

NRC CONTAINMENT LOADS WORKING GROUP
FMRC RESULTS FOR BWR-MARK III STANDARD PROBLEM

Robert Zalosh
Erdem Ural
Factory Mutual Research Corp.
Norwood, MA 02062

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TABLE I - ASSUMED SPARGER LOCATIONS AND FLAME HEIGHT RESTRICTIONS
DUE TO OBSTRUCTIONS FOR BWR MARK III DESIGN

<u>Sparger Number</u>	<u>Azimuthal Angle*</u>	<u>Source</u>	<u>Flame Height Restriction (ft)</u>
1	16°	ADS	22
2	48°	ADS	120
3	88°	ADS	120
4	120°	ADS	120
5	184°	ADS	120
6	256°	ADS	22
7	288°	ADS	22
8	312°	Adjacent	120
9	328°	ADS	120

* East = 0° for Grand Gulf

TABLE II - CODE INPUT PARAMETERS

<u>Class</u>	<u>Variable</u>	<u>Input Value</u>	<u>Units</u>
Vessel (Global) Description	Diameter	34.84	m
	Height	43.06	m
	Steel Surface Fraction	0.887	-
	Total Steel Mass	2.64E6	kg
	Total Steel Surface	3.55E4	m ²
	Equipment Surface Area per Unit Volume	0.7316	m ² /m ³
	Characteristic Equipment Dimension	3.5	m
Global Initial Conditions	Pressure	117.15	kPa
	Temperature	322	°K
	Steam Mole Fraction	10%	-
	Hydrogen Mole Fraction	0	-
	Hydrogen Injection Temperature	344.26	°K
Wetwell Geometry	Inner Wall Diameter	25.30	m
	Outer Wall Diameter	37.95	m
	Sparger Axes Envelope Diameter	28.35	m
	Flame Diameter	3.05	m

TABLE III - PARAMETERS FOR BWR MARK III DESIGN TEST CASES SPECIFIED BY NRC

	<u>H₂ Release</u> <u>Case</u>	<u>Release</u> <u>Rate lb/min</u>	<u>Release</u> <u>Duration (min)</u>	<u>Number of</u> <u>Spargers</u>
Design Base Cases	{ A	40	75	9
	{ B	75	40	9
	{ C	100	30	9
Sensitivity Analysis ⁴ Cases	{ S-1	50	30	9
	{ S-2	100	10	9
	{ S-3	100	30	1
	{ S-4	50	10	1

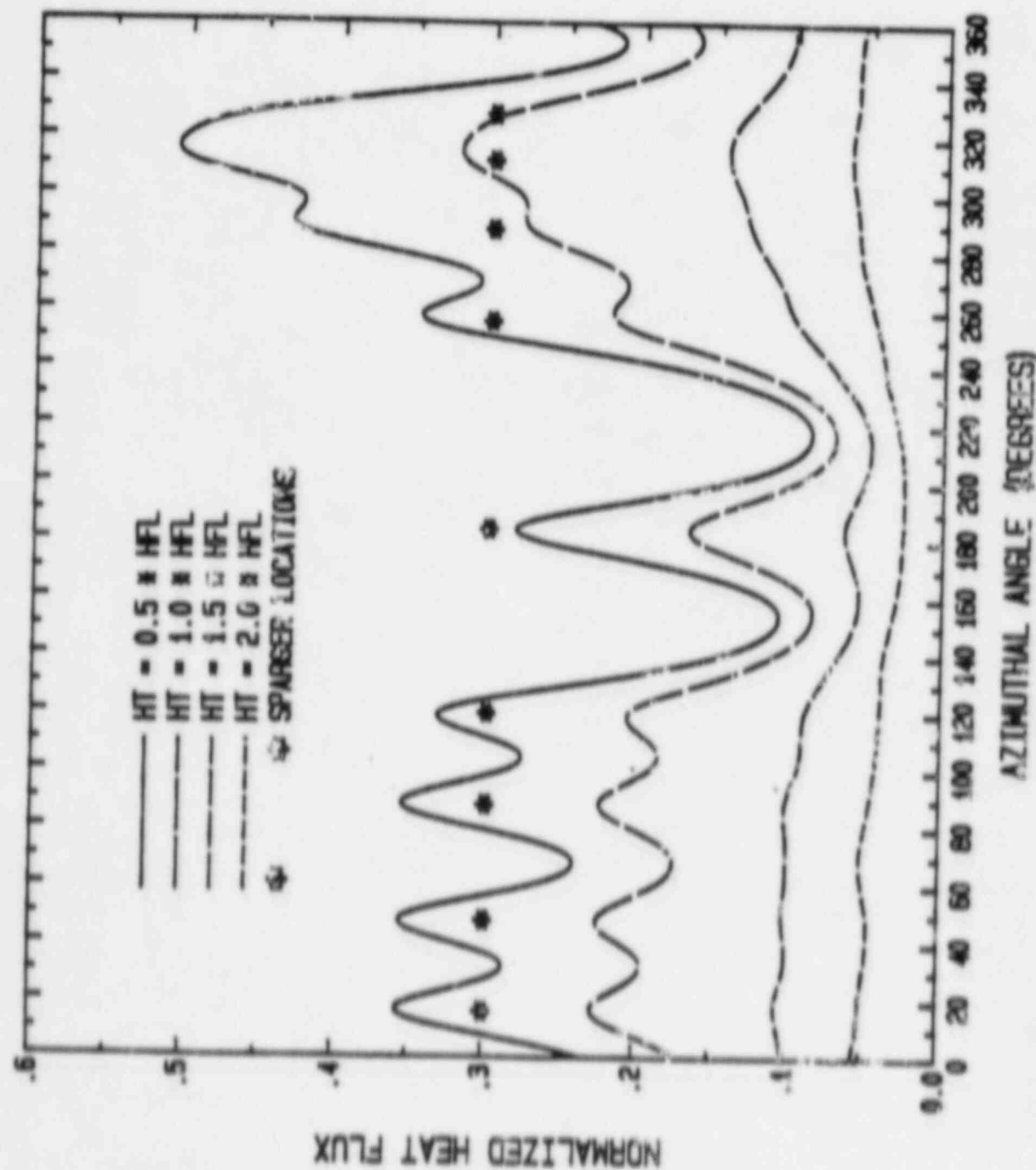
TABLE IV - SUMMARY OF RESULTS

Case	Peak Pressure (psia)	Containment Averaged Peak Temperature (°C)	Peak Heat Flux ^b (1000 Btu/hr ft ²)						Flame Height ^a (ft)		Flame Temp. (°C)		Burn Duration (sec)
			10 ft	20 ft	30 ft	10 ft	20 ft	30 ft	Initial	Final	Initial	Final	
A	28	200	8.0	6.2	5.6	1.0	0.73	0.52	11	38	1000	340	3150
B	30	240	12	8.8	7.7	1.9	1.5	1.1	17	52	1000	340	1680
C	32	260	14	10	9.0	2.4	2.1	1.5	20	60	1000	330	1260
S-1	27	190	9.2	7.0	6.2	1.3	0.93	0.67	13	28	1000	540	1800
S-2	28	230	14	10	9.0	2.4	2.1	1.5	20	32	1000	700	600
S-3	32	260	28	29	30	4.0	4.4	4.5	62	120	1000	330	1260
S-4	24	140	21	22	20	2.7	3.0	2.9	45	55	1000	850	600

