AUG 23 1973

DOCKET NOS.: 50-438 AND 50-439

APPLICANT: TENNESSEE VALLEY AUTHORITY (TVA)

FACILITY: BELLEFONTE NUCLEAR PLANT, UNITS 1 & 2

SUMMARY OF MEETING HELD ON AUGUST 3, 1973 TO DISCUSS CONTAINMENT PRESSURE ANALYSIS

On August 3, 1973 representatives of TVA and their NSSS, B&W, met with the Regulatory staff to discuss the containment subcompartment analysis and the mass and energy release models to be used in the Bellefonte containment design. A presentation of the structural margins in the subcompartment design was included. The discussions included areas of interest to the Containment Systems and Structural Engineering Branches.

A list of attendees and detailed agenda are enclosed. In addition, copies of a handout and slides used in the meeting will be placed in the appropriate files.

The TVA-B&W presentation is summarized below:

1. Subcompartment Analysis

The modeling and input associated with the calculation of differential pressures in the reactor building subcompartments were discussed. Three methods of predicting these pressures were compared. These included a Brown Boveri code, BT-129, the contempt-PS code and B&W's CRAFT code. A comparison of the Contempt-PS code with the BT-129 code showed good agreement (within 5 percent) and both codes predicted pressures about 50 percent higher than the CRAFT code. TVA proposes to use pressure predictions of the BT-129 code with a 10 percent margin.

2. Mass and Energy Release Models

The methods and models used in the calculation of the mass and energy release into the containment were presented. Assumptions as to the secondary system performance, the modeling of metal stored heat and CRAFT modeling were discussed. The affect of the steam generator performance on both postulated hot leg and cold leg breaks was described. The calculation

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DATE ▶		

of reactor building pressure assumed a small leak prepressurizing the building to 4 psig followed by the worst large break. The reactor building design pressure (50 psig) is approximately 25% greater than the maximum calculated pressure (about 40 psig).

3. Structural Margin

The allowance in the structural code for a 1.50 factor on subcompartment differential pressure was noted. This safety factor was compared to the staff's requirement for margin in the PSAR design to account for unknowns which might arise at the time of the plant's completion. TVA proposes to use a 10% margin on subcompartment pressures and design to the appropriate code.

4. Staff Comments

The current models used by the staff and our future plans in this area were described. In addition, several areas were identified where additional information would probably be needed for the Bellefonte review. These included nodal meshing in the heat sinks, treatment of the liner/concrete gap, justification of noding in the subcompartment model and a benchmark comparison of CRAFT and CONTEMPT for a simple two node problem.

Don K. Davis, Project Manager
Pressurized Water Reactors Br. No. 4
Directorate of Licensing

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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

AUG 2 3 1973

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ATTENDANCE LIST

Atomic Energy Commission

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Tom Greene
Horst Menzel
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W. Lau
Panos Ioannides

Babcock & Wilcox

D. W. Berger
J. T. Walton
K. C. Shieh
Charles E. Parks
Burt Dunn

---

*Denotes part-time attendance

7/31/73

AGENDA FOR AUGUST 3, 1973 TVA MEETING

A. Objective

B. Subcompartment Analysis

1. Mass and Energy Release

   A. Documentation of Code
   B. Description of Break

2. Containment Codes

   A. BT-129
   B. CONTEMPT-PS
   C. CRAFT

3. Input Preparation

   A. Volume and Flow Path Description
   B. Information Translation and Friction Effects

4. Multinode Results

5. 2-Node Iteration Technique

6. 2-Node Results

7. Conclusion

C. Mass & Energy Release Models

1. Methods used in Calculations

   A. CRAFT Code
   B. PRIT Code

2. Assumptions Made in Analysis

   A. Secondary Side of Steam Generators
   B. Metal Heat
   C. Craft Modeling

3. Steam Generator Performance

   A. Hot leg Breaks
   B. Cold Leg Breaks

4. RB Pressure Calculation

5. Margins (Small leak followed by large break)

D. Structural Margins

E. Conclusions

July 31, 1973

BT 129

"A PROGRAM FOR SOLVING MULTIREGION CONTAINMENT PROBLEMS"

Code Description Written by

Brown Boveri Corporation
Baden, Switzerland

Editing by

Babcock & Wilcox Company
Lynchburg, Virginia U.S.A.

ABSTRACT

Program BT 129 calculates temperature and pressure in a maximum of 15 compartments of a reactor containment or turbine building after a pipe rupture.

Each compartment may be connected to any other compartment by:

(a) One opening that is always open,

(b) One opening that releases instantaneously after a prescribed differential pressure is reached in either direction,

(c) One opening that behaves either as a second "b" opening or as an opening which opens only in one direction after a prescribed differential pressure is reached and which requires time to accelerate. This can be viewed as a disk, or plug, being pushed out of an opening.

In addition, there may be up to two special time-dependent openings, whose effective area increases quadratically with time after a fixed differential pressure is reached in either direction.

The release rate of steam and/or water into an arbitrarily chosen compartment may vary linearly with time over a maximum of 120 time intervals of varying length; specific enthalpy must be constant over each interval.

The first finite forward difference is used to calculate mass flow in and out of each compartment under quasi-stationary adiabatic conditions. Summing these flows and their accompanying enthalpy transfer provides the basis for an iterative energy balance in each compartment. The total energy in each compartment is calculated for successive values of temperature until a temperature is found at which the calculated energy agrees closely enough with the energy within the room.

Air properties are calculated from the ideal gas law; steam and water properties are taken from steam tables. Thermodynamic equilibrium between air, steam and water is assumed at every step.

TABLE OF CONTENTS

1. PURPOSE OF THE PROGRAM

The containment of a nuclear power plant must be designed to withstand the high temperatures and pressures which result from a steam or pressurized water line rupture. A detailed calculation of the conditions during and immediately after such a release can lead to great savings in the cost of the containment by reducing uncertainties in the containment design criteria. This program is suitable for detailed calculations to optimize the lay-out of compartments within the containment as well as for a series of scoping calculations to set gross requirements for the outer shell of the containment.

2. THEORETICAL BASIS

2.1 Program Structure

Functionally, the program is divided into two parts, the initial data preparation and the calculational section.

The initial data preparation, done only once per case, is divided into the following subsections:

1.1 Brings constants and parameters into the program and writes

1.2 Time-dependent release data read and written

1.3 All flows, masses, etc. initialized to zero

1.4 Room and wall data read

1.5 Write initial conditions for each room

1.6 Write wall data

1.7 Initial thermodynamic state calculated in each room

1.8 Write state at time = 0.

1.9 Determination of first time step

The calculational section, which is repeated iteratively for each time step, is divided as follows:

2.1 Calculates all quantities required for the flow calculation

- 2.1.1 Checks for an opening and sets flow direction
- 2.1.2 Choose flow equation, based on critical flow criterion
- 2.1.3 Calculate the size of the opening and write changes
- 2.1.4 Flows are calculated

2.2 Energy and Mass balances

- 2.2.1 Flows in and out of each room are summed
- 2.2.2 Release accounted for
- 2.2.3 Inner loop to determine temperature and state

2.3 Print out of results

Comment cards within the program identify each such subsection and each step within the calculation.

2.2 Mathematical Formulation

2.2.1 Connections between Containment Compartments

The flow area connecting any two compartments I and K in the containment is calculated at each time step. The calculation proceeds in seven steps as follows:

1. Differential pressure is defined as

   DPIK = PT(I) - PT(K)

   where PT(I) = total pressure in compartment I
   PT(K) = total pressure in compartment K

   Note: Manipulations within the program ensure that DPIK is always positive by reversing I and K if necessary.

2. A dummy variable A is initialized to zero.

$$A = 0$$

Each contribution to the effective flow area is added to A in succession.

3. The special time-dependent openings are taken into account as follows. When DPIK first equals or exceeds P1, the opening is considered to start to open half-way through the preceding time interval:

$$TB = TIME - DT/2$$

At later stages,

$$A = A1\ (TIME + DT/2 - TB)^2 / TO1^2$$

until the opening has fully opened. Then,

$$A = A1$$

The second special time dependent opening is calculated in the same manner with P1 replaced by P2, TO1 by TO2, and A1, by A2.

4. The always-open area is added:

$$A = A + AOA\ (I,K)$$

5. If DPIK equals or exceeds DP1, the differential pressure set for the instantaneous opening, then the area of the opening is added:

$$A = A + AI\ (I,K)$$

6. If DPIK equals or exceeds DP2, the differential pressure at which the accelerated opening begins to open, the area is enlarged as follows:

(a) If TDSK (I,K) equals zero, the opening is a second instantaneous rupture:

$$A = A + AACC\ (I,K)$$

(b) Otherwise, the opening is one for which speed and accelaration must be found to find its position:

$$ACC = 9.81\ (DPIK-WD(I,K))/WD(I,K)$$

$$SPD\ (I,K) = SPD\ (I,K) + ACC \times DT$$

$$PDSK(I,K) = PDSK(I,K) + SPD\ (I,K) \times DT + ACC \times DT^2/2$$

The accelerated opening is considered to be a disk of thickness TDSK (I,K). If PDSK(I,K) exceeds TDSK(I,K), it has begun to open and the cylindrical area:

$$(PDSK(I,K)-TDSK(I,K)) \quad \sqrt{4\pi\ AACC(I,K)}$$

is calculated. If this area exceeds AACC (I,K), then:

$$A = A + AACC\ (I,K)$$

otherwise:

$$A = A + (PDSK(I,K)-TDSK(I,K)) \sqrt{4\pi\ AACC(I,K)}$$

7. The newly-calculated opening A is compared with A(I,K), the opening calculated and stored at the previous step, If A is larger, it replaces A (I,K) and if the time interval is to be printed a message indicating I, K, the area and time of the last written interval and the area (A) and time (TIME) of the present interval is printed.

2.2.2 Mass Transfer Rates Between Compartments

The total mass flow from compartment I to compartment K is calculated according to the following equations:

When the flow is subsonic,

$$FT(I,K) = A(I,K)\sqrt{\left[\frac{k(I)}{k(I)-1}\right]\left[\left(\frac{1}{Pr}\right)^{\frac{2}{k(I)}} - \left(\frac{1}{Pr}\right)^{\frac{k(I)+1}{k(I)}}\right]\left[2 \times P(I) \times g \times \rho(I)\right]}$$

When the flow is sonic,

$$FT(I,K) = A(I,K)\sqrt{\left[\frac{k(I)}{k(I)+1}\right]\left[\frac{2}{k(I)+1}\right]^{\frac{2}{k(I)-1}}\left[2 \times P(I) \times g \times \rho(I)\right]}$$

In both cases the pressure ratio, Pr, is defined as

$$Pr = \frac{P(I)}{P(K)}$$

Subsonic flow occurs when

$$Pr < \left[\frac{2}{k(I)+1}\right]^{\frac{k(I)}{1-k(I)}}$$

The density, $\rho(I)$, and specific heat ratio, $k(I)$, used in the above equations are determined from

$$\rho(I) = \frac{MA(I) + MS(I) + [F \times MW(I)]}{V(I)}$$

and

$$k(I) = \frac{[CPA(I) \times MA(I)] + [CPS(I) \times MS(I)] + [F \times CPW(I) \times MW(I)]}{[CVA(I) \times MA(I)] + [CVS(I) \times MS(I)] + [F \times CVW(I) \times MW(I)]}$$

The actual flow rates for the air, steam, and water are

$$FA(I,K) = FT(I,K) \left[\frac{MA(I)}{MA(I) + MS(I) + [F \times MW(I)]} \right]$$

$$FS(I,K) = FT(I,K) \left[\frac{MS(I)}{MA(I) + MS(I) + [F \times MW(I)]} \right]$$

$$FW(I,K) = FT(I,K) \left[\frac{F \times MW(I)}{MA(I) + MS(I) + [F \times MW(I)]} \right]$$

2.2.3 <u>Mass and Energy Balance</u>

At the end of each time-step, the following variables are stored for each compartment I:

MA(I), MS(I), MW(I), EA(I), ES(I), EW(I), UA(I), US(I), UW(I), TNEW(I), HANEW(I), HSNEW(I), HWNEW(I), and PNEW(I).

