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CONTENTS

REMTECH TECHNICAL NOTE

SUBJECT: Preliminary Cycle 1 NLS Base Heating Environments

DATE: September 13, 1991

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CONTRACT NO.: NAS8–38141

PREPARED FOR: Marshall Space Flight Center ED33

INTRODUCTION

A preliminary analysis of National Launch System ascent plume induced base heating environments has been completed to support the Induced Environments Panel's objective to assist in maturing the NLS vehicle (1.5 stage and HLLV) design. Environments during ascent have been determined from this analysis for a few selected locations on the engine nozzles and base heat shield for both vehicles. The environments reflect early summer 1991 configurations and performance data and conservative methodology. A more complete and thorough analysis is under way to update these environments for the Cycle 1 review in January 1992.

INPUTS

HLLV and 1.5 stage base configuration data were provided by MSFC PD-24 in a NLS data package dated April 12, 1991. The pertinent base geometry dimensions are reproduced in this report as Figs. 1 through 3.

NLS performance data and STME/ASRM motor nozzle data were also provided by MSFC in an April 23, 1991, data package and are summarized in Fig. 4. Chamber pressure histories for the core main engines and boosters are shown in Fig. 5.

The HLLV and 1.5 stage vehicle trajectories were prepared by MSFC EP55 and transmitted to REMTECH May 10, 1991. These were preliminary engine out trajectories based upon the assumptions listed in Fig. 6. Time-altitude plots from these trajectories are shown in Fig. 7

BODY POINT SELECTION

This was a preliminary study performed on short notice so the body points were limited to two per vehicle. The criteria for selecting the points was to choose a location on the engine nozzle and a location on the base heat shield where base heating would be most severe. For the HLLV the nozzle point was located on the STME aft lip at an angular position which has maximum view of the ASRM plume. The heat shield location

was the center of the core vehicle base, assuming the shield was located approximately 150 in. forward of the nozzle exit plane.

For the 1.5 stage reference vehicle, the heat shield point was between outboard engines and the nozzle point was on one center engine nozzle lip facing the other center engine nozzle. The six pack 1.5 stage vehicle points were selected between a four engine cluster on the heat shield, and on one center engine nozzle lip facing across the base toward the opposed center engine. The body points selected for this study are displayed in Fig. 8.

METHODOLOGY

Ascent base heating is a combination of plume radiation and convection occurring when plume gases are recirculated into the base Both heating modes are basically a function of altitude, with flight-time effects also entering through variations in engine thrust. Radiation occurs throughout ascent and is often a maximum at lift-off, usually decreases with altitude, and may exhibit spikes (increases) when gas recirculation occurs or during engine shutdown. Recirculated gas convection is initiated in multiple engine launch vehicles such as the NLS at higher altitudes when large plume expansions and plume interactions occur. Once initiated, base convection normally continues to increase with altitude until a mass exchange balance is achieved in the base (often referred to as choked base flow); at that altitude and above, the convective heating remains constant.

Infrared radiation from the rocket exhaust plumes varies strongly with surface position as the view of the plumes and shading by other surfaces change. In contrast, the convective heating environment resulting from reversed plume boundary layer gases is specified as relatively constant over zones. The choice of propellants and operating conditions of the engines are important to both components of base heating because they dictate (1) the thermochemistry of the exhaust products which either radiate or are reversed into the base, and (2) transport properties which determine the fundamental processes for energy exchange in the base. Specific adaptations of the general base heating methodology to the NLS vehicles are summarized in the following discussion.

PLUME RADIATION

Plume radiation estimates were made by scaling available plume data to approximate the STME plumes and by modifying Cycle 1 ASRM methodology for the ASRM plumes. The procedures used for each plume source are described in this subsection.

The STME plumes were approximated using similar O2/H2 plumes previously generated for the Advanced Launch System studies (Re=52.4, Pc=2250 psia, O/F=6.0, and A/A^*=60). These plumes have an exit pressure below that of the A/A^*=45 engines on the NLS vehicles, so it was necessary to compensate for this by scaling the plume size, pressure, and temperature to simulate the size and properties required for the NLS. The scaled plumes approximated STME plumes at altitude pressures ranging from below sea level to 190 kft. The radiation rates predicted using the scaled plumes were plotted and the resulting functions of altitude pressure were interpolated at the correct altitude

pressures to obtain STME rates from sea level to 160 kft. It was assumed that the base pressure, plume shapes, and plume radiation above 160 kft are constant.

Because the plume predictions were made using simple axisymmetric plumes, it was necessary to approximate effects anticipated as a result of two characteristics which were not modeled: shock regions between the plumes at high altitudes and turbine exhaust injection into the nozzle.

Although the shock regions between plumes represent a significant fraction of the radiation source at high altitude, the overall high altitude radiation is relatively low because of the very low temperatures and pressures in the balance of the combined plume. The difference between axisymmetric plumes and the true 3-D plume at high altitude were estimated for NLS stages based on experience from the Saturn S-II and Shuttle SSME.

The effect of afterburning and base burning can be a significant radiation and convection source, but there is no experience with these effects for a vehicle with O2/H2 propellants. The contribution of these sources for the NLS vehicles were predicted based on estimates of the increase in radiation resulting from afterburning and estimates from characteristics of turbine exhaust reversal and base burning on Saturn S-IC.

The Cycle 1 ASRM methodology was used to predict the radiation source at sea level and at the shutdown spike, but the altitude adjustment function was reduced based on estimates of two effects: differences in plumes caused by the powered center body and attenuation of ASRM radiation by the STME plumes.

The Shuttle Cycle 1 ASRM altitude adjustment function (which describes the ratio of altitude to sea-level radiation) was extrapolated from the empirically determined RSRM altitude adjustment which was based primarily on measurements in the ET base region. The altitude adjustment function increases from 1.0 to 1.3 during the first 10 kft of ascent and indicates significant radiation from reversed gases in the 90 to 120 kft range. These effects appear to be caused in some part by the expansion of the plume into the ET base region, and these same effects are not expected to be seen in the HLLV vehicle because STME plume flow will occupy the center of the base. As a result, the altitude adjustments for the HLLV were reduced slightly from those used for the Shuttle ASRM Cycle 1 predictions.

The combined STME and ASRM radiation were predicted separately using different methodologies and then added to determine the plume radiation environment for the HLLV. This procedure does not recognize the attenuation of the ASRM plume radiation by the STME plumes, so an estimated adjustment was made to account for STME plume absorption. As the ASRM methodology is developed, it is anticipated that this effect can be modeled more realistically.

PLUME-INDUCED CONVECTION

Convective heating from recirculated plume gases is not determined by a rigorous computational procedure or computer code, but relies on judicious scaling and application of existing flight and model data. For this study, which considered the STME LO2/LH2

The study did not address plume induced flow separation which will likely ingest hot plume recirculated gases into the separated region along the tank sidewall of the core stage. Heating in the PIFS region is less severe than the normal base heating to the engines and heat shield, but has not been quantified in this analysis.

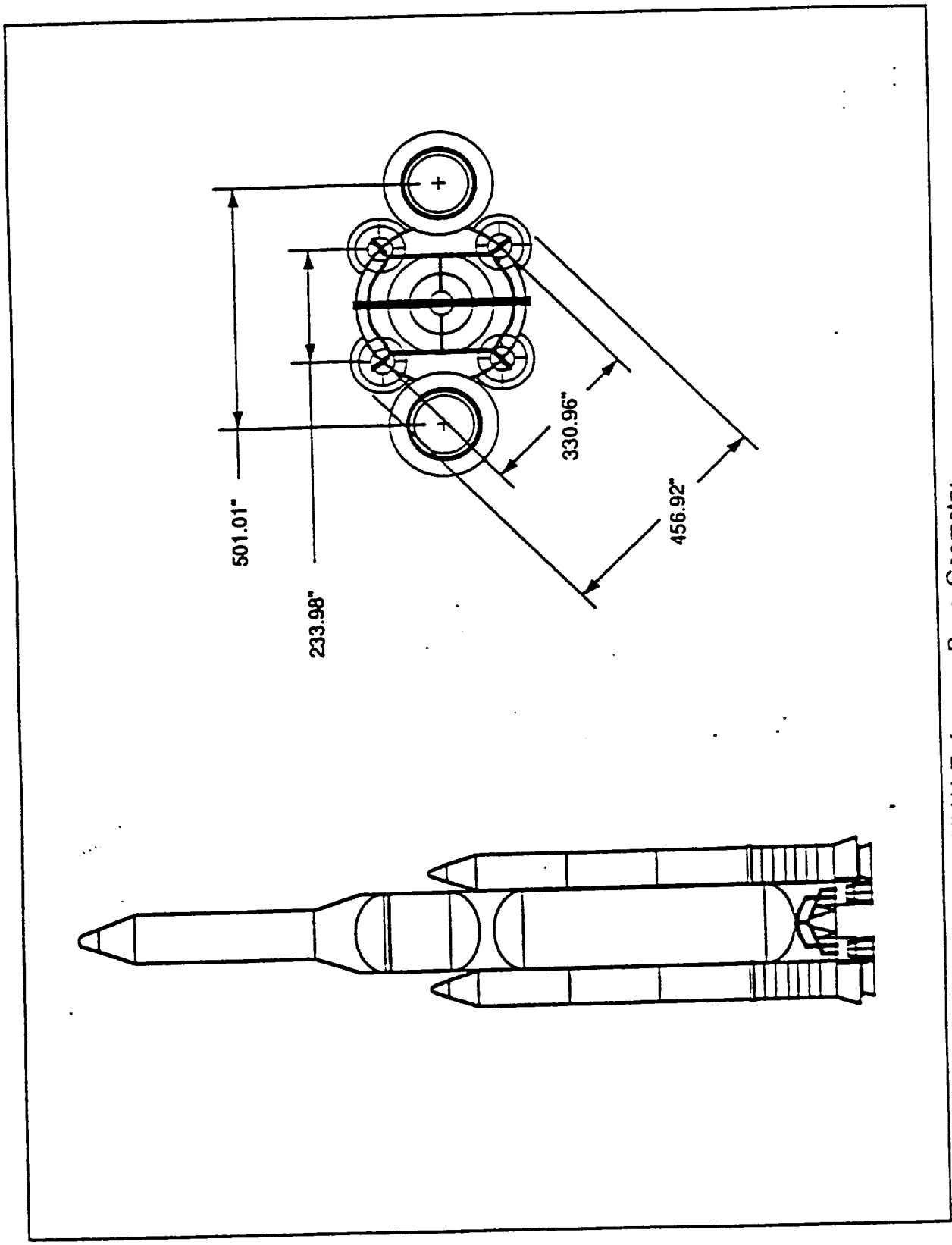


Figure 1: In-Line HLLV Reference Base Geometry

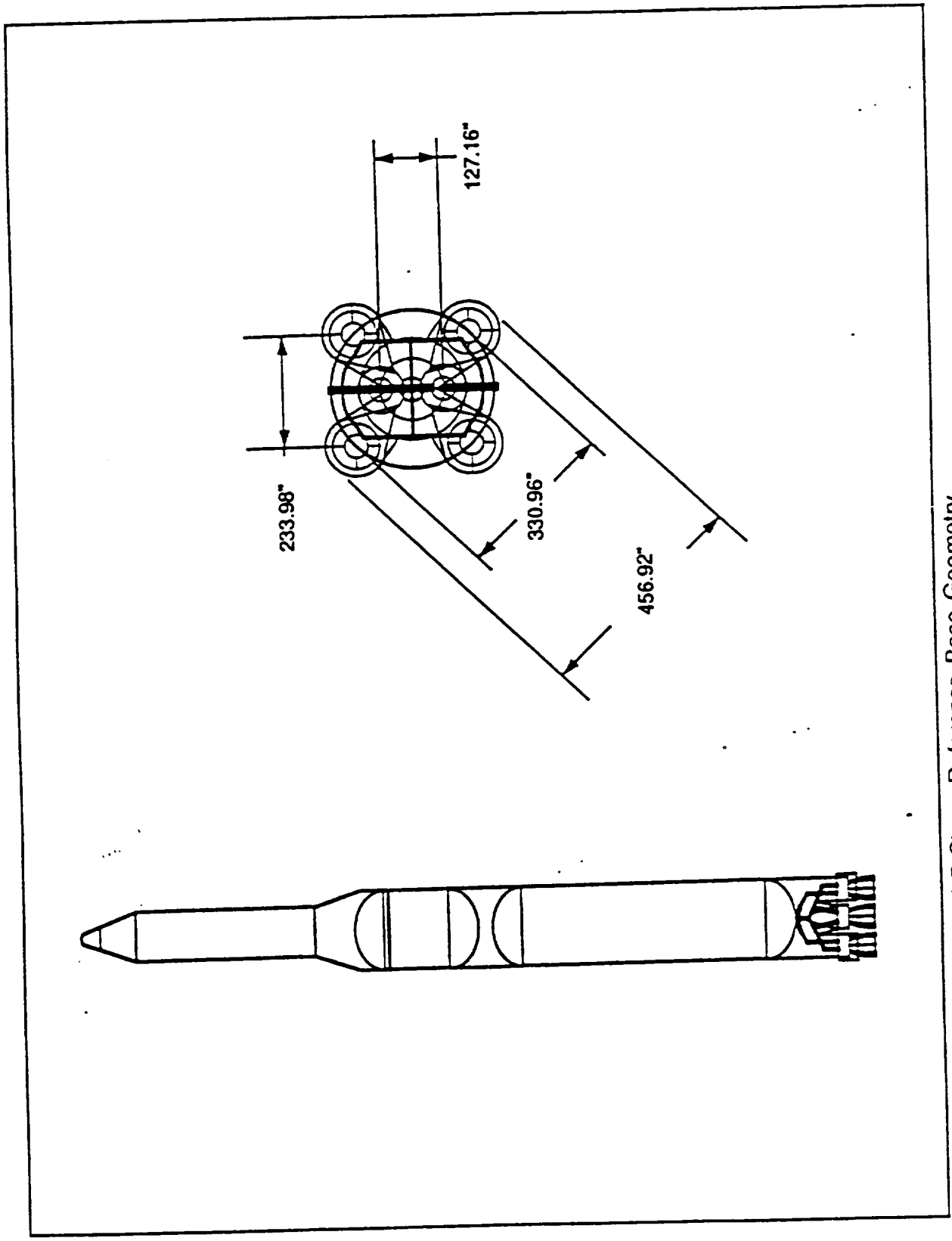
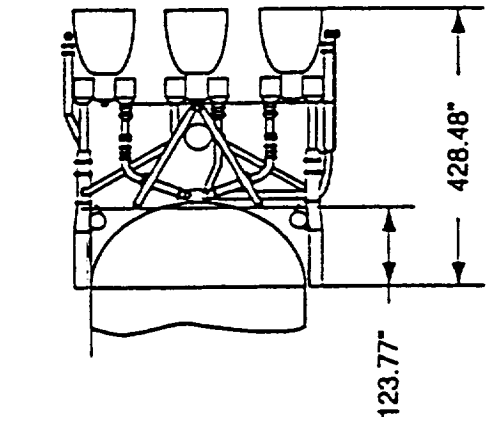


Figure 2: 1.5 Stage Reference Base Geometry



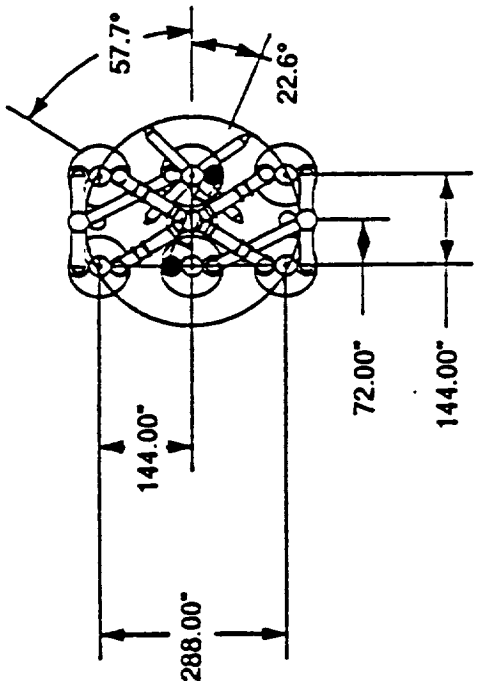


Figure 3: 1.5 Stage Six-Pack Base Geometry

- **STME**

Propellants:	LO_2/LH_2
Mixture Ratio:	6.0
Throat Diameter:	13.1 inches (ID)
Expansion Ratio:	45:1
Nozzle Exit Diameter:	87.8 inches (ID)
Chamber Pressure:	2250 psia

- **ASRM**

Propellants:	19% Aluminum 69% Amonium Perchlorate 9% HTPB
Throat Diameter:	54.48 inches
Expansion Ratio:	7.54:1
Nozzle Exit Diameter:	149.64 inches
Chamber Pressure:	Variable (See next chart)

Figure 4: STME and ASRM Performance Data

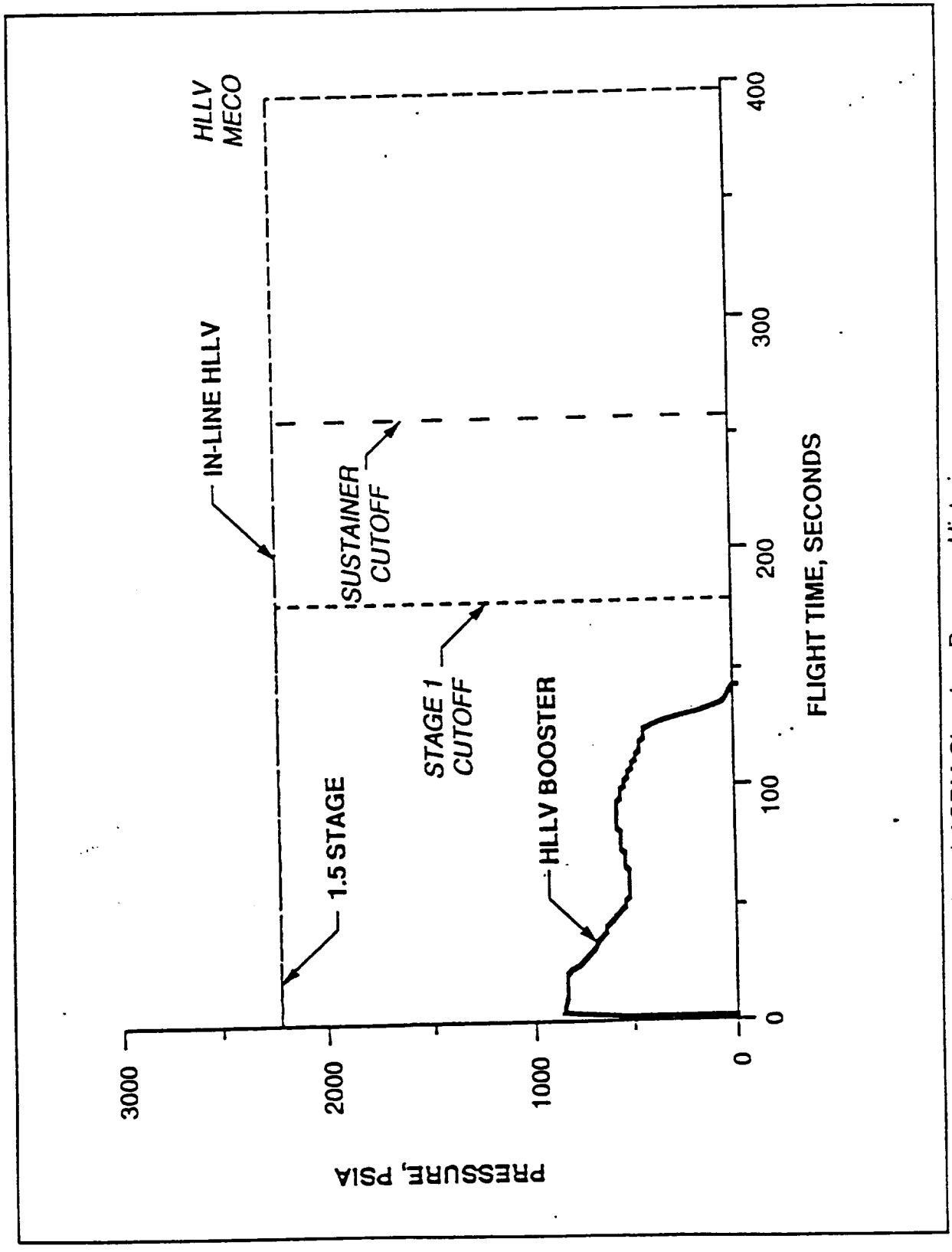


Figure 5: STME and ASRM Chamber Pressure Histories

HLLV TRAJECTORY

— NEW ED35 AERO DATA 3/2
6/91 – HLLV W/ASRM 4g cons
DEG TO 220 X 30 with 4
10-APR-1991 12:59:52.61

Input File: DISK$USER5:[MASTRE.OPG.HLLV.MARCUS]HLLV5FT_4G.DAT;11
Output File: DISK$USER5:[MASTRE.OPG.HLLV.MARCUS]HLLV5FT_4G.OPG;12
Plot File: DISK$USER5:[MASTRE.OPG.HLLV.MARCUS]HLLV5FT_4G.PLT;12
Scratch File: DISK$USER5:[MASTRE.OPG.HLLV.MARCUS]HLLV5FT_4G.ASC;12

1.5 STAGE TRAJECTORY

@ 400K' — STAGE 1.5 — 4
0:1 — 6.0:1 — STANDARD ET
10-MAY-1991 09:03:24.68

Input File: DISK$USER5:[MASTRE.OPG.STAGE.DAVE]S24C3A.DAT;1
Output File: DISK$USER5:[MASTRE.OPG.STAGE.DAVE]S24C3A.OPG;2
Plot File: DISK$USER5:[MASTRE.OPG.STAGE.DAVE]S24C3A.PLT;2
Scratch File: DISK$USER5:[MASTRE.OPG.STAGE.DAVE]S24C3A.ASC;2

