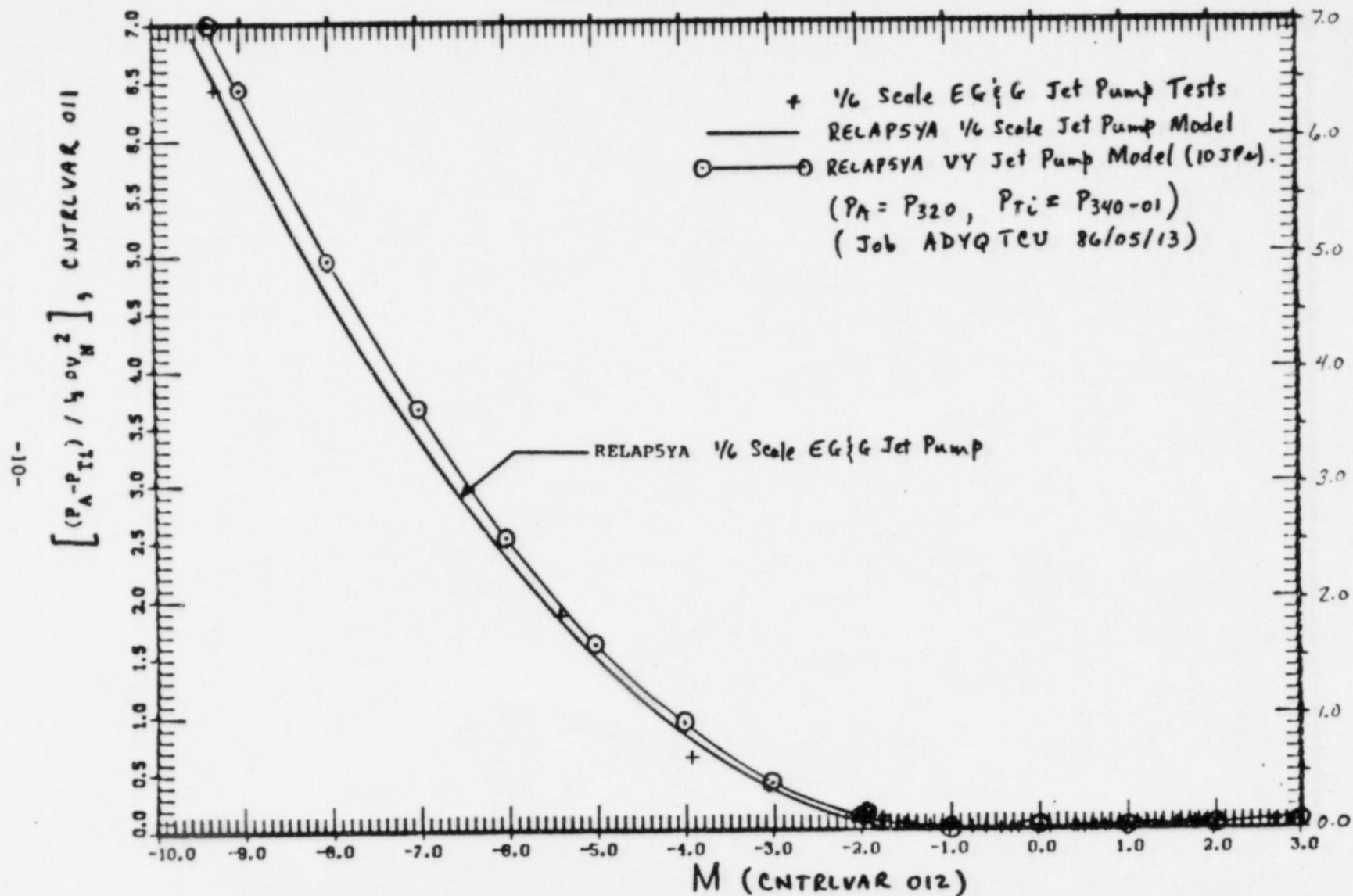


Figure II. 1.4
Negative Drive; Normalized Pressure Difference versus M
(Suction Plenum to Throat)