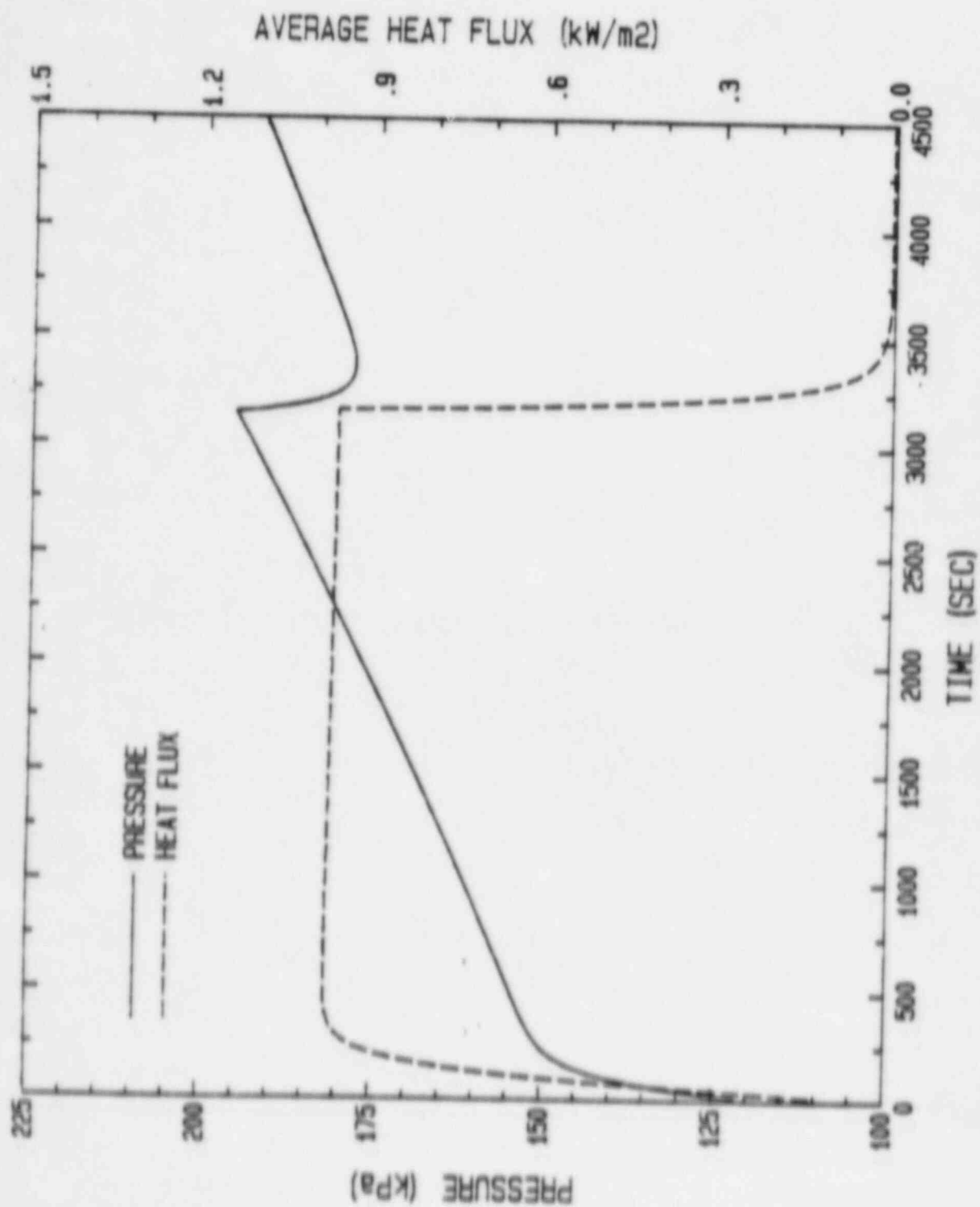
^b Heat fluxes decrease rapidly in time (see enclosed plots).

^a Height above suppression pool surface in the absence of obstructions.

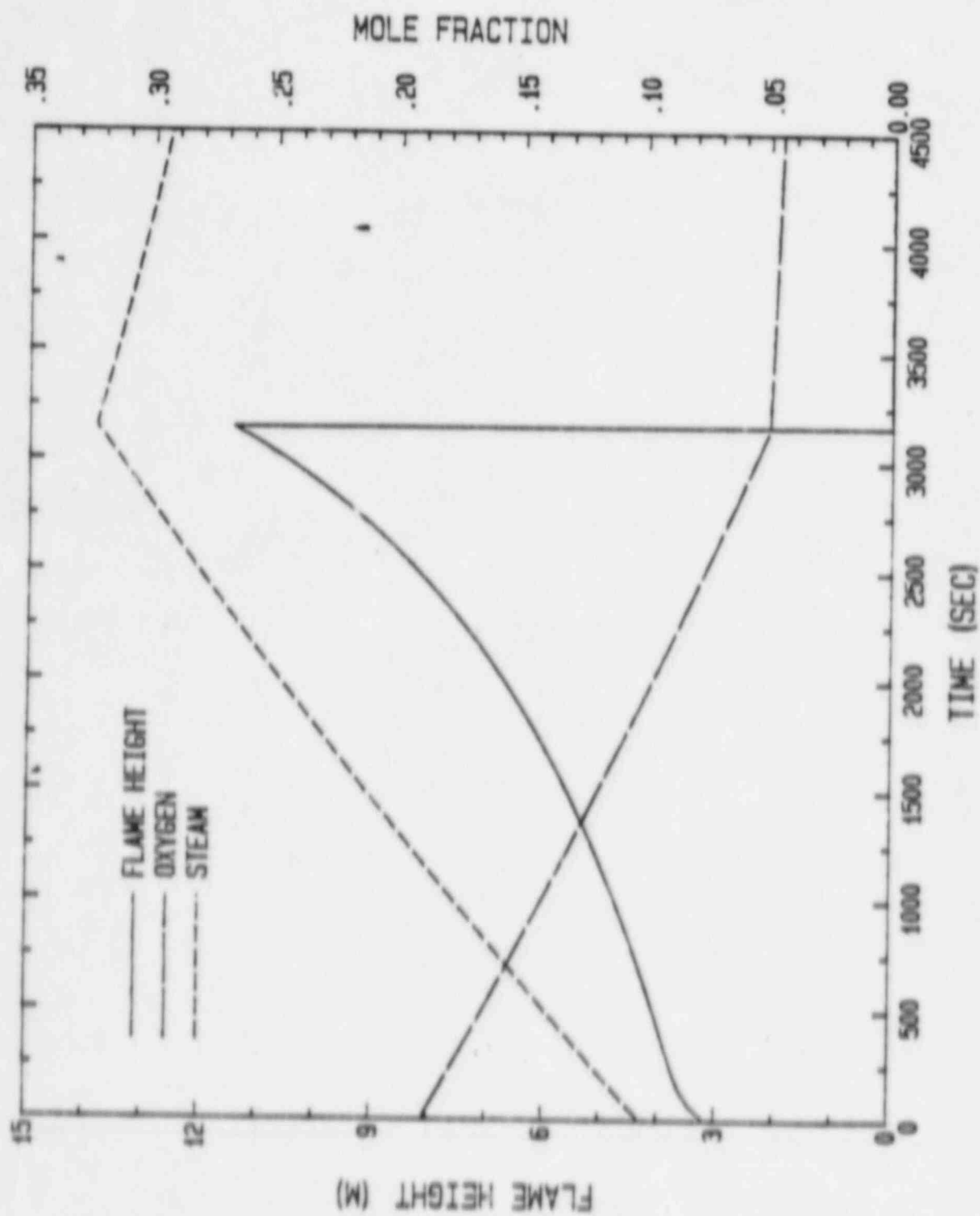
Radiant heat flux calculations used flame height restrictions shown in Table I.