They are updated as follows:

$$MA(I) = MA(I) - \sum_k DT \times FA(I,K)$$

$$EA(I) = EA(I) - \sum_k DT \times HANEW(I) \times FA(I,K)$$

$$MS(I) = MS(I) - \sum_k DT \times FS(I,K)$$

$$ES(I) = ES(I) - \sum_k DT \times HSNEW(I) \times FS(I,K)$$

$$MW(I) = MW(I) - \sum_k DT \times FW(I,K)$$

$$EW(I) = EW(I) - \sum_k HWNEW(I) \times FW(I,K)$$

The letter E is used for energies in the flow integration process, the letter U in the iteration process for finding the correct temperature to a given total energy.

The release is taken into account if I = Rupture i.e., if I denotes the room where the rupture occured.

The energy balance, repeated separately for each compartment, begins by summing the total energy in the compartment:

$$ESUM = EA(I) + ES(I) + EW(I) + EREL$$

$EREL \neq 0$ only if I = Rupture

Given MA(I), MS(I) and MW(I) the total internal energy ETOT in the room is calculated for various temperatures TNEW(I) until

$$\frac{ETOT - ESUM}{ESUM} \leq 0.005$$

The starting temperature is TEMP(I), the temperature in the compartment at the end of the previous step. The second is TEMP(I) incremented by $\pm$ 2^{o}C or a fraction $1/2^{n}$ of it.

2.2.4 Mass and Energy Release

The release room may be freely chosen and the release of steam and water may be specified as a series of linear functions over a maximum of 120 intervals. These intervals can be freely chosen and do not depend on the time step DT. A time interval is specified by giving:

L = interval index

WM1(L) = initial water release rate

WM2(L) = terminal water release rate

WE(L) = water specific enthalphy

T(L) = time at the beginning of the interval

Within the interval, the release rate varies linearly with time from WM1(L) tp WM2(L): the specific enthalpy remains constant at WE(L). Thus, the total steam mass and enthalpy releases up to the beginning of interval L are:

$$SMT(L) = \sum_{I=1}^{L-1} WM1(I) \left[T(I+1) - T(I)\right] + \sum_{I=1}^{L-1} \frac{1}{2} \left[WM2(I) - WM1(I)\right] \left[T(I+1) - T(I)\right]$$

$$SET(L) = \sum_{I=1}^{L-1} WE(I) \left[SMT(I+1) - SMT(I)\right]$$

To avoid problems arising from numerical integration, the integrated releases are calculated analytically at each time step and compared with the total release up to that point. The difference is then released into the release room. At time TIME in interval L, the integrated steam release is:

$$SMTI = SMT(L) + \left[TIME - T(L)\right] WM1(L) + \frac{1}{2}\left[\frac{WM2(L) - WM1(L)}{T(L+1) - T(L)}\right]\left[TIME - T(L)\right]^2$$

$$EREL = SET(L) + WE(L)\left[SMTI - SMT(L)\right]$$

2.2.4 Size of time step

The program reduces automatically the input time step so that no mass changes larger than 2% in any room can occur.

2.3 References

1. "Dynamische Belastung einges Containments bei einem schweren Reaktorunfall" H.G. Seipel ATKE 11-62 (367-372) 1966
2. "Differenzdrücke zwischen den Räumen eines Sicherheitsbehälters nach einem Primärkreisbruch" H.G. Seipel und D. Meinhardt ATKE 13-68 (401-407) 1968
3. "Einführung in die Technische Thermodynamik" E. Schmidt Springer-Verlag 1960 (BBC Bibliothek HS 7647.5)

4. "Berechnung der Differenzdrücke zwischen einzelnen Räumen eines Containments nach einem Primärkreis-Rohrleitungsbruch"
J. Cicic

3. ACCURACY AND CALCULATION TIME

The program uses single precision for all variables.

Calculation time depends very strongly on the complexity of the problem and the number of inner iterations required to find the time step and temperature. Test cases which were typical of more detailed calculations required about 600 sec. For a given type of problem, calculation time should be proportional to the number of time steps; it should increase at least as quickly as the number of compartments, but not as quickly as the number of connections.

4. PROGRAM OUTPUT DESCRIPTION

4.1 Verification of Input Data

At the beginning of each case, all input variables are written with a German language identification and with their units.

4.2 Results

At each print-out, the time and the title of the case are indicated. The temperature and the pressure masses and energies of air, steam and water as well as the relative humidity and density of the gas phase are given for each compartment. The integrated releases and the check sums (total masses of air, steam, water and their sum) are also printed.

Finally, the flow conditions for each opening are written in kg/s of steam , air and water with the maximum speed which was achieved by the mixture in the print interval. At the end of the calculation, the program prints the maximum differential pressure between every combination of two rooms and the time at which this pressure occured.

4.3 MESSAGES

4.3.1 Error Messages

When an error condition is encountered, the calculation stops, a message is written and the program attempts to start the following case. The message indicates the nature of the error, the point at which it occured, the variable which caused difficulty and its value. Using the code "ENDE" on the last title or remark card ensures that the job will not be terminated because of an attempt to read alphabetical characters on a numerical format and that succeeding cases do not get out of phase. Error messages at the input stage occur when:

1. IMAX exceeds 15,
2. More than 120 releases intervals are given,
3. A room index I or K is negative,
4. The sum AOA(I,K) + AI(I,K) + AACC(I,K) is negative.

4.3.2 Terminal messages

Any error messages originating the steam table program are beyond the control of the program and can cause the job to be terminated without attempting further cases.

5. Definition of TERMS

A = Dummy variable used to sum effective flow areas

A(I,K) = Total effective area between compartments I and K

AACC(I,K) = Effective area of accelerated opening between compartment I and K

ACC = Acceleration of the disk plug at any point for an accelerated opening

AI(I,K) = Area of instantaneous opening between compartments I and K

AOA(I,K) = Area of always open opening between compartments I and K

A1 = Fully opened area of 1st time dependent opening

A2 = Fully opened area of 2nd time dependent opening

CPA(I) = Constant pressure specific heat of air in compartment I

CPS(I) = Constant pressure specific heat of steam in compartment I

CPW(I) = Constant pressure specific heat of water in compartment I

CVA(I) = Constant volume specific heat of air in compartment I

CVS(I) = Constant volume specific heat of steam in compartment I

CVW(I) = Constant volume specific heat of water in compartment I

DPIK = Differential pressure between compartments I and K

DP1 = Differential pressure for which the instantaneous opening opens

DP2 = Differential pressure for which the accelerated opening begins to open

DT = Program time step

EA(I) = Energy of air in compartment I calculated by flow integration process

EREL = Energy released into compartment from rupture

ES(I) = Energy of steam in compartment I calculated by flow integration process

WSUM = Total energy in a compartment found by flow integration process

ETOT = Total energy in a compartment found by iteration process

EW(I) = Energy of water in compartment I calculated by flow integration process

F = Water carry-over parameter

FA (I,K) = Flow rate of air from compartment I to K

FS(I,K) = flow rate of steam from compartment I to K

FT(I,K) = Total flow rate from compartment I to K

FW(I,K) = Flow rate of water from compartment I to K g = Gravitational constant

HANEW(I) = Enthalpy of air in room I

HSNEW(I) = Enthalpy of steam in room I

HWNEW(I) = Enthalpy of water in room I

IMAX = Maximum number of compartments, i.e., 15

k(I) = ratio of specific heats in compartment I

L = Interval index

MA(I) = Mass of air in compartment I

MS(I) = Mass of steam in compartment I

MW(I) = Mass of water in compartment I

P(I) = Pressure in compartment I

PDSK(I,K) = Position of disk plug in accelerated opening between compartments I and K

PNEW(I) = Pressure in room I-found by iteration process

Pr = Pressure ratio

PT(I) Total pressure in compartment I

P1 = Differential pressure for which 1st time dependent opening begins to open

P2 = Differential pressure for which 2nd time dependent opening begins to open.

Rupture = Integer, compartment number where energy release occurs.

SET(L) = Total energy released from rupture to time L

SMTI = Integral steam mass released from rupture

SMT(L) = Total steam mass released up to TIME L

SPD = Speed of disk plug at any point in accelerated opening

TB = Problem time at which a time dependent opening begins to open

TDSK(I,K) = Thickness of disk plug in accelerating opening , i.e. distance through which the disk has to move before the opening begins to open

T(L) = Time at beginning of interval L

TIME = Problem time at point of reference in program

TO1 = Time required for 1st time dependent opening to open

TO2 = Time required for 2nd time dependent opening to open

TNEW(I) = Temperature in room I - found by iteration process

UA(I) = Energy of air in compartment I calculated from iteration process

US(I) = Energy of steam in compartment I calculated from iteration process

UW(I) = Energy of water in compartment I calculated from iteration process

V(I) = volume of compartment I

WD(I,K) = Weight per unit area of disk plug in the accelerating opening between compartments I and K