Figure 6: HLLV and 1.5 Stage Preliminary Trajectory Descriptions

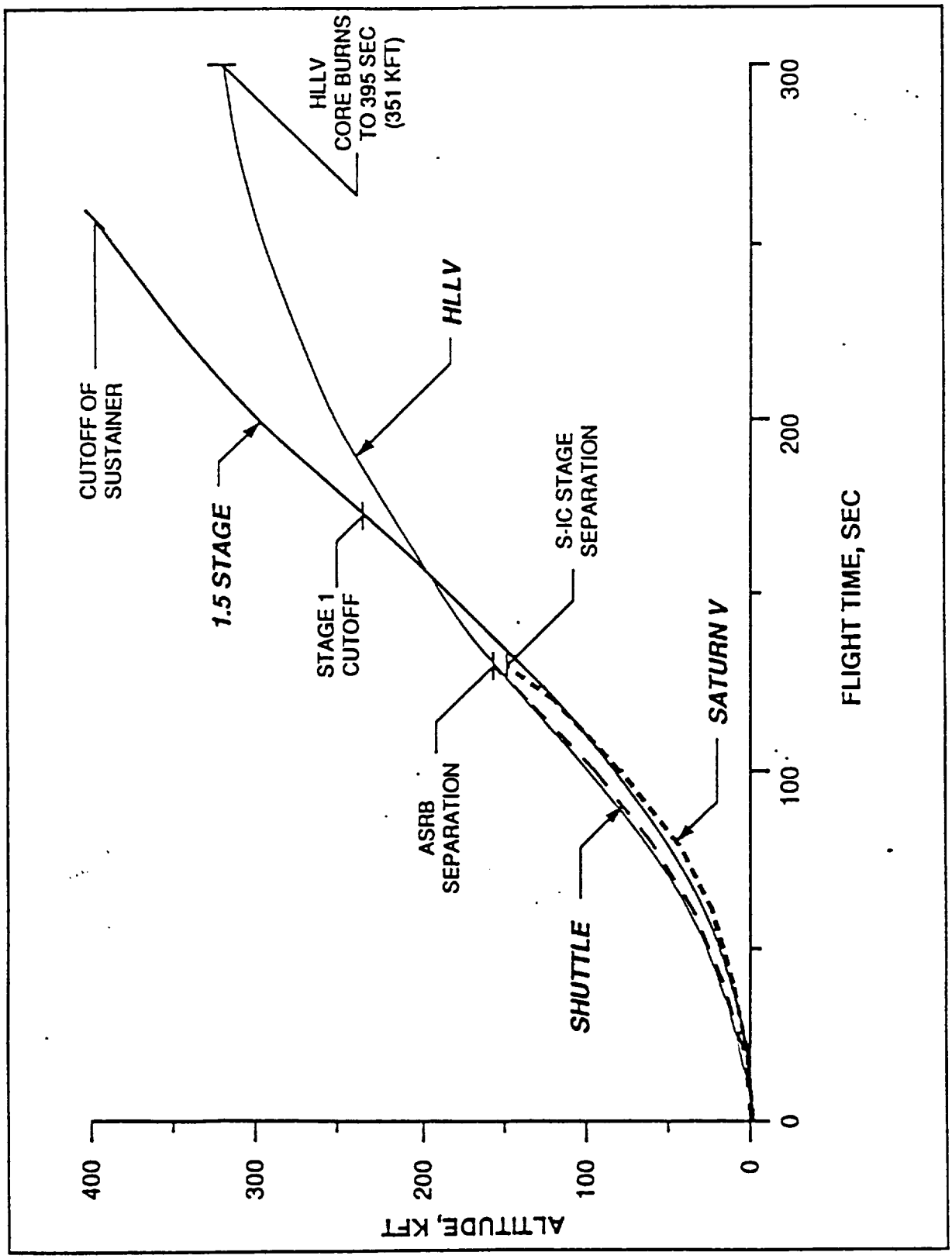


Figure 7: Preliminary Trajectory Time-Altitude Comparisons

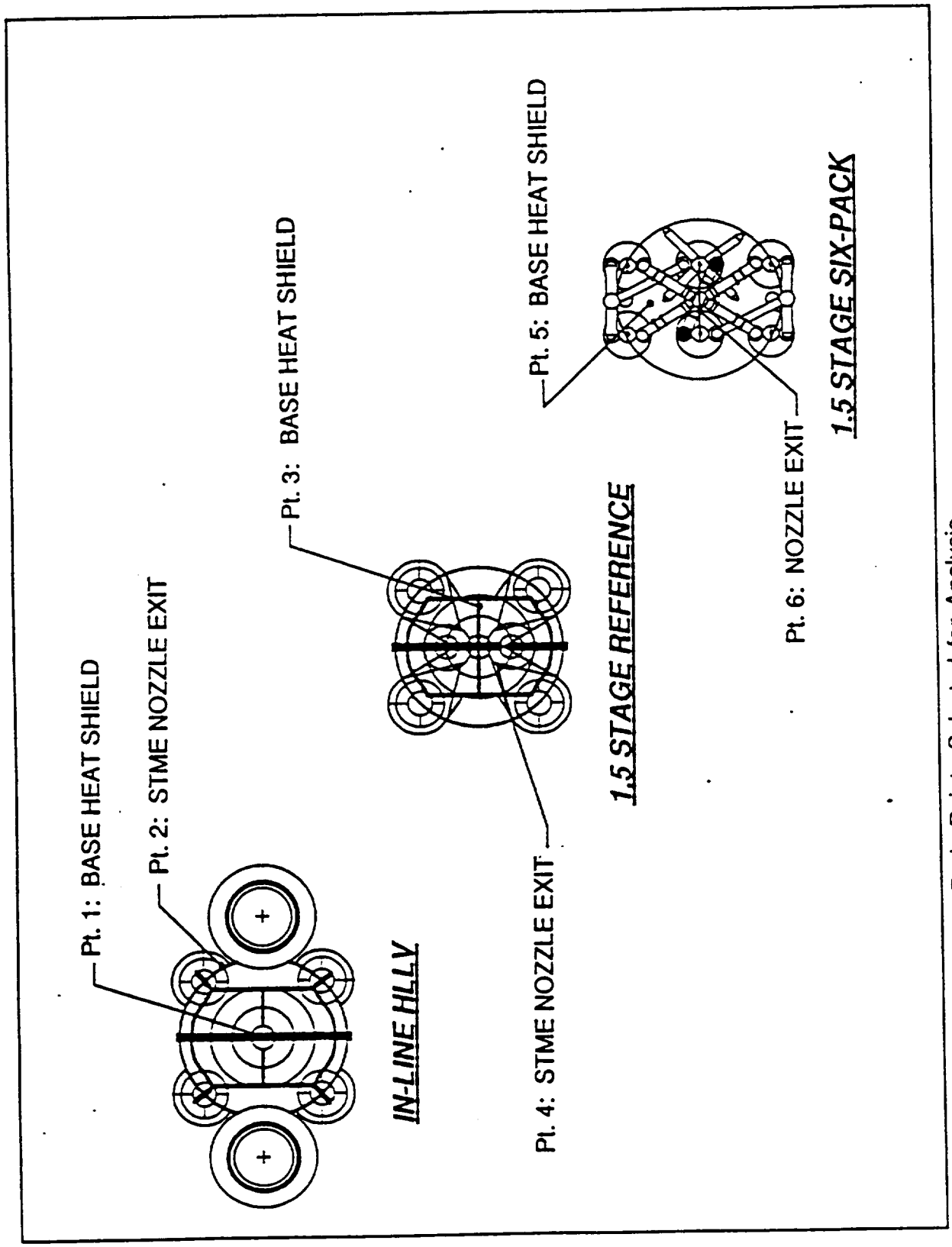


Figure 8: Body Points Selected for Analysis

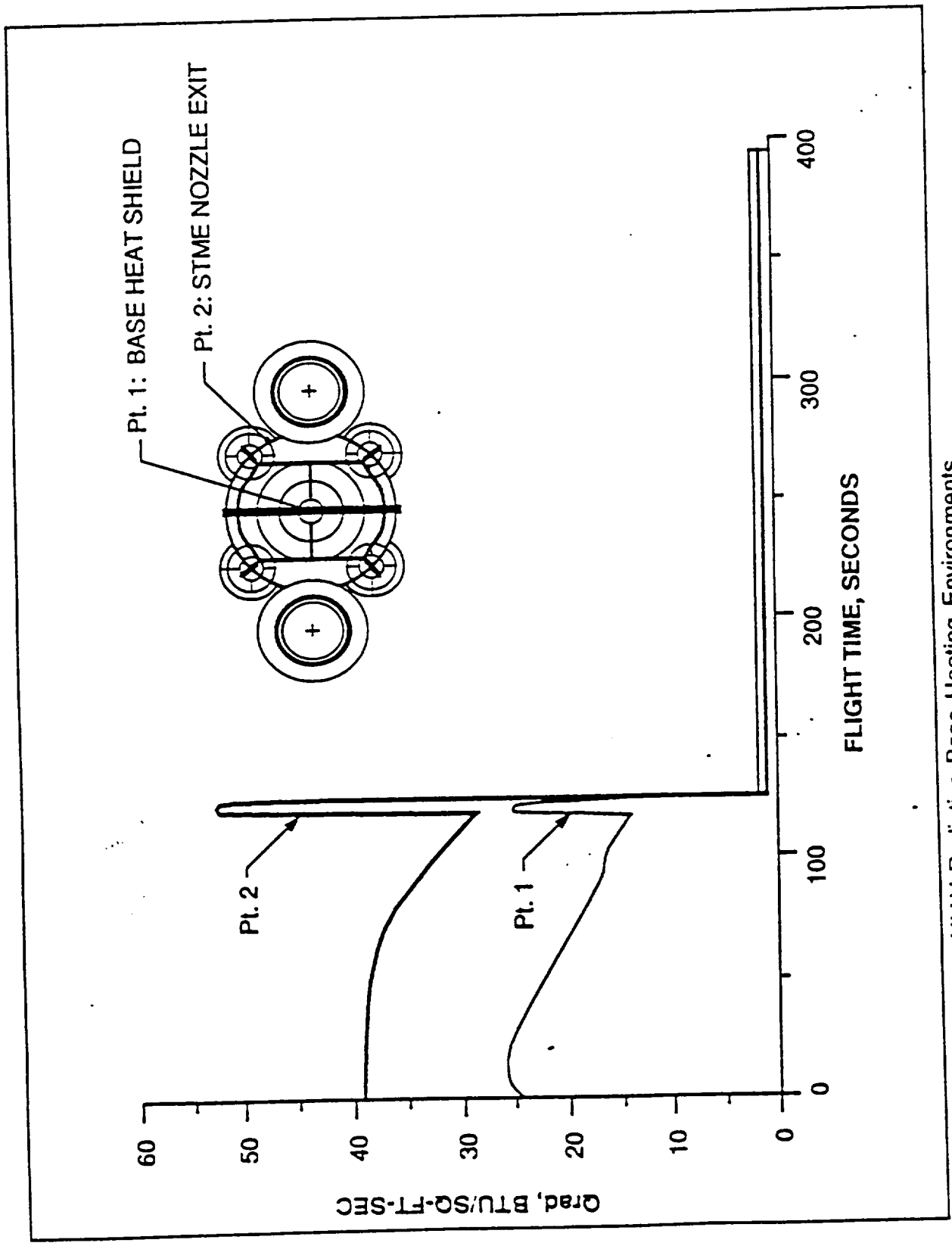


Figure 9: HLLV Radiative Base Heating Environments

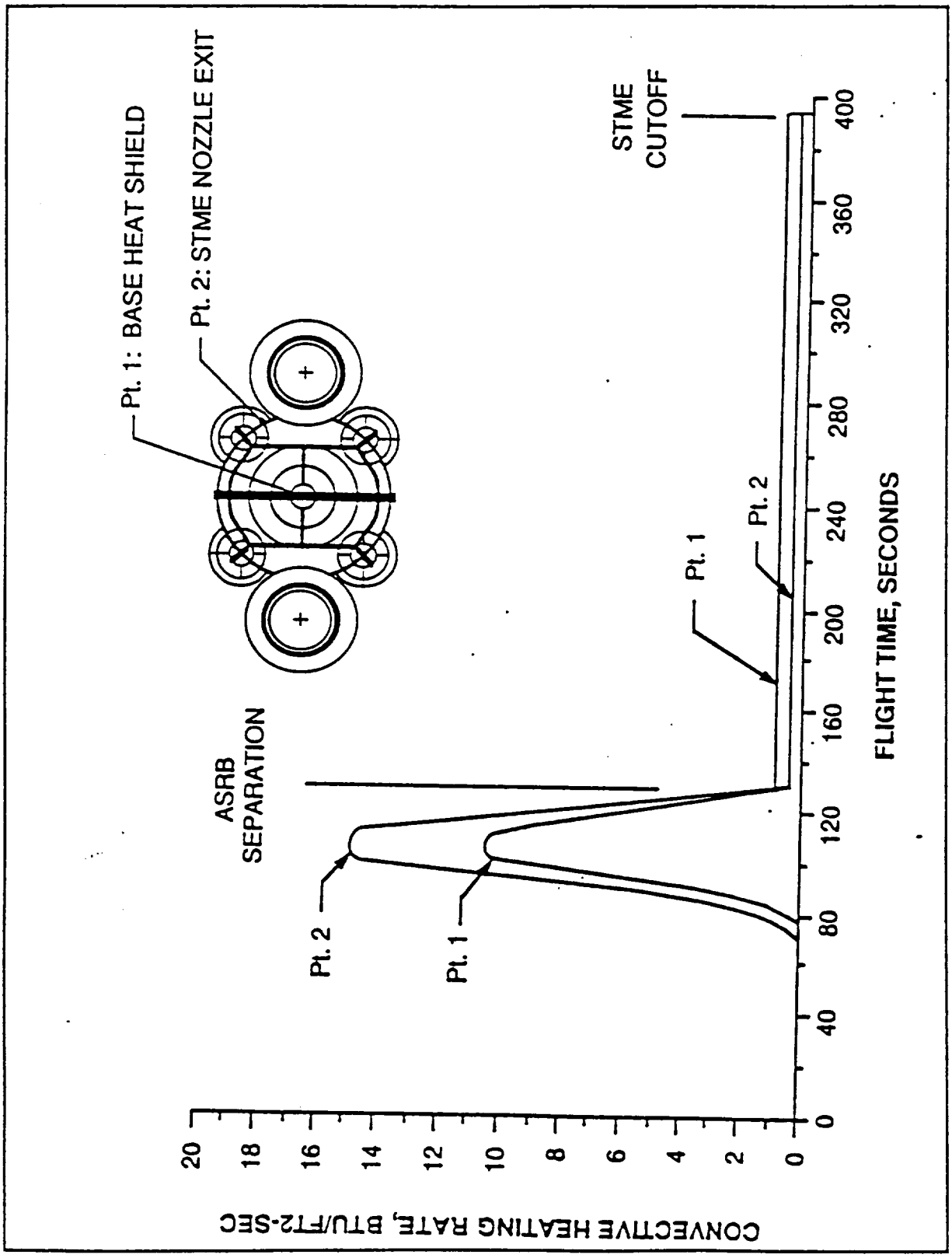


Figure 10: HLLV Convective Base Heating Environments

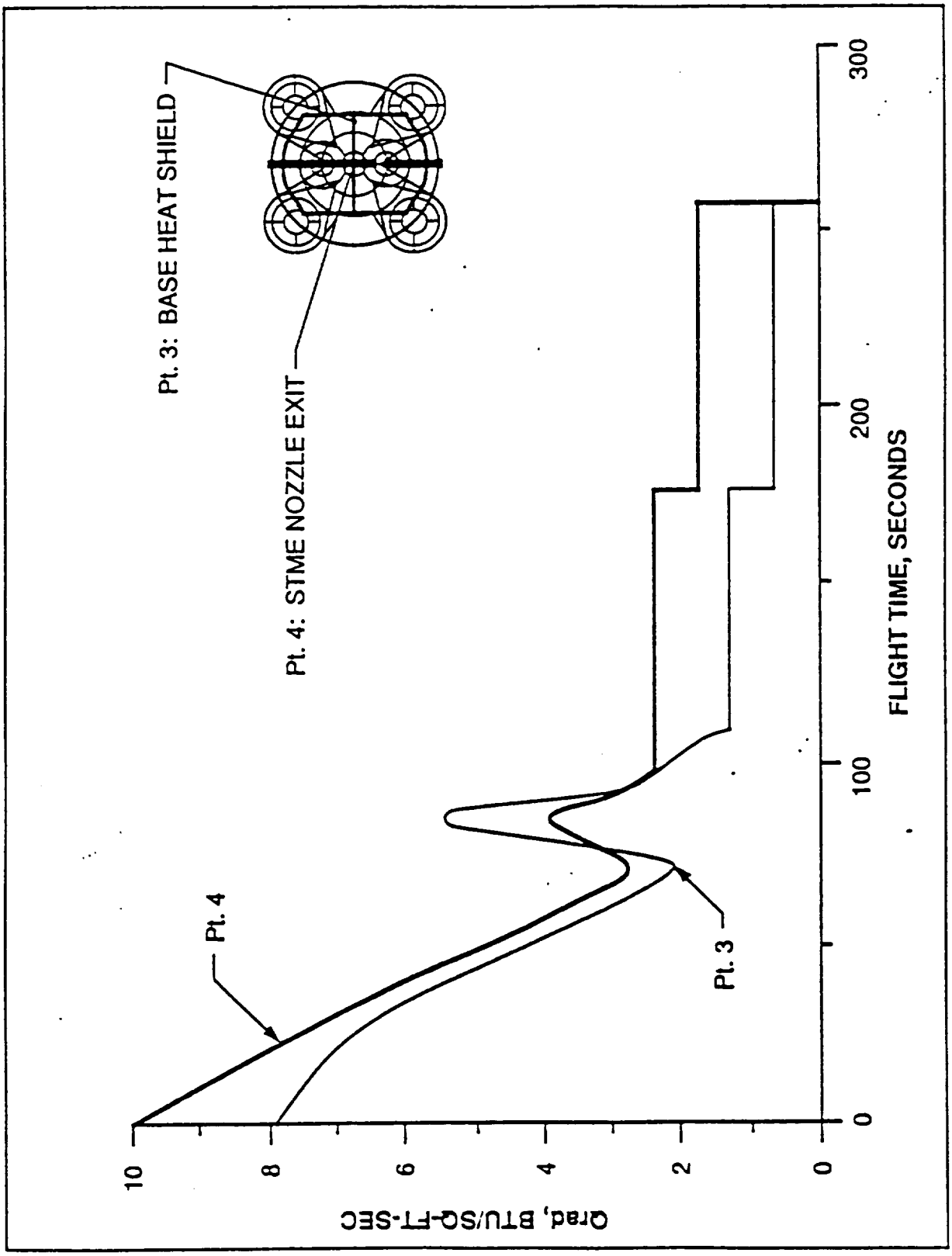


Figure 11: 1.5 Stage Reference Radiative Base Heating Environments

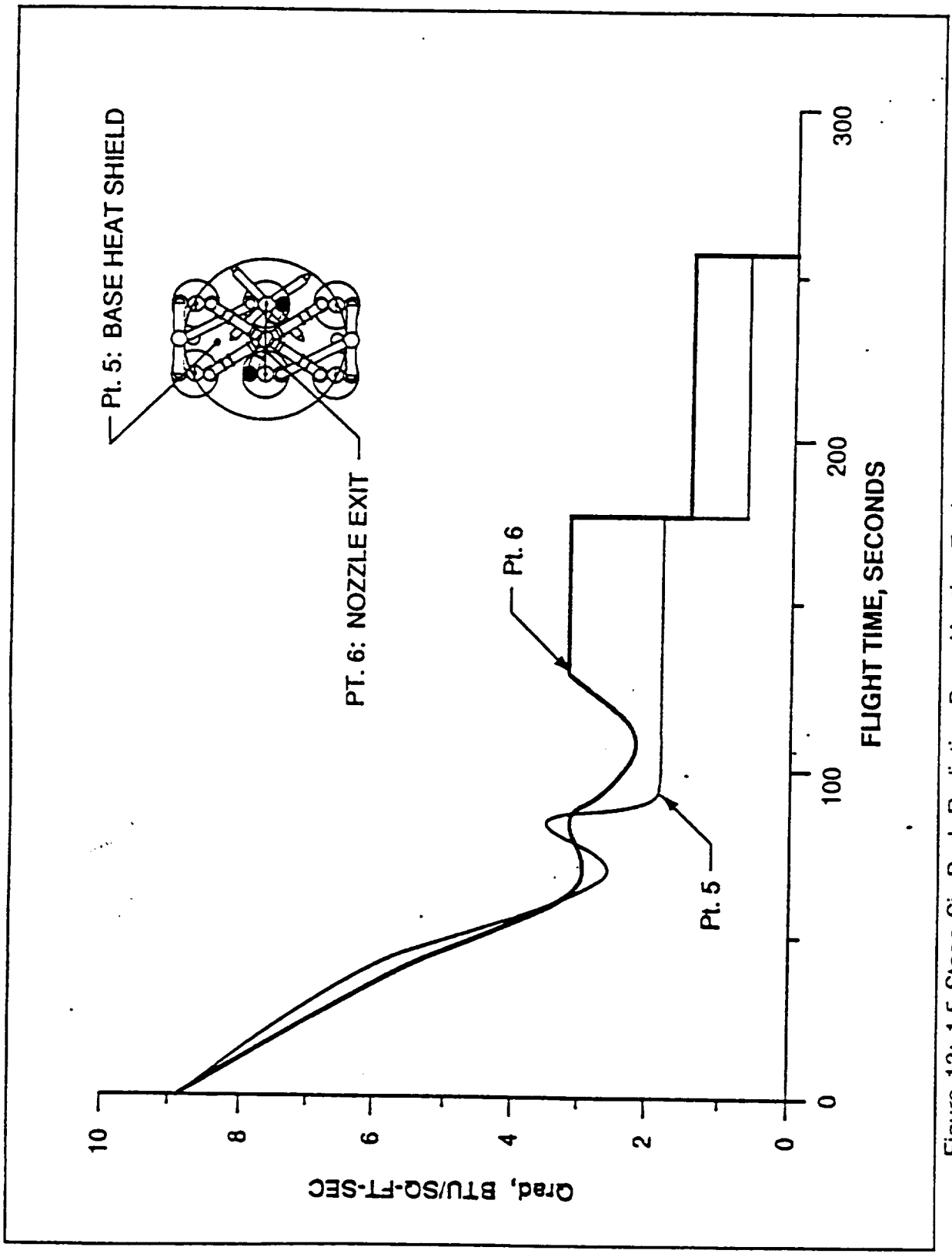


Figure 13: 1.5 Stage Six-Pack Radiative Base Heating Environments

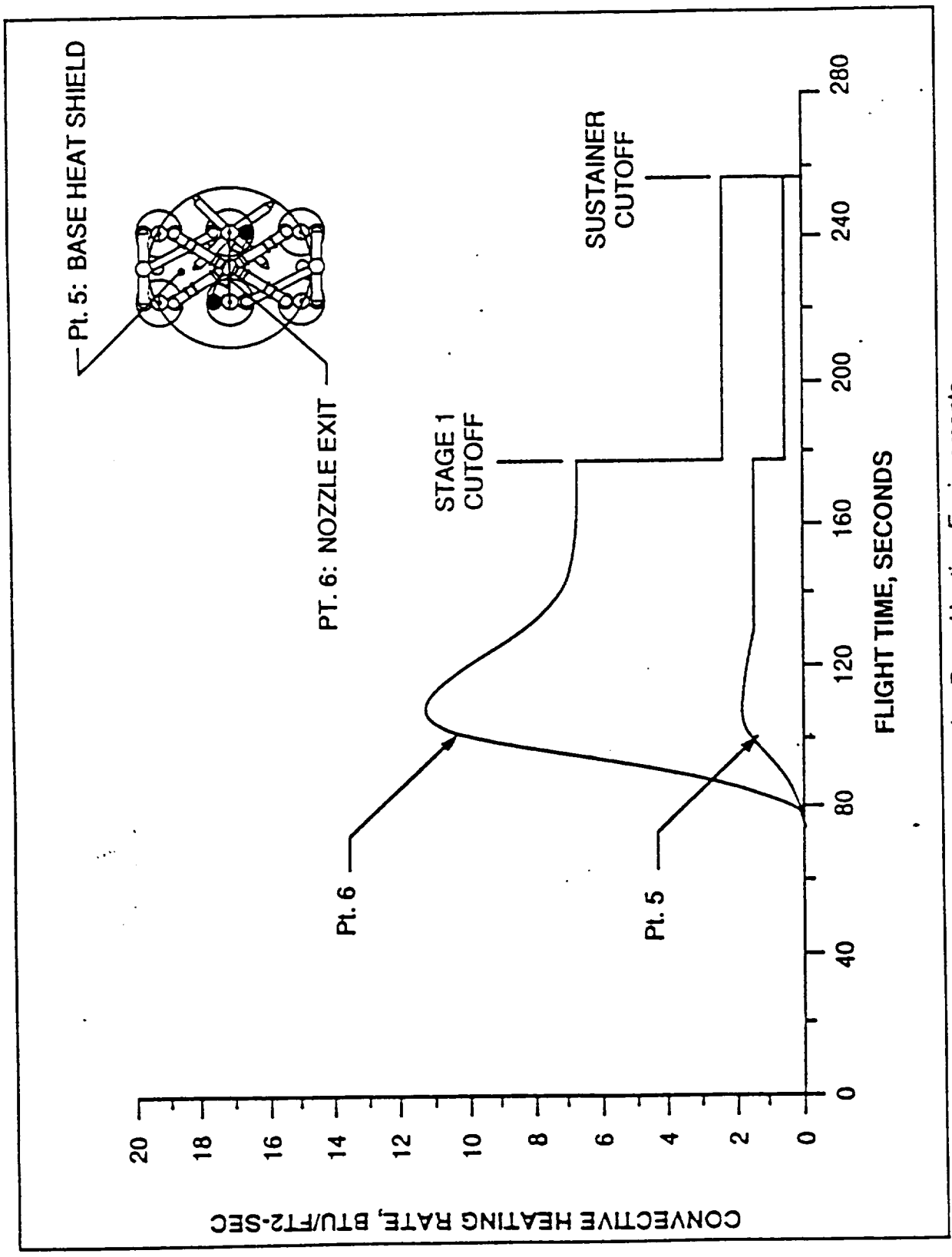
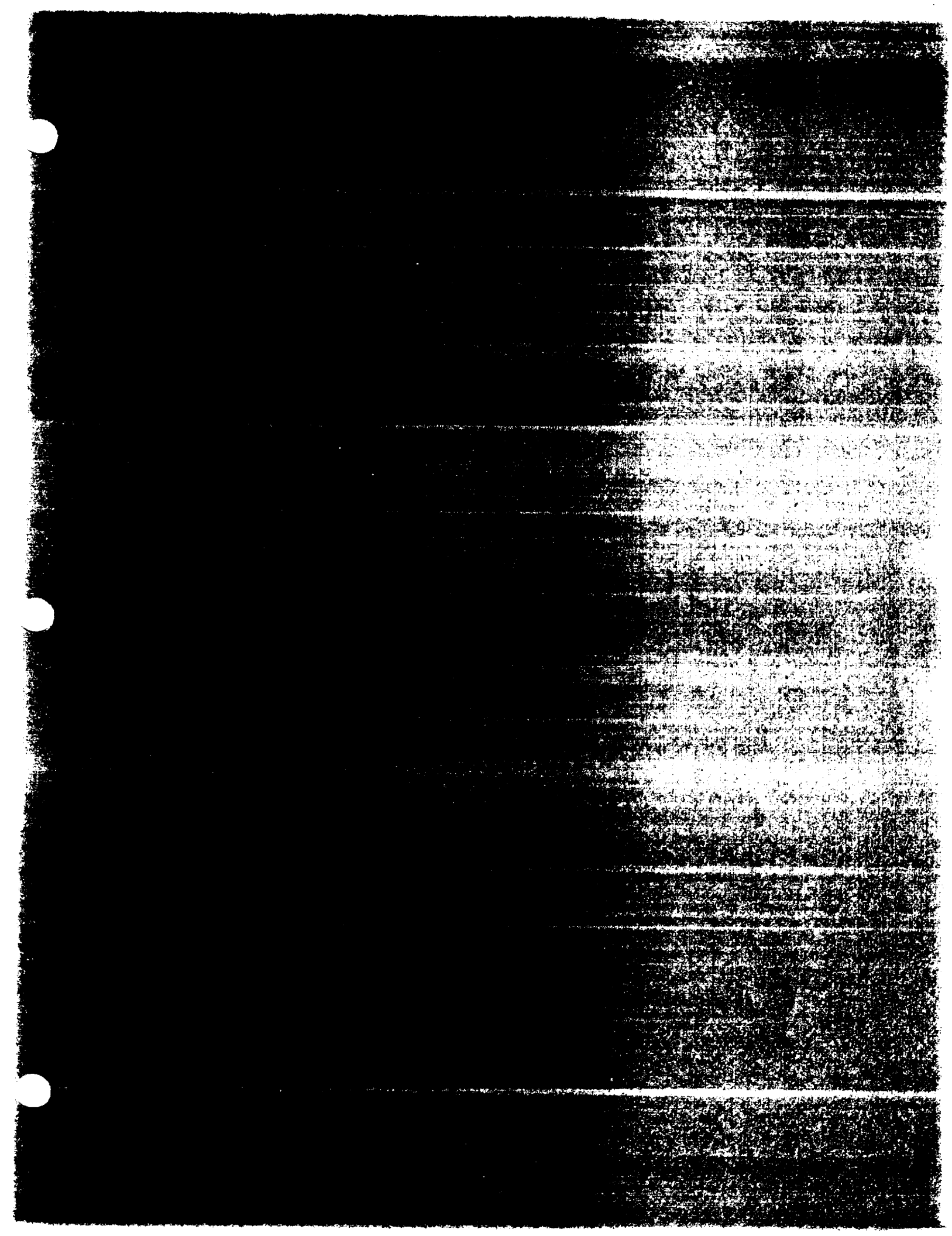


Figure 14: 1.5 Stage Six-Pack Convective Base Heating Environments



REMTECH TECHNICAL NOTE

SUBJECT: Cycle 1 NLS Base Heating Environments

DATE: January 24, 1992

AUTHORS: Robert L. Bender, Maurice J. Prendergast, and John E. Reardon

CONTRACT NO.: NAS8-38141

PREPARED FOR: Marshall Space Flight Center ED33

INTRODUCTION

Preliminary NLS Cycle 1 base heating environments have been previously reported in Refs. [1,2]. The environments reported in those references represented early efforts to quantify the base heating for a few selected points in the base region. Both HLLV and 1.5 Stage vehicles were considered. In recent months an intensive effort has been under way to better understand and quantify the additional base heating resulting from burning of the STME turbine exhaust discharge gases. Improved plume models have also been developed to improve plume radiation predictions. Additional body points in the base region were also considered to assist the TPS designers and STPT engine thermal analysts. In addition, the analyses reflect trajectories tailored to maximize base heating and operational parameters such as throttling and engine out which are part of the latest reference mission. The environments presented in this technical note reflect conservative assumptions and methodology and are representative of typical preliminary design estimates.

INPUTS

The base configurations for the HLLV and 1.5 Stage vehicles shown in Figs. 1 and 2 were provided by MSFC in the NLS System Definition data package dated May 31, 1991 [3]. General design information specifying the shape and location of proposed base heat shield and STME heat shields was extracted from Boeing presentation material [4] updated by the telephone conversation with Keith Luschei [5] of the Boeing Defense and Space Group. Configuration data defining the ASRB utilized on the HLLV was extracted from Refs. [6–8]. Similar information describing the STME was provided by the STPT in an engine characteristics description package [9].

The HLLV and 1.5 Stage vehicle trajectories were prepared by MSFC EP55 and reported in Refs. [10,11], respectively. The trajectories reflect long-burn-time exposure to heating which is accomplished through 3σ low ASRM and STME thrust dispersions. HLLV trajectories also reflect one STME out from lift-off; 1.5 Stage trajectories include STME throttling in the 40 to 120 second time interval.