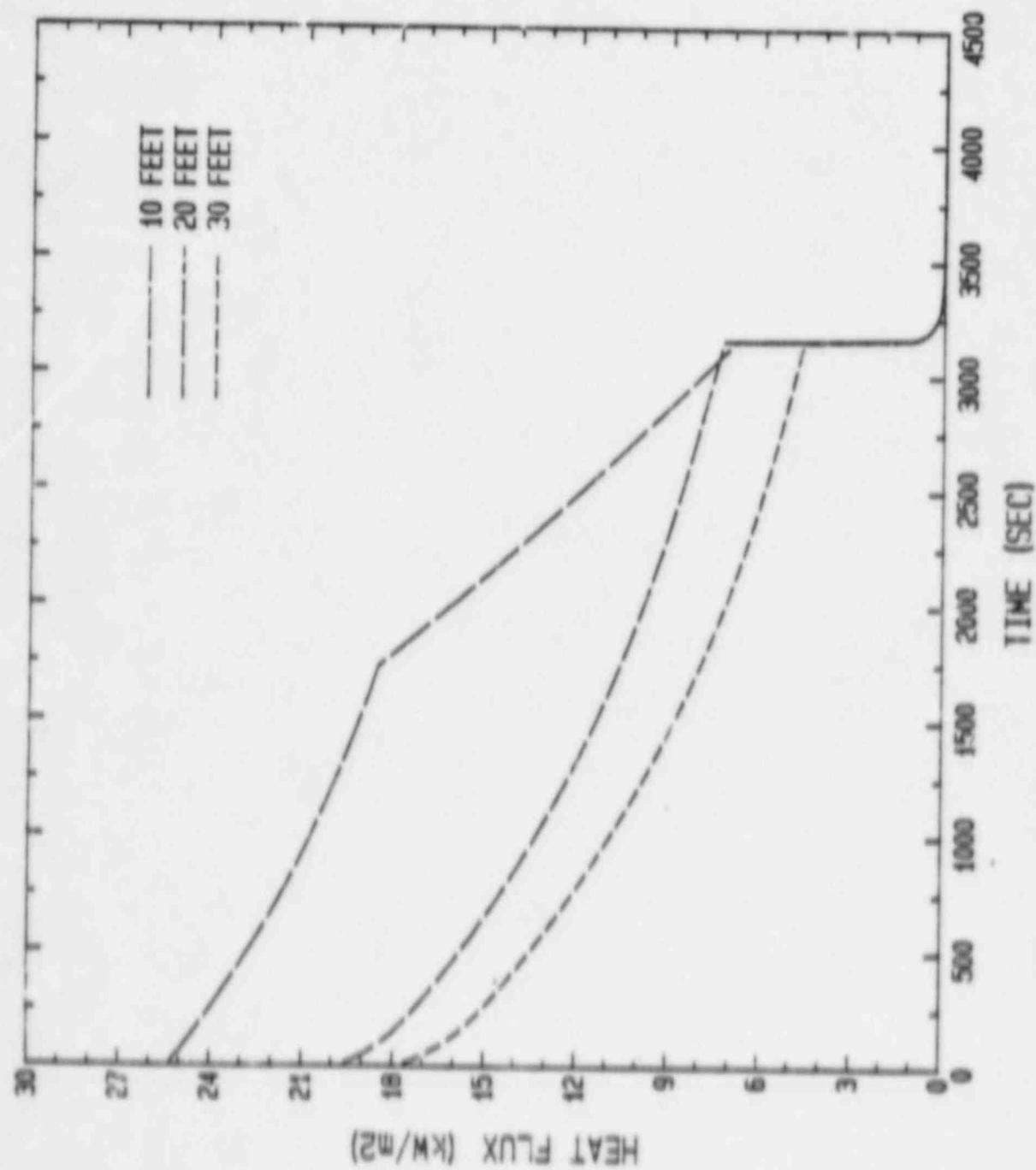
RADIANT HEAT FLUX AT OUTER METWELL WALL
(NORMALIZED WITH FLAME EMISSIVE POWER)