RTF
5/13/86

STEADY STATE MODEL ASSESSMENT

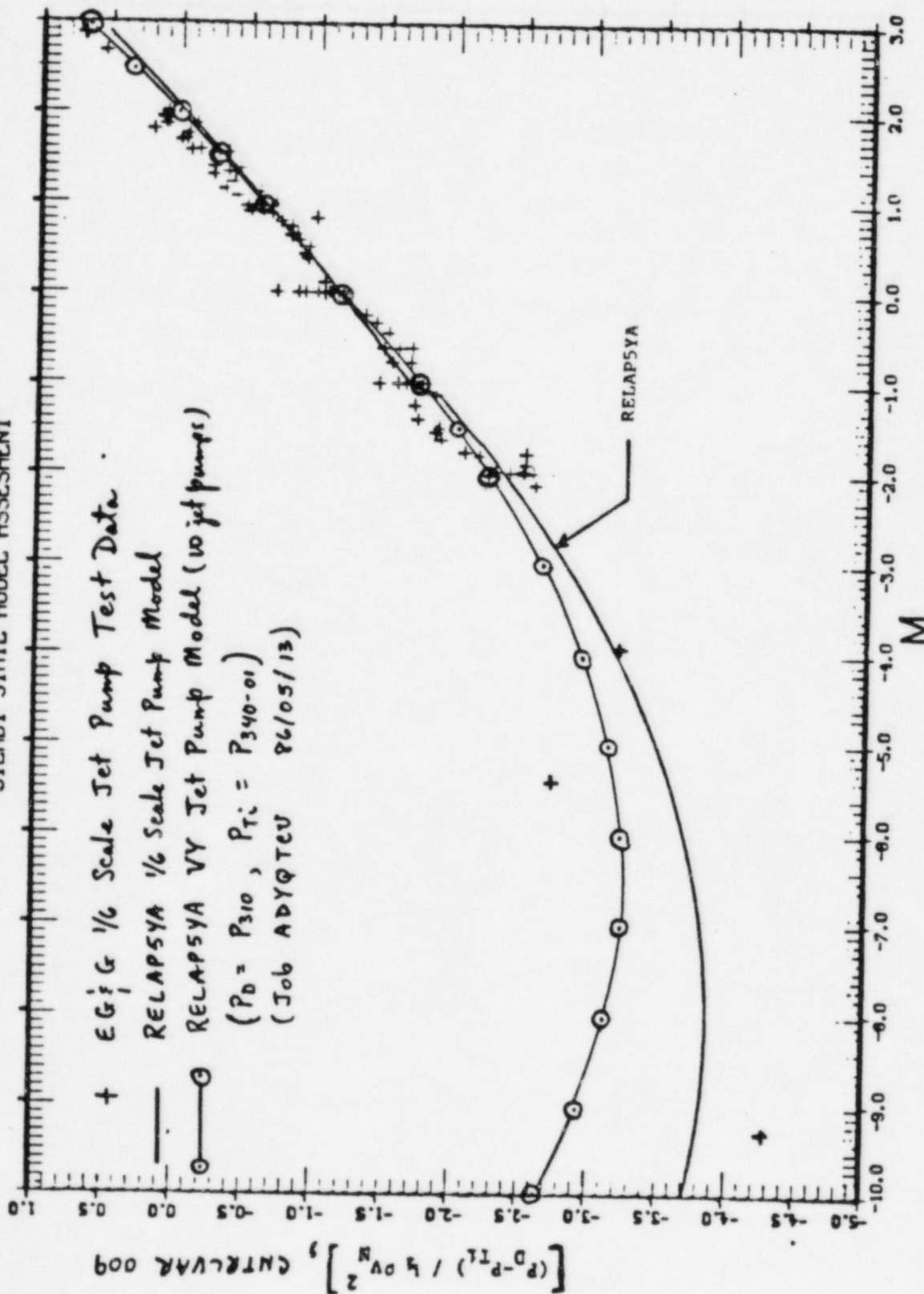


Figure II. 1.5
 Negative Drive; Normalized Pressure Difference versus M
 (Drive Line to Throat)