WE(L) = Water specific enthalpy in interval L

WM1(L) = Initial water release rate in interval L

WM2(L) = Final water release rate in interval L

ρ (I) = Density in compartment I

BLOWDOWN ANALYSIS NODING DIAGRAM

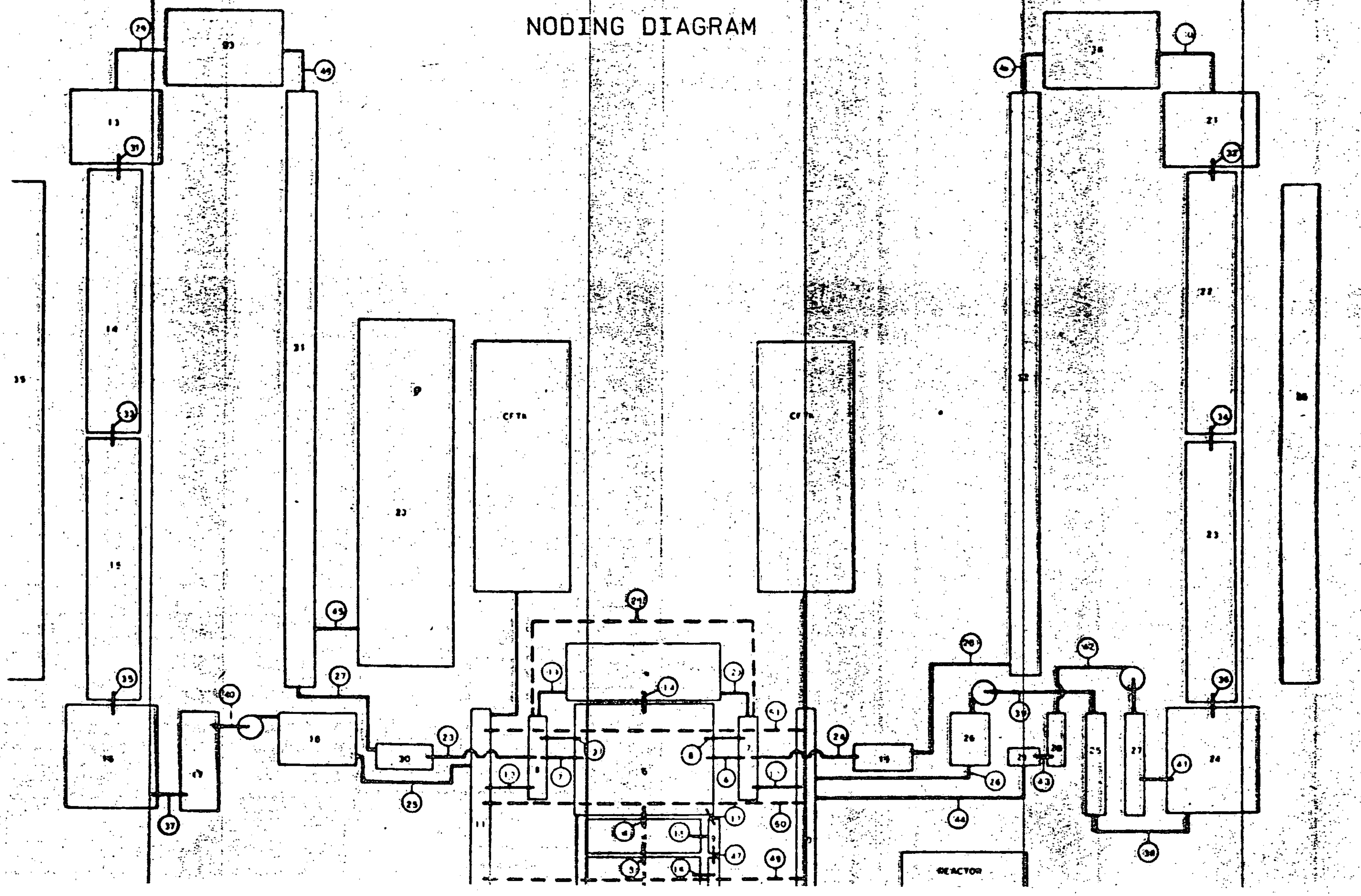
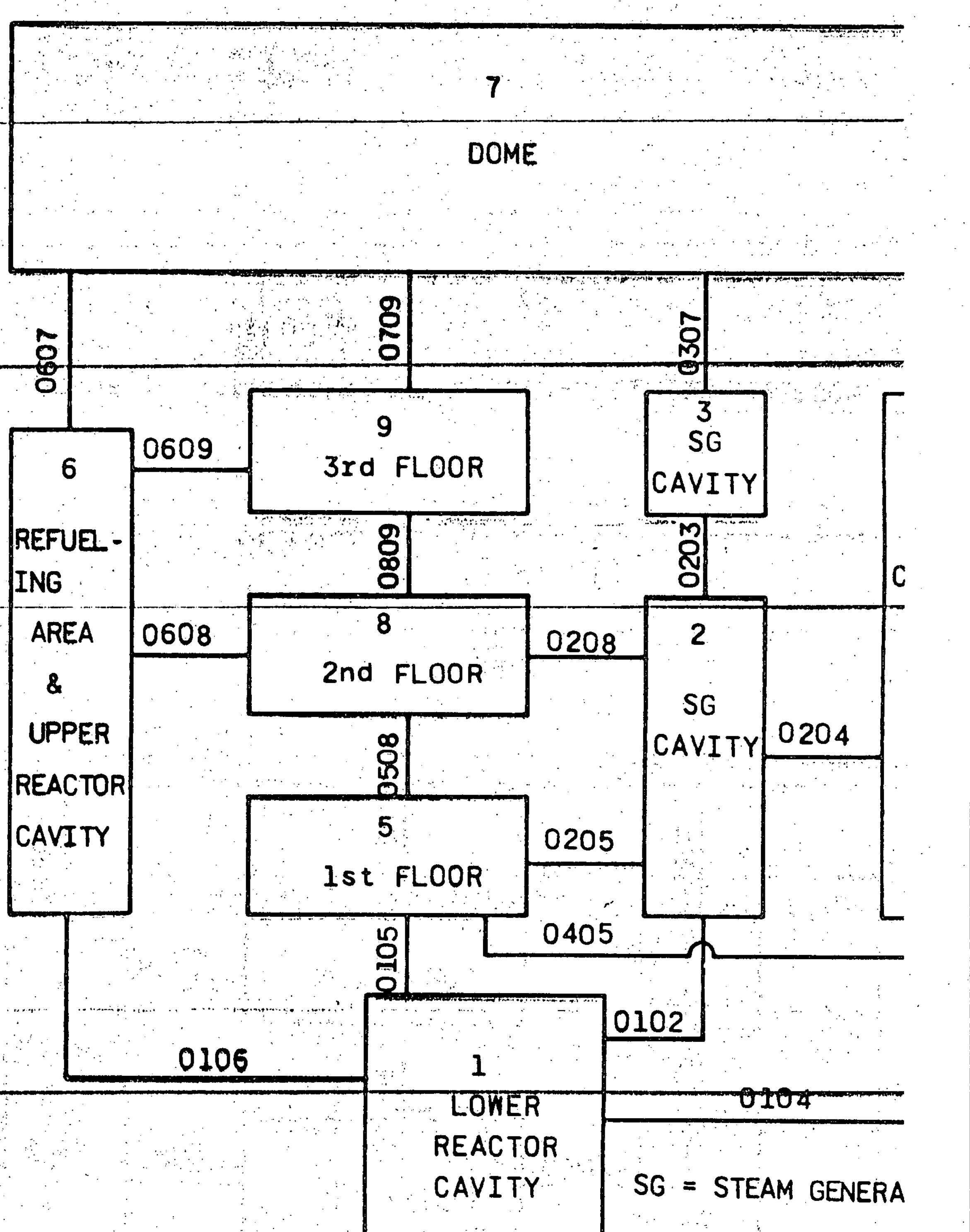