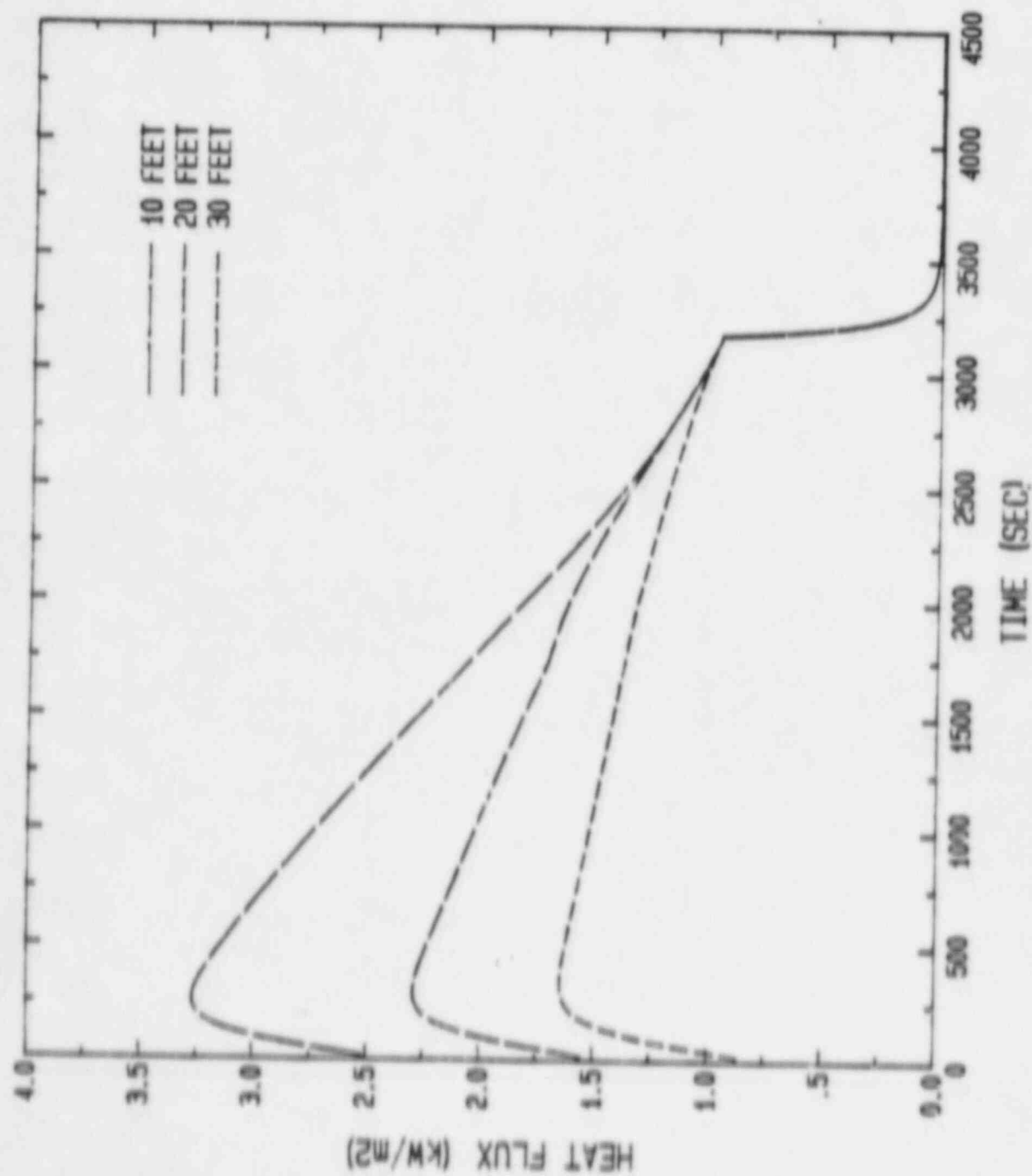
CASE-A : 40 lb/min THROUGH 9 SPARGERS
PRESSURE AND AVERAGE HEAT FLUX IN THE CONTAINMENT



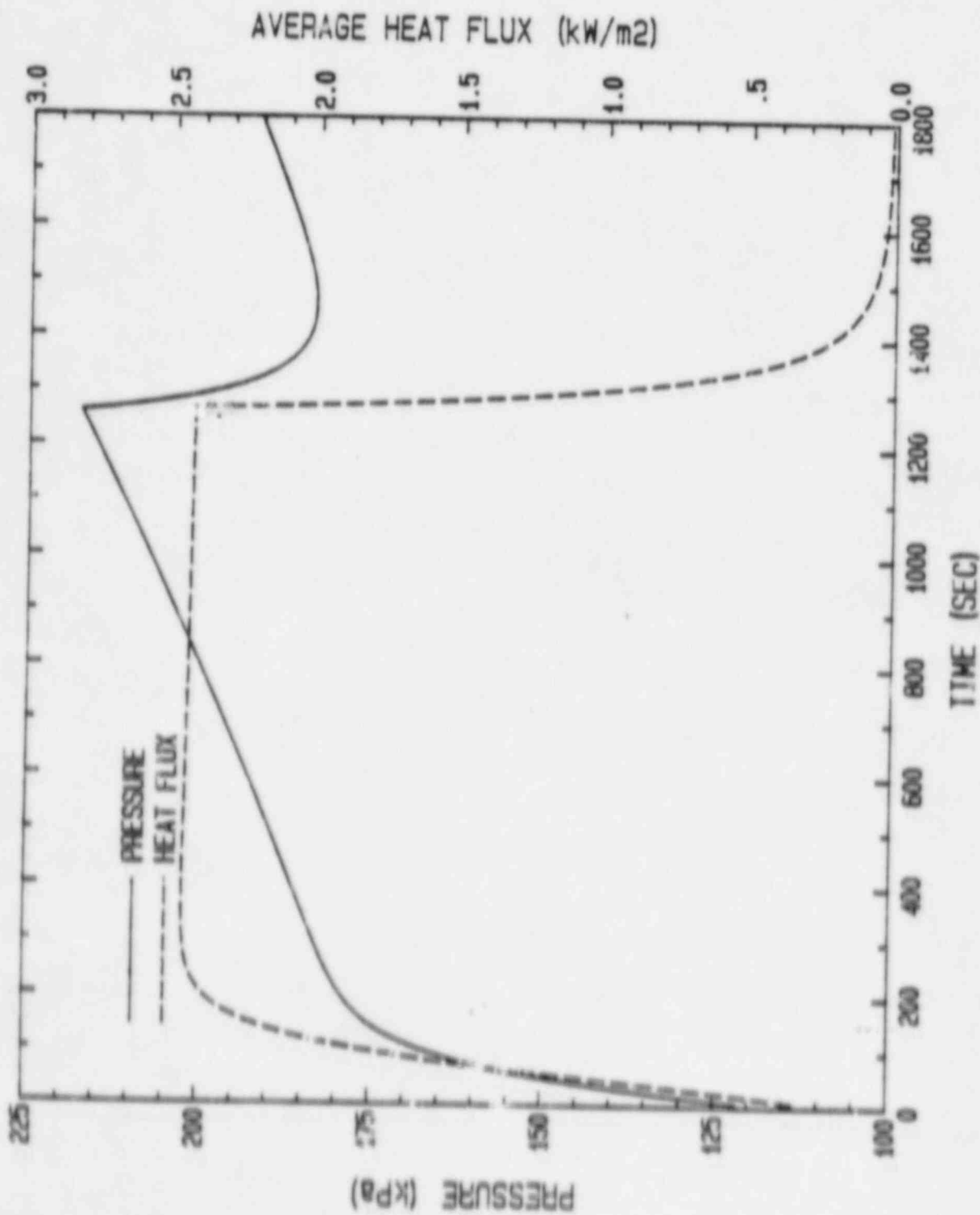
CASE-A : 40 lbm/min THROUGH 9 SPARGERS
FLAME HEIGHT, OXYGEN AND STEAM CONCENTRATIONS