RTF
 5/13/96

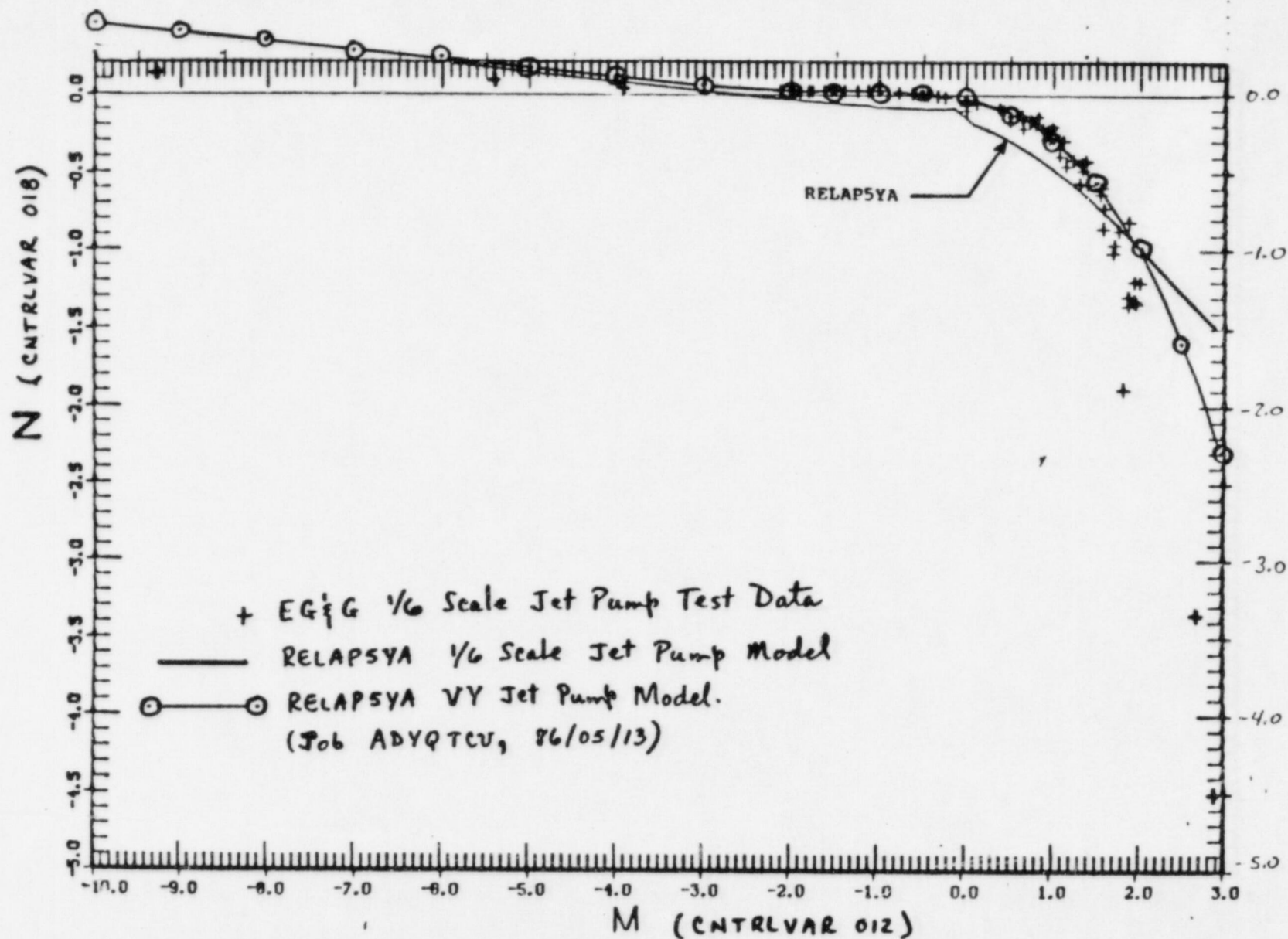


Figure II. 1.6
Negative Drive; N versus M

RTF
5/13/86

UPPER PLENUM

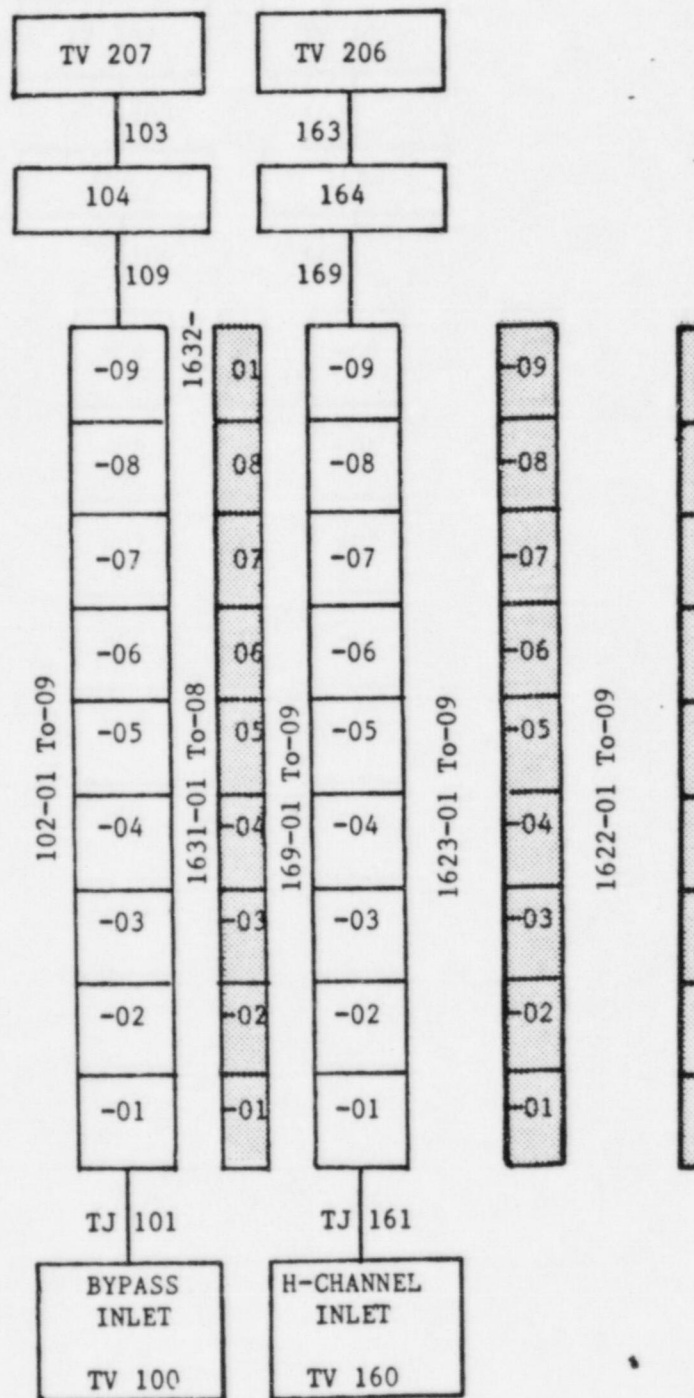


Figure 3.1-1: VY HC Axial Nodalization

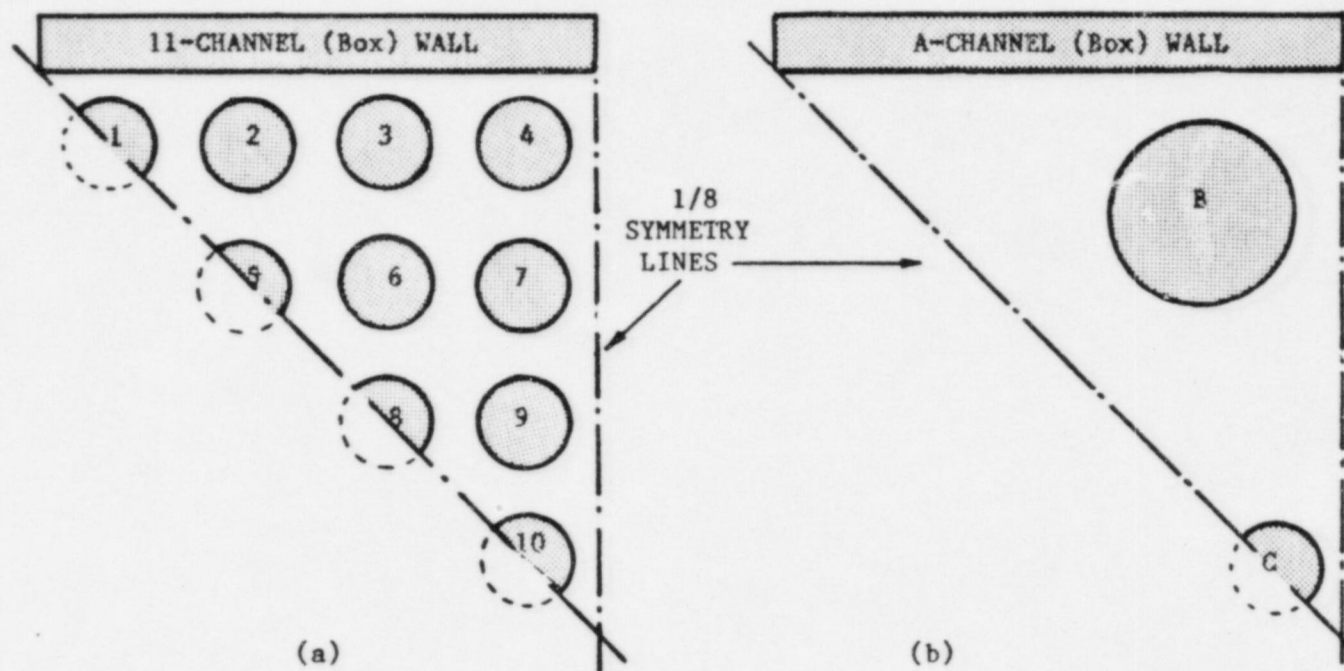


Figure 3.1-2: VY Rod Lay Out: (a) Number and Location of the Rods Represented, and (b) As Modeled

DIFFERENCES BETWEEN VY EM HEAT TRANSFER &
APPENDIX K ACCEPTABLE CORRELATIONS OR VALUES

APPENDIX K
PARAGRAPH

TOPIC

VY - EM

I. C. 4

CRITICAL HEAT FLUX

Modified Biasi - Zuber

I. C. 5

Post - CHF Heat Transfer

- | | |
|--|-------------|
| • Return to Nucleate & TRANS.
Boiling Lockout | • Same |
| • Transition & Film Boiling | • Different |

I. D. 6

CONVECTIVE HEAT TRANSFER
COEFFICIENTS FOR BWR FUEL
RODS under "Spray Cooling"

- | | |