FIGURE 1   SCHEMATIC OF REACTOR BUILDING SUBCOMPA



GENERATION OF RESISTANCE FACTORS

SHOCK LOSS: $k = 1/2 / C_D$

THEREFORE IF $C_D = .6$ $K = 2.777 \cong 2.8$

FRICTION LOSS: EVALUATED ON JUDGEMENT

FROM $k = fl/D$

WITH $f = .028$

FOR PATH 0105 $k_{fr} = .21$

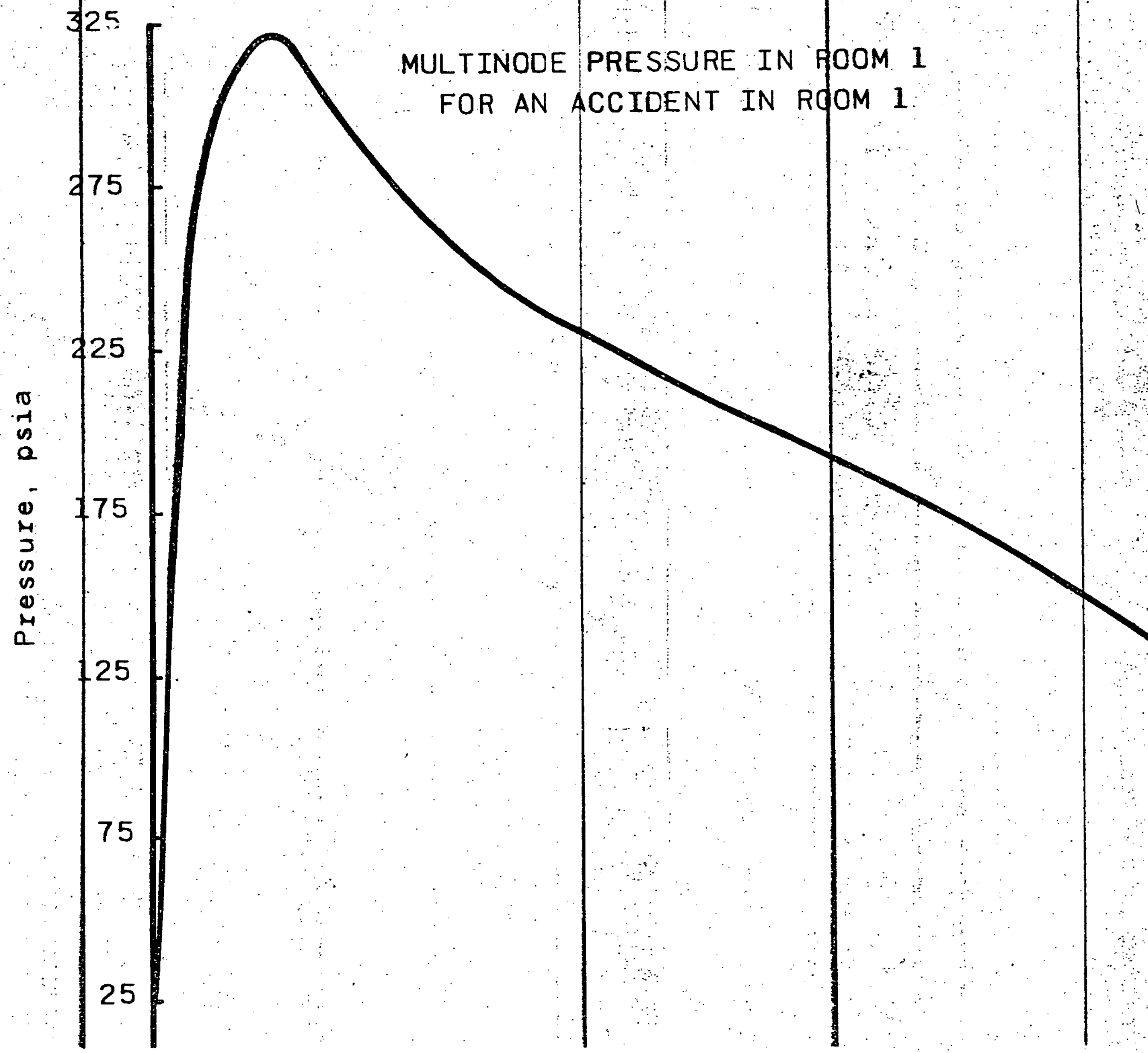
BEND LOSS: EVALUATED USING B&W STANDARDS FOR PATH 0105 $k_B = .84$

TOTAL $k = \Sigma ki$ FOR 0105 $k_T = 3.85$

C_D FOR MULTINODE CODE = .51

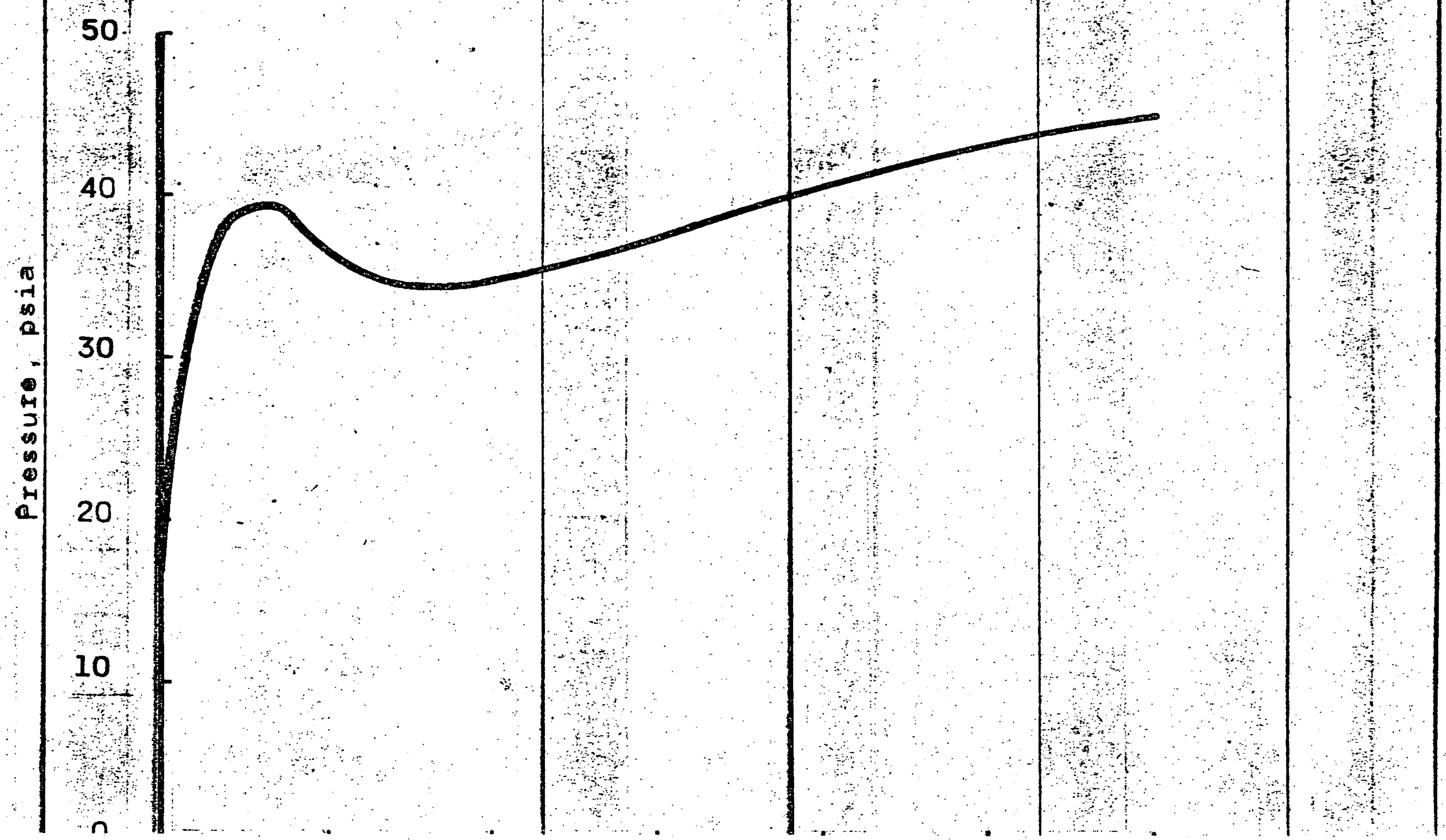
k FOR 2-NODE CODE = 3.85

$$3.85 = \frac{1}{(.51)^2}$$

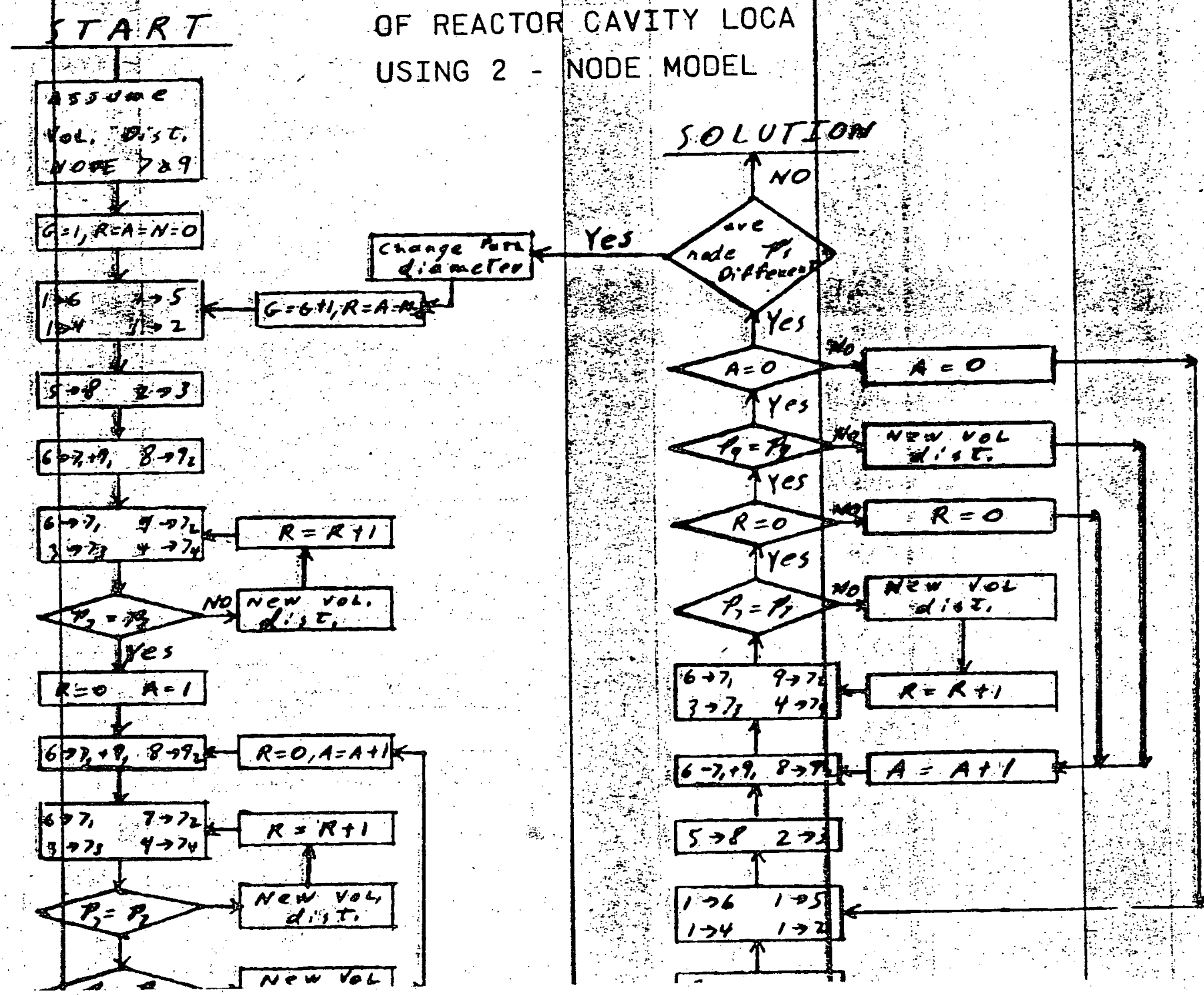


MULTINODE PRESSURE IN ROOM 1
FOR AN ACCIDENT IN ROOM 1
Pressure, psia
325
275
225
175
125
75
25