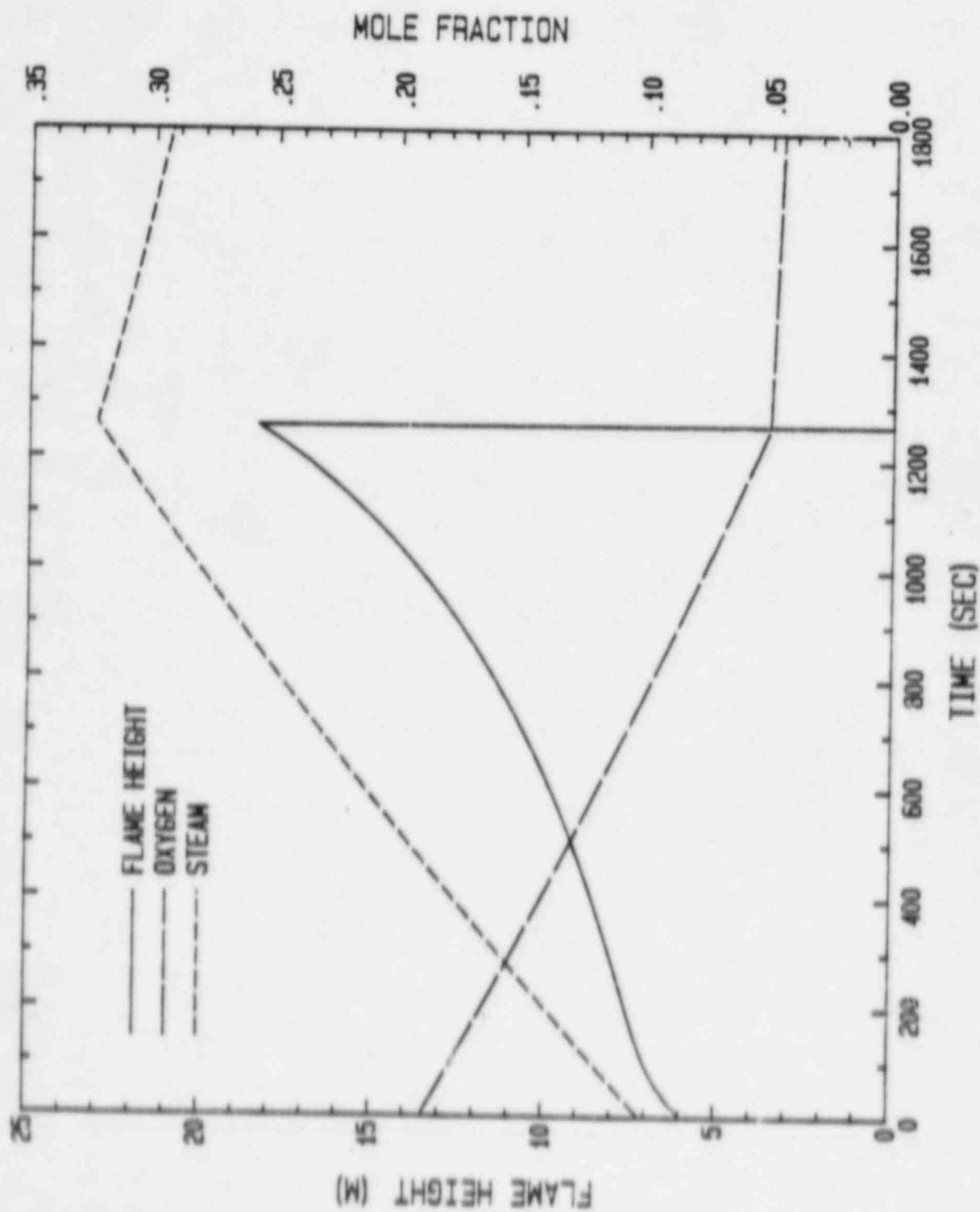
CASE-A : 40 lb/min THROUGH 9 SPARGERS
INNER WALL PEAK HEAT FLUXES



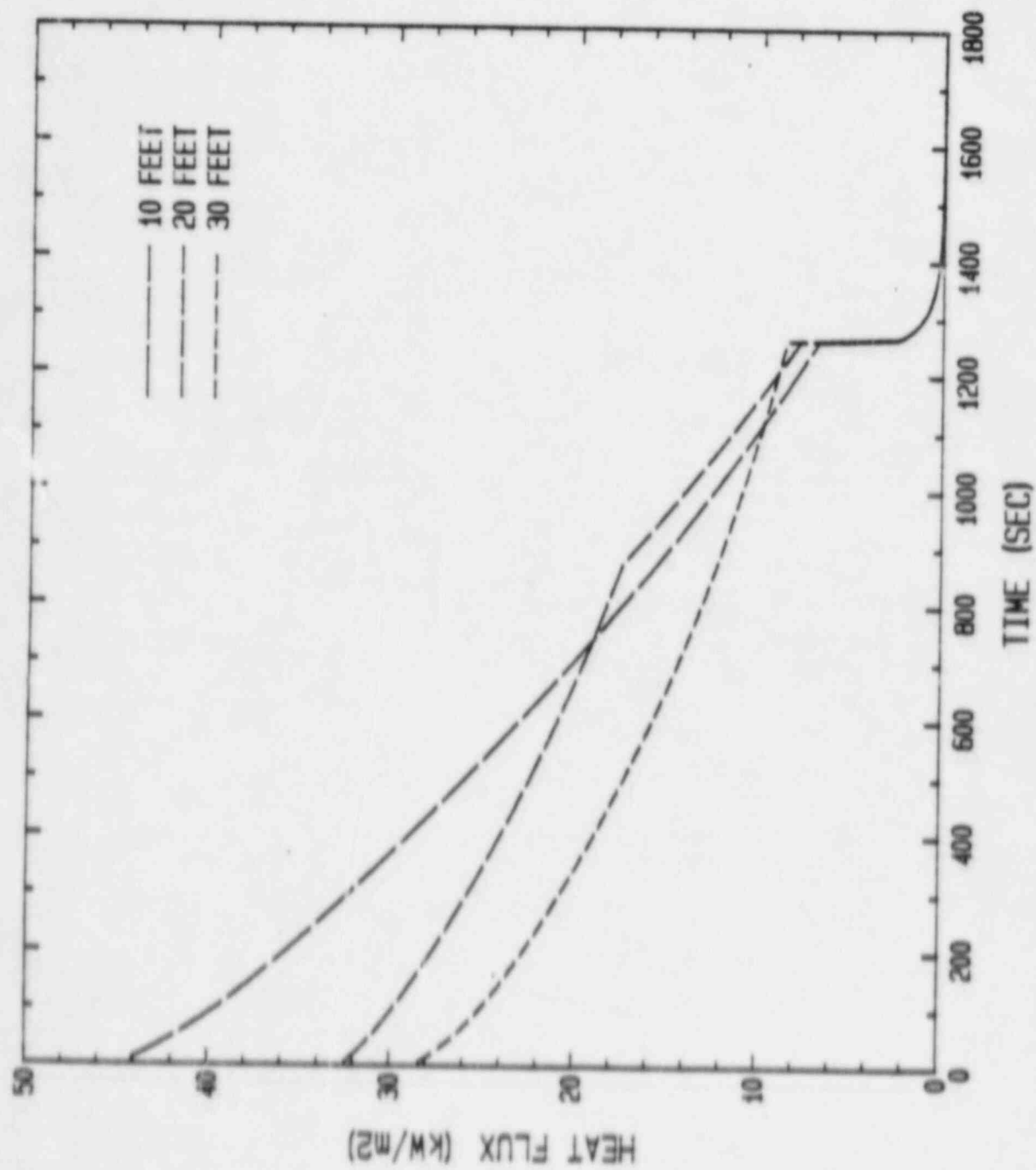
CASE-A : 40 lb/min THROUGH 9 SPARGERS
OUTER WALL PEAK HEAT FLUXES