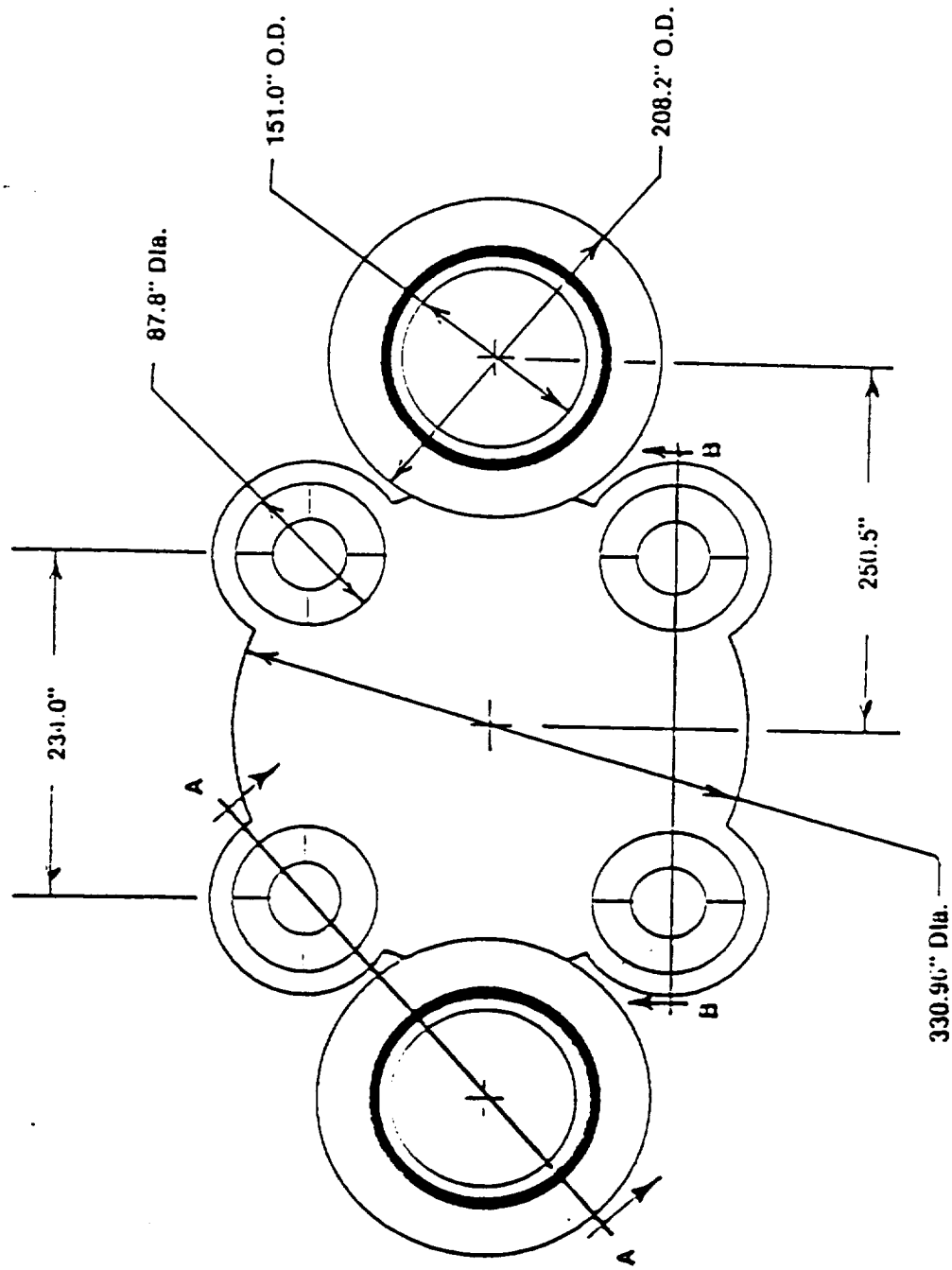


Figure 1: NLS HLLV Base Configuration

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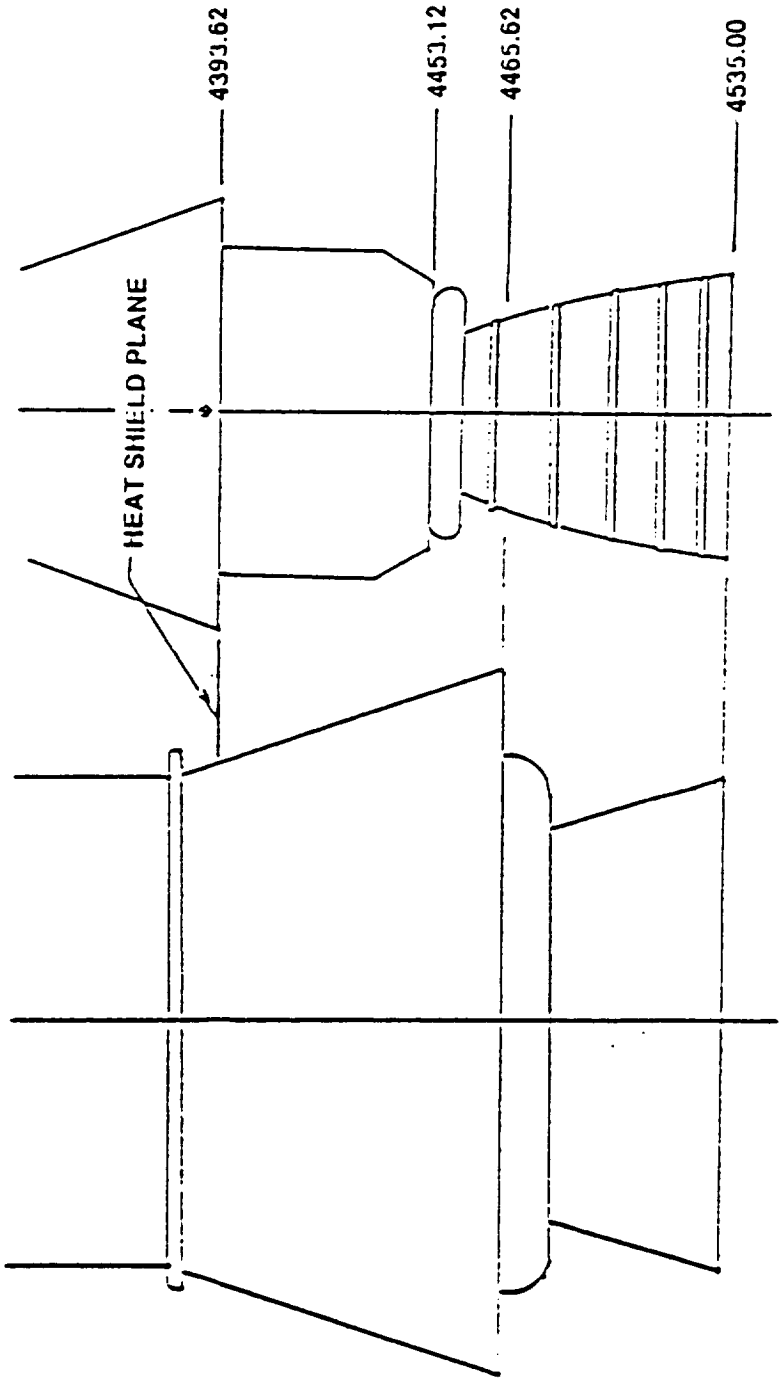

Figure 1: (Continued) NLS HLLV Base Configuration

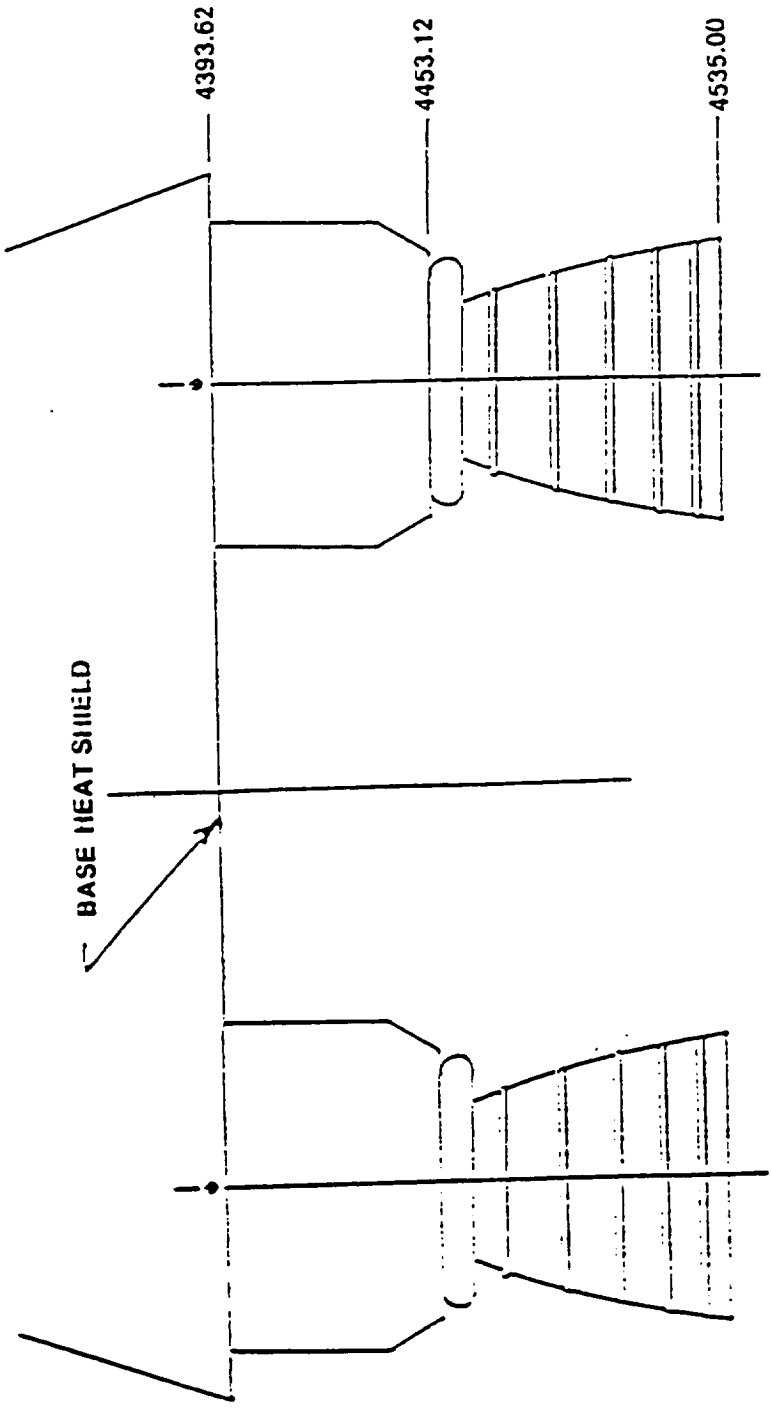

Figure 1: (Concluded) NLS HLLV Base Configuration

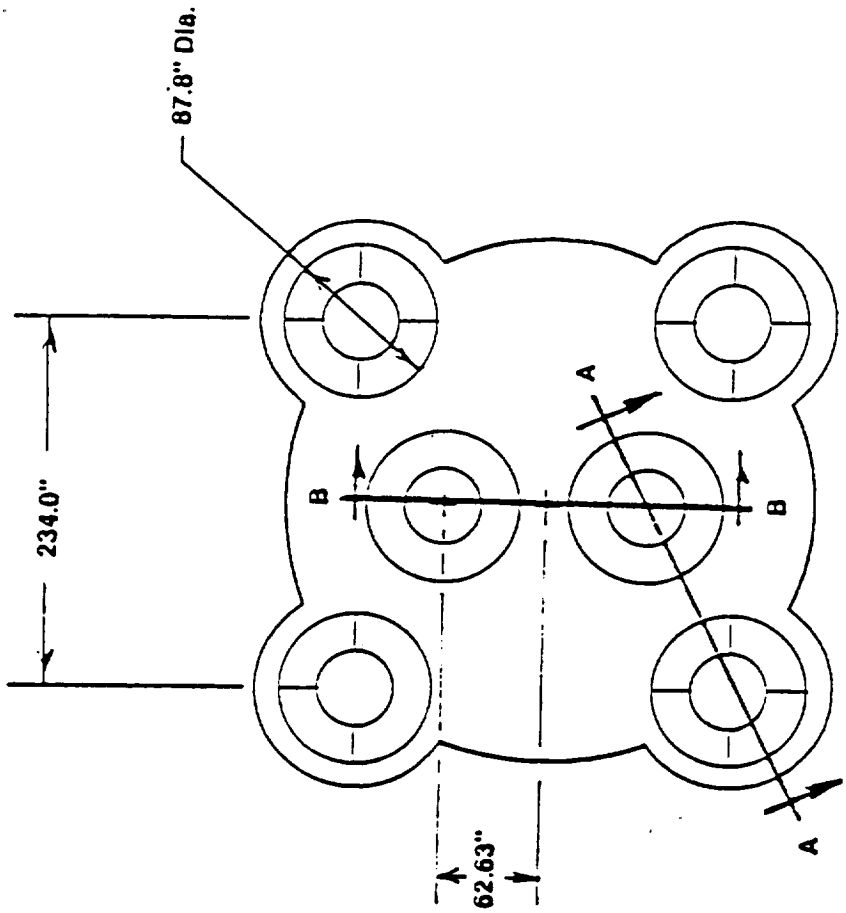

Figure 2: NLS 1.5 Stage Base Configuration

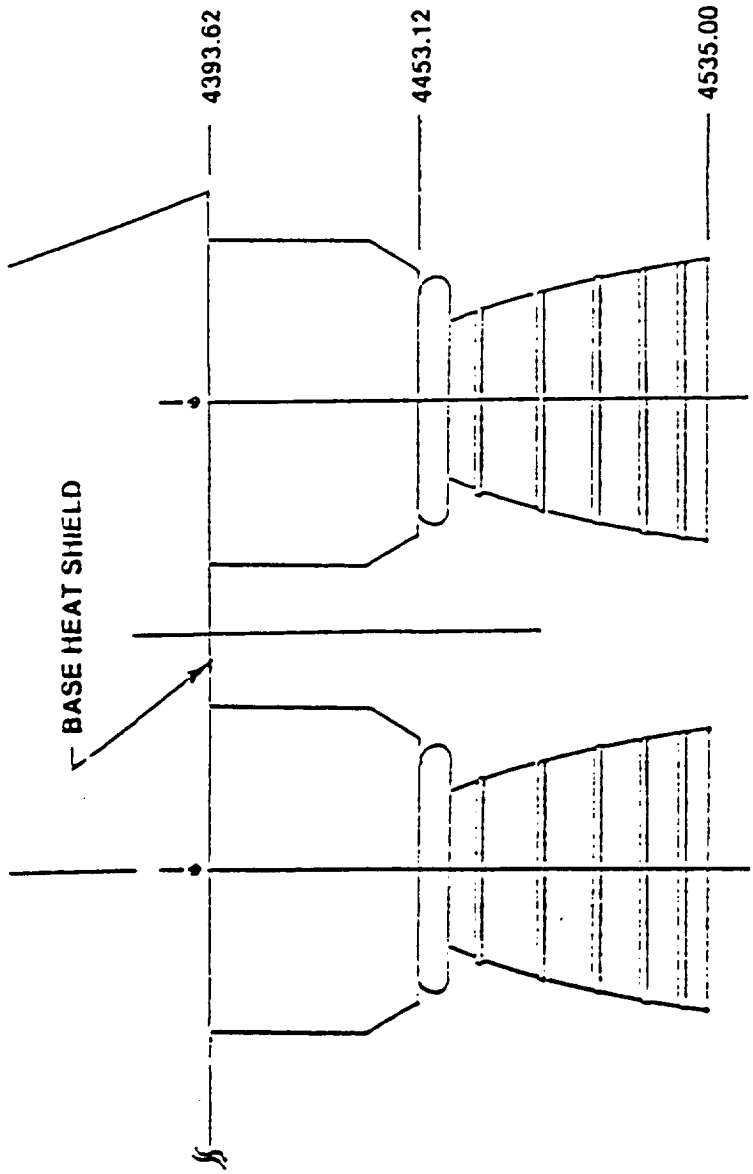

Figure 2: (Continued) NLS 1.5 Stage Base Configuration

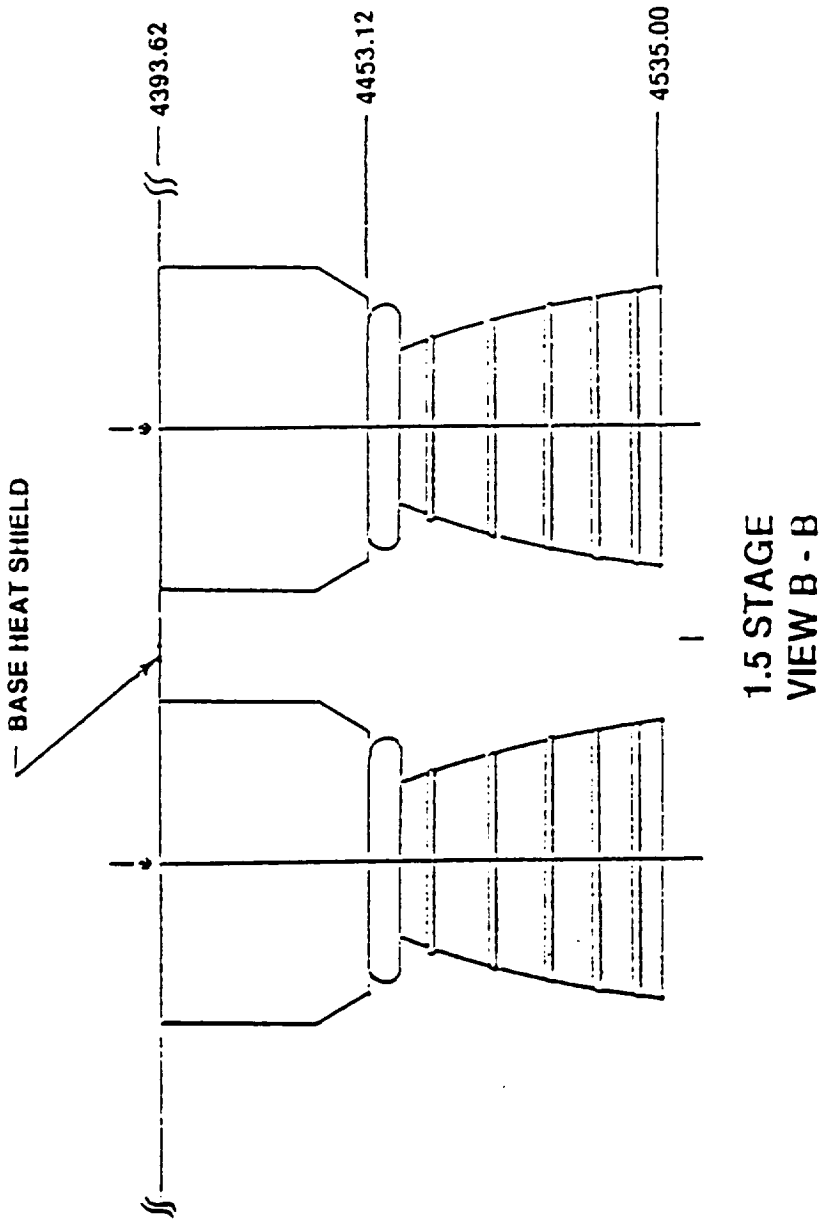

Figure 2: (Continued) NLS 1.5 Stage Base Configuration

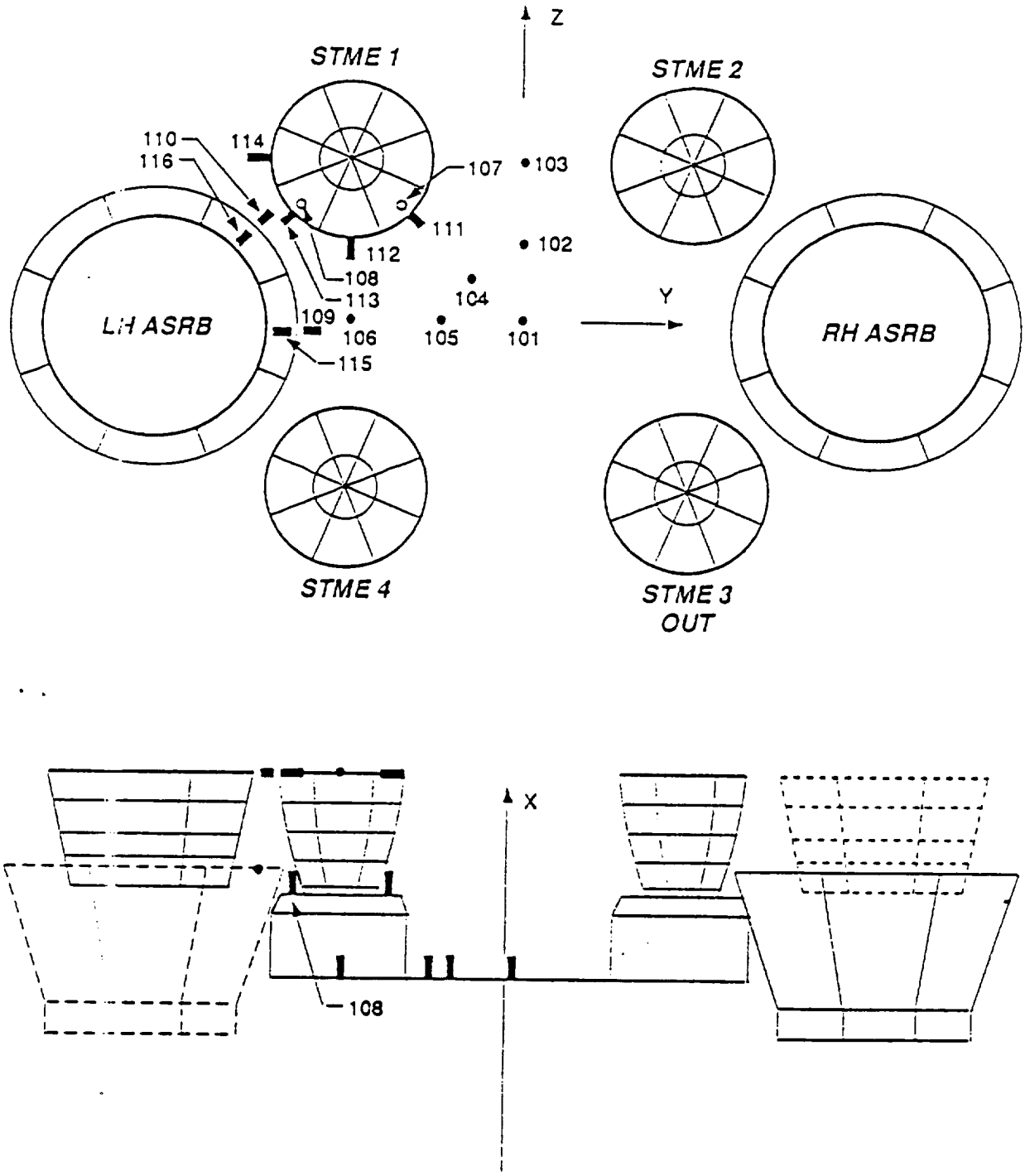

Figure 3: HLLV Body Points Selected for Base Heating Analysis

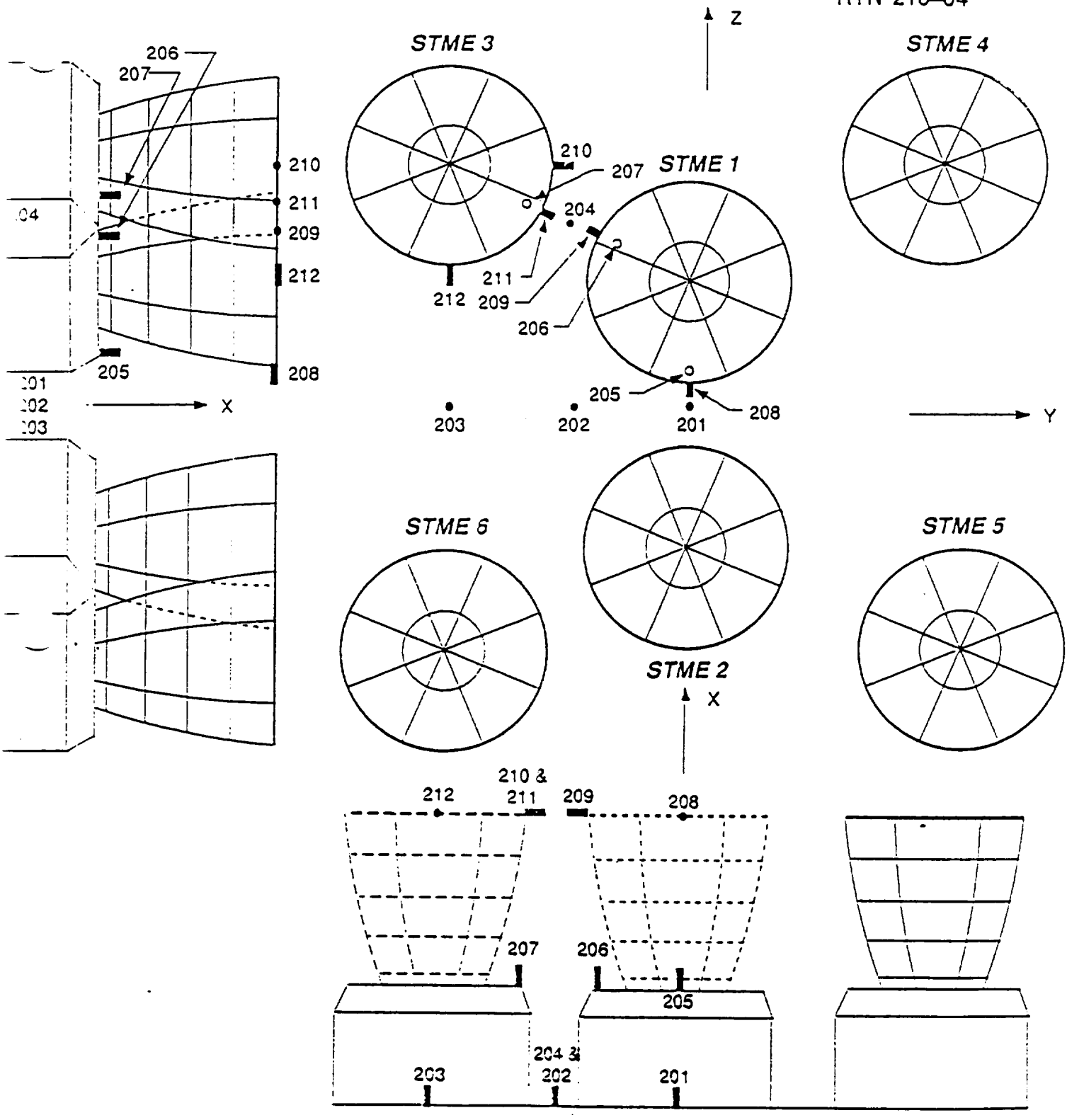

Figure 4: 1.5 Stage Body Points Selected for Base Heating Analysis

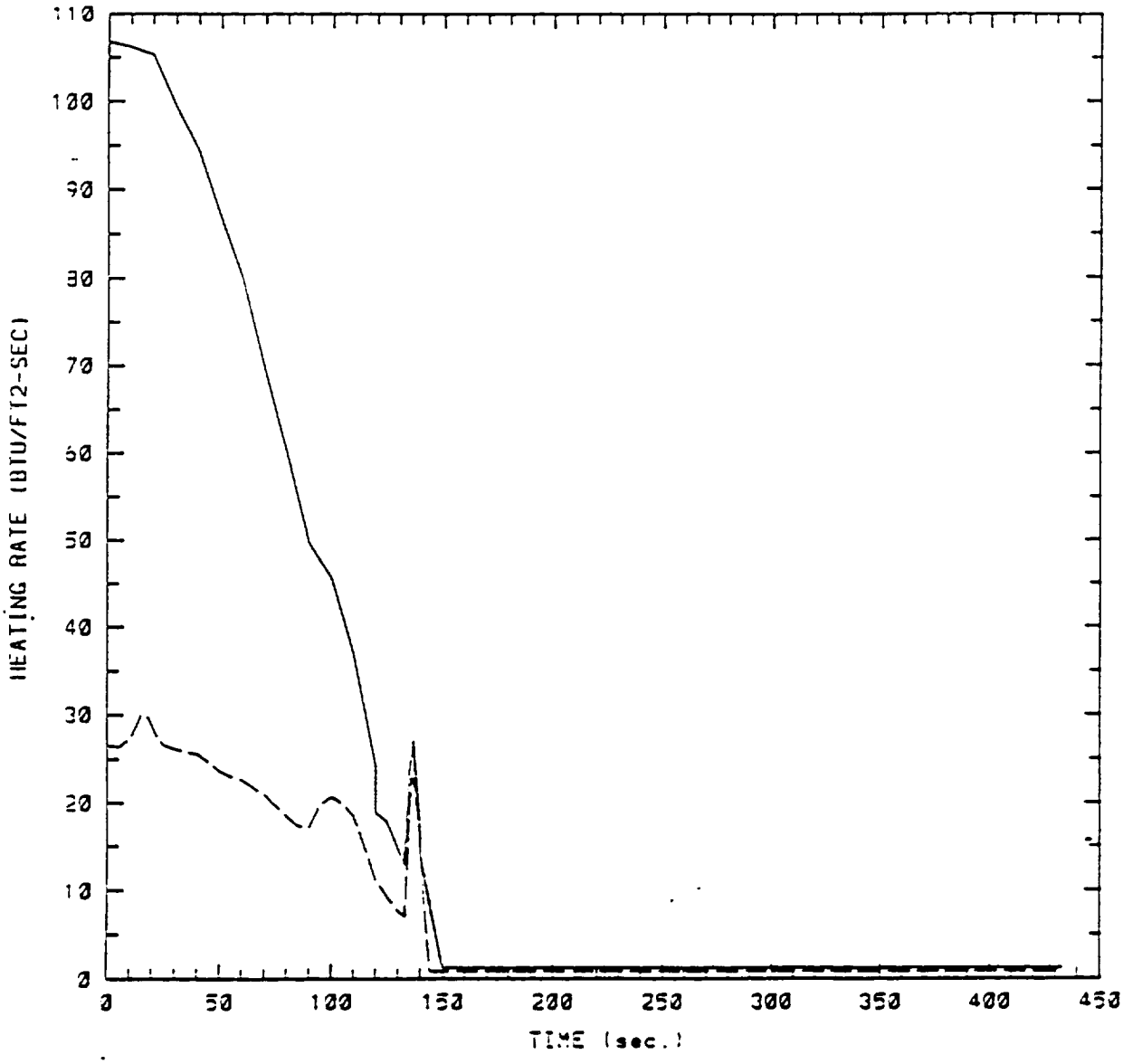

Figure 5: Radiation and Total Base Heating —
HLLV Core Base Heat Shield Body Point 101