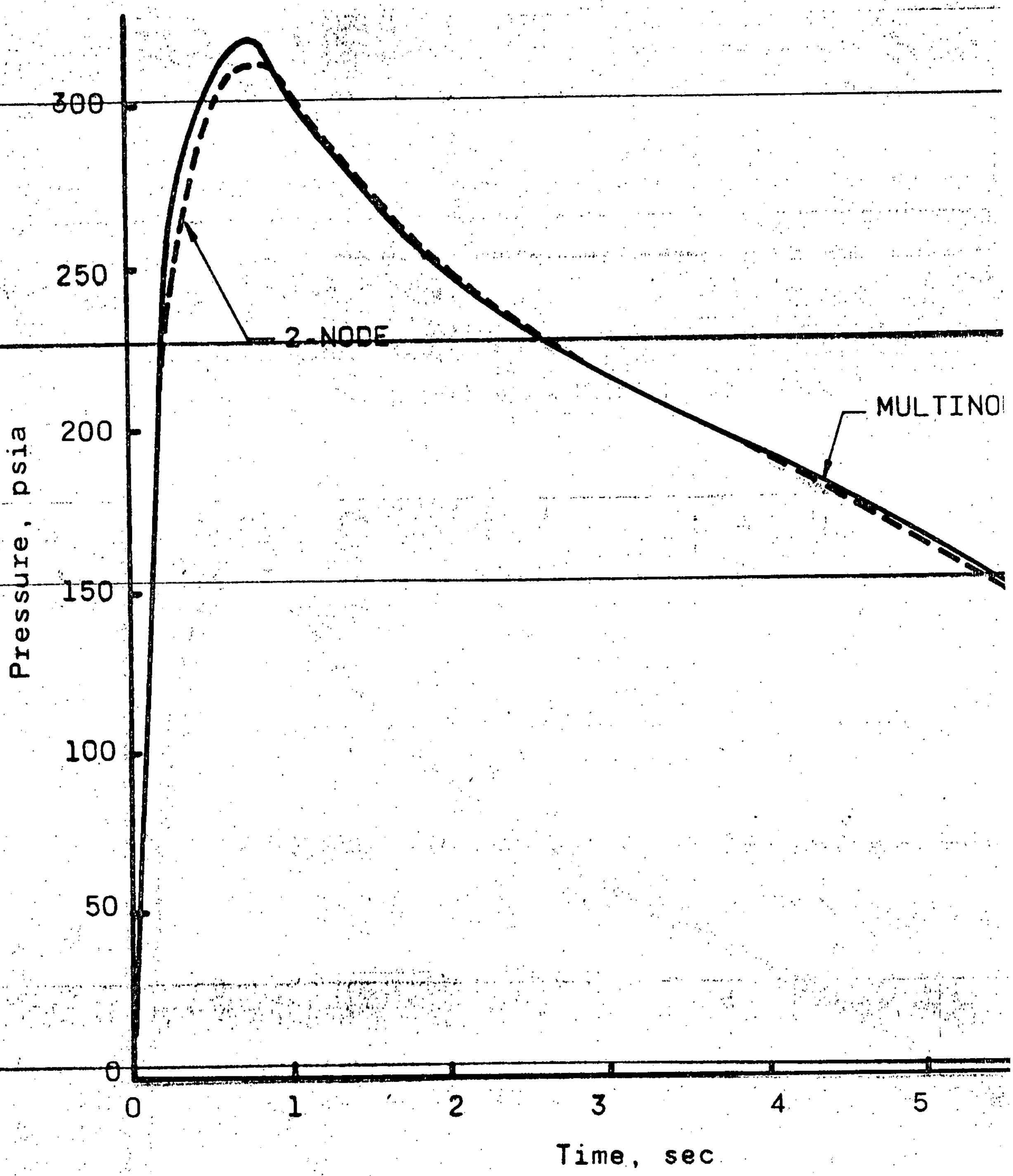
MULTINODE PRESSURE IN ROOM 2
FOR AN ACCIDENT IN ROOM 2



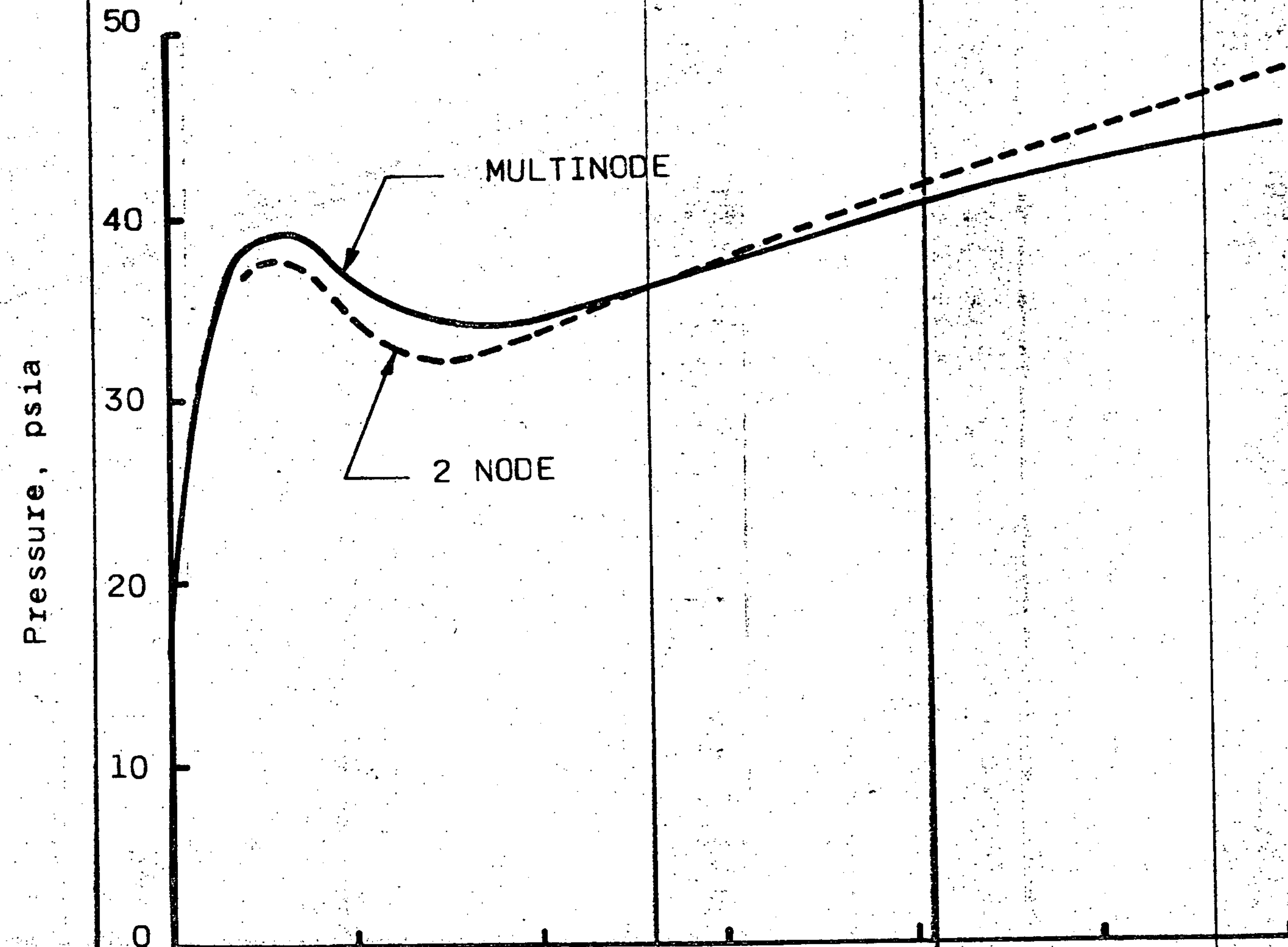
FLOW CHART FOR ANALYSIS OF REACTOR CAVITY LOCA USING 2 - NODE MODEL

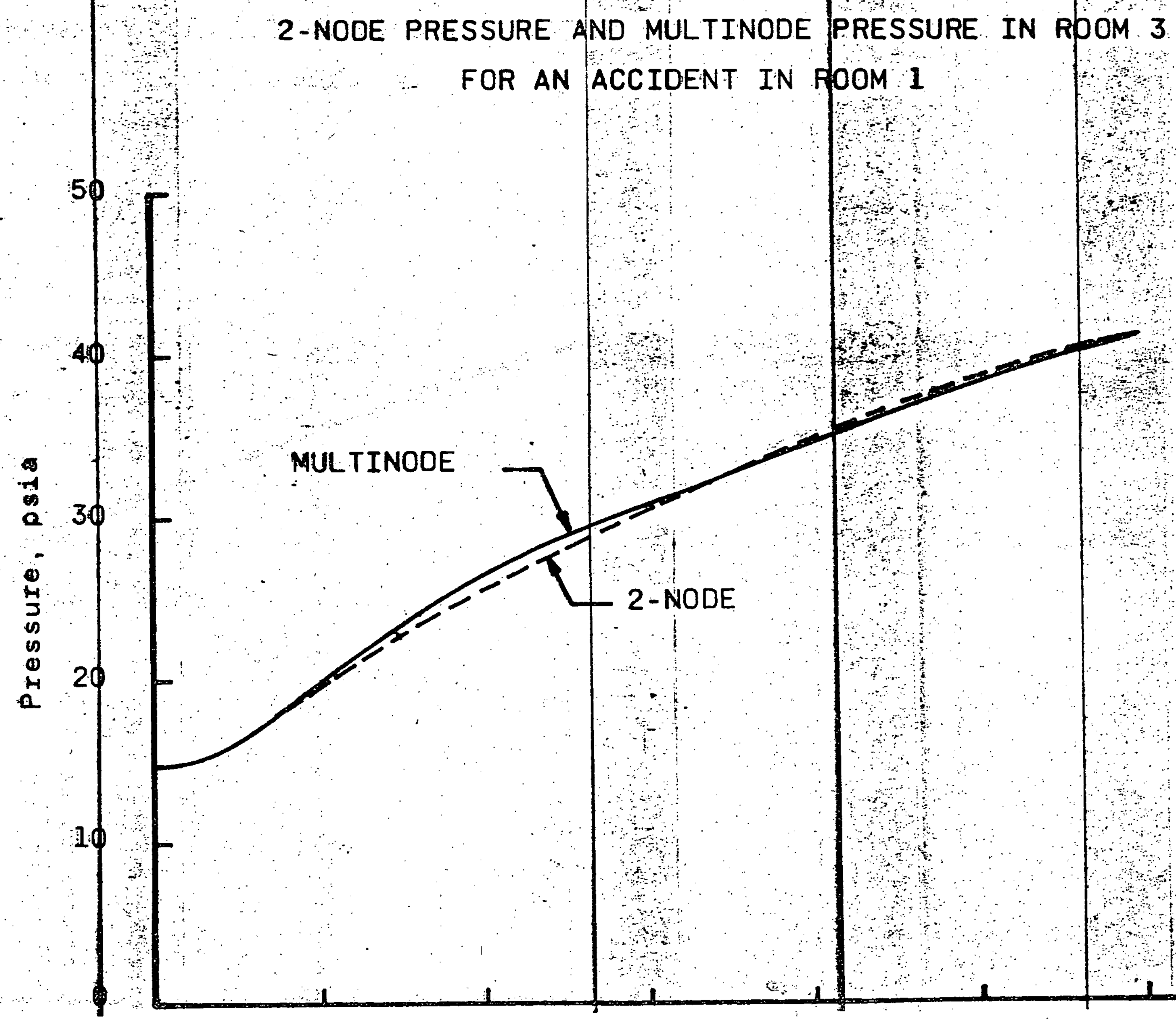


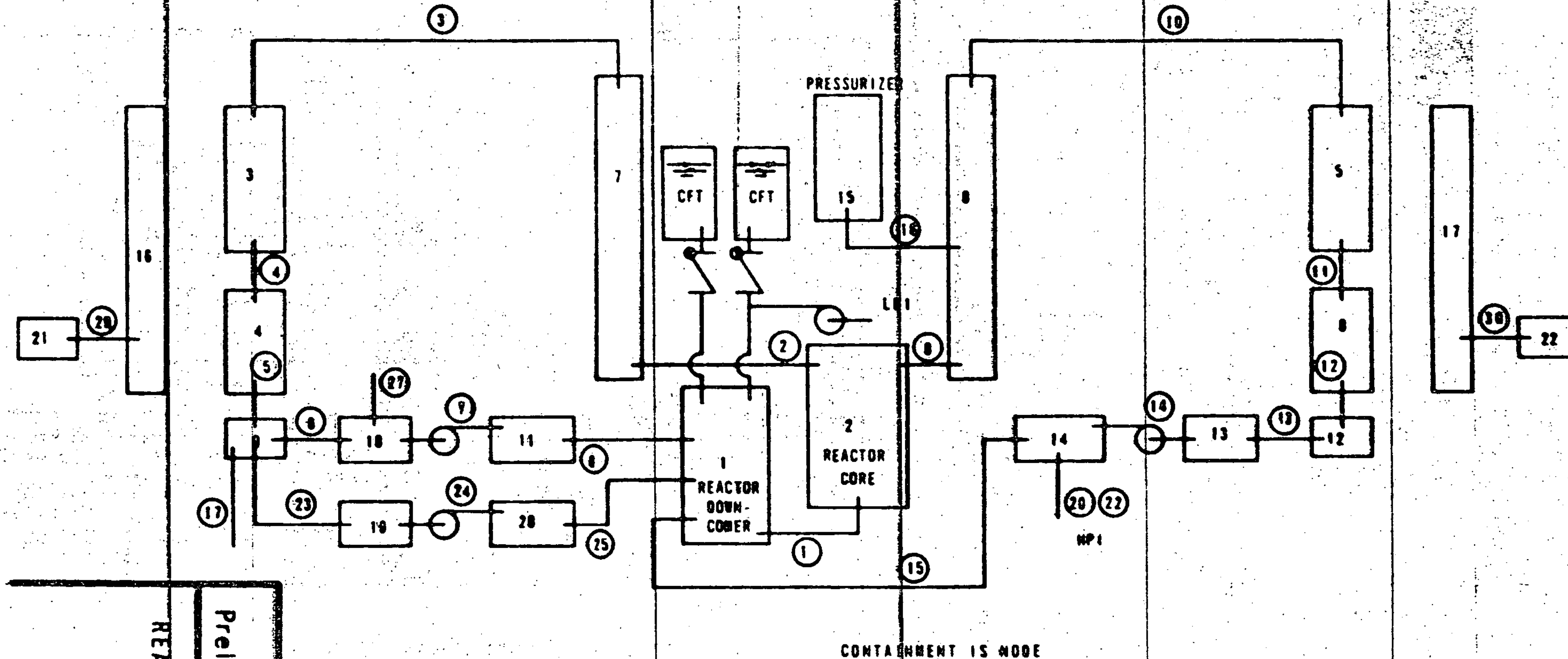
2 NODE PRESSURE AND MULTINODE PRESSURE IN ROOM 1 FOR AN ACCIDENT IN ROOM 1



2 NODE PRESSURE AND MULTINODE PRESSURE IN ROOM 2 FOR AN ACCIDENT IN ROOM 2




2-NODE PRESSURE AND MULTINODE PRESSURE IN ROOM 3
FOR AN ACCIDENT IN ROOM 1
Pressure, psia
50
40
30
20
10
0
MULTINODE
2-NODE