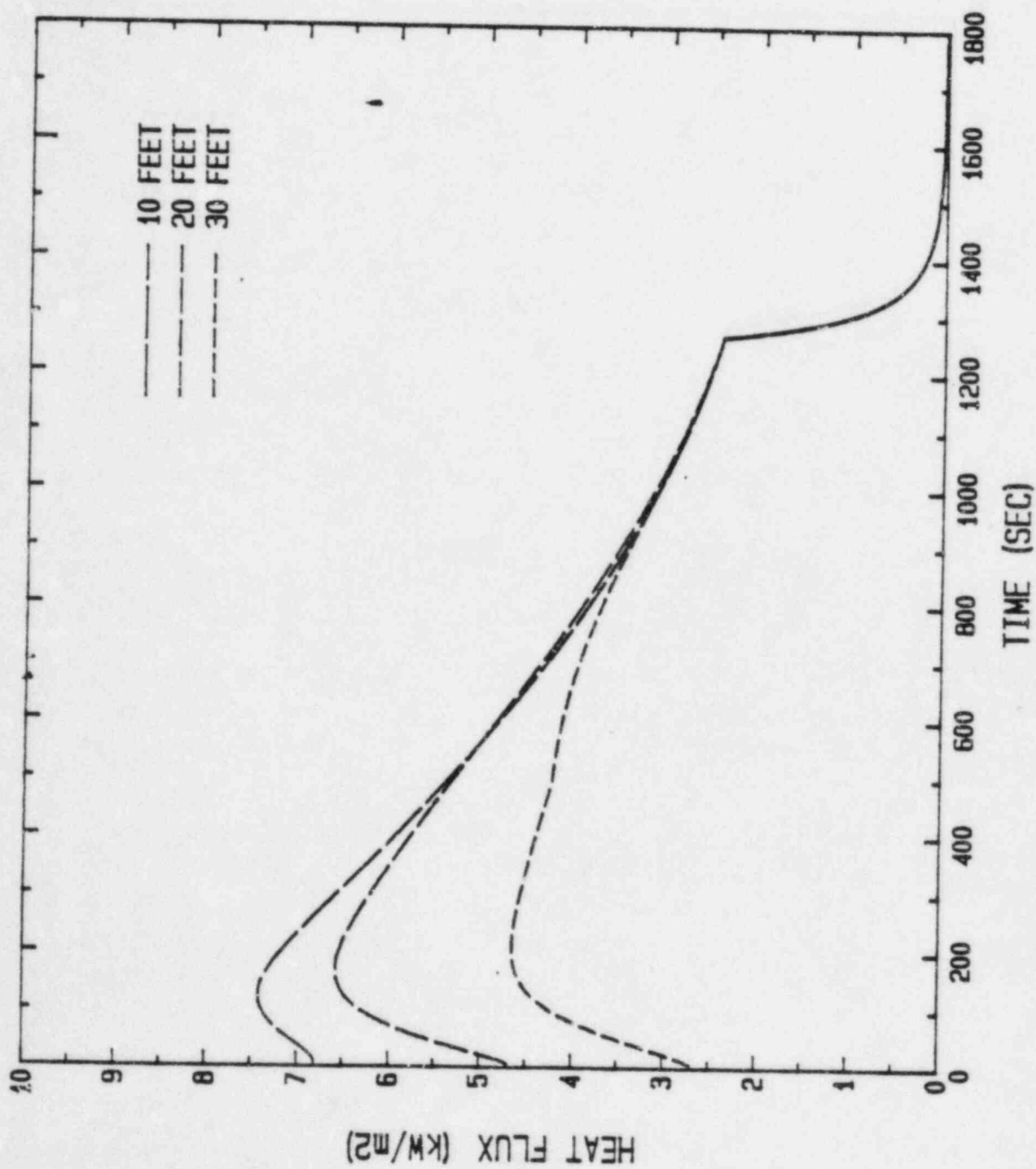
CASE-C : 100 lb/min THROUGH 9 SPARGERS
PRESSURE AND AVERAGE HEAT FLUX IN THE CONTAINMENT



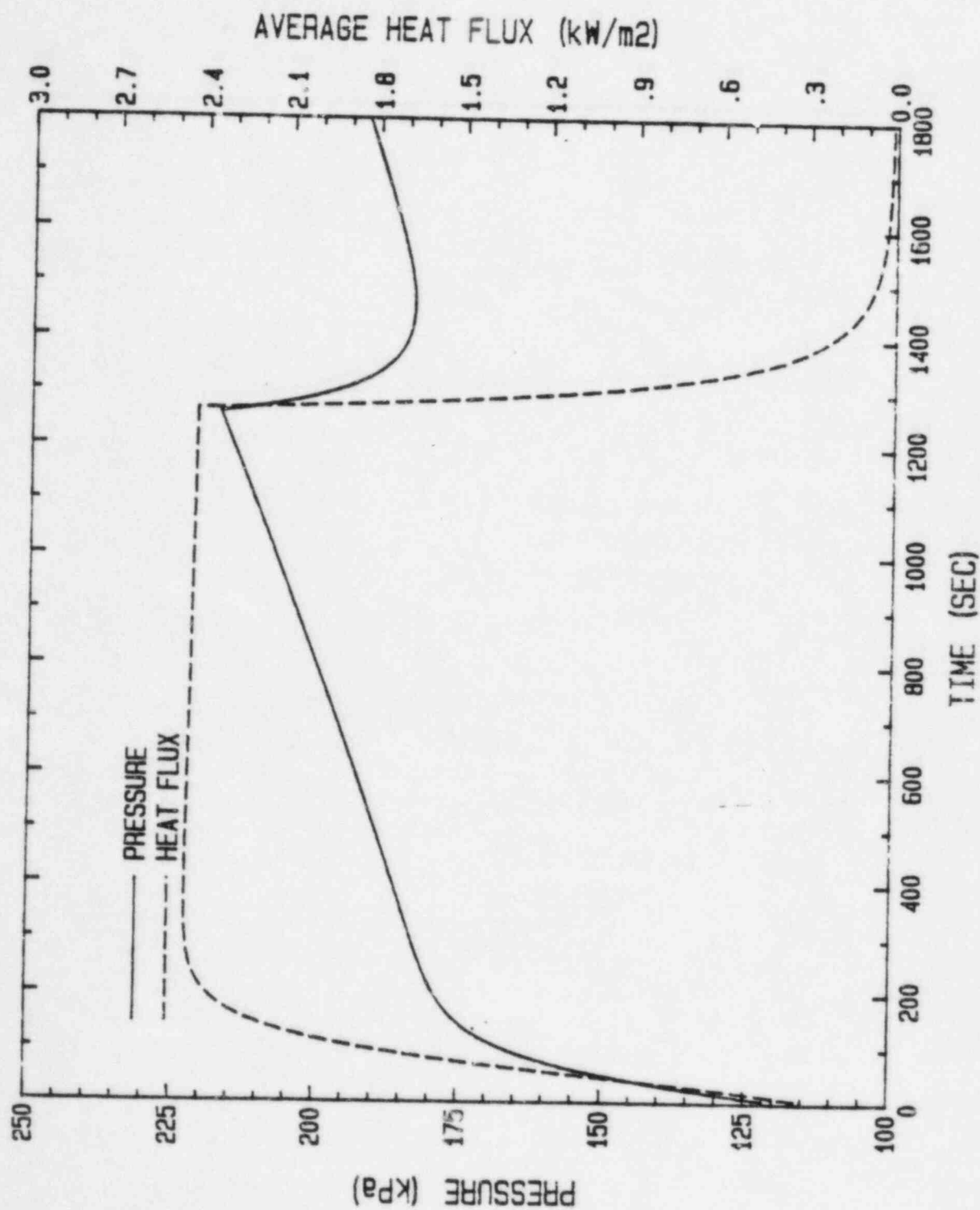
CASE-C : 100 lbm/min THROUGH 9 SPARGERS
FLAME HEIGHT, OXYGEN AND STEAM CONCENTRATIONS