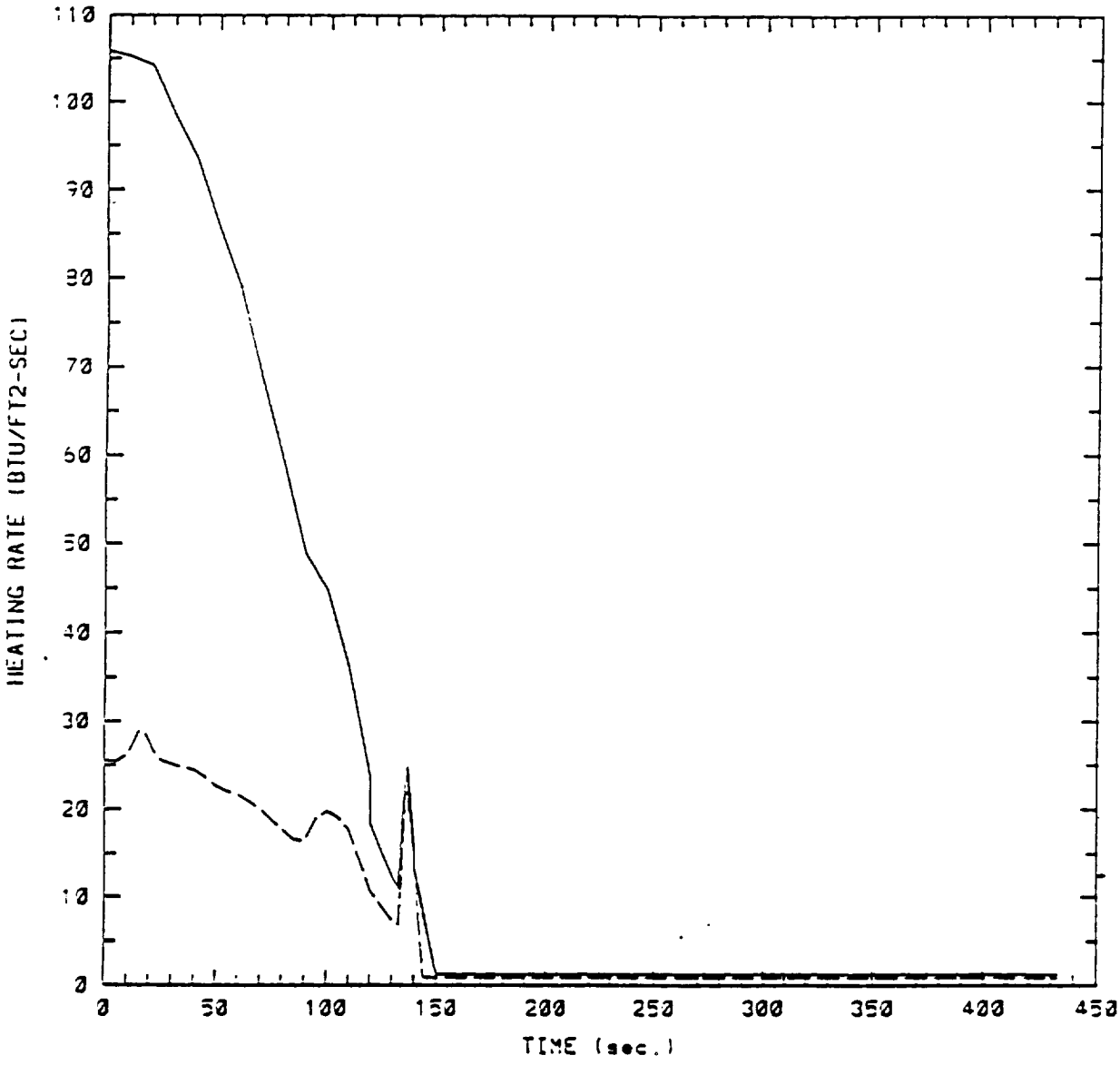

Figure 6: Radiation and Total Base Heating —
HLLV Core Base Heat Shield Body Point 102

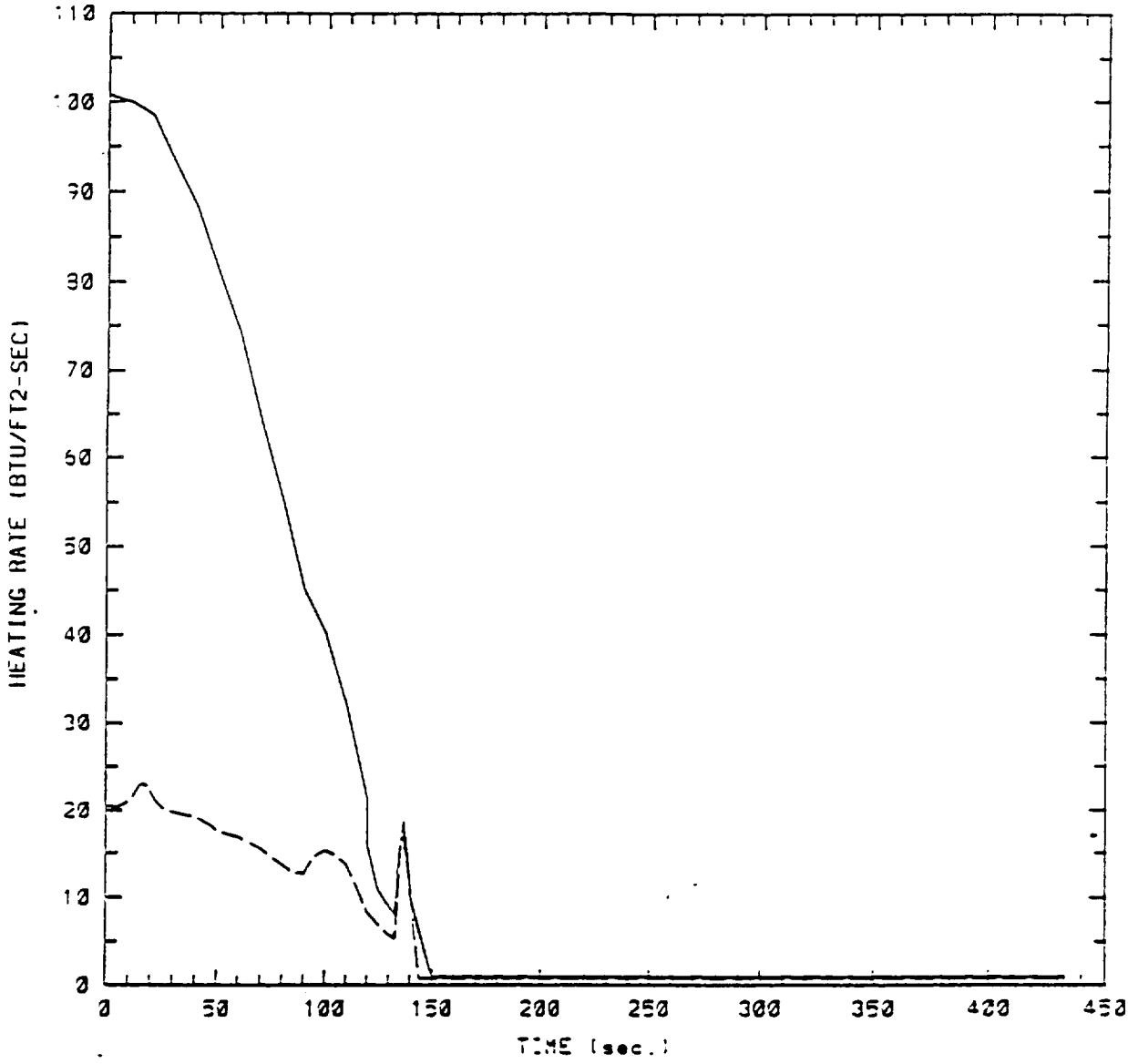

Figure 7: Radiation and Total Base Heating —
HLLV Core Base Heat Shield Body Point 103

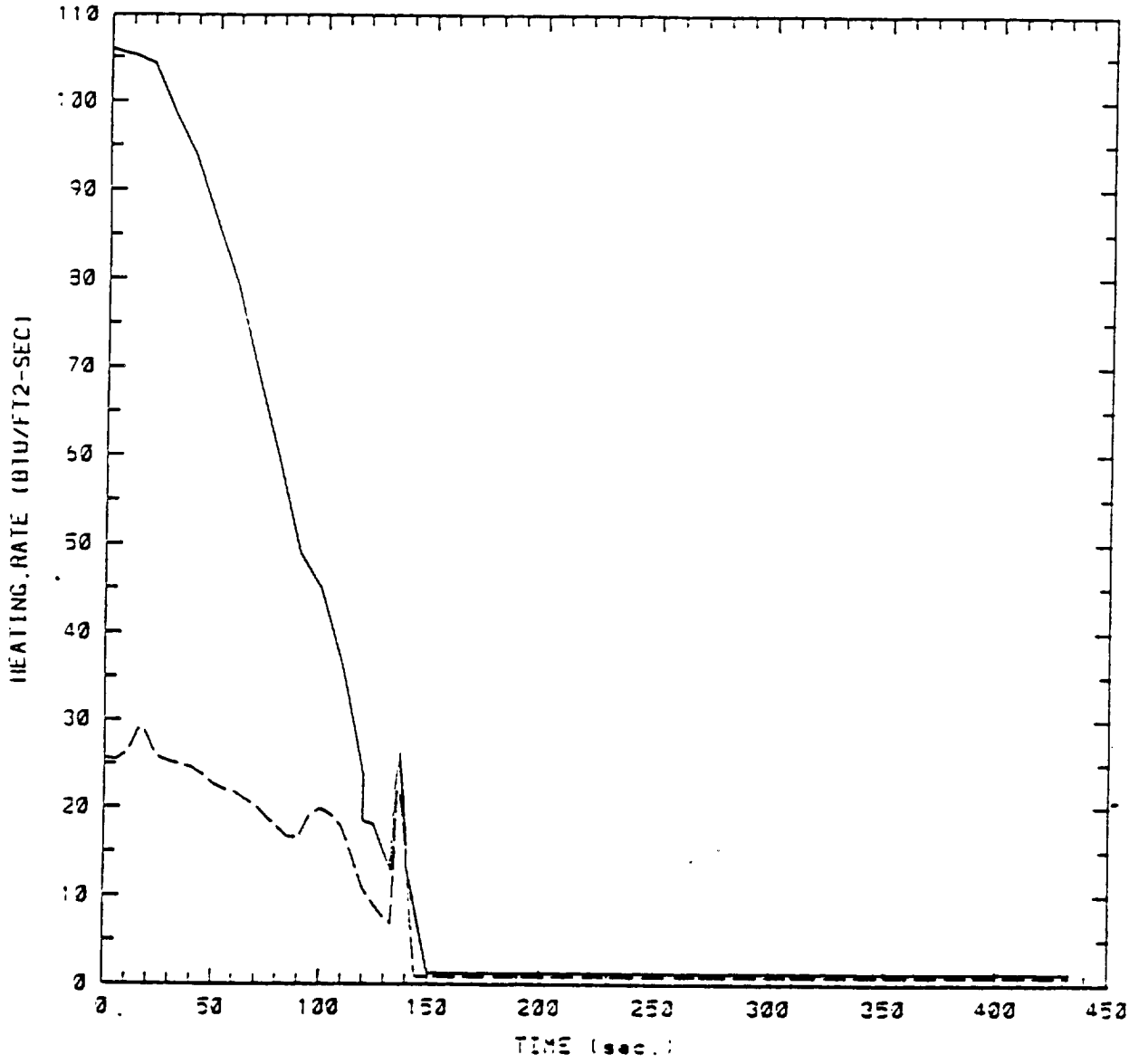

Figure 9: Radiation and Total Base Heating —
HLLV Core Base Heat Shield Body Point 105

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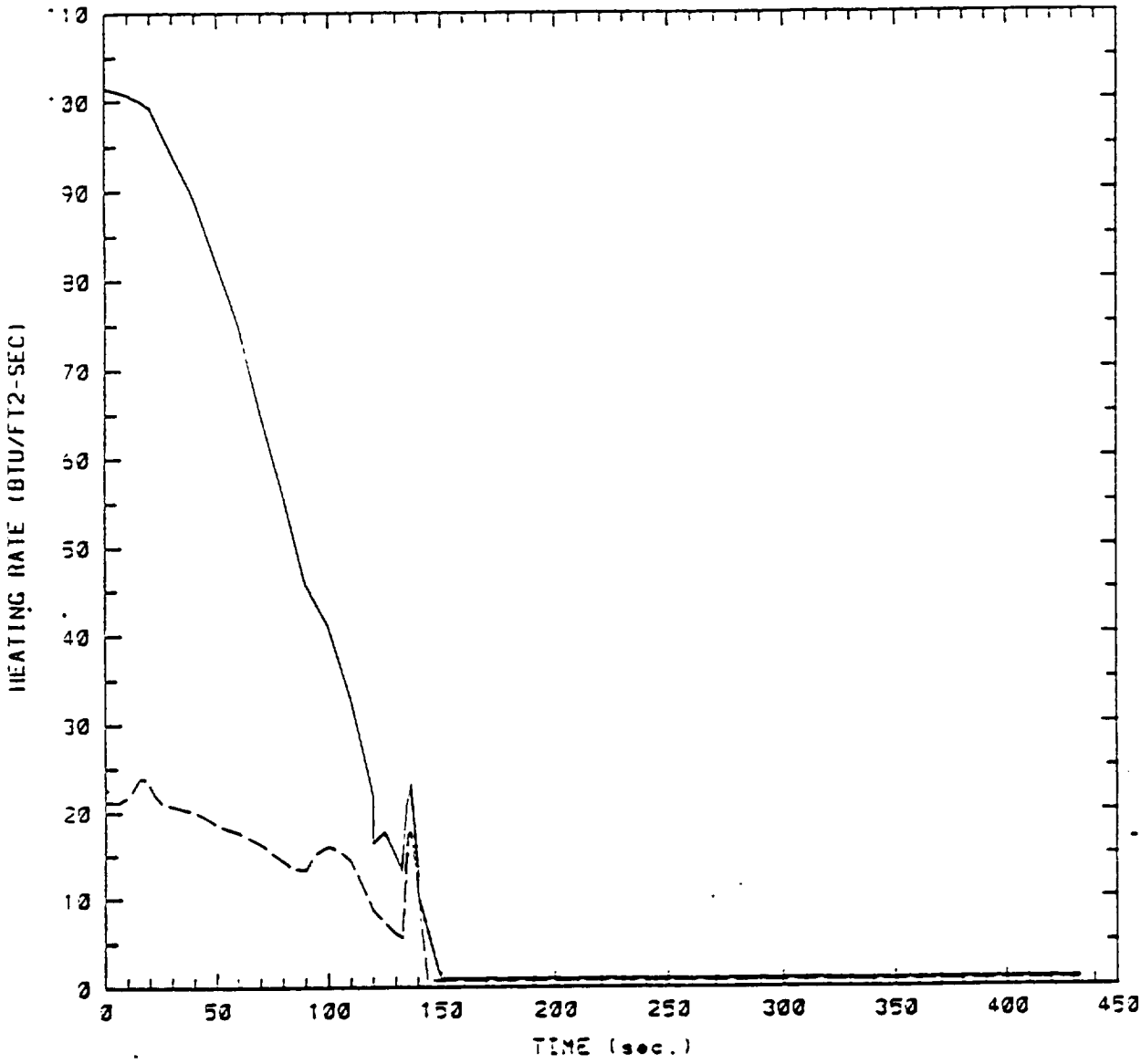

Figure 10: Radiation and Total Base Heating —
HLLV Core Base Heat Shield Body Point 106

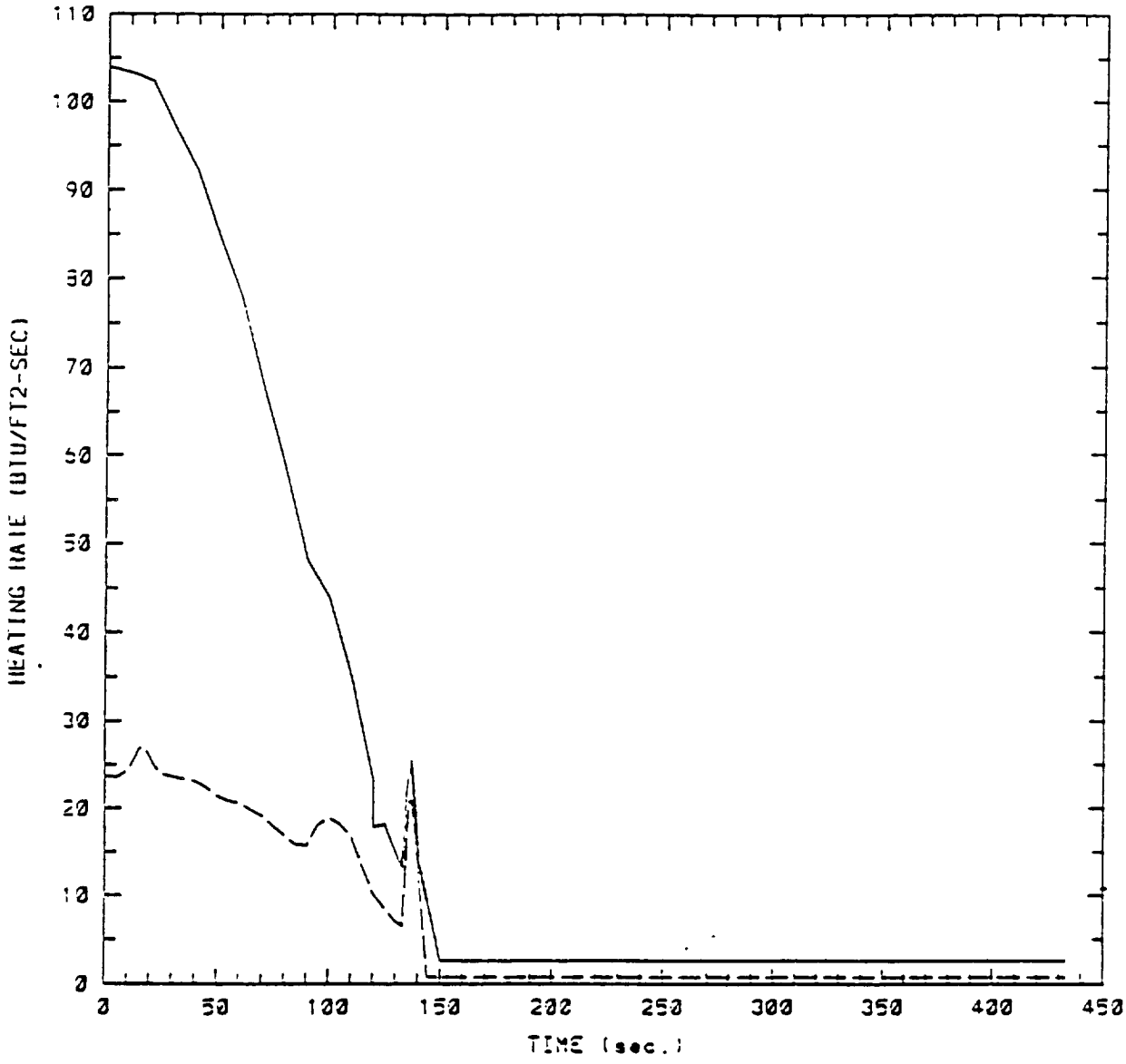

Figure 11: Radiation and Total Base Heating — HLLV STME Heat Shield Body Point 107

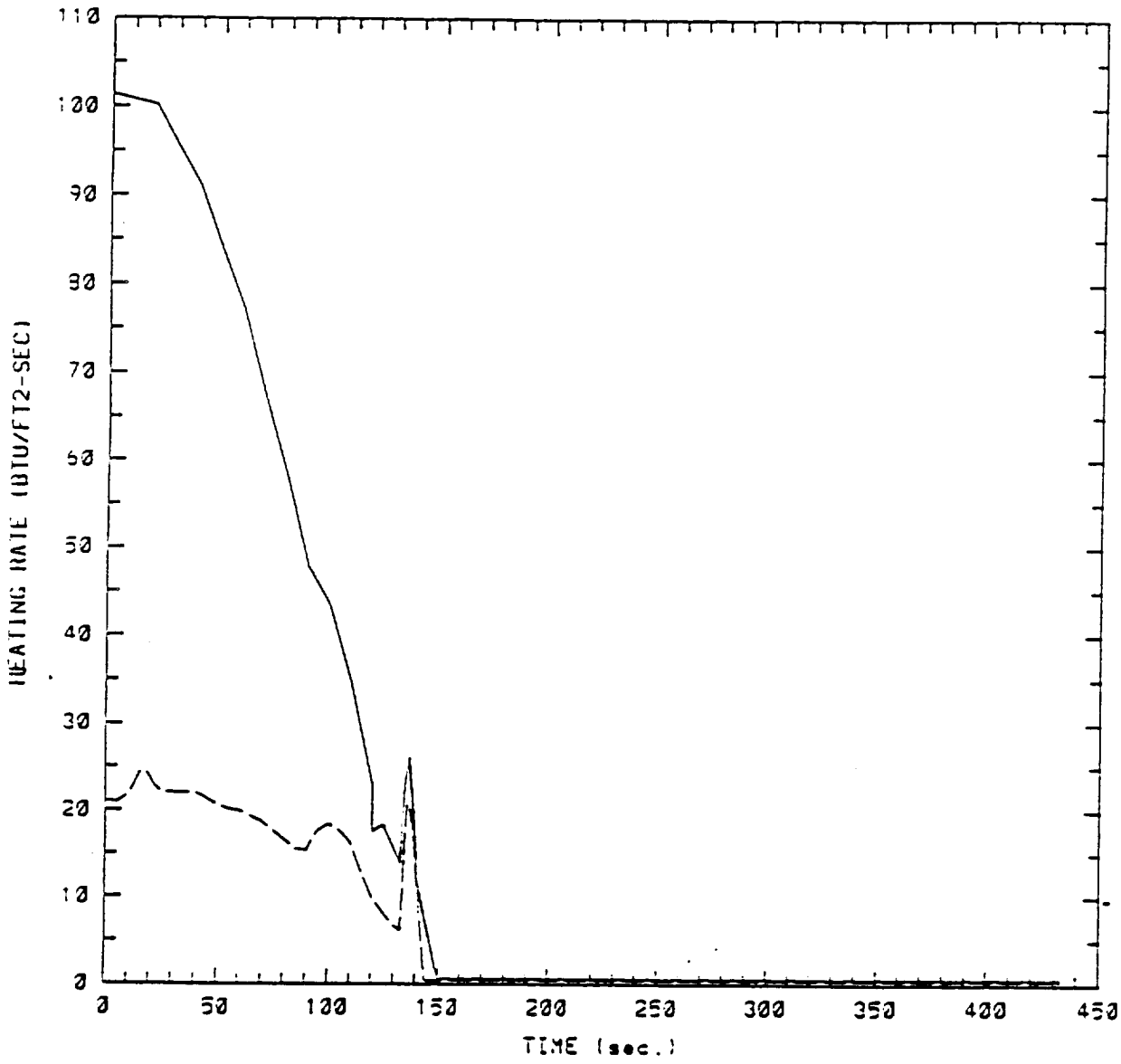

Figure 12: Radiation and Total Base Heating — HLLV STME Heat Shield Body Point 108

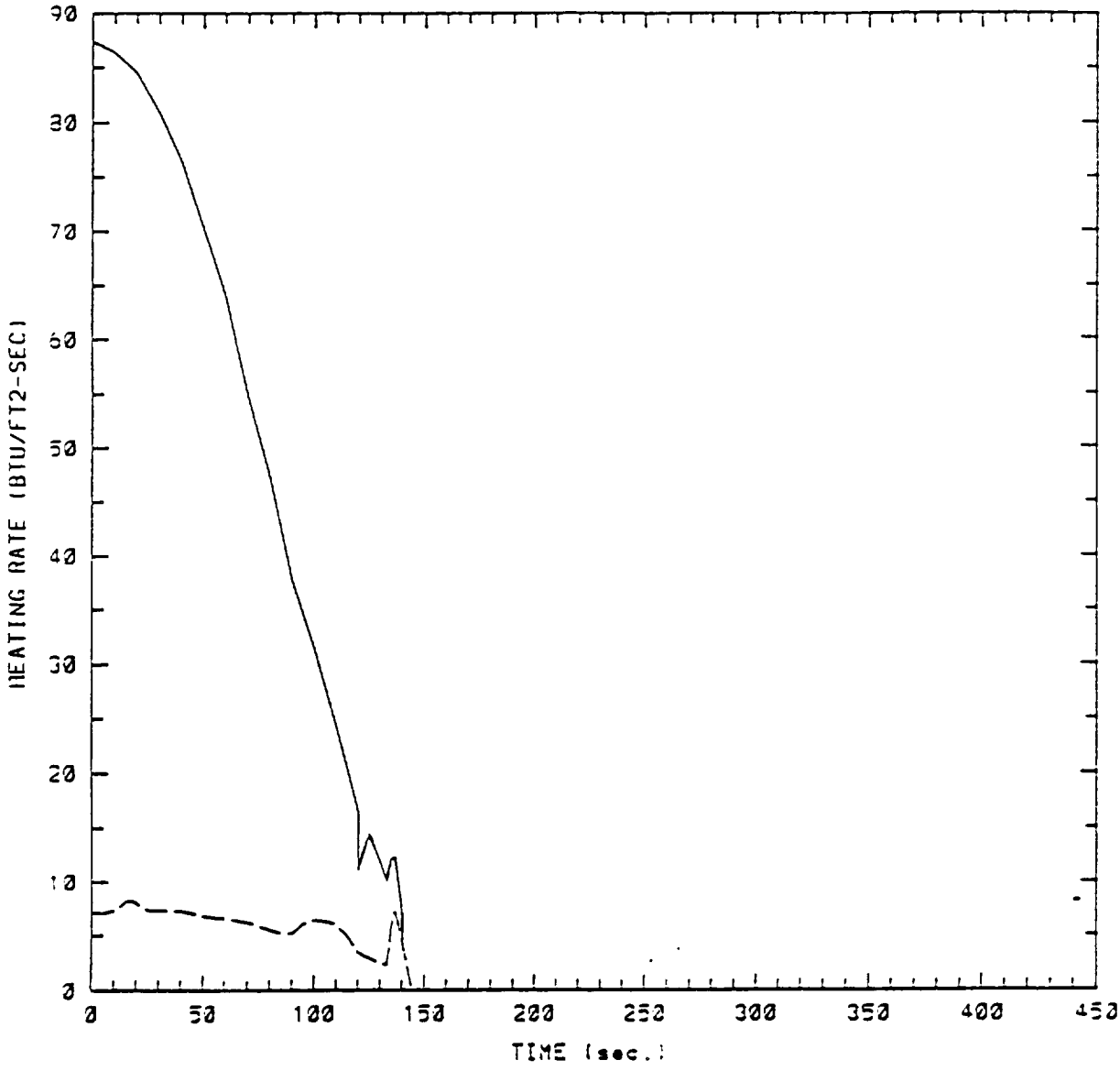

Figure 13: Radiation and Total Base Heating —
HLLV ASRB Skirt Trailing Edge Body Point 109