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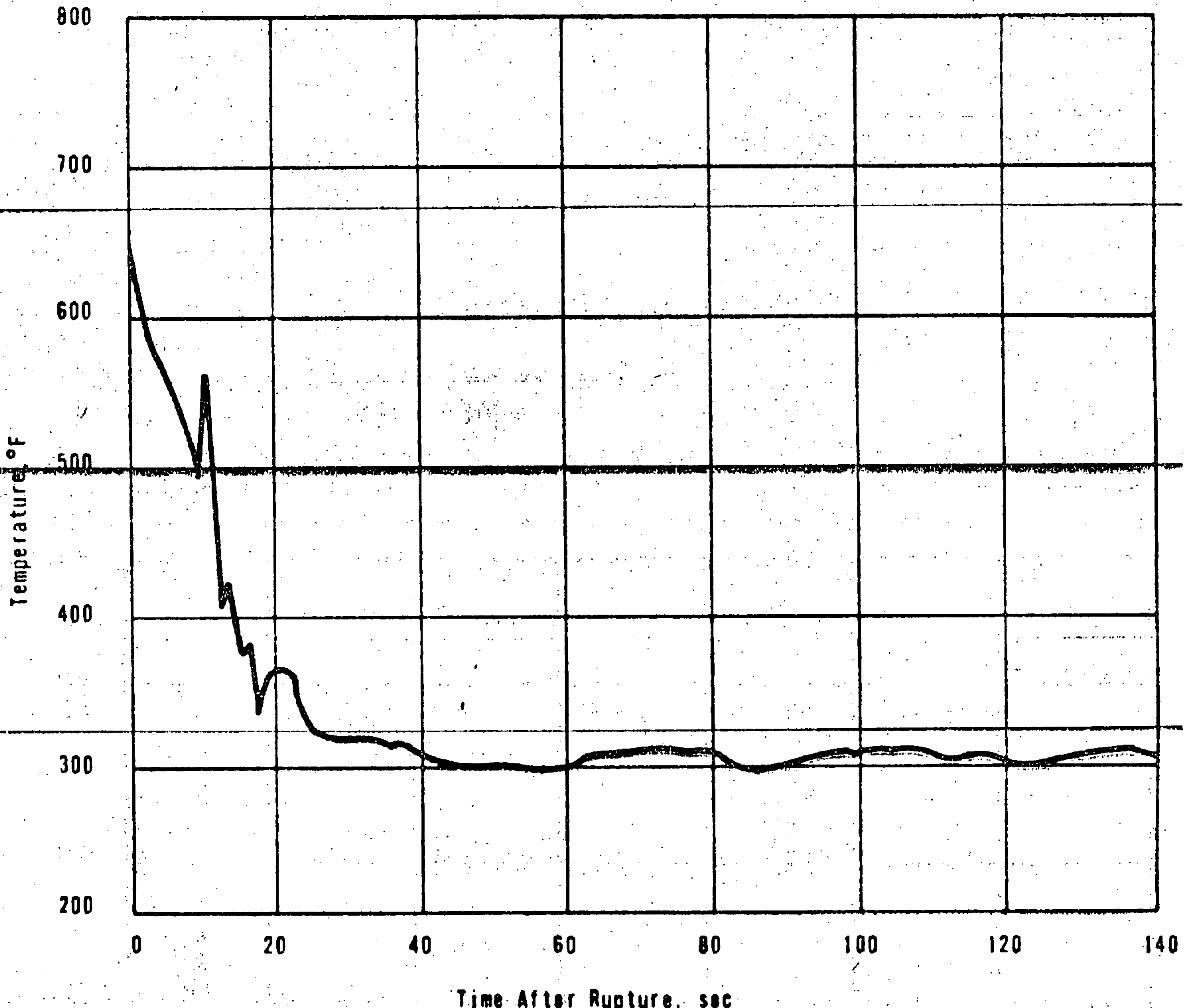
REACTOR BUILDING PRESSURE
NODE DIAGRAM
FIGURE 6.2-1A
ADDED BY AMMENDMENT 1.

Table 6.2-2. Chronology of Events for the Design Basis Loss-of-Coolant Accident (15.75 ft^2)

Event	Time, s
Accident	0.0
Core flood tank injection starts	9.0
End of blowdown	24.0
Maximum reactor building pressure	22.0
High and low pressure injection starts	27.0
Emergency fan coolers start	31.0
Depletion of core flood tanks	68.0
Building sprays start	81.0
Depletion of borated water storage tank	3,480
Recirculation starts	3,480



~~CLAD TEMPERATURE VS TIME FOR~~
15.17 FT^2, HOT LEG SPLIT

Figure Q6.5-1

Table 6.2-1. (Cont'd)

X. Additional Information (cont'd)

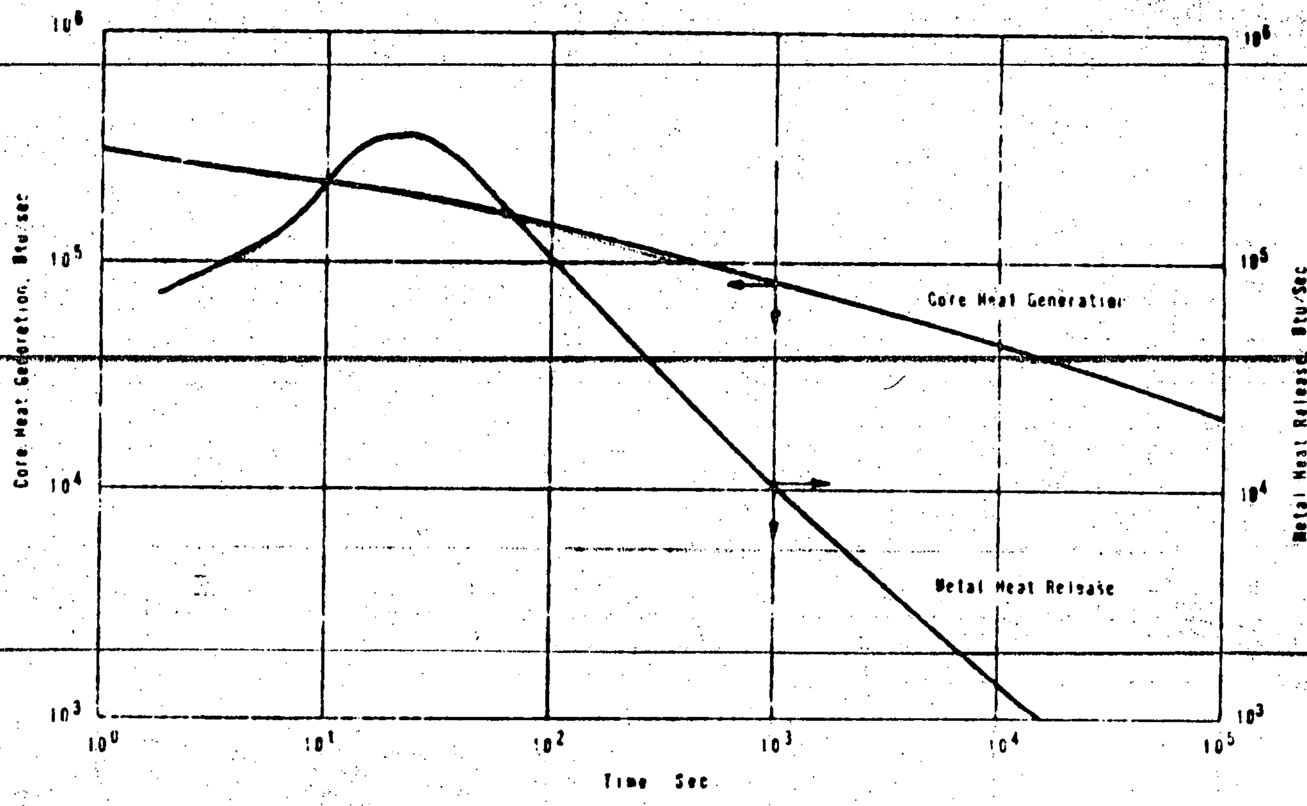
B. Primary Metal Heat vs Time, 15.75 ft^2 HLB

Time, s	Primary metal heat, Btu × 10^{-6}
0	0
50	16.8619
100	27.1394
150	33.6054
200	38.9059
250	43.3589
300	47.1369
350	51.7409
400	55.5431
450	58.9556
500	62.7397
560	64.0663
680	65.7008
800	67.0915
920	68.3972
1,040	69.5062
1,220	71.0219
1,460	72.5993
1,700	74.580
2,900	81.372
4,100	86.083
6,500	92.570
11,300	100.597
18,500	109.341
25,700	116.510
32,900	122.545
58,100	129.229
86,900	136.089
109,500	141.253
720,500	148.740

C. See Figure 6.2-13.

D. Heat Removal Capability of the Reactor Building Spray System (See paragraph 6.2.2.1.1)

E. Heat Removal Capacity (per Fan) for the Reactor Building Steam-Air Mixture (Rate = 203.61T - 19,343 Btu/s)



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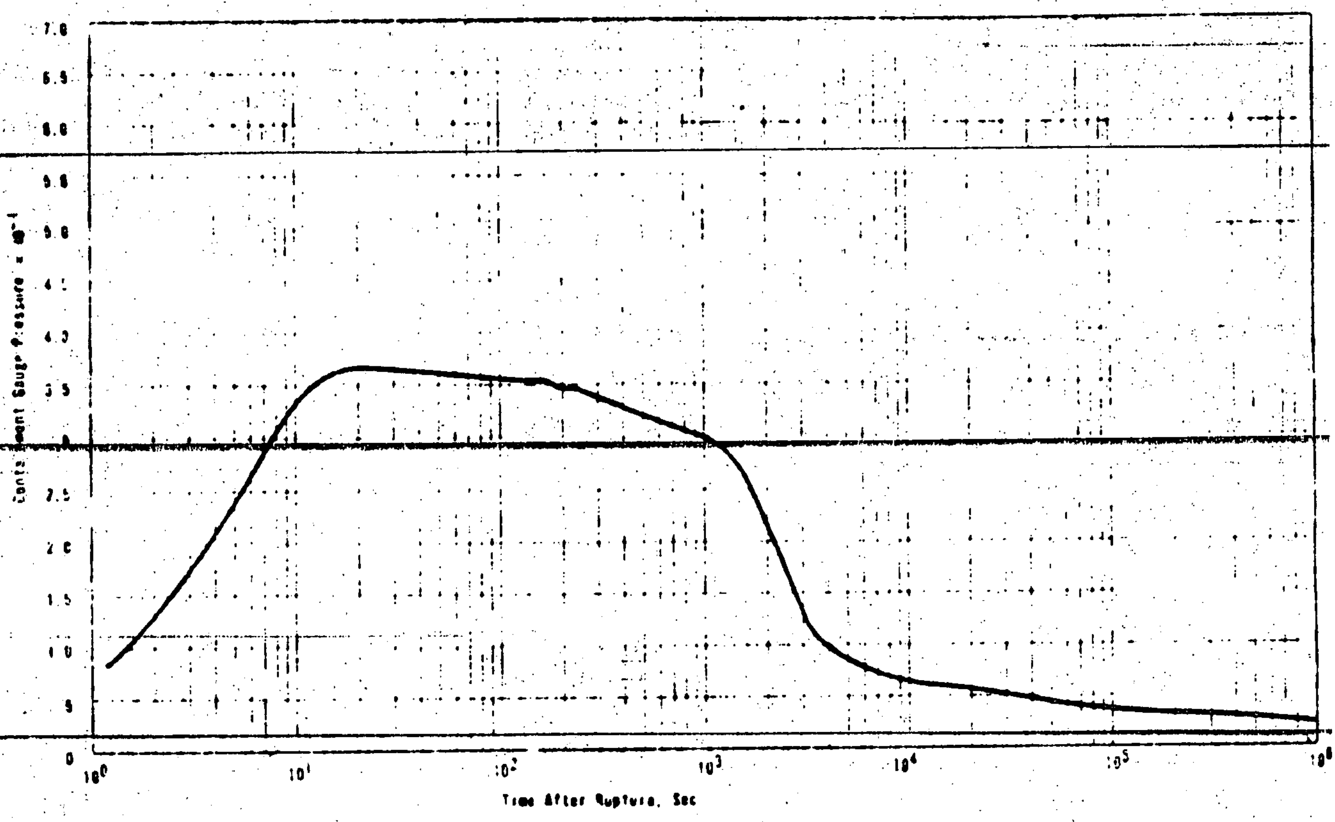
CORE HEAT GENERATION AND
METAL HEAT RELEASE VS TIME