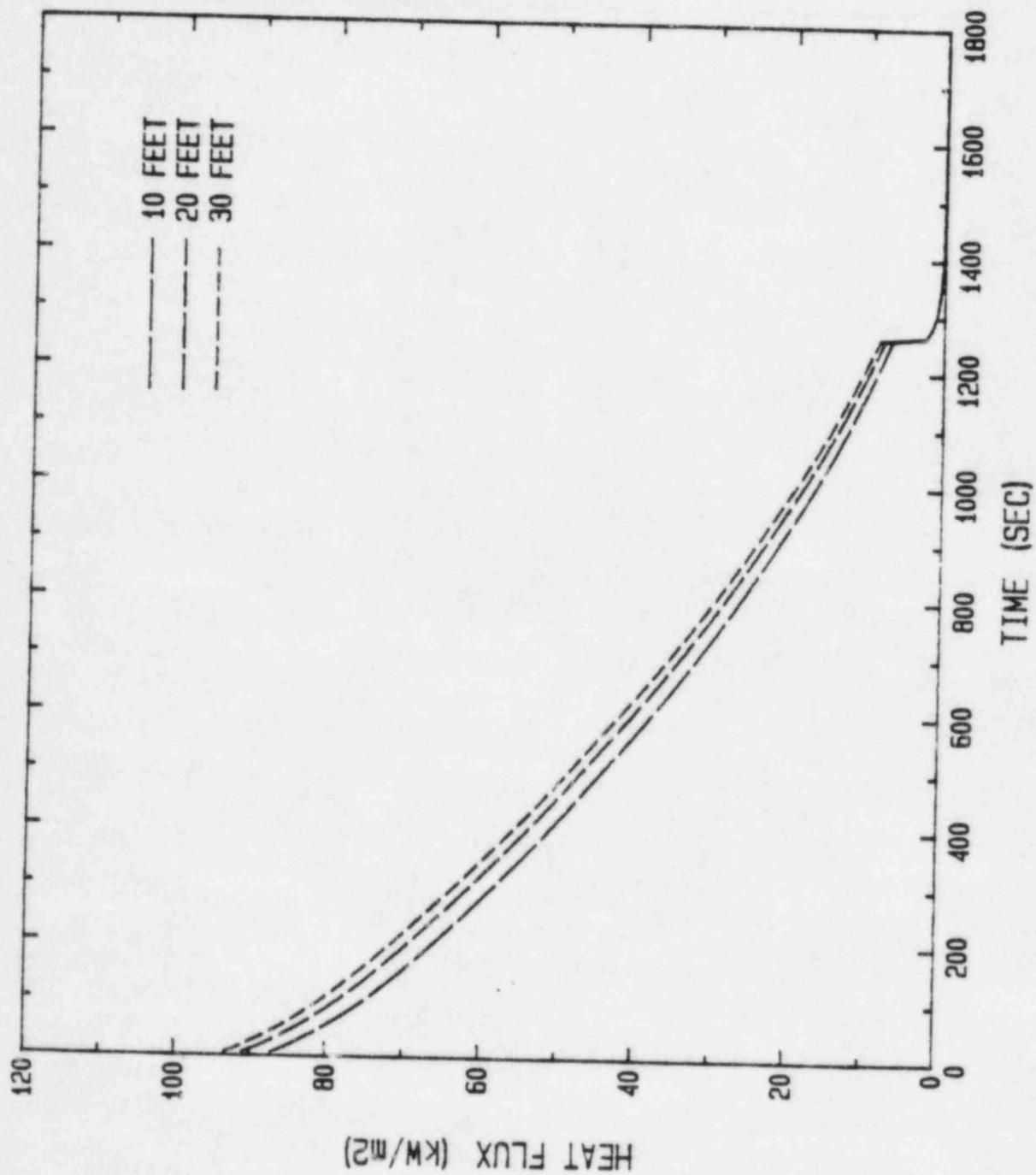
CASE-C: 100 lb/min THROUGH 9 SPARGERS
INNER WALL PEAK HEAT FLUXES