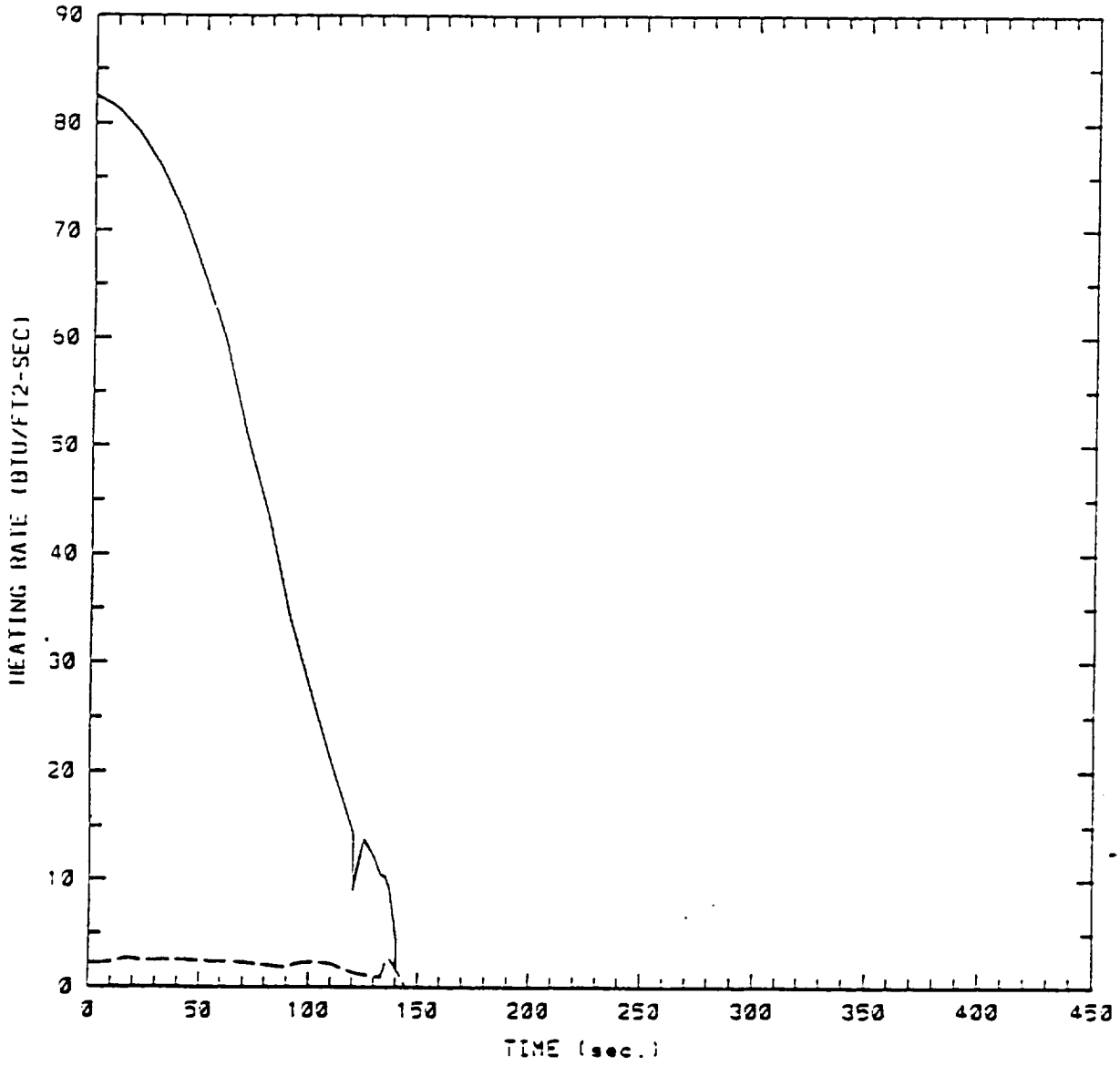

Figure 14: Radiation and Total Base Heating —
HLLV ASRB Skirt Trailing Edge Body Point 110

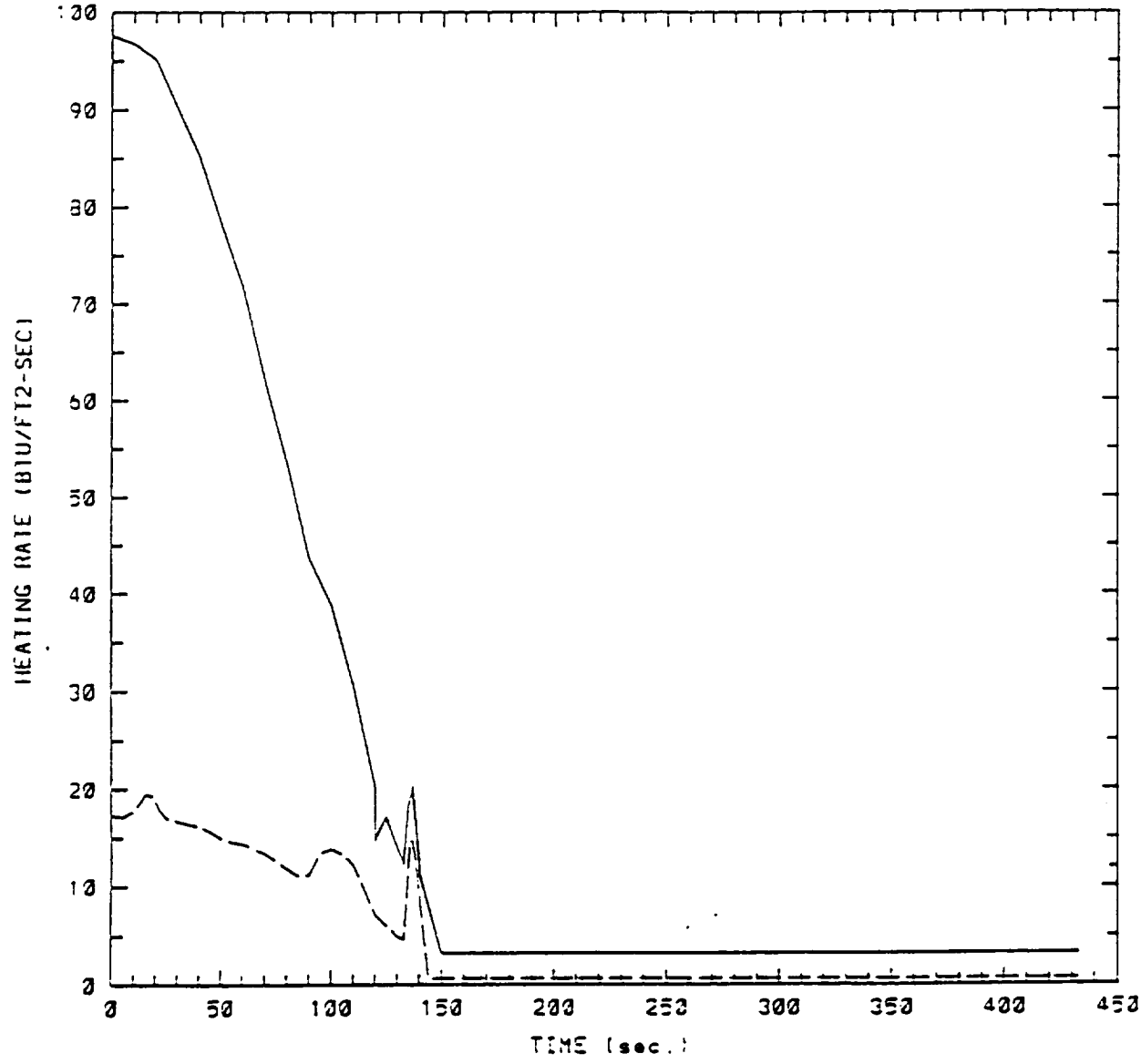

Figure 15: Radiation and Total Base Heating — HLLV STME Nozzle Exit Body Point 111

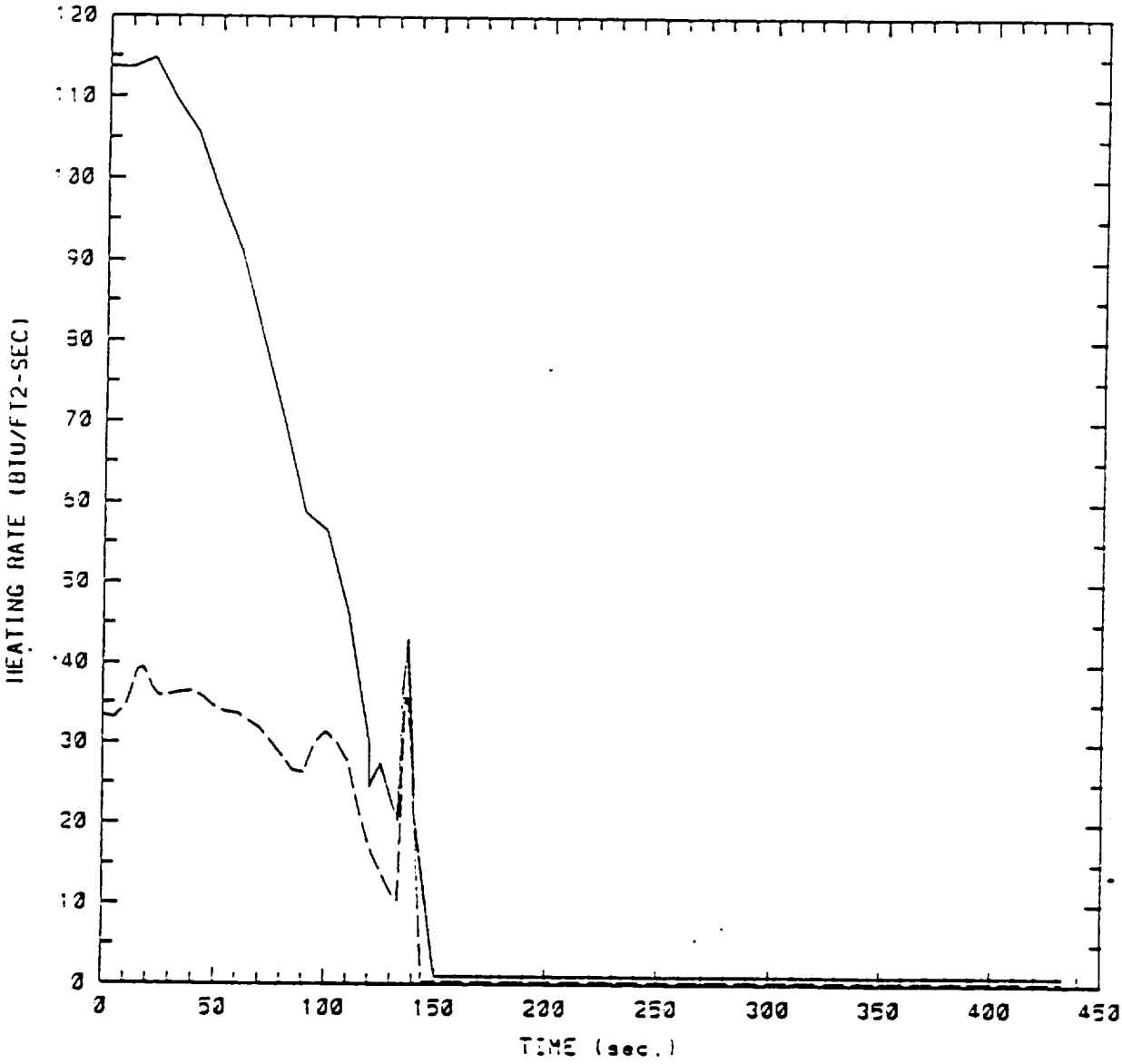

Figure 17: Radiation and Total Base Heating — HLLV STME Nozzle Exit Body Point 113

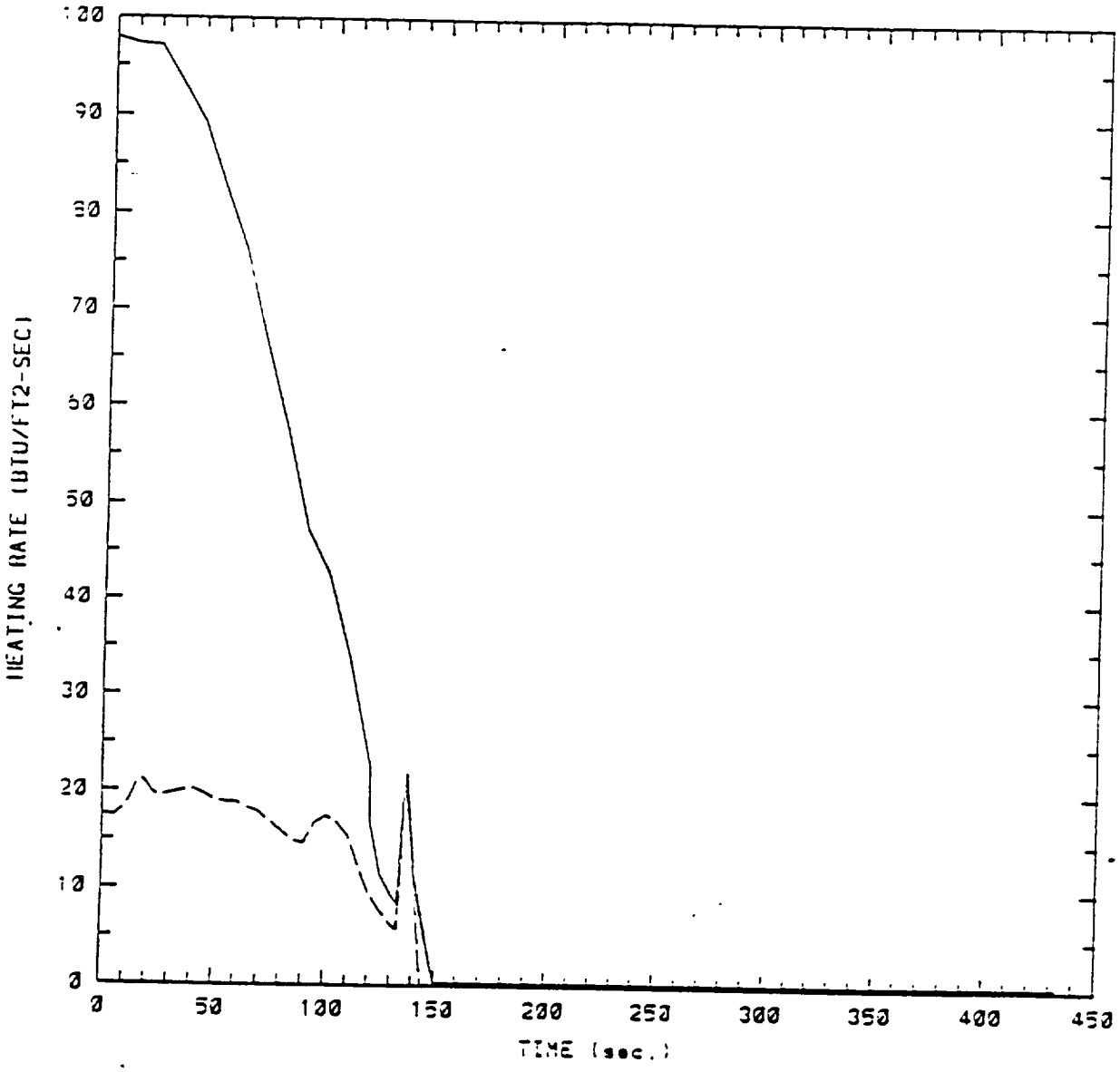

Figure 18: Radiation and Total Base Heating — HLLV STME Nozzle Exit Body Point 114

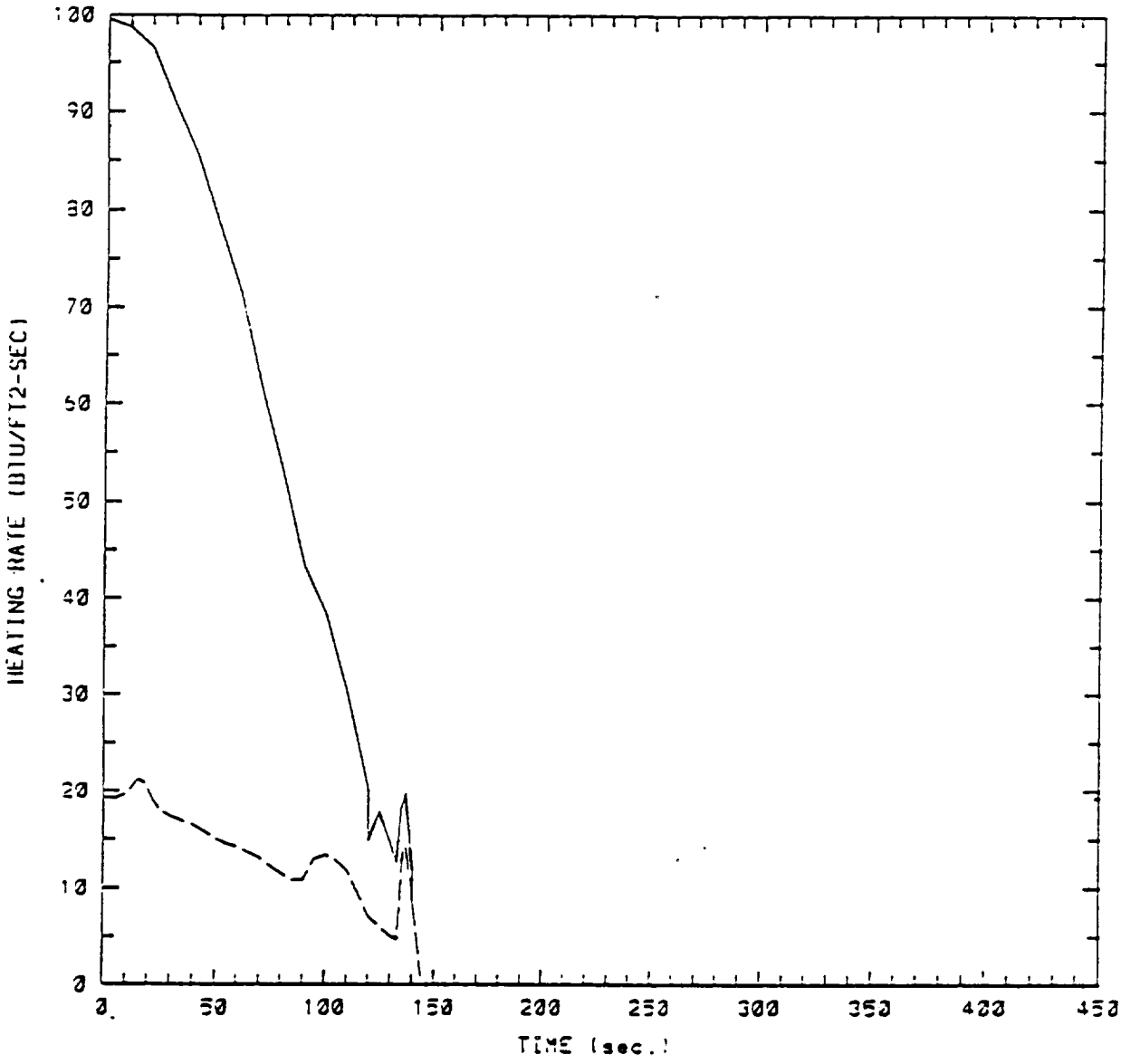

Figure 19: Radiation and Total Base Heating — HLLV ASRB Nozzle Exit Body Point 115

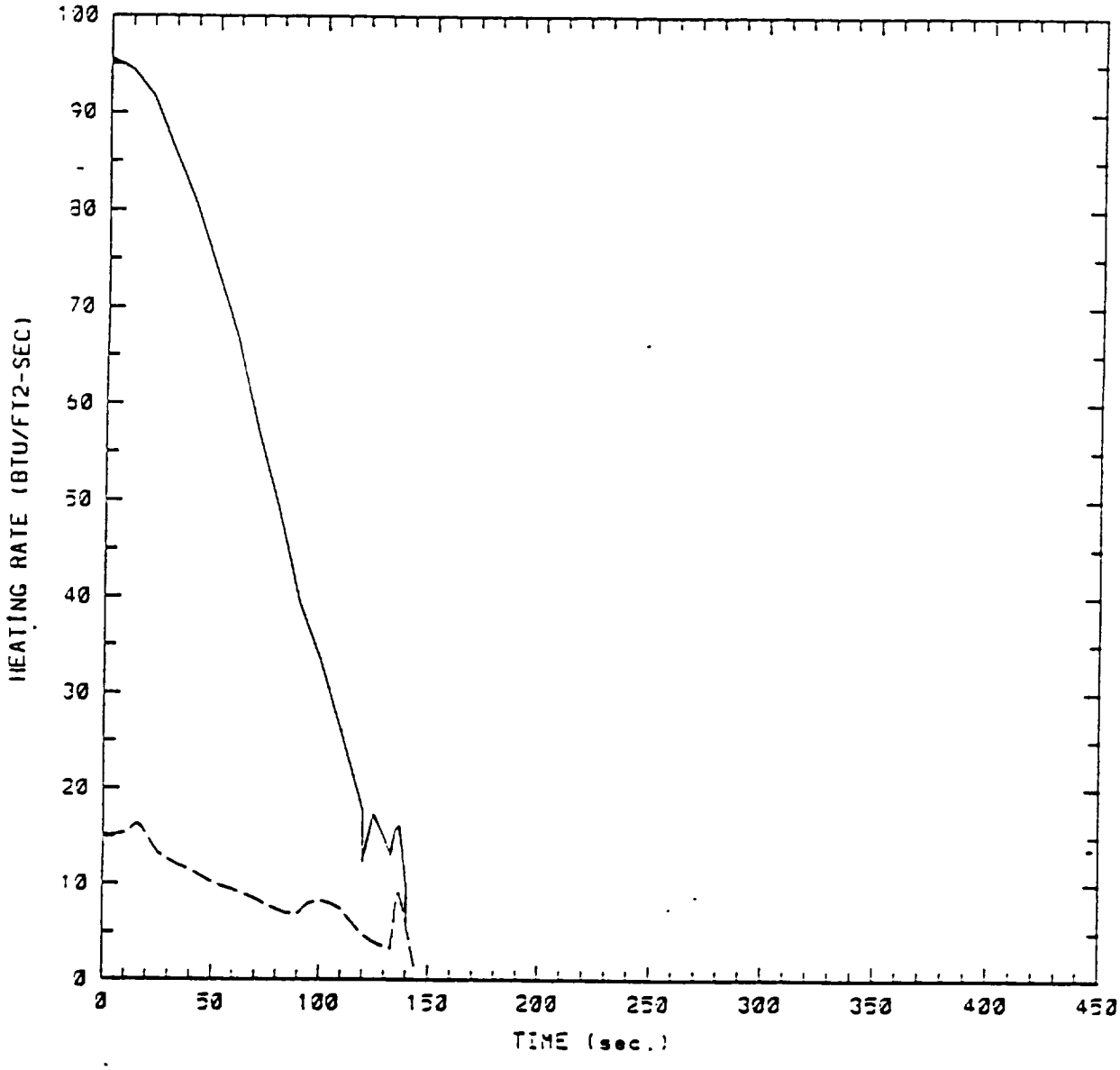

Figure 20: Radiation and Total Base Heating — HLLV ASRB Nozzle Exit Body Point 116

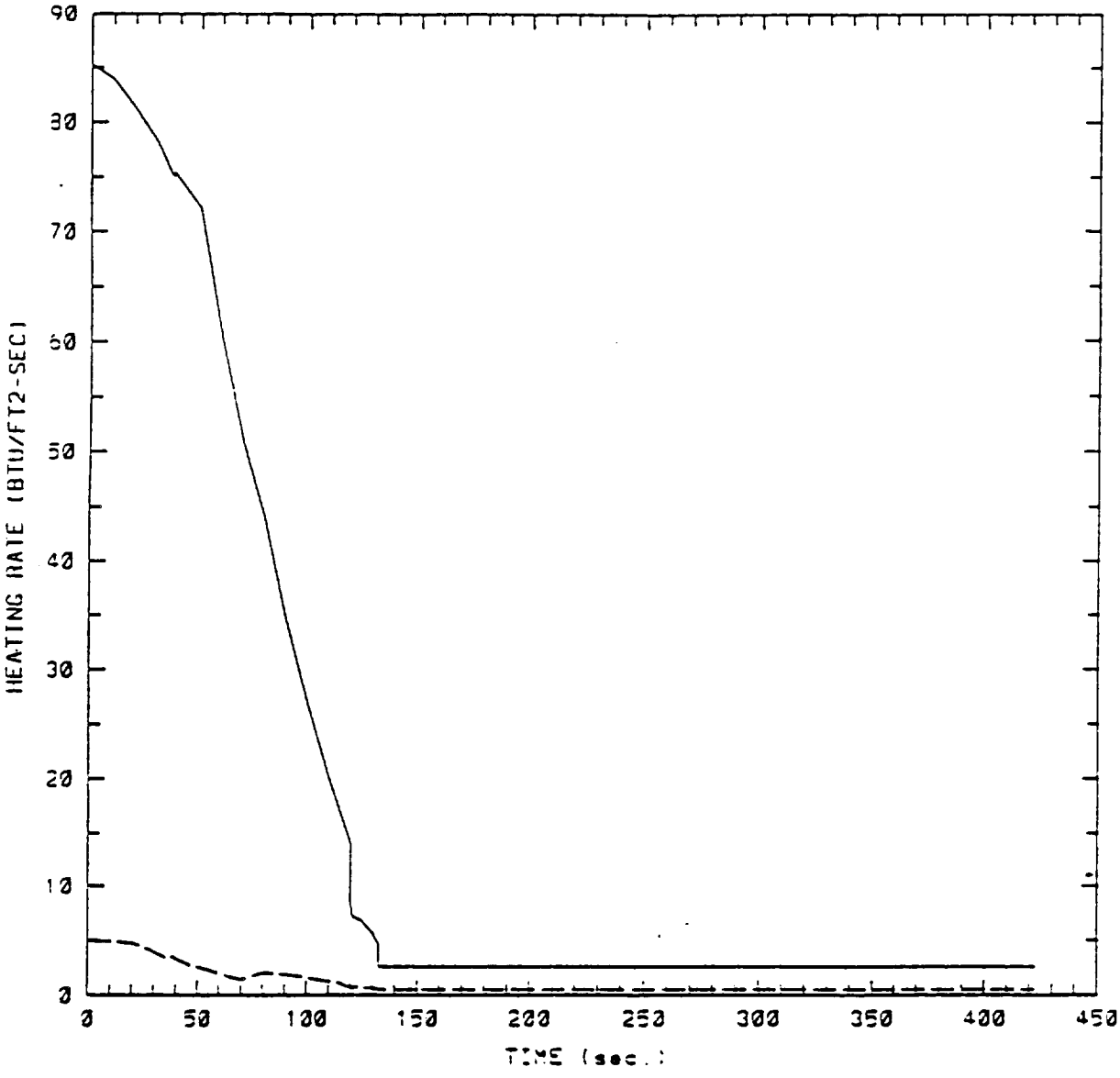

Figure 21: Radiation and Total Base Heating —
1.5 Stage Core Base Heat Shield Body Point 201