|--|---------------------------------------|
| • $t_{LPF} \rightarrow t_{cs}$: $h = 0.0$ | • RSYA EM Logic |
| • $t > t_{cs}$: $h = 3.0, 2.5, 1.5$ | • RSYA EM H.T. |
| • $t > t_{REFLOOD}$: $h = 25$ | • Rewet/Quench Model
and Trip 695. |

I. D. 7

BWR Channel Box Under
"Spray Cooling"

- | | |
|--|---------------------|
| • $t_{LPF} \rightarrow t_{cs}$: $h = 0.0$ | • No Lockouts |
| • $t_{cs} \rightarrow t_{RIQ}$: $h = 5.0$ | • RIQ outer surface |
| • $t_{RIQ} = 60 \text{ sec} + t_{YAMANOCHI}$ | • RSYA HT Correl. |

JUSTIFICATION OF RELAP5YA CHF MODELS
FOR VY LOCA LICENSING ANALYSIS METHOD

CODE ASSESSMENT

STEADY STATE

- | | |
|---|---|
| <ul style="list-style-type: none">• 5-Columbia
SS CHF Tests• 4- GENERAL ELECTRIC
SS CHF Tests• 3- ORNL THTF
SS Film Boiling Tests | <ul style="list-style-type: none">• Section 3.2, Vol. III, Book II (YAEC-1300P)
Q/A VII. 11, 12, 27, Book III (Responses)• Same as above• Same as above and
Section 5.1.3, Vol. III, Book II
Q/A VII. 13, Book II |
|---|---|

TRANSIENTS

- | | |
|---|--|
| <ul style="list-style-type: none">• ORNL THTF Transient
Film Boiling Test 3.08.6C• ORNL THTF Quasi SS
Boiloff Test 3.09.10I• TLTA LBLOCA (BE)
Test 6425/R2• TLTA LBLOCA (EM)
Test 6425/R2• TLTA LBLOCA (BE)
Test 6426/R1• TLTA BOILOFF (BE)
Test 6441/R6 | <ul style="list-style-type: none">• Section 5.1.4, Vol. III, Book II
Q/A VII. 14, Book III• Section 5.1.5, Vol. III, Book II
Q/A VII 17, 18, Book III• Section 5.2.3.4, Vol. III, Book II
BWR Appendix A.IV.1 Book III• Section 5.2.3.5, Vol. III, Book II• Section 5.2.4, Vol. III, Book II• Section 5.2.6, Vol. III, Book II.
Q/A VII. 27, Book III |
|---|--|