FIGURE 6.2-4



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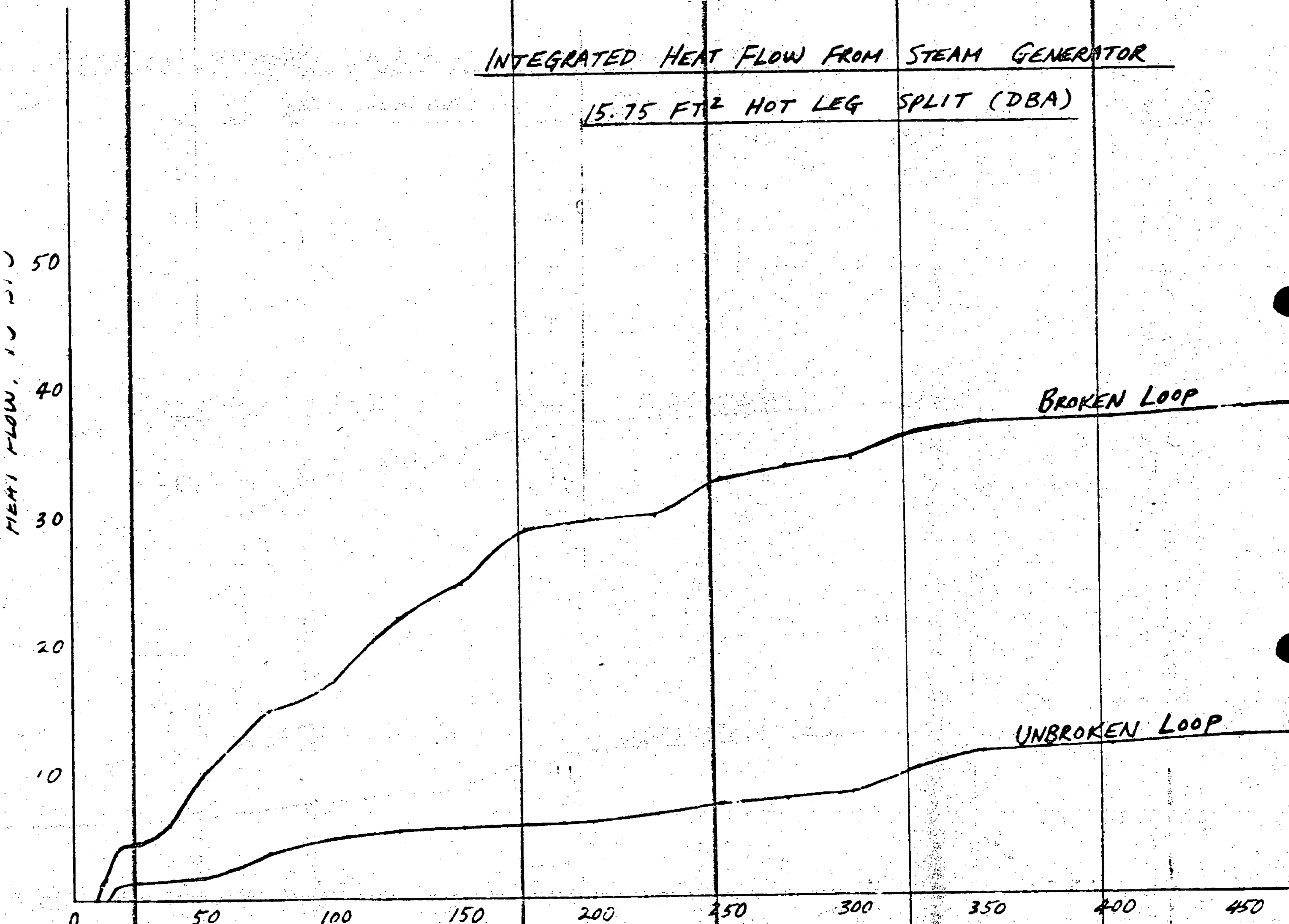
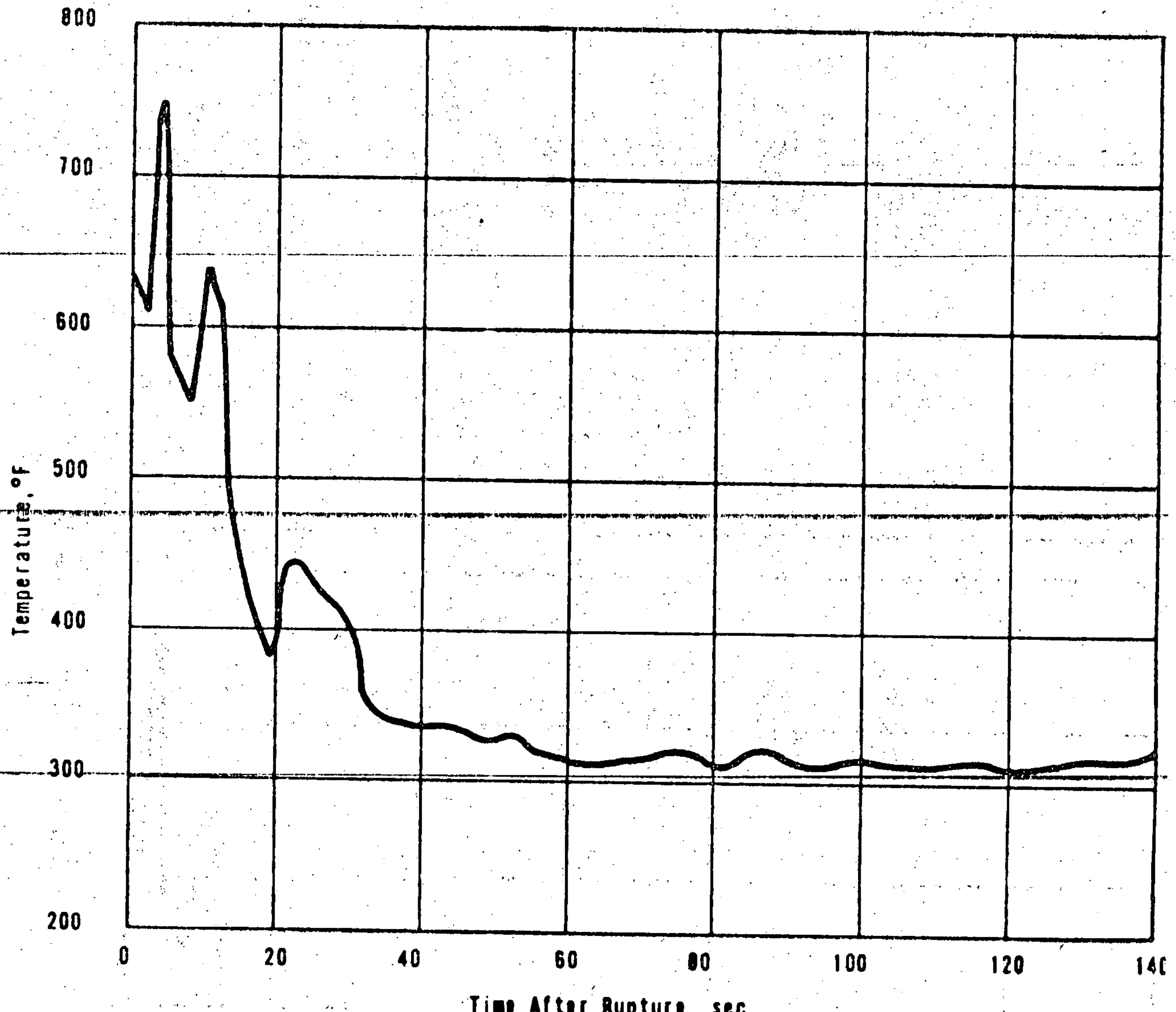
CONTAINMENT PRESSURE VS TIME (15.75 FT^2 BREAK)

FIGURE 6.2-2

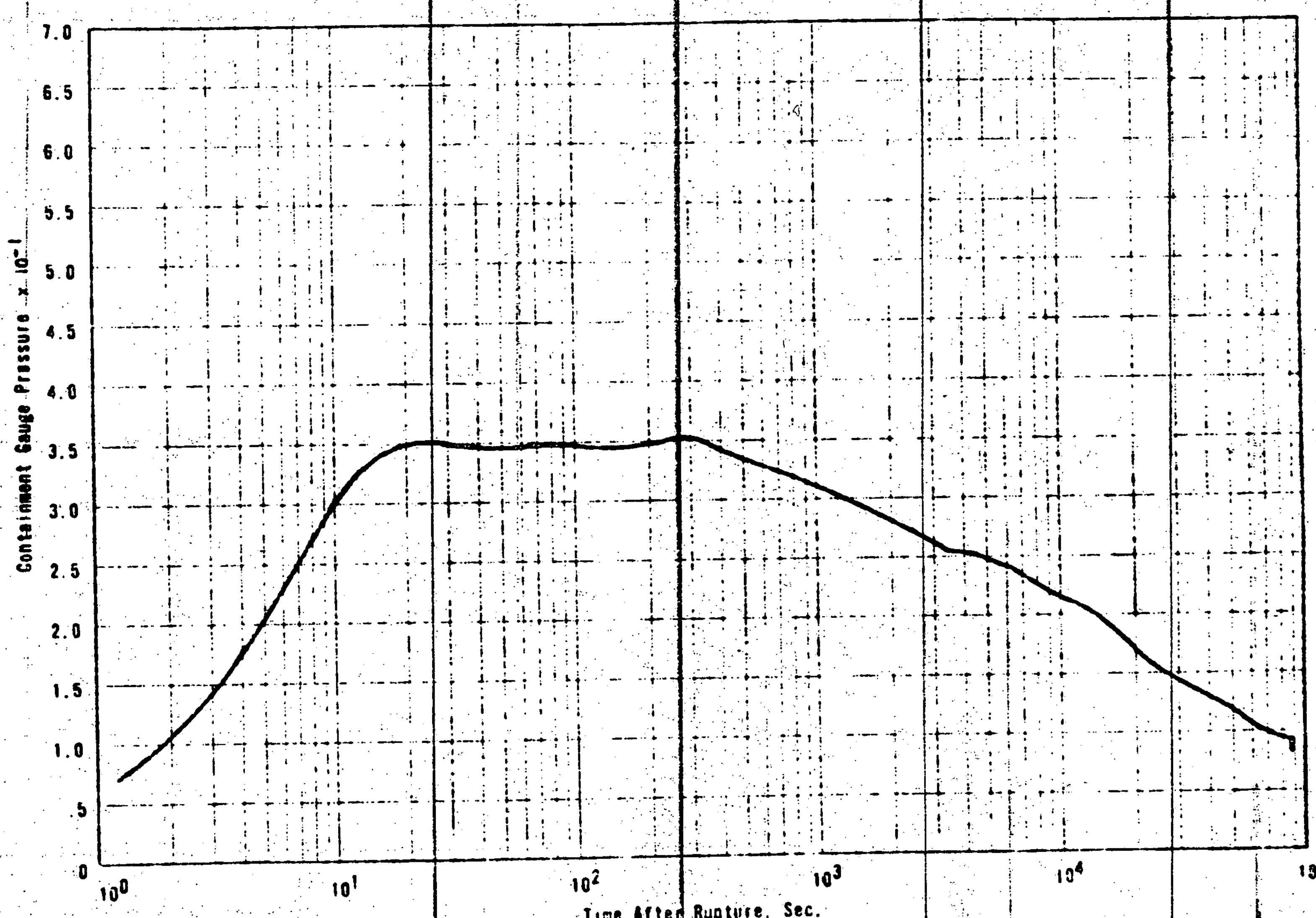

INTEGRATED HEAT FLOW FROM STEAM GENERATOR
15.75 FT^2 HOT LEG SPLIT (DBA)
BROKEN LOOP
UNBROKEN LOOP
50
40
30
20
10
0
50
100
150
200
250
300
350
400
450