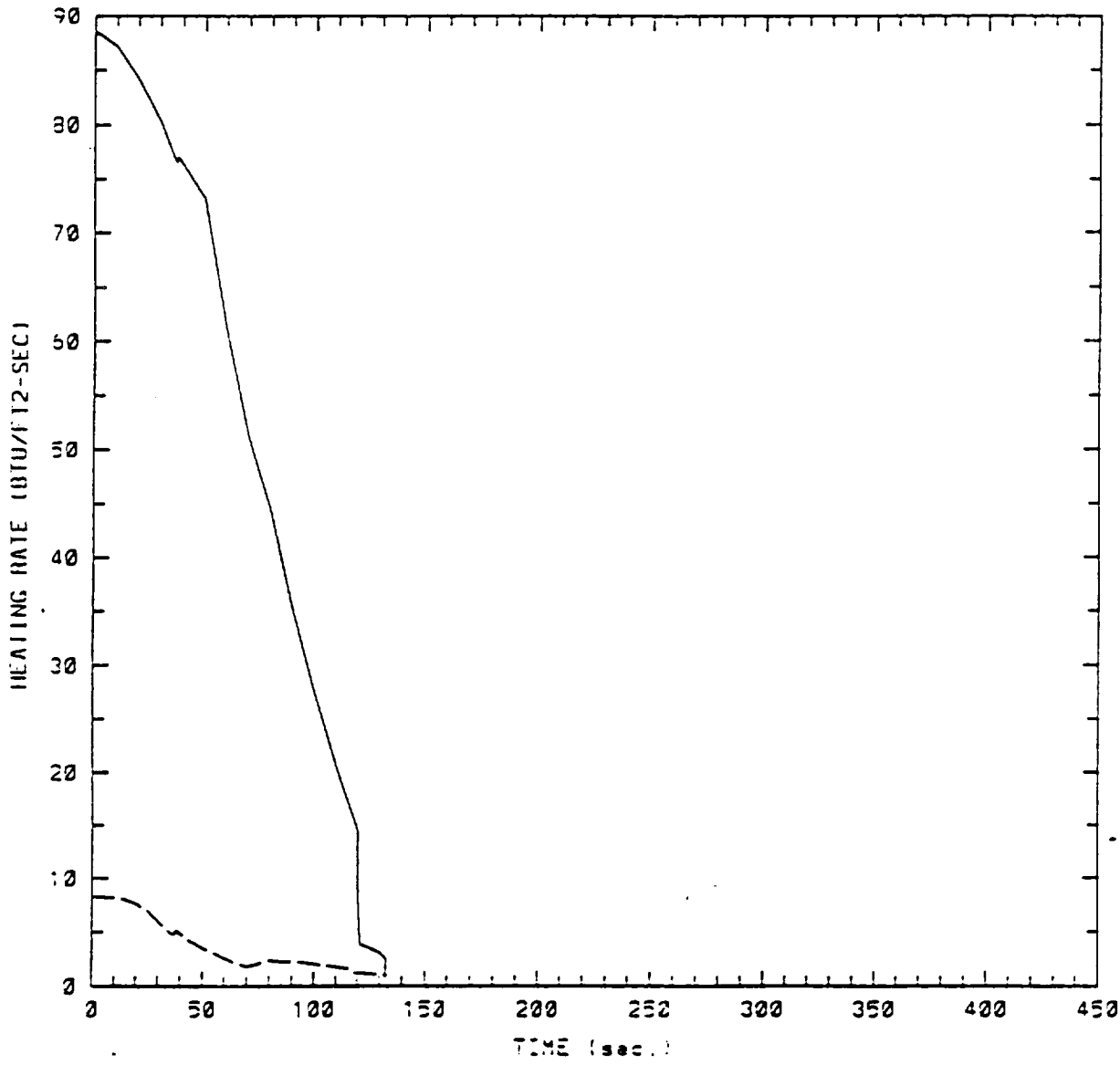

Figure 22: Radiation and Total Base Heating —
1.5 Stage Core Base Heat Shield Body Point 202

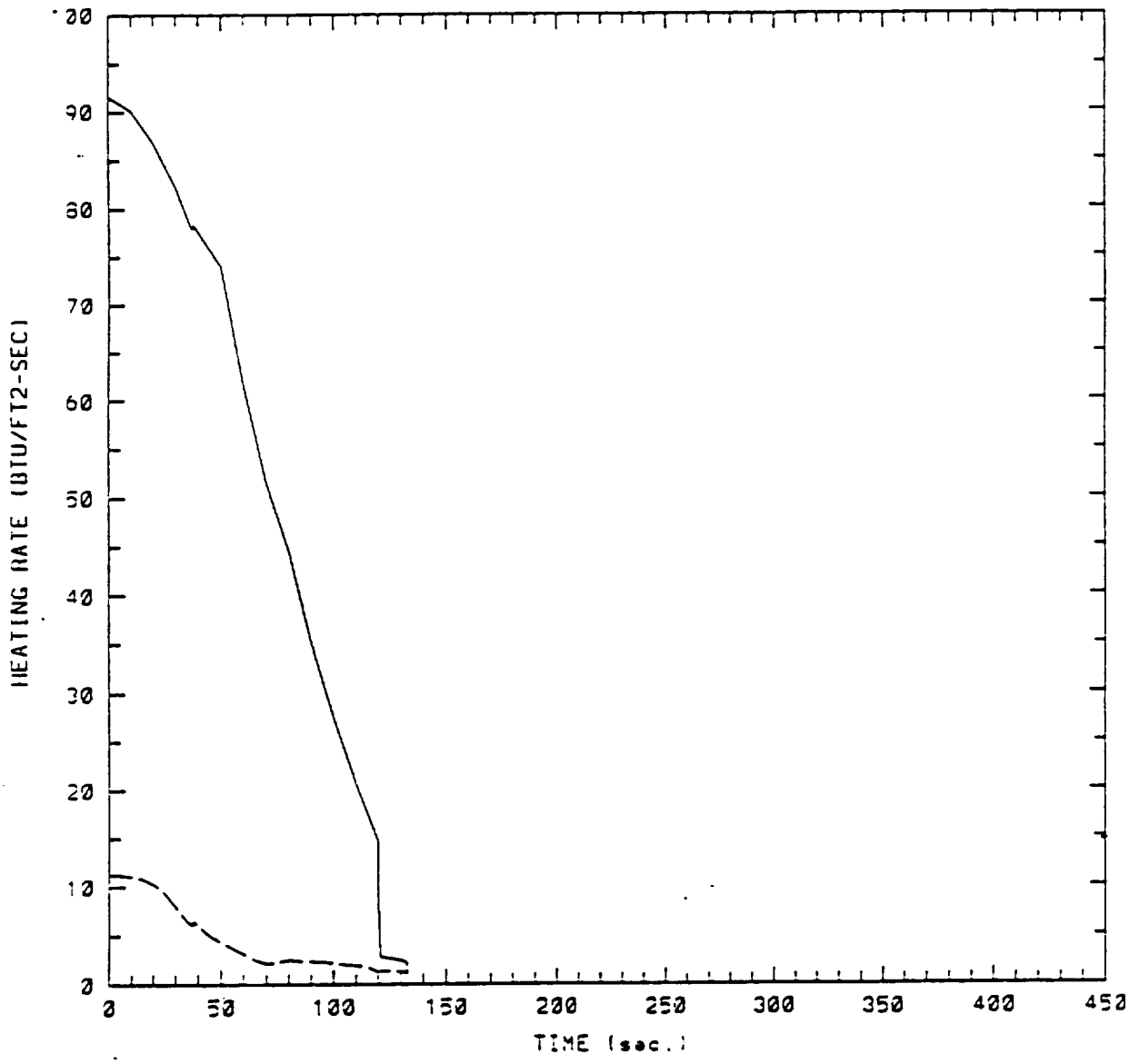

Figure 23: Radiation and Total Base Heating —
1.5 Stage Core Base Heat Shield Body Point 203

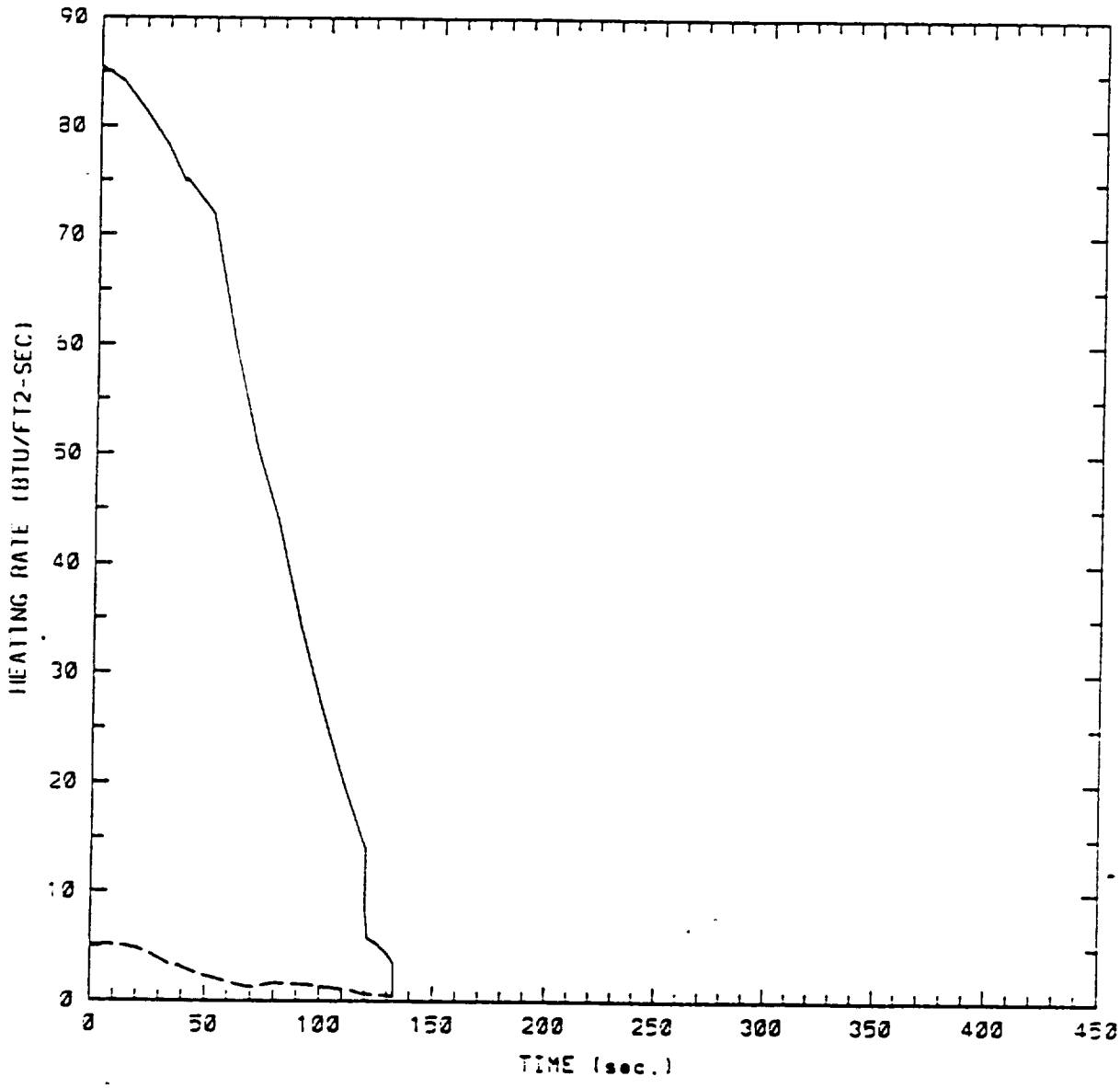

Figure 24: Radiation and Total Base Heating —
1.5 Stage Core Base Heat Shield Body Point 204

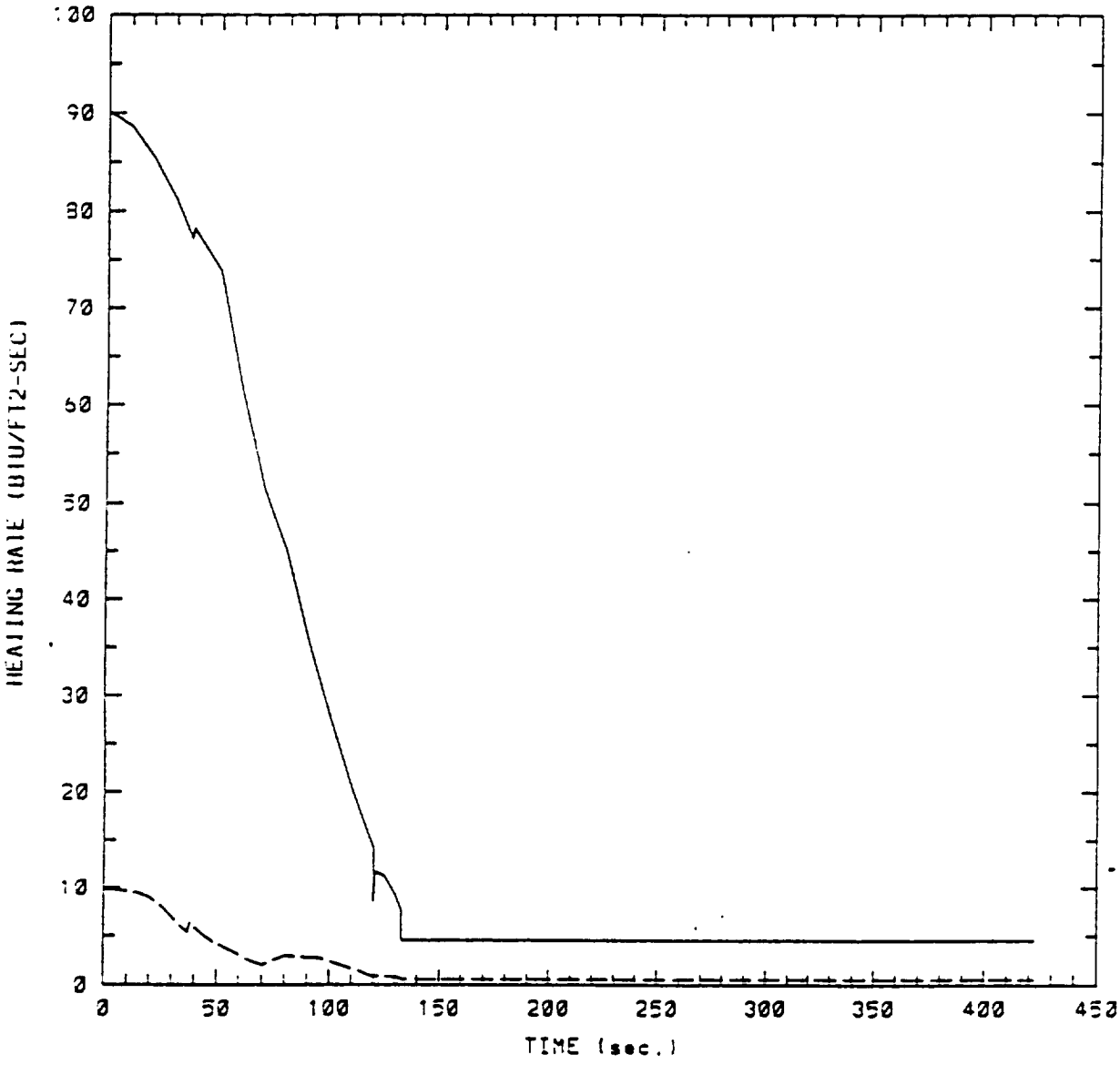

Figure 25: Radiation and Total Base Heating — 1.5 Stage Inboard STME Heat Shield Body Point 205

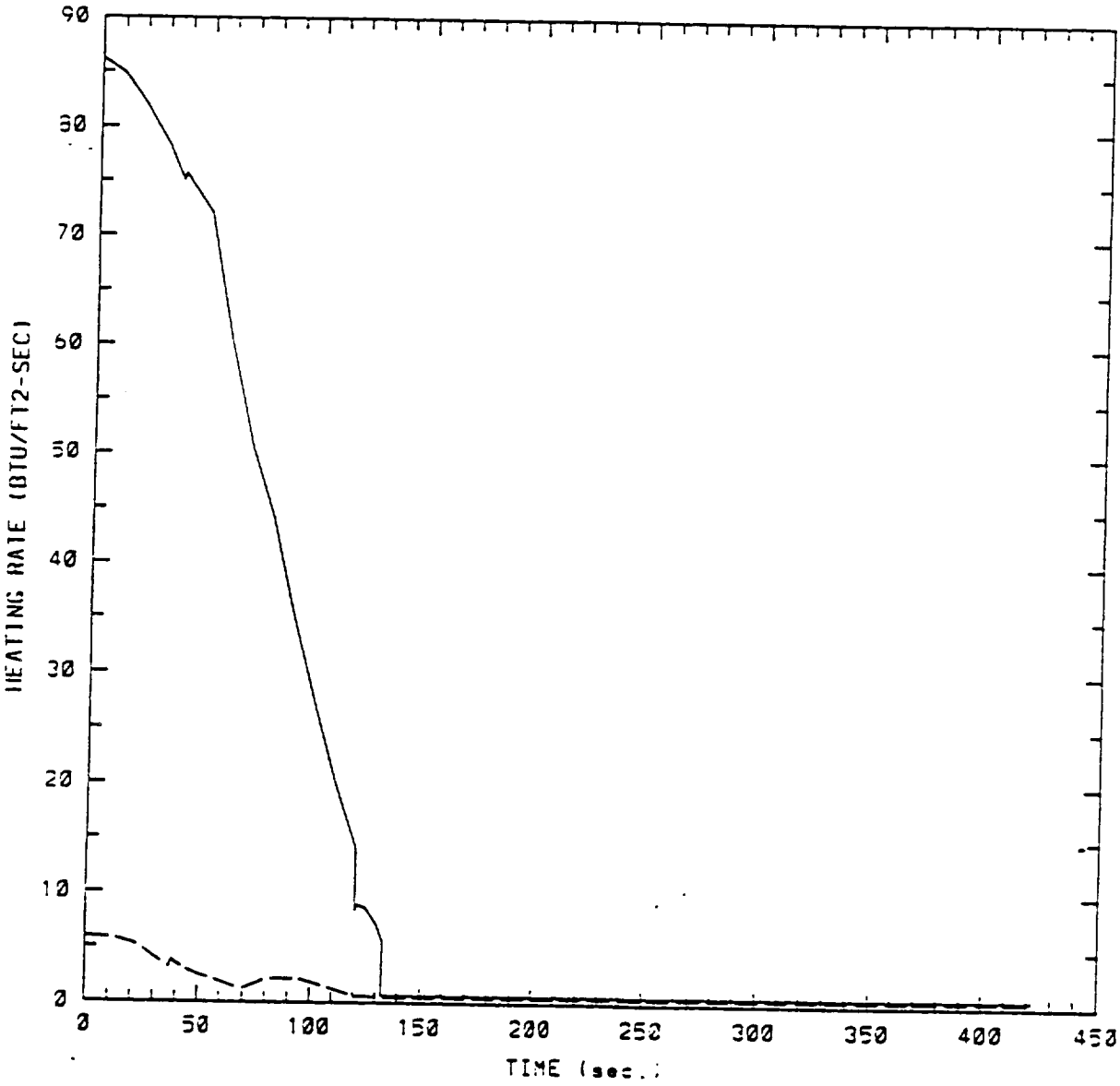

Figure 26: Radiation and Total Base Heating — 1.5 Stage Inboard STME Heat Shield Body Point 206

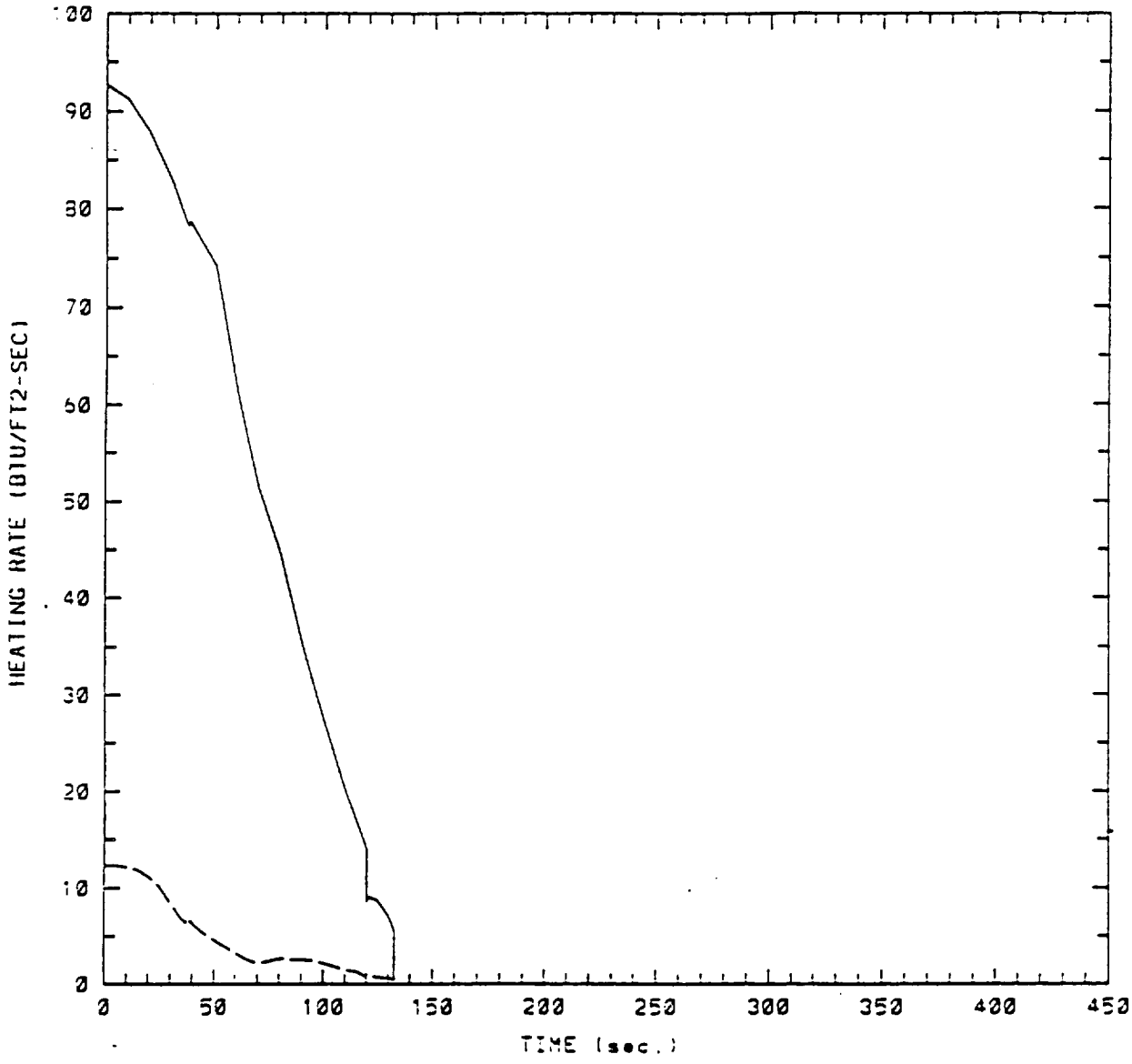

Figure 27: Radiation and Total Base Heating — 1.5 Stage Outboard STME Heat Shield Body Point 207

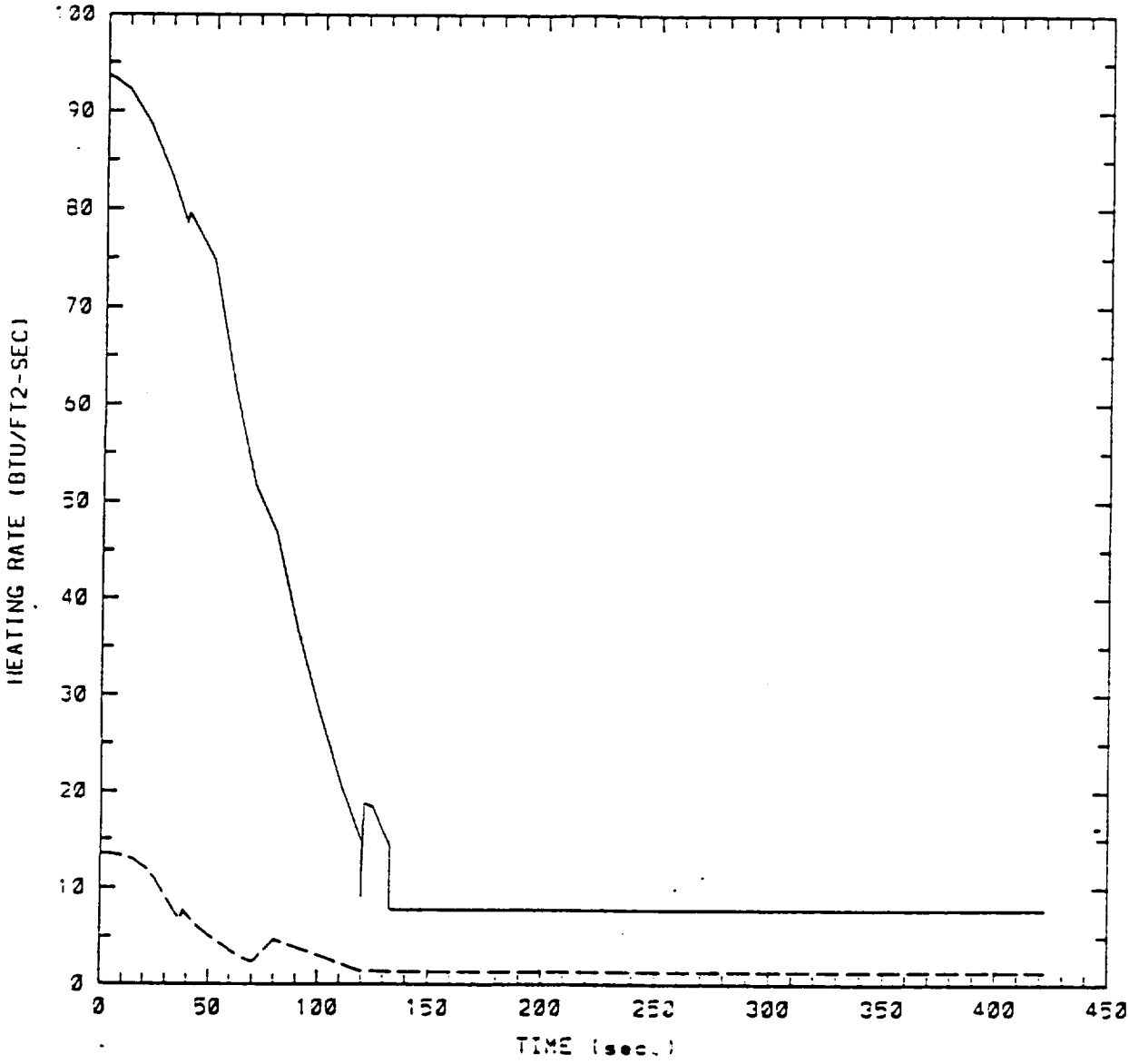

Figure 28: Radiation and Total Base Heating — 1.5 Stage Inboard STME Nozzle Exit Body Point 208