ADDED CONSERVATISMS IN VY LOCA LICENSING MODEL

- 1.02 CORE POWER
- SEVERE CORE AXIAL & RADIAL PEAKING FACTORS
- 1.20 x 1971 ANS DECAY HEAT STANDARD

JUSTIFICATION OF RELAP5YA POST-CHF MODELS
FOR VY LOCA LICENSING ANALYSIS METHOD

CODE ASSESSMENT

REFERENCES IN YAEC SUBMITTALS

- | | |
|--|---|
| • 3- ORNL THTF
SS Film Boiling Tests | • Section 5.1.3, Vol. III, Book II
Q/A VII. 13, Book III |
| • ORNL THTF Transient
Film Boiling Test 3.08.6C | • Section 5.1.4, Vol. III, Book II
Q/A VII. 14, Book III |
| • ORNL THTF Quasi SS
Boiloff Test 3.09.10I | • Section 5.1.5, Vol. III, Book II
Q/A VII. 17, 18 Book III |
| • 2- ORNL THTF Reflood
Tests 3.09.10φ and Q | • Section 5.1.6, Vol. III, Book II
Q/A VII. 19, 20, 21, 22, Book III |
| • TLTA LBLOCA (BE)
Test 6425/R2 | • Section 5.2.3.4, Vol. III, Book II
BWR Q/A Appendix A.IV.1, Book III |
| • TLTA LBLOCA (EM)
Test 6425/R2 | • Section 5.2.3.5, Vol. III, Book II |
| • TLTA LBLOCA (BE)
Test 6426/R1 | • Section 5.2.4, Vol. III, Book II |
| • TLTA Boiloff (BE)
Test 6441/R6 | • Section 5.2.6, Vol. III, Book II
Q/A VII. 27, Book III |
| • LOFT SBLOCA (BE)
Test L3-6/L8-1 | • Section 5.3, Vol. III, Book II
Q/A II. 5, 6, 7, 8 Book III |

ADDED CONSERVATISM IN VY LOCA LICENSING MODEL

- 1.02 CORE POWER
- SEVERE CORE AXIAL & RADIAL PEAKING FACTORS
- 1.20 x 1971 ANS DECAY HEAT STANDARD

RTF HT-3
7/29/86

JUSTIFICATION FOR VY EM HEAT TRANSFER IN
PLACE OF APPENDIX K, I.D.6 and I.D.7 COEFFICIENTS

1. TLTA LBLOCA Tests simulate a BWR LOCA much better than old GE Core Spray Tests (circa 1972, 1973).
TLTA Tests 6425/R2 (Avg. Power, Avg ECC) and 6424/R1 (Peak Power, Avg ECC) show that PCT, Temperature Turnaround and Core Reflooding occur during, not after, the blowdown period. Significant 2ϕ and steam cooling occur in the bundle after Lower Plenum Flashing up to Core Spray Injection Time. PCT occurs shortly after LPCS & LPCI injection begins.
2. RELAP5YA "BE" prediction of Test 6425/R2 bounds the PCT. Thus our "BE" prediction is conservative.
RELAP5YA EM prediction of Test 6425/R2 bounds the PCT with additional margin. Thus the "EM" is more conservative.
3. RELAP5YA "BE" prediction of Test 6426/R1 shows higher PCT and larger $\Delta T = T_{wall} - T_{coolant}$. Thus steam cooling model is conservative.
4. Old GE Core Spray Tests did not simulate:
 - Vapor updraft from lower plenum due to $-dP/dt$
 - Bypass to lower bundle leakage path
 - Bypass cooling of channel box
 - Realistic pressure histories and flow paths
5. RELAP5YA VY LBLOCA predictions are similar to TLTA.
6. VY does not use 7×7 fuel assemblies.

RTF HT-4

7/29/86