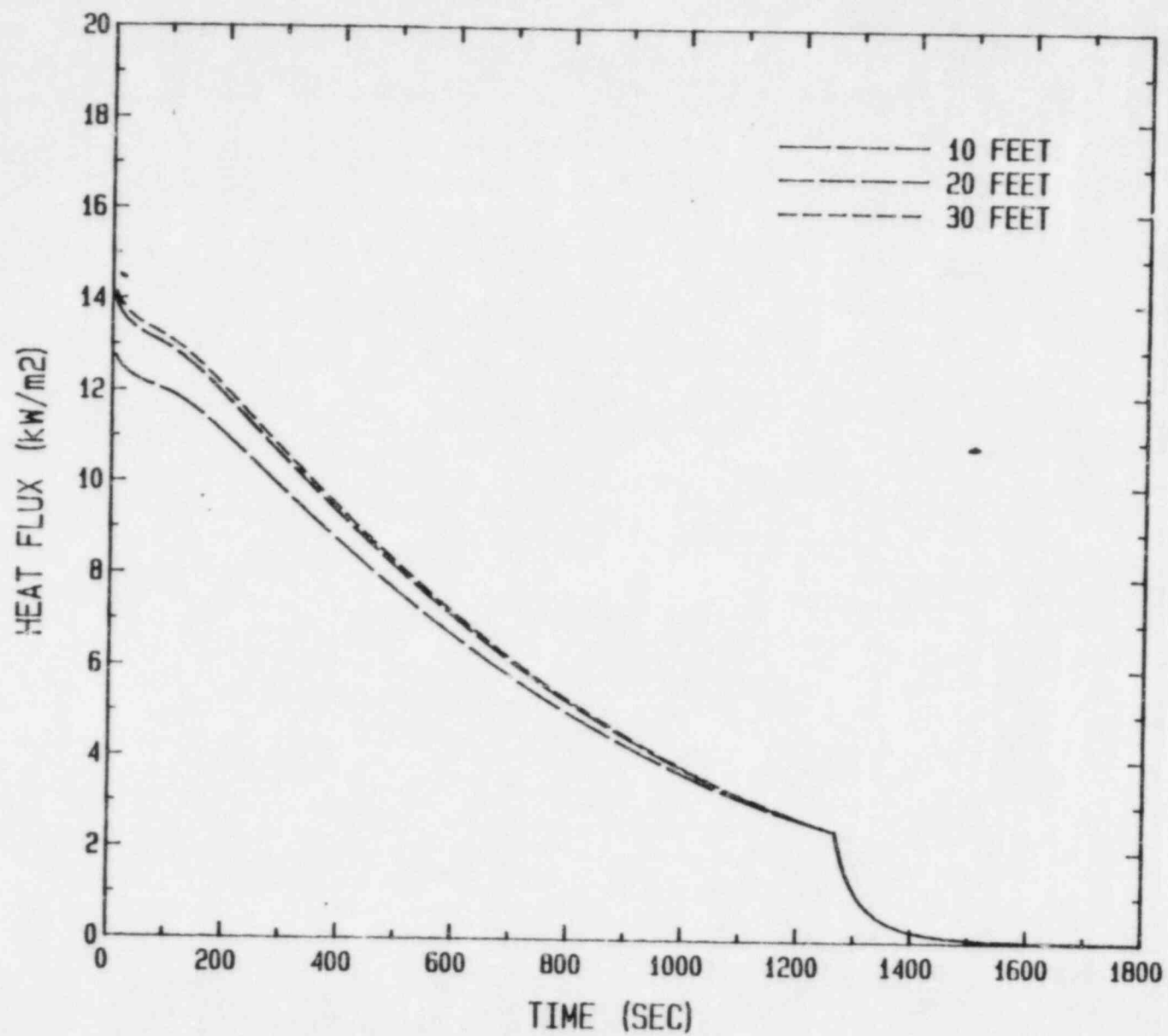
CASE-C: 100 lb/min THROUGH 9 SPARGERS
OUTER WALL PEAK HEAT FLUXES



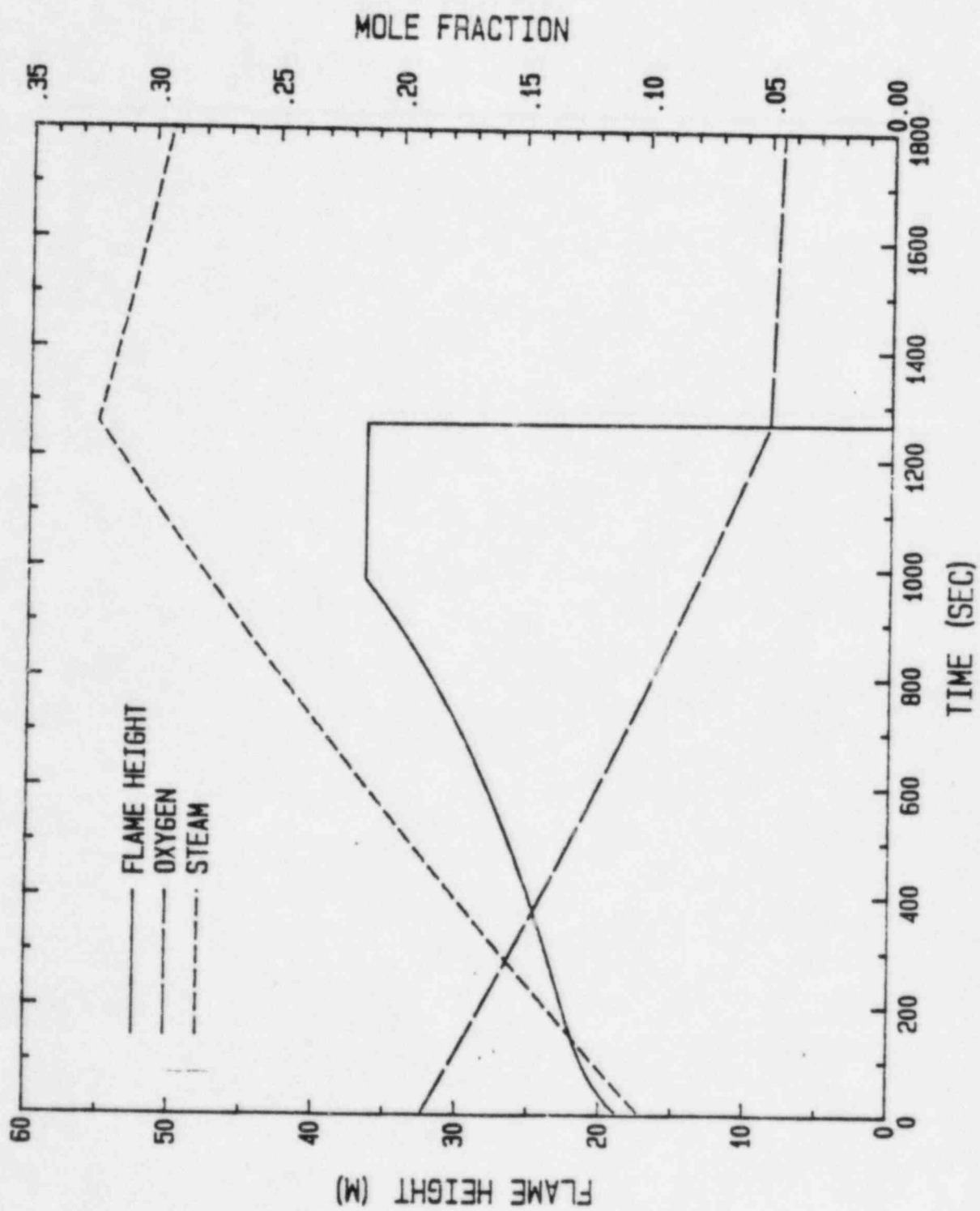
CASE-S3: 100 lb/min THROUGH 1 SPARGER
PRESSURE AND AVERAGE HEAT FLUX IN THE CONTAINMENT



CASE-S3 : 100 lb/min THROUGH 1 SPARGER
INNER WALL PEAK HEAT FLUXES



CASE-S3 : 100 lb/min THROUGH 1 SPARGER
OUTER WALL PEAK HEAT FLUXES



CASE-S3 : 100 lbm/min THROUGH 1 SPARGER
FLAME HEIGHT, OXYGEN AND STEAM CONCENTRATIONS