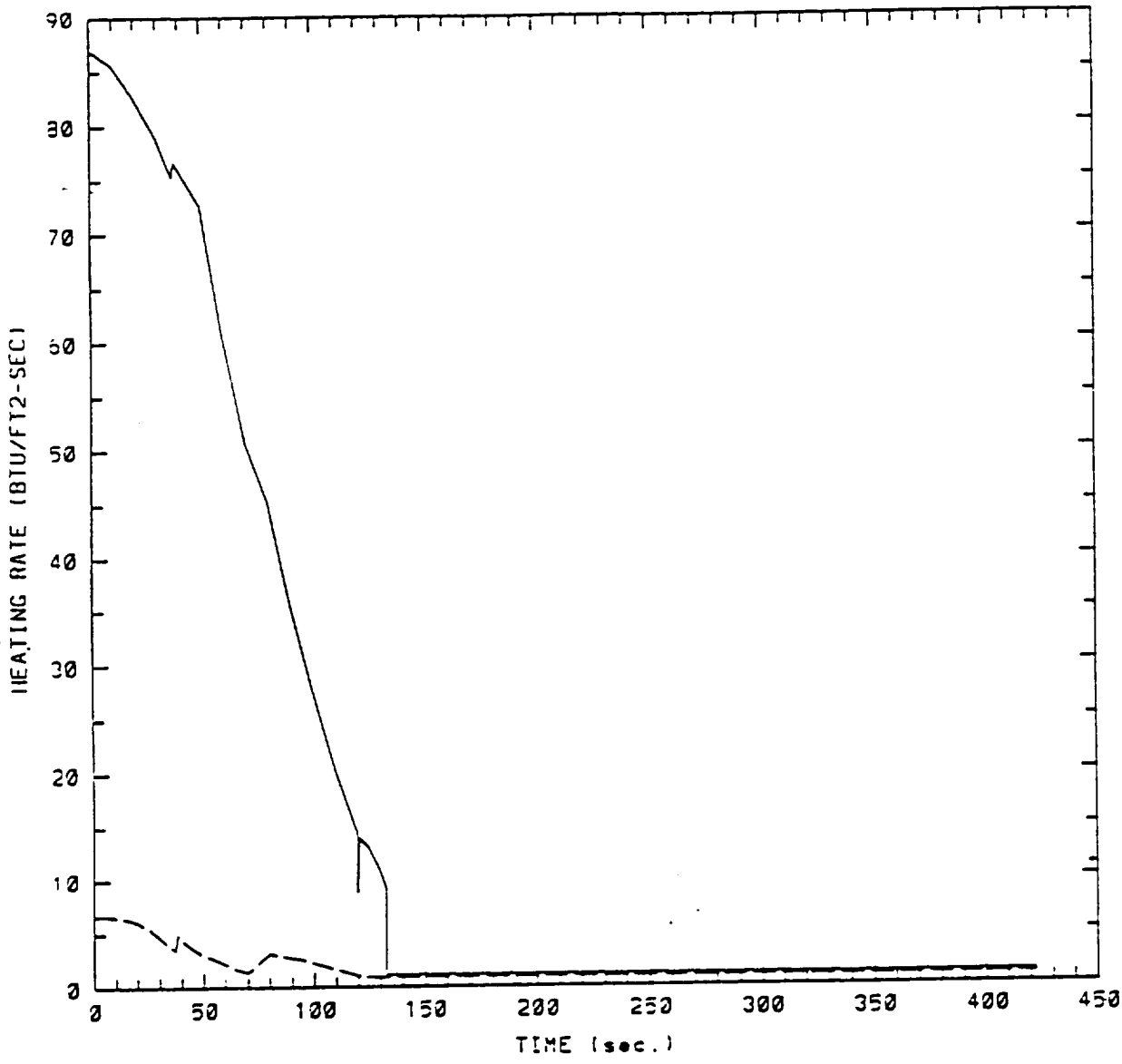

Figure 29: Radiation and Total Base Heating — 1.5 Stage Inboard STME Nozzle Exit Body Point 209

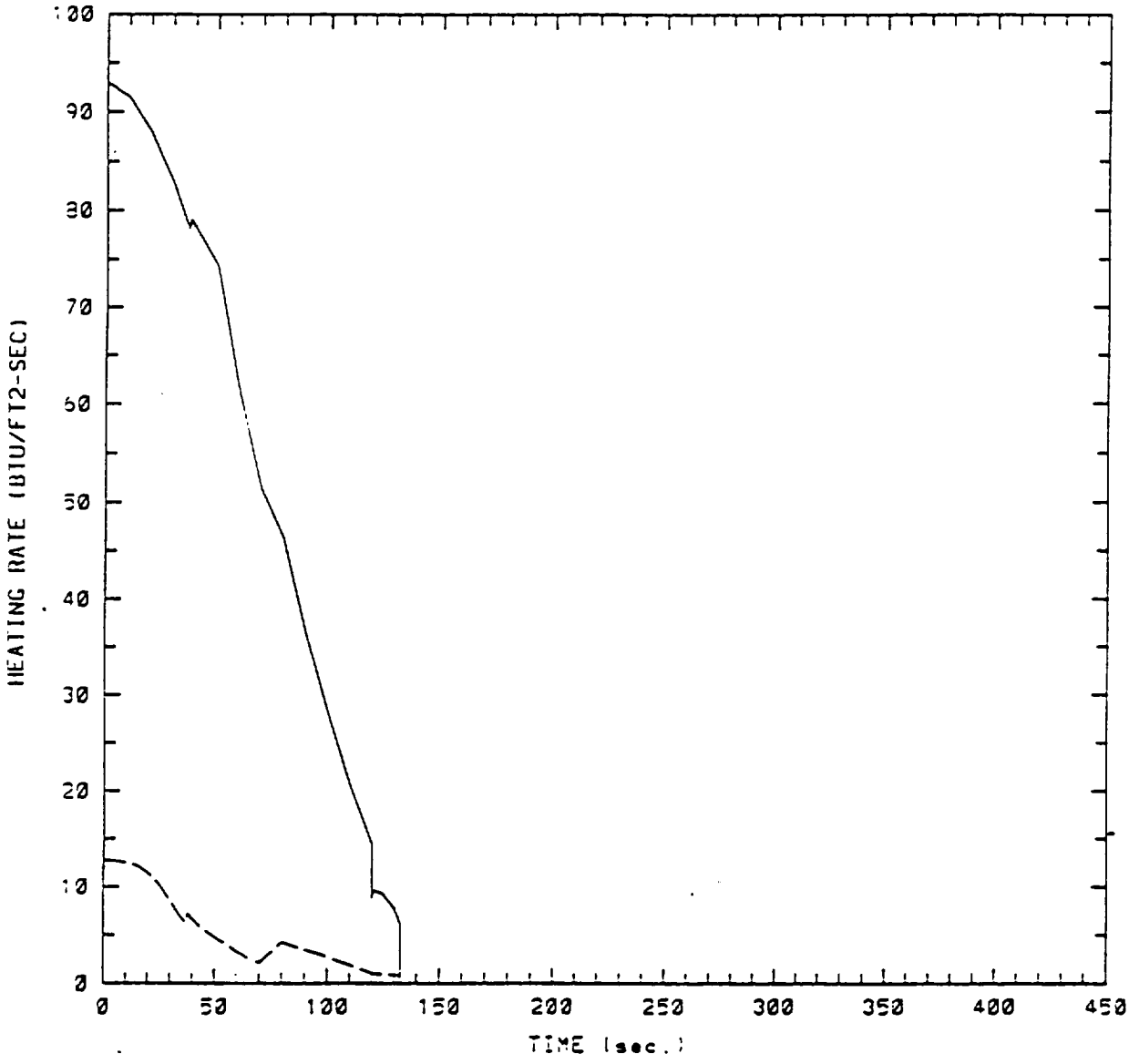

Figure 30: Radiation and Total Base Heating — 1.5 Stage Outboard STME Nozzle Exit Body Point 210

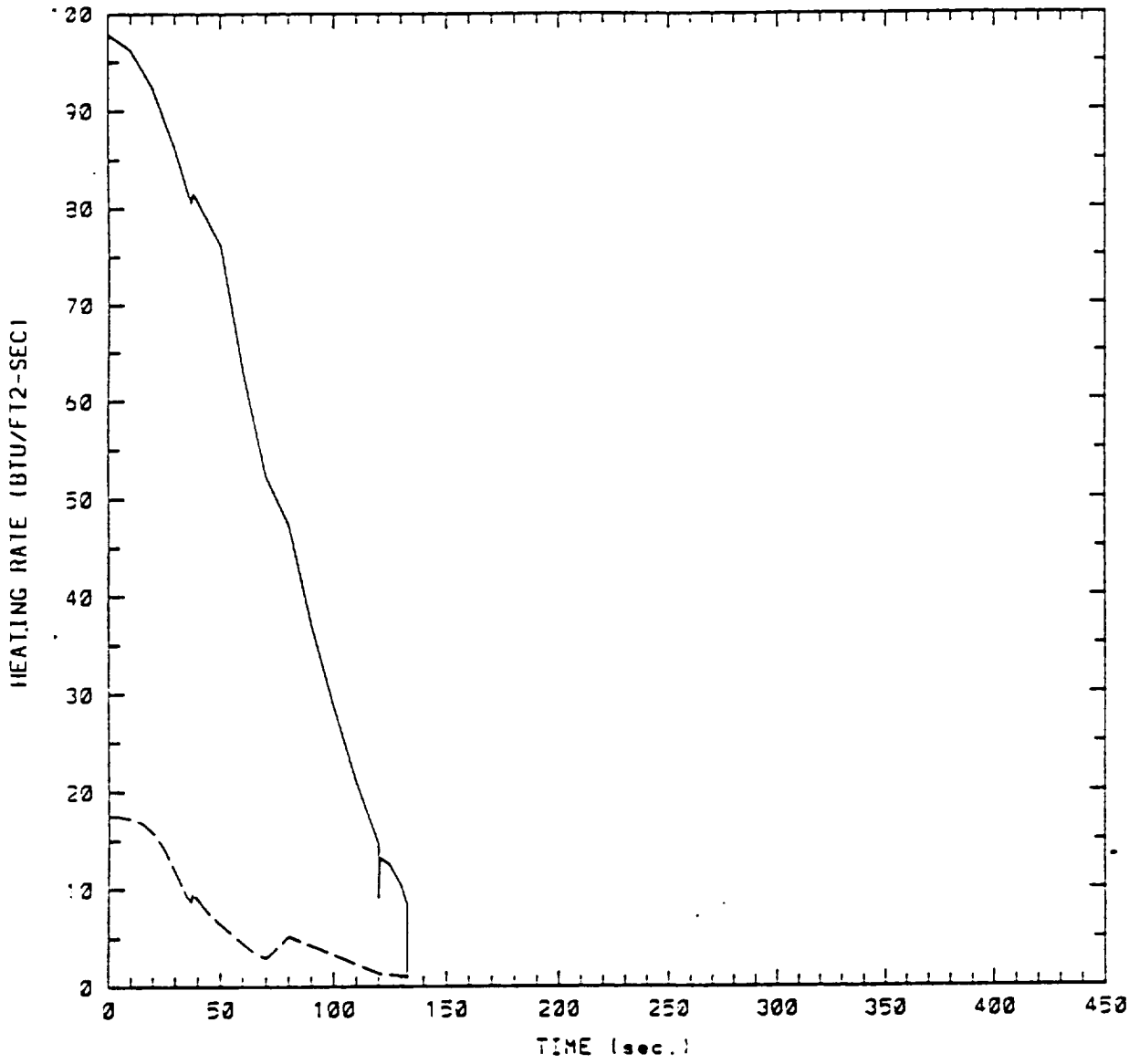

Figure 31: Radiation and Total Base Heating — 1.5 Stage Outboard STME Nozzle Exit Body Point 211

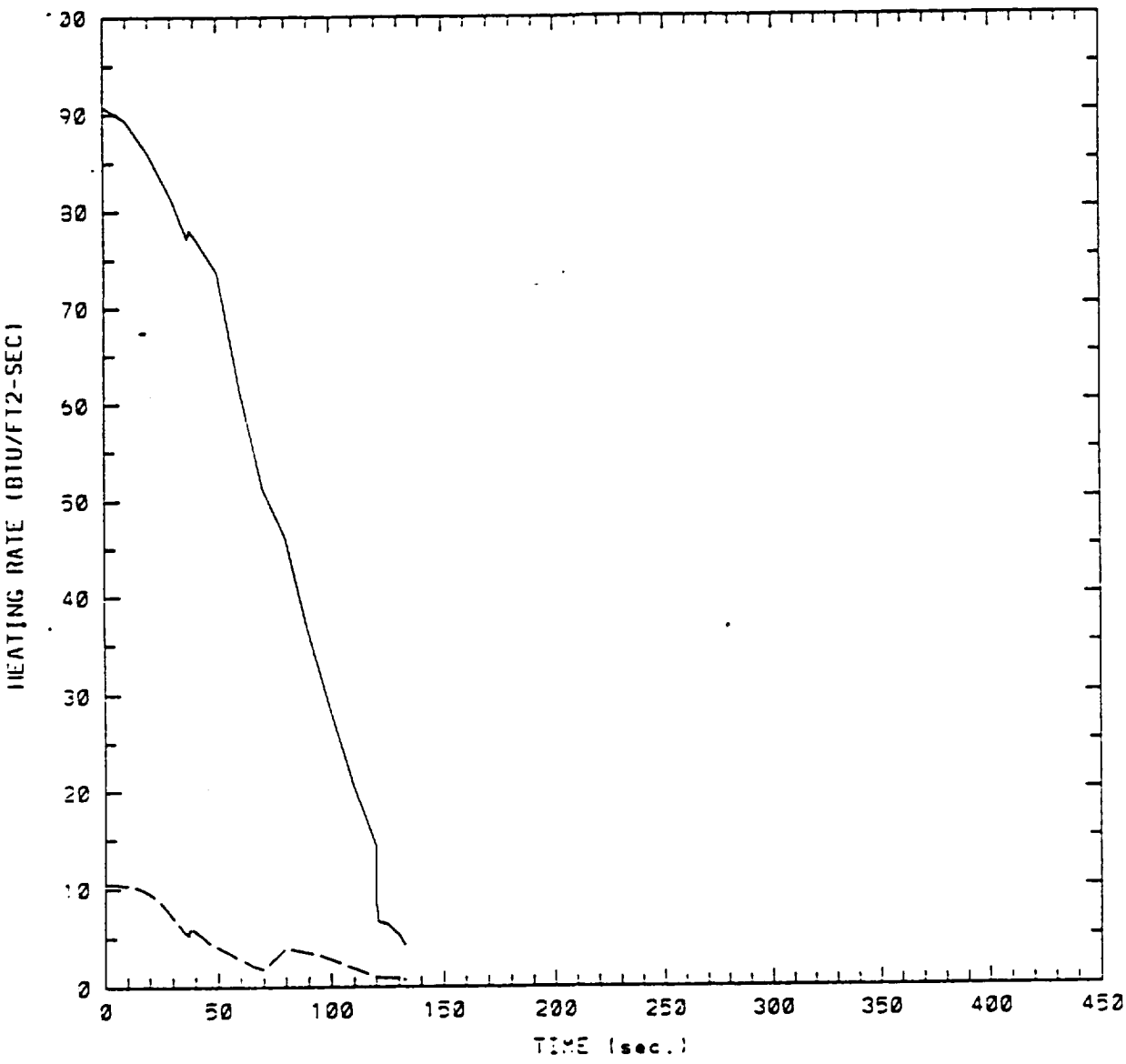

Figure 32: Radiation and Total Base Heating — 1.5 Stage Outboard STME Nozzle Exit Body Point 212

Table 1: HLLV and 1.5 Stage Body Point Location Definitions

HLLV

Location	B.P.	Facing Direction	X (in)	Y (In)	Z (In)
Heat Shield	101	Aft (+X)	4393.6	.0	.0
	102			.0	58.5
	103			.0	117.0
	104			− 41.4	41.4
	105			− 58.5	.0
	106	↓	↓	−117.0	.0
STME Heat Shield	107	Aft (+X)	4453.1	− 88.0	88.0
	108	Aft (+X)	4453.1	−146.0	88.0
ASRB Aft Skirt Trailing Edge	109	+Y	4465.6	−146.4	.0
	110	YZ*	↓	−176.9	73.6
STME Nozzle Exit	111	YZ	4535.0	− 84.8	84.8
	112	−Z		−117.0	71.5
	113	YZ*		−149.2	84.8
	114	−Y	↓	−162.5	117.0
ASRB Nozzle Exit	115	+Y	4535.0	−174.4	0.0
	116	YZ*	↓	−196.7	53.8

1.5 Stage

Location	B.P.	Facing Direction	X (in)	Y (in)	Z (in)
Heat Shield	201	Aft (+X)	4393.6	.0	.0
	202			− 58.5	.0
	203			−117.0	.0
	204	↓	↓	− 58.5	89.8
STME Heat Shield	205	Aft (+X)	4453.1	.0	21.6
	206			− 37.2	79.9
	207	↓	↓	− 79.8	99.8
STME Nozzle	208	−Z	4535.0	.0	17.1
	209	YZ*		− 41.3	81.8
	210	+Y		− 71.5	117.0
	211	YZ		− 75.8	97.8
	212	−Z	↓	−117.0	71.5

* Unit Normal Parallel to Y-Z Plane

Table 2: HLLV Radiation Environments

TOTAL PLUME RADIATION FOR:
HLLV Environment with an STME Out (Margins ME=1.20 BE=1.25)
HLLV STME Altitude Adjustment Functions
HLLV Cycle 1 Radiation Trajectory Booster Adjustment
NLS HLLV Plume Radiation Trajectory with STME Out (EP55 (91-125) Sep. 26 1991)

Alt (kft)	Time* (sec)	Heating Rate (Btu/ft2-sec) for Points Listed											
		101	102	103	104	105	106	107	108	111	112	113	114
0.	0.0	26.52	25.56	20.51	25.48	25.65	21.24	23.69	21.08	17.27	20.83	33.39	17.59
0.	5.0	26.36	25.41	20.39	25.32	25.49	21.12	23.54	20.93	17.16	20.69	33.13	17.45
1.	10.0	27.21	26.22	21.01	26.15	26.31	21.77	24.33	21.75	17.71	21.43	34.57	18.27
1.	12.0	28.11	27.08	21.66	27.02	27.17	22.46	25.16	22.59	18.29	22.21	36.05	19.12
2.	14.0	29.22	28.13	22.47	28.10	28.23	23.31	26.17	23.63	19.00	23.17	37.88	20.16
2.	15.0	29.85	28.74	22.93	28.71	28.84	23.79	26.76	24.22	19.41	23.71	38.93	20.75
2.	16.0	29.98	28.86	23.01	28.85	28.97	23.88	26.89	24.41	19.48	23.85	39.29	20.98
3.	18.0	29.75	28.63	22.79	28.64	28.73	23.66	26.71	24.36	19.27	23.70	39.35	21.10
4.	20.0	28.79	27.70	22.02	27.72	27.80	22.88	25.86	23.66	18.59	22.93	38.29	20.59
4.	22.0	27.58	26.54	21.08	26.57	26.63	21.90	24.79	22.73	17.74	21.95	36.83	19.86
6.	25.0	26.56	25.54	20.25	25.60	25.64	21.06	23.91	22.06	16.97	21.13	35.86	19.45
9.	30.0	26.10	25.08	19.79	25.18	25.18	20.61	23.55	22.00	16.64	20.93	36.11	19.74
12.	35.0	25.76	24.73	19.45	24.87	24.83	20.28	23.29	21.99	16.40	20.80	36.38	20.02
16.	40.0	25.50	24.48	19.19	24.64	24.57	20.03	23.10	21.96	16.19	20.66	36.51	20.18
20.	45.0	24.64	23.64	18.51	23.82	23.74	19.33	22.34	21.34	15.62	20.02	35.60	19.74
24.	50.0	23.55	22.59	17.65	22.78	22.69	18.45	21.38	20.52	14.95	19.22	34.37	19.11
29.	55.0	22.94	21.99	17.15	22.20	22.09	17.94	20.84	20.11	14.57	18.81	33.83	18.86
34.	60.0	22.57	21.63	16.84	21.85	21.73	17.62	20.53	19.93	14.36	18.61	33.67	18.83
40.	65.0	21.73	20.83	16.18	21.05	20.92	16.94	19.79	19.28	13.85	18.00	32.69	18.31
46.	70.0	20.92	20.05	15.55	20.28	20.13	16.29	19.08	18.67	13.36	17.42	31.78	17.84
52.	75.0	19.65	18.82	14.57	19.05	18.90	15.27	17.93	17.63	12.58	16.44	30.13	16.96
59.	80.0	18.46	17.68	13.68	17.91	17.76	14.34	16.86	16.61	11.83	15.49	28.43	16.01
66.	85.0	17.29	16.56	12.82	16.77	16.63	13.44	15.78	15.53	11.09	14.49	26.55	14.96
73.	90.0	17.19	16.46	12.74	16.66	16.53	13.36	15.70	15.39	11.21	14.52	26.26	14.76
81.	95.0	19.76	18.91	14.64	19.16	19.00	15.34	18.11	17.64	13.42	17.06	30.00	16.79
89.	100.0	20.67	19.78	15.32	20.04	19.87	16.05	18.88	18.43	13.88	17.72	31.40	17.59
98.	105.0	19.89	19.04	14.75	19.28	19.12	15.45	18.10	17.64	13.24	16.93	30.05	16.85
107.	110.0	18.47	17.68	13.72	17.90	17.76	14.35	16.73	16.27	12.20	15.60	27.69	15.53
116.	115.0	14.91	14.28	11.11	14.44	14.34	11.61	13.39	12.91	9.77	12.43	21.87	12.26
125.	120.0	11.19	10.72	8.33	10.84	10.77	8.72	10.19	9.92	7.20	9.33	16.84	9.47
134.	125.0	9.38	8.99	7.01	9.08	9.03	7.33	8.53	8.25	6.04	7.78	13.94	7.83
144.	130.0	7.70	7.38	5.77	7.44	7.41	6.03	6.98	6.70	4.97	6.35	11.25	6.31
149.	133.0	7.15	6.87	5.37	6.92	6.89	5.61	6.49	6.20	4.62	5.89	10.39	5.82
151.	134.0	11.84	11.35	8.81	11.48	11.40	9.23	10.79	10.54	7.65	9.92	17.96	10.10
153.	135.0	18.06	17.30	13.37	17.52	17.37	14.02	16.50	16.30	11.66	15.26	28.00	15.77
155.	136.0	22.77	21.79	16.81	22.10	21.89	17.65	20.82	20.66	14.70	19.30	35.59	20.06
156.	137.0	22.77	21.79	16.81	22.10	21.89	17.65	20.82	20.66	14.70	19.30	35.59	20.06
158.	138.0	20.47	19.59	15.13	19.86	19.68	15.87	18.71	18.53	13.22	17.32	31.88	17.97
160.	139.0	17.33	16.60	12.83	16.82	16.67	13.46	15.83	15.63	11.20	14.64	26.84	15.12
162.	140.0	14.21	13.61	10.54	13.78	13.67	11.05	12.96	12.74	9.18	11.96	21.79	12.27
162.	140.3	13.39	12.83	9.94	12.98	12.89	10.42	12.22	11.98	8.66	11.26	20.48	11.52
169.	144.3	0.88	0.87	0.78	0.82	0.87	0.78	0.73	0.40	0.59	0.53	0.30	0.12
178.	150.0	0.88	0.87	0.78	0.82	0.87	0.78	0.73	0.40	0.59	0.53	0.30	0.12
361.	432.6	0.88	0.87	0.78	0.82	0.87	0.78	0.73	0.40	0.59	0.53	0.30	0.12
Heat Load		3215.15	3092.65	2451.79	3098.94	3104.26	2549.45	2892.99	2667.82	2082.73	2501.91	4345.12	2388.44

Table 3: HLLV Radiation Environments

TOTAL PLUME RADIATION FOR:
HLLV Environment with an STME Out (Margins ME=1.20 BE=1.25)
HLLV STME Altitude Adjustment Functions
HLLV Cycle 1 Radiation Trajectory Booster Adjustment
NLS HLLV Plume Radiation Trajectory with STME Out (EP55 (91-125) Sep. 26 1991)

Alt (kft)	Time* (sec)	Heating Rate (Btu/ft2-sec) for Points Listed 109	110	115	116
0.	0.0	7.15	2.27	19.28	15.26
0.	5.0	7.10	2.26	19.17	15.19
1.	10.0	7.37	2.36	19.67	15.47
1.	12.0	7.65	2.46	20.20	15.78
2.	14.0	8.00	2.59	20.86	16.16
2.	15.0	8.19	2.66	21.24	16.37
2.	16.0	8.25	2.69	21.24	16.31
3.	18.0	8.21	2.70	20.87	15.87
4.	20.0	7.96	2.64	20.03	15.12
4.	22.0	7.63	2.55	19.03	14.28
6.	25.0	7.37	2.50	18.00	13.30
9.	30.0	7.33	2.54	17.36	12.52
12.	35.0	7.31	2.57	16.88	11.90
16.	40.0	7.28	2.59	16.47	11.42
20.	45.0	7.07	2.54	15.78	10.81
24.	50.0	6.80	2.46	15.00	10.17
29.	55.0	6.66	2.43	14.53	9.74
34.	60.0	6.61	2.42	14.21	9.40
40.	65.0	6.39	2.36	13.65	8.96
46.	70.0	6.20	2.30	13.10	8.52
52.	75.0	5.86	2.19	12.26	7.89
59.	80.0	5.53	2.08	11.51	7.38
66.	85.0	5.19	1.96	10.80	6.96
73.	90.0	5.20	1.95	10.91	6.96
81.	95.0	6.09	2.25	12.99	8.03
89.	100.0	6.46	2.38	13.41	8.32
98.	105.0	6.31	2.31	12.81	7.98
107.	110.0	5.97	2.17	11.82	7.40
116.	115.0	4.96	1.79	9.53	6.04
125.	120.0	3.46	1.35	7.15	4.75
134.	125.0	2.92	1.16	6.05	4.09
144.	130.0	2.43	0.98	5.04	3.48
149.	133.0	2.28	0.93	4.72	3.28
151.	134.0	3.73	1.45	7.57	5.00
153.	135.0	5.65	2.15	11.35	7.28
155.	136.0	7.10	2.68	14.21	9.01
156.	137.0	7.10	2.68	14.21	9.01
158.	138.0	6.40	2.42	12.81	8.17
160.	139.0	5.44	2.08	10.91	7.02
162.	140.0	4.48	1.73	9.01	5.87
162.	140.3	4.23	1.64	8.52	5.58
166.	144.3	0.37	0.24	0.92	0.99
Heat Load		868.38	311.16	1946.83	1345.72

Table 4: HLLV Convective Environments for Body Point 101

HLS HLLV
BODY POINT # 101 -- CORE BASE HEAT SHIELD
ASSD - ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2*SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	5.110E-03	9.91	9.50	7.35	4.80	2.24	-0.31
130.6	123.0	2477.	4.646E-03	9.37	9.00	7.05	4.73	2.40	0.08
134.3	125.0	2555.	4.218E-03	8.84	8.50	6.73	4.62	2.51	0.40
138.1	127.0	2633.	3.822E-03	8.31	8.00	6.39	4.48	2.57	0.66
144.5	130.0	2750.	3.167E-03	7.25	7.00	5.67	4.09	2.50	0.92
149.2	133.0	2808.	2.557E-03	6.00	5.80	4.73	3.45	2.17	0.89
152.9	135.0	2847.	2.167E-03	5.17	5.00	4.09	3.01	1.92	0.84
156.4	137.0	2886.	1.790E-03	4.34	4.20	3.45	2.55	1.66	0.76
162.8	140.3	2950.	1.120E-03	2.79	2.70	2.23	1.67	1.11	0.55
162.8	140.3	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
178.8	150.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
246.4	200.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
361.5	432.6	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6564.34 (BTU/FT2)

Table 5: HLLV Convective Environments for Body Point 102

BLS REV
BODY POINT # 102 -- CORE BASE HEAT SHIELD
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (FT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	3.927E-03	7.61	7.30	5.65	3.69	1.72	-0.24
130.6	123.0	2477.	3.562E-03	7.18	6.90	5.40	3.62	1.84	0.06
134.3	125.0	2555.	3.176E-03	6.65	6.40	5.07	3.48	1.89	0.30
138.1	127.0	2633.	2.819E-03	6.13	5.90	4.72	3.31	1.90	0.49
144.5	130.0	2750.	2.262E-03	5.18	5.00	4.05	2.92	1.79	0.66
149.2	133.0	2808.	1.808E-03	4.24	4.10	3.34	2.44	1.53	0.63
152.9	135.0	2847.	1.517E-03	3.62	3.50	2.86	2.10	1.35	0.59
156.4	137.0	2886.	1.236E-03	3.00	2.90	2.38	1.76	1.14	0.53
162.8	140.3	2950.	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
162.8	140.3	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
178.8	150.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
246.4	200.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
361.5	432.6	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6529.70 (BTU/FT2)

Table 6: HLLV Convective Environments for Body Point 103

BODY POINT # 103 -- CORE BASE HEAT SHIELD
ASRM/2 ENGINE OUT = LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 199

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	2.313E-03	4.49	4.30	3.33	2.17	1.02	-0.14
130.6	123.0	2477.	2.142E-03	4.32	4.15	3.25	2.18	1.11	0.04
134.3	125.0	2555.	1.935E-03	4.05	3.90	3.09	2.12	1.15	0.18
138.1	127.0	2633.	1.768E-03	3.84	3.70	2.96	2.07	1.19	0.31
141.5	130.0	2750.	1.493E-03	3.42	3.30	2.67	1.93	1.18	0.43
149.2	133.0	2808.	1.190E-03	2.80	2.70	2.20	1.60	1.01	0.41
152.9	135.0	2847.	9.970E-04	2.38	2.30	1.88	1.38	0.88	0.39
156.4	137.0	2886.	7.673E-04	1.86	1.80	1.48	1.09	0.71	0.33
162.8	140.3	2950.	4.564E-04	1.14	1.10	0.91	0.68	0.45	0.22
162.8	140.3	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
178.8	150.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
246.4	200.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
361.5	432.6	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6435.18 (BTU/FT2)