CLAD TEMPERATURE VS TIME FOR 11.17 FT^2
DOUBLE-ENDED AT PUMP SUCTION

Figure Q6.5-2

ADDED BY AMMENDMENT 1,



REACTOR BUILDING PRESSURE VERSUS TIME

[illegible]

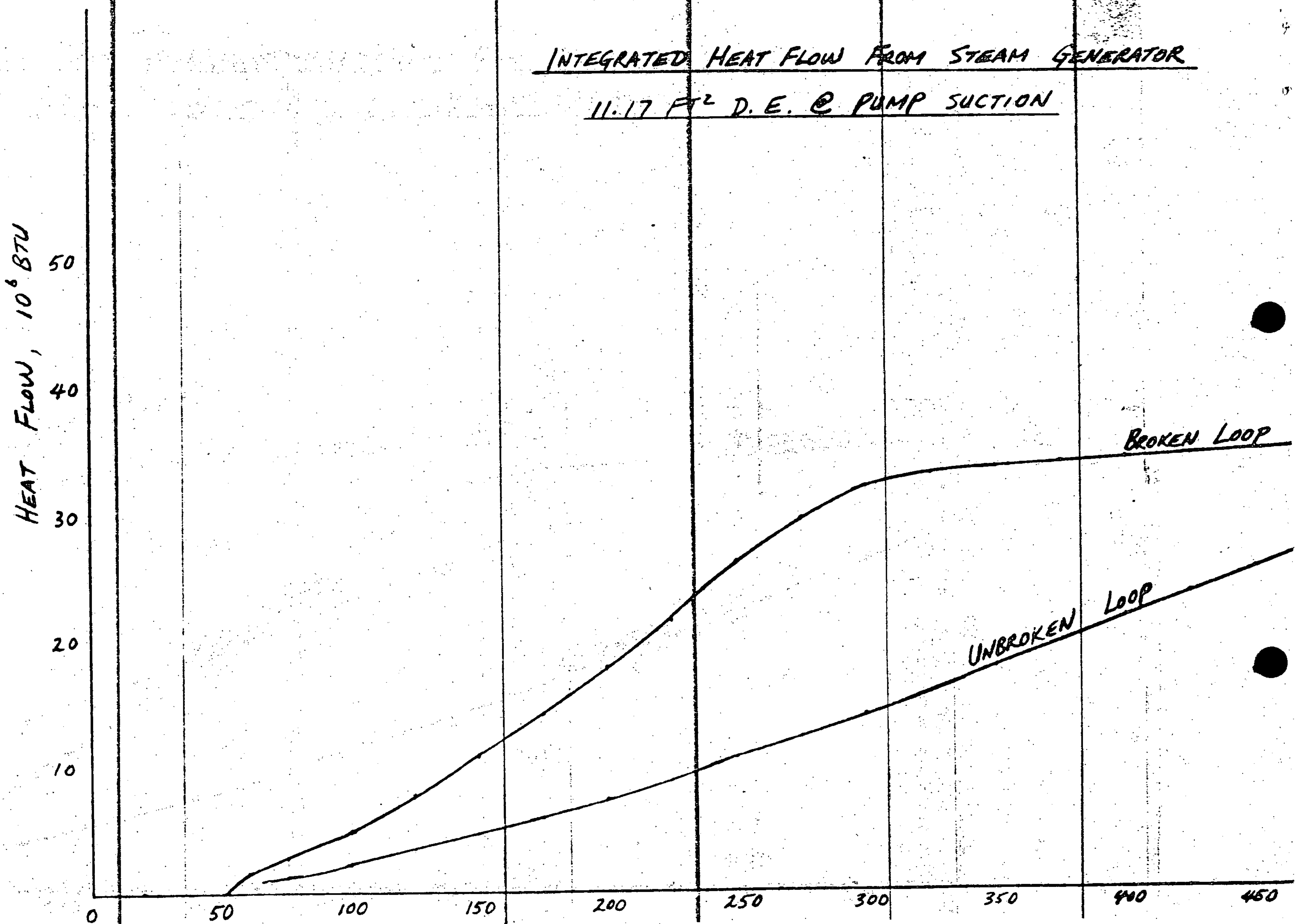

INTEGRATED HEAT FLOW FROM STEAM GENERATOR
11.17 FT2 D.E. @ PUMP SUCTION
HEAT FLOW, 10^6 BTU
10
20
30
40
50
0
50
100
150
200
250
300
350
400
450
BROKEN LOOP
UNBROKEN LOOP

Table 6.2-1. (Cont'd)

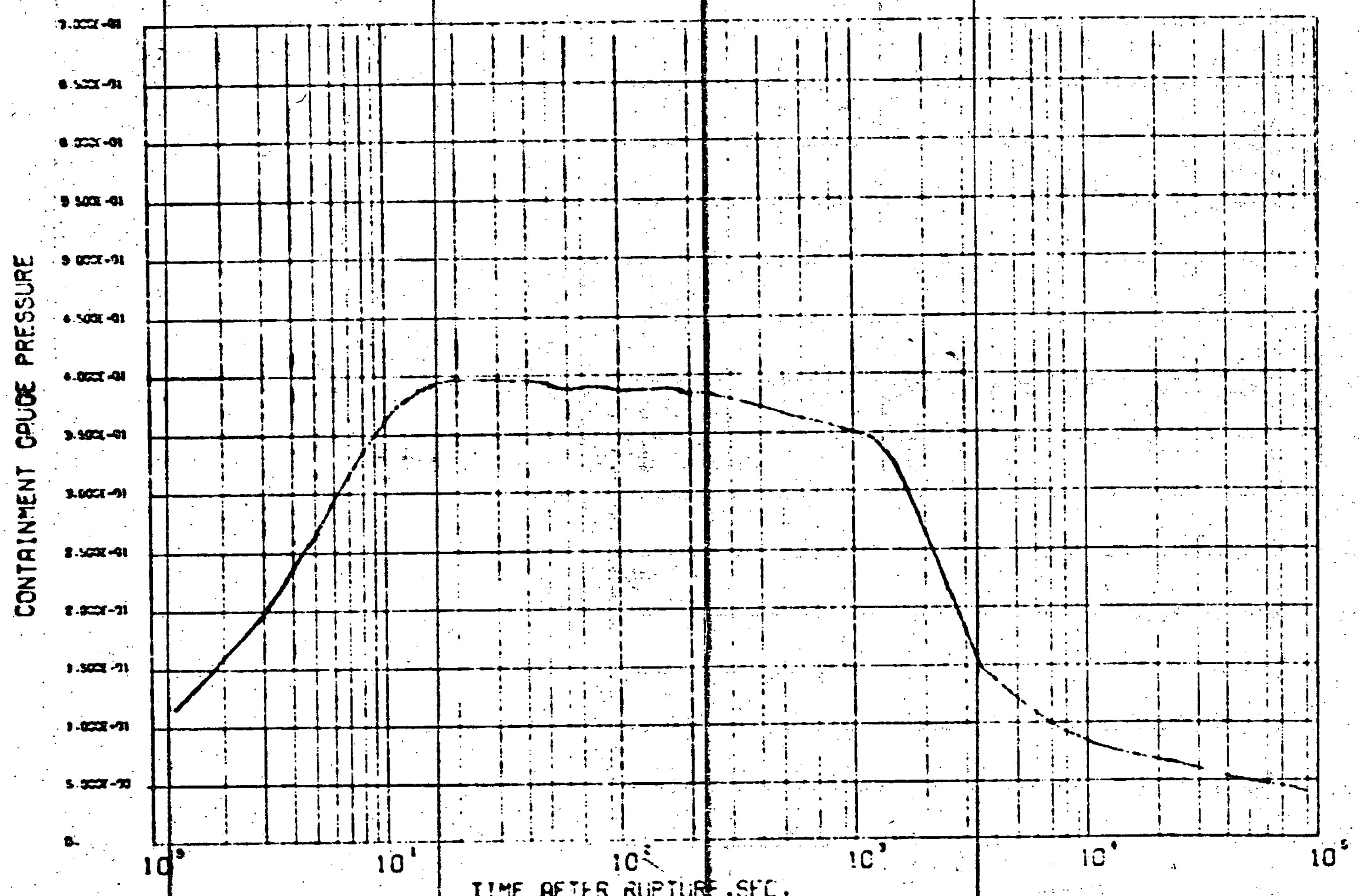
III. Design Basis Accident

	Assumed pipe break area (ft^2), cold leg breaks						
	11.17	11.17[a]	8.55	6.7	6.7[b]	3.0	0.5
Peak press., psig	34.73	35.30	34.51	34.21	34.76	33.50	28.95
Peak temp, F	250.35	251.37	249.94	249.39	250.39	248.09	239.07
Time of peak press., s	279.1	278.10	278.1	278.1	320.10	239.1	450.10
Energy released to containment at time of peak press., 10^6 Btu[c]	497.68	497.60	495.66	492.37	513.63	465.70	417.76
Energy absorbed by passive heat sinks at time of peak press., 10^6 Btu[d]	59.87	60.15	59.74	59.55	64.55	53.64	69.94

	Assumed pipe break area (ft^2), hot leg breaks					
	15.75[e]	12.0	8.0	5.0	3.0	1.0
Peak pressure, psig	36.66	36.44	36.10	35.91	35.80	33.89
Peak temp, F	253.80	253.43	252.89	252.50	252.31	248.86
Time of peak press., s	22.00	25.00	25.20	34.80	60.00	160.1
Energy released to containment at time of peak press., 10^6 Btu[c]	380.17	381.21	376.82	380.02	388.42	388.67
Energy absorbed by passive heat sinks at time of peak press., 10^6 Btu[d]	12.32	15.01	14.54	19.04	25.69	40.13

[a] Double-ended break.
[b] 0.6 double-ended break.
[c] Energies relative to 32F.
[d] Energies in sinks before accident = 0.

TVA RUCTOR BUILDING PRESSURE ANALYSIS



PRESSURE AS FUNCTION OF TIME

CONTPA6