Table 7: HLLV Convective Environments for Body Point 104

NLS HLLV
BODY POINT # 104 -- CORE BASE HEAT SHIELD
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	4.841E-03	9.39	9.00	6.97	4.55	2.13	-0.30
130.6	123.0	2477.	4.440E-03	8.96	8.60	6.74	4.52	2.30	0.08
134.3	125.0	2555.	4.020E-03	8.42	8.10	6.41	4.40	2.39	0.38
138.1	127.0	2633.	3.583E-03	7.79	7.50	5.99	4.20	2.41	0.62
144.5	130.0	2750.	2.941E-03	6.74	6.50	5.26	3.79	2.32	0.85
149.2	133.0	2808.	2.381E-03	5.59	5.40	4.40	3.21	2.02	0.83
152.9	135.0	2847.	1.951E-03	4.66	4.50	3.68	2.71	1.73	0.75
156.4	137.0	2886.	1.577E-03	3.83	3.70	3.04	2.25	1.46	0.67
162.8	140.3	2950.	9.544E-04	2.38	2.30	1.90	1.42	0.94	0.47
162.8	140.3	2950.	2.490E-04	0.62	0.60	0.50	0.37	0.25	0.12
178.8	150.0	2950.	2.490E-04	0.62	0.60	0.50	0.37	0.25	0.12
246.4	200.0	2950.	2.490E-04	0.62	0.60	0.50	0.37	0.25	0.12
361.5	432.6	2950.	2.490E-04	0.62	0.60	0.50	0.37	0.25	0.12

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6613.72 (BTU/FT2)

Table 8: HLLV Convective Environments for Body Point 105

NLS HLLV
BODY POINT # 105 -- CORE BASE HEAT SHIELD
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 199

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	5.379E-03	10.43	10.00	7.74	5.05	2.36	-0.33
130.6	123.0	2477.	4.956E-03	10.00	9.60	7.52	5.04	2.56	0.08
134.3	125.0	2555.	4.467E-03	9.36	9.00	7.12	4.89	2.66	0.42
138.1	127.0	2633.	3.966E-03	8.62	8.30	6.63	4.65	2.67	0.69
144.5	130.0	2750.	3.303E-03	7.56	7.30	5.91	4.26	2.61	0.96
149.2	133.0	2808.	2.646E-03	6.21	6.00	4.89	3.57	2.24	0.92
152.9	135.0	2847.	2.254E-03	5.38	5.20	4.25	3.13	2.00	0.87
156.4	137.0	2886.	1.833E-03	4.45	4.30	3.53	2.61	1.70	0.78
162.8	140.3	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
162.8	140.3	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
178.8	150.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
246.4	200.0	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08
361.5	432.6	2950.	1.660E-04	0.41	0.40	0.33	0.25	0.16	0.08

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6569.94 (BTU/FT2)

Table 9: HLLV Convective Environments for Body Point 106

HLLV
BODY POINT # 106 -- CORE BASE HEAT SHIELD
ASRM'S ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TF (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	5.917E-03	11.47	11.00	8.51	5.56	2.60	-0.36
130.6	123.0	2477.	5.524E-03	11.14	10.70	8.38	5.62	2.86	0.09
134.3	125.0	2555.	5.161E-03	10.81	10.40	8.23	5.65	3.07	0.49
138.1	127.0	2633.	4.730E-03	10.28	9.90	7.91	5.55	3.18	0.82
144.5	130.0	2750.	4.072E-03	9.33	9.00	7.29	5.25	3.22	1.18
149.2	133.0	2808.	3.351E-03	7.87	7.60	6.19	4.52	2.84	1.17
152.9	135.0	2847.	2.904E-03	6.93	6.70	5.48	4.03	2.58	1.12
156.4	137.0	2886.	2.344E-03	5.69	5.50	4.52	3.34	2.17	1.00
162.0	140.3	2950.	1.203E-03	3.00	2.90	2.39	1.79	1.19	0.59
162.0	140.3	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
178.8	150.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
246.4	200.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
361.5	432.6	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6537.75 (BTU/FT2)

Table 10: HLLV Convective Environments for Body Point 107

BODY POINT # 107 -- STME HEAT SHIELD
ASPM : ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (FEET)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	5.541E-03	10.74	10.30	7.97	5.20	2.43	-0.34
130.6	124.0	2477.	5.240E-03	10.57	10.15	7.95	5.33	2.71	0.09
134.3	125.0	2555.	4.764E-03	9.98	9.60	7.60	5.22	2.83	0.45
138.1	127.0	2633.	4.300E-03	9.34	9.00	7.19	5.04	2.89	0.74
144.5	130.0	2750.	3.620E-03	8.29	8.00	6.48	4.67	2.86	1.05
149.2	133.0	2808.	2.954E-03	6.94	6.70	5.46	3.98	2.51	1.03
152.9	135.0	2847.	2.471E-03	5.90	5.70	4.66	3.43	2.19	0.96
156.4	137.0	2886.	1.961E-03	4.76	4.60	3.78	2.80	1.82	0.84
162.8	140.3	2950.	1.037E-03	2.58	2.50	2.06	1.55	1.03	0.51
162.8	140.3	2950.	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
178.8	150.0	2950.	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
246.4	200.0	2950.	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
361.5	432.6	2950.	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 7018.37 (BTU/FT2)

Table 11: HLLV Convective Environments for Body Point 108

BODY POINT # 108 -- STME HEAT SHIELD
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EI 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	5.756E-03	11.16	10.70	8.28	5.40	2.53	-0.35
130.6	123.0	2477.	5.369E-03	10.83	10.40	8.14	5.46	2.78	0.09
134.3	125.0	2555.	5.012E-03	10.50	10.10	7.99	5.49	2.98	0.48
138.1	127.0	2633.	4.634E-03	10.07	9.70	7.75	5.44	3.12	0.80
144.5	130.0	2750.	4.027E-03	9.22	8.90	7.21	5.20	3.18	1.17
149.2	133.0	2808.	3.395E-03	7.97	7.70	6.27	4.58	2.88	1.18
152.9	135.0	2847.	2.948E-03	7.04	6.80	5.56	4.09	2.61	1.14
156.4	137.0	2886.	2.302E-03	5.58	5.40	4.43	3.28	2.13	0.98
162.8	140.3	2950.	1.120E-03	2.79	2.70	2.23	1.67	1.11	0.55
162.8	140.3	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
178.8	150.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
246.4	200.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
361.5	432.6	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6535.16 (BTU/FT2)

Table 13: HLLV Convective Environments for Body Point 110

HLS HLLV
BODY POINT # 110 -- ASRB SKIRT TRAILING EDGE
ASRM-3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EF 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 400	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	7.262E-03	14.08	13.50	10.45	6.82	3.19	-0.44
130.6	123.0	2477.	6.815E-03	13.75	13.20	10.34	6.93	3.52	0.12
134.3	125.0	2555.	6.303E-03	13.20	12.70	10.05	6.90	3.75	0.60
138.1	127.0	2633.	5.781E-03	12.56	12.10	9.67	6.78	3.89	1.00
144.5	130.0	2750.	4.977E-03	11.40	11.00	8.91	6.42	3.93	1.44
149.2	133.0	2808.	4.189E-03	9.84	9.50	7.74	5.65	3.55	1.46
152.9	135.0	2847.	3.511E-03	8.38	8.10	6.63	4.87	3.11	1.36
156.4	137.0	2886.	2.771E-03	6.72	6.50	5.34	3.95	2.57	1.18
162.8	140.3	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
162.8	140.3	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
170.8	150.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
246.4	200.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
361.5	432.6	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6513.85 (BTU/FT2)

Table 14: HLLV Convective Environments for Body Point 111

HLS HLLV
BODY POINT # 111 -- SIME NOZZLE EXIT
ASSM + ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EI 55 (91-251) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	6.455E-03	12.52	12.00	9.29	6.06	2.83	-0.39
130.6	123.0	2477.	5.989E-03	12.08	11.60	9.08	6.09	3.10	0.10
134.3	125.0	2555.	5.509E-03	11.54	11.10	8.79	6.03	3.28	0.52
138.1	127.0	2633.	4.969E-03	10.80	10.40	8.31	5.83	3.34	0.86
144.5	130.0	2750.	4.118E-03	9.43	9.10	7.37	5.31	3.25	1.19
149.2	133.0	2808.	3.395E-03	7.97	7.70	6.27	4.58	2.88	1.18
152.9	135.0	2847.	2.861E-03	6.83	6.60	5.40	3.97	2.54	1.11
156.4	137.0	2886.	2.344E-03	5.69	5.50	4.52	3.34	2.17	1.00
162.8	140.3	2950.	1.286E-03	3.20	3.10	2.56	1.92	1.27	0.63
162.8	140.3	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
178.8	150.0	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
246.4	200.0	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
361.5	432.6	2950.	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 7245.91 (BTU/FT2)

Table 15: HLLV Convective Environments for Body Point 112

BODY POINT # 112, SIME NOZZLE EXIT
ASCENT ENGINE OUT - LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	6.939E-03	13.46	12.90	9.99	6.57	3.05	-0.42
130.6	123.0	2477.	6.402E-03	12.91	12.40	9.71	6.51	3.31	0.11
134.3	125.0	2555.	5.856E-03	12.27	11.80	9.34	6.41	3.48	0.56
138.1	127.0	2633.	5.351E-03	11.63	11.20	8.95	6.28	3.60	0.93
144.5	130.0	2750.	4.480E-03	10.26	9.90	8.02	5.78	3.54	1.30
149.2	133.0	2808.	3.704E-03	8.70	8.40	6.84	4.99	3.14	1.29
152.9	135.0	2847.	3.164E-03	7.55	7.30	5.97	4.39	2.81	1.22
156.4	137.0	2886.	2.600E-03	6.31	6.10	5.01	3.71	2.41	1.11
162.8	140.3	2950.	1.411E-03	3.51	3.40	2.81	2.10	1.40	0.69
162.8	140.3	2950.	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
178.8	150.0	2950.	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
246.4	200.0	2950.	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
361.5	432.6	2950.	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 7026.05 (BTU/FT2)

Table 16: HLLV Convective Environments for Body Point 113

[illegible] HLLV
BODY POINT # 113 -- STME NOZZLE EXIT
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 28, 1991

ALT (FT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.85	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	7.800E-03	15.12	14.50	11.22	7.32	3.42	-0.48
130.6	123.0	2477.	7.279E-03	14.68	14.10	11.04	7.40	3.76	0.12
134.3	125.0	2555.	6.700E-03	14.04	13.50	10.69	7.34	3.99	0.64
138.1	127.0	2633.	6.116E-03	13.29	12.80	10.23	7.17	4.12	1.06
144.5	130.0	2750.	5.204E-03	11.92	11.50	9.31	6.71	4.11	1.51
149.2	133.0	2808.	4.409E-03	10.35	10.00	8.15	5.94	3.74	1.53
152.9	135.0	2847.	3.771E-03	9.00	8.70	7.12	5.23	3.34	1.46
156.4	137.0	2886.	3.154E-03	7.65	7.40	6.08	4.50	2.92	1.34
162.8	140.3	2950.	1.701E-03	4.24	4.10	3.39	2.53	1.68	0.83
162.8	140.3	2950.	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14
178.8	150.0	2950.	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14
246.4	200.0	2950.	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14
361.5	432.6	2950.	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6733.92 (BTU/FT2)

Table 17: HLLV Convective Environments for Body Point 114

HLLV
BODY POINT # 114 -- STME NOZZLE EXIT
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (FEET)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	2.152E-03	4.17	4.00	3.10	2.02	0.94	-0.13
130.6	123.0	2477.	2.013E-03	4.06	3.90	3.05	2.05	1.04	0.03
134.3	125.0	2555.	1.836E-03	3.85	3.70	2.93	2.01	1.09	0.17
138.1	127.0	2633.	1.672E-03	3.63	3.50	2.80	1.96	1.13	0.29
144.5	130.0	2750.	1.403E-03	3.21	3.10	2.51	1.81	1.11	0.41
149.2	133.0	2808.	1.190E-03	2.80	2.70	2.20	1.60	1.01	0.41
152.9	135.0	2847.	9.970E-04	2.38	2.30	1.88	1.38	0.88	0.39
156.4	137.0	2886.	7.673E-04	1.86	1.80	1.48	1.09	0.71	0.33
162.8	140.3	2950.	4.564E-04	1.14	1.10	0.91	0.68	0.45	0.22
162.8	140.3	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
178.8	150.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
246.4	200.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
361.5	432.6	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6432.73 (BTU/FT2)

Table 18: HLLV Convective Environments for Body Point 115

BODY POINT # 115 -- ASRB NOZZLE EXIT
ASRB - ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	6.885E-03	13.35	12.80	9.91	6.47	3.02	-0.42
130.0	123.0	2477.	6.402E-03	12.91	12.40	9.71	6.51	3.31	0.11
134.4	125.0	2555.	5.856E-03	12.27	11.80	9.34	6.41	3.48	0.56
138.1	127.0	2633.	5.256E-03	11.42	11.00	8.79	6.16	3.54	0.91
144.5	130.0	2750.	4.344E-03	9.95	9.60	7.78	5.60	3.43	1.26
149.2	133.0	2808.	3.483E-03	8.18	7.90	6.44	4.70	2.95	1.21
152.9	135.0	2847.	2.948E-03	7.04	6.80	5.56	4.09	2.61	1.14
156.4	137.0	2886.	2.344E-03	5.69	5.50	4.52	3.34	2.17	1.00
162.8	140.3	2950.	1.328E-03	3.31	3.20	2.64	1.98	1.31	0.65
162.8	140.3	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
178.8	150.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
246.4	200.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
361.5	432.6	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6494.19 (BTU/FT2)

Table 19: HLLV Convective Environments for Body Point 116

HLS HLLV
BODY POINT # 116 -- ASRB NOZZLE EXIT
ASRM/3 ENGINE OUT @ LIFTOFF, HIGH LOFT, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-125) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.6	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
8.6	30.0	4140.	2.040E-02	75.07	73.44	64.87	54.67	44.47	34.27
15.6	40.0	4120.	1.930E-02	70.64	69.09	60.99	51.34	41.69	32.04
24.4	50.0	4100.	1.780E-02	64.79	63.37	55.89	46.99	38.09	29.19
34.6	60.0	4080.	1.620E-02	58.64	57.35	50.54	42.44	34.34	26.24
46.3	70.0	4060.	1.380E-02	49.68	48.58	42.78	35.88	28.98	22.08
59.4	80.0	4040.	1.190E-02	42.60	41.65	36.65	30.70	24.75	18.80
74.2	90.0	3950.	9.500E-03	33.15	32.40	28.40	23.65	18.90	14.15
90.4	100.0	3870.	7.500E-03	25.58	24.98	21.83	18.08	14.33	10.58
107.8	110.0	3760.	5.697E-03	18.80	18.34	15.95	13.10	10.25	7.41
126.0	120.0	3640.	4.200E-03	13.36	13.02	11.26	9.16	7.06	4.96
126.0	120.0	2360.	4.198E-03	7.98	7.64	5.88	3.78	1.68	-0.42
126.9	121.0	2399.	7.800E-03	15.12	14.50	11.22	7.32	3.42	-0.48
130.6	123.0	2477.	7.228E-03	14.58	14.00	10.96	7.35	3.74	0.12
134.3	125.0	2555.	6.650E-03	13.93	13.40	10.61	7.28	3.96	0.63
138.1	127.0	2633.	6.068E-03	13.19	12.70	10.15	7.12	4.08	1.05
144.5	130.0	2750.	5.158E-03	11.81	11.40	9.23	6.65	4.08	1.50
149.2	133.0	2808.	4.321E-03	10.15	9.80	7.99	5.82	3.66	1.50
152.9	135.0	2847.	3.684E-03	8.79	8.50	6.95	5.11	3.27	1.43
156.4	137.0	2886.	3.069E-03	7.45	7.20	5.91	4.38	2.84	1.31
162.8	140.3	2950.	1.577E-03	3.93	3.80	3.14	2.35	1.56	0.77
162.8	140.3	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
178.8	150.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
246.4	200.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
361.5	432.6	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6526.44 (BTU/FT2)

Table 21: 1.5 Stage Radiation Environments

TOTAL PLUME RADIATION FOR:
1.5 Stage Plume Radiation for 6/2 with BE 75% 36-120 seconds
Estimated Base-Gas Burning Added 50-120 Kft
NLS 1.5 Stage Plume Heating Trajectory (6/2 EP55 (91-126) Sep. 1991)

Alt (kft)	Time* (sec)	Heating Rate (Btu/ft2-sec) for Points Listed 201	205	206	208	209
0.	0.0	4.98	9.82	5.90	13.48	6.72
0.	5.0	4.97	9.78	5.88	13.42	6.70
1.	10.0	4.93	9.66	5.81	13.23	6.61
2.	15.0	4.86	9.46	5.68	12.91	6.46
3.	20.0	4.70	8.97	5.39	12.14	6.11
5.	25.0	4.38	8.15	4.89	10.90	5.53
8.	30.0	3.91	6.94	4.14	9.05	4.65
11.	35.0	3.43	5.71	3.41	7.24	3.80
12.	37.0	3.27	5.36	3.19	6.70	3.53
13.	38.0	3.56	6.41	3.90	7.80	4.92
14.	40.0	3.31	5.88	3.56	7.17	4.46
18.	45.0	2.83	4.89	2.92	5.97	3.62
23.	50.0	2.50	4.20	2.50	5.10	3.06
28.	55.0	2.23	3.63	2.18	4.36	2.64
33.	60.0	1.93	3.02	1.84	3.55	2.19
38.	65.0	1.63	2.42	1.48	2.81	1.71
44.	70.0	1.43	2.03	1.25	2.32	1.40
51.	75.0	1.72	2.50	1.68	3.48	2.30
57.	80.0	2.02	2.98	2.11	4.69	3.20
65.	85.0	1.90	2.85	2.18	4.23	2.91
72.	90.0	1.83	2.80	2.11	3.86	2.73
80.	95.0	1.74	2.74	2.15	3.48	2.55
89.	100.0	1.59	2.37	1.85	3.05	2.24
97.	105.0	1.42	2.01	1.57	2.62	1.93
106.	110.0	1.26	1.65	1.27	2.19	1.62
115.	115.0	1.08	1.26	0.97	1.76	1.31
125.	120.0	0.68	0.83	0.62	1.36	1.04
127.	121.0	0.67	0.81	0.61	1.35	1.05
129.	122.0	0.77	0.92	0.64	1.40	0.95
135.	125.0	0.71	0.85	0.60	1.38	0.94
145.	130.0	0.62	0.74	0.55	1.35	0.93
149.	132.0	0.58	0.70	0.52	1.34	0.93
151.	132.9	0.48	0.57	0.46	1.31	0.91
177.	146.0	0.48	0.57	0.46	1.31	0.91
499.	403.0	0.48	0.57	0.46	1.31	0.91
501.	421.9	0.48	0.57	0.46	1.31	0.91
Heat Load **		469.62	731.45	491.01	1131.08	693.57

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Table 22: 1.5 Stage Convective Environments for Body Point 201

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 201 -- CORE BASE HEAT SHIELD
(2 HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 20, 1991

ALT (KFT)	TIME (SEC)	TP (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	3.517E-03	6.78	6.50	5.02	3.26	1.51	-0.25
130.6	123.0	2454.	3.292E-03	6.56	6.30	4.92	3.27	1.63	-0.02
134.5	125.0	2520.	3.081E-03	6.35	6.10	4.81	3.27	1.73	0.18
138.5	127.0	2586.	2.786E-03	5.92	5.70	4.53	3.14	1.74	0.35
144.6	130.0	2684.	2.332E-03	5.19	5.00	4.02	2.85	1.69	0.52
150.6	132.9	2780.	1.830E-03	4.25	4.10	3.33	2.42	1.50	0.59
150.6	132.9	2780.	9.375E-04	2.17	2.10	1.71	1.24	0.77	0.30
158.9	136.9	2930.	8.787E-04	2.17	2.10	1.73	1.29	0.85	0.41
177.4	146.0	2950.	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
495.6	393.0	2950.	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
498.7	403.0	2500.	1.071E-03	2.19	2.10	1.65	1.11	0.58	0.04
501.1	421.9	2500.	1.071E-03	2.19	2.10	1.65	1.11	0.58	0.04

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 7122.42 (BTU/FT2)

Table 24: 1.5 Stage Convective Environments for Body Point 203

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 203 -- CORE BASE HEAT SHIELD
G/C HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-120) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	7.576E-04	1.46	1.40	1.08	0.70	0.32	-0.05
130.6	123.0	2454.	7.053E-04	1.41	1.35	1.05	0.70	0.35	0.00
134.5	125.0	2520.	6.566E-04	1.35	1.30	1.02	0.70	0.37	0.04
138.5	127.0	2586.	6.109E-04	1.30	1.25	0.99	0.69	0.38	0.08
144.6	130.0	2684.	5.364E-04	1.19	1.15	0.92	0.66	0.39	0.12
150.6	132.9	2780.	4.911E-04	1.14	1.10	0.89	0.65	0.40	0.16
150.6	132.9	2780.	8.929E-05	0.21	0.20	0.16	0.12	0.07	0.03
158.9	136.9	2930.	8.368E-05	0.21	0.20	0.16	0.12	0.08	0.04
177.4	146.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
495.6	393.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
498.7	403.0	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00
501.1	421.9	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6519.36 (BTU/FT2)

Table 25: 1.5 Stage Convective Environments for Body Point 204

1.5 STAGE REFERENCE VEHICLE
BODY POINT # 204 -- CORE BASE HEAT SHIELD
[illegible] LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 26, 1991

ALT (FT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	2.760E-03	5.32	5.10	3.94	2.56	1.18	-0.20
130.6	123.0	2454.	2.612E-03	5.21	5.00	3.90	2.60	1.29	-0.02
134.5	125.0	2520.	2.374E-03	4.89	4.70	3.70	2.52	1.33	0.14
138.5	127.0	2586.	2.151E-03	4.57	4.40	3.50	2.42	1.35	0.27
144.6	130.0	2684.	1.772E-03	3.94	3.80	3.06	2.17	1.28	0.40
150.6	132.9	2780.	1.362E-03	3.16	3.05	2.48	1.80	1.12	0.44
150.6	132.9	2780.	8.929E-05	0.21	0.20	0.16	0.12	0.07	0.03
158.9	136.9	2930.	8.368E-05	0.21	0.20	0.16	0.12	0.08	0.04
177.4	146.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
495.6	393.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
498.7	403.0	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00
501.1	421.9	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6557.53 (BTU/FT2)

Table 26: 1.5 Stage Convective Environments for Body Point 205

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 205 -- SIDE HEAT SHIELD
6/2 HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EF 55 (91-126) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TF (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	5.898E-03	11.37	10.90	8.42	5.47	2.52	-0.42
130.6	123.0	2454.	5.590E-03	11.15	10.70	8.35	5.56	2.76	-0.03
134.5	125.0	2520.	5.253E-03	10.82	10.40	8.19	5.57	2.94	0.32
138.5	127.0	2586.	4.888E-03	10.39	10.00	7.95	5.50	3.06	0.62
144.6	130.0	2684.	3.965E-03	8.82	8.50	6.83	4.85	2.87	0.89
150.6	132.9	2780.	3.080E-03	7.15	6.90	5.61	4.07	2.53	0.99
150.6	132.9	2780.	1.786E-03	4.14	4.00	3.25	2.36	1.46	0.57
158.9	136.9	2930.	1.674E-03	4.13	4.00	3.30	2.46	1.62	0.79
177.4	146.0	2950.	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
495.6	393.0	2950.	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
498.7	403.0	2500.	2.041E-03	4.16	4.00	3.14	2.12	1.10	0.08
501.1	421.9	2500.	2.041E-03	4.16	4.00	3.14	2.12	1.10	0.08

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 7720.64 (BTU/FT2)

Table 27: 1.5 Stage Convective Environments for Body Point 206

[illegible] STAGE REFERENCE VEHICLE
BODY POINT # 206 -- SIME HEAT SHIELD
[illegible] HIGH FLOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 26, 199[illegible]

ALT (KFT)	TIME (SEC)	Tw (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	4.491E-03	8.66	8.30	6.41	4.17	1.92	-0.32
130.6	123.0	2454.	4.232E-03	8.44	8.10	6.32	4.21	2.09	-0.03
134.5	125.0	2520.	4.040E-03	8.32	8.00	6.30	4.28	2.26	0.24
138.5	127.0	2586.	3.617E-03	7.69	7.40	5.88	4.07	2.26	0.46
144.6	130.0	2684.	3.032E-03	6.74	6.50	5.23	3.71	2.19	0.68
150.6	132.9	2780.	2.277E-03	5.28	5.10	4.14	3.01	1.87	0.73
150.6	132.9	2780.	8.929E-05	0.21	0.20	0.16	0.12	0.07	0.03
158.9	136.9	2930.	8.368E-05	0.21	0.20	0.16	0.12	0.08	0.04
177.4	146.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
495.6	393.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
498.7	403.0	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00
501.1	421.9	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6593.57 (BTU/FT2)

Table 28: 1.5 Stage Convective Environments for Body Point 207

[illegible] 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 207 -- SIME HEAT SHIELD
[illegible] LONG BODY CONVECTIVE PLUME HEATING TRAJECTORY FROM EI 55 (91-126) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2380.	4.491E-03	8.66	8.30	6.41	4.17	1.92	-0.32
130.6	123.0	2454.	4.232E-03	8.44	8.10	6.32	4.21	2.09	-0.03
134.5	125.0	2520.	4.040E-03	8.32	8.00	6.30	4.28	2.26	0.24
138.5	127.0	2586.	3.617E-03	7.69	7.40	5.88	4.07	2.26	0.46
144.6	130.0	2684.	3.032E-03	6.74	6.50	5.23	3.71	2.19	0.68
150.6	132.9	2780.	2.277E-03	5.28	5.10	4.14	3.01	1.87	0.73
150.6	132.9	2780.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
158.9	136.9	2930.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
177.4	146.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
495.6	393.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
498.7	403.0	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
501.1	421.9	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6535.77 (BTU/FT2)

Table 29: 1.5 Stage Convective Environments for Body Point 208

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 208 -- INBD STME NOZZLE (LIP)
6/2 HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EF 55 (91-126) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	9.416E-03	18.15	17.40	13.45	8.74	4.03	-0.68
130.6	123.0	2454.	8.986E-03	17.92	17.20	13.43	8.93	4.44	-0.05
134.5	125.0	2520.	8.586E-03	17.69	17.00	13.39	9.10	4.81	0.52
138.5	127.0	2586.	7.918E-03	16.83	16.20	12.87	8.92	4.96	1.00
144.6	130.0	2684.	6.670E-03	14.83	14.30	11.50	8.16	4.83	1.49
150.6	132.9	2780.	5.804E-03	13.46	13.00	10.56	7.66	4.76	1.86
150.6	132.9	2780.	2.857E-03	6.63	6.40	5.20	3.77	2.34	0.91
158.9	136.9	2930.	2.678E-03	6.61	6.40	5.28	3.94	2.60	1.26
177.4	146.0	2950.	2.656E-03	6.61	6.40	5.28	3.96	2.63	1.30
495.6	393.0	2950.	2.656E-03	6.61	6.40	5.28	3.96	2.63	1.30
498.7	403.0	2500.	3.265E-03	6.66	6.40	5.03	3.40	1.76	0.13
501.1	421.9	2500.	3.265E-03	6.66	6.40	5.03	3.40	1.76	0.13

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 8491.62 (BTU/FT2)

Table 30: 1.5 Stage Convective Environments for Body Point 209

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 209 -- TRBD STME NOZZLE (LIP)
67% HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TF (DEG F)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R) 360	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	6.981E-03	13.46	12.90	9.97	6.48	2.99	-0.50
130.6	123.0	2454.	6.583E-03	13.13	12.60	9.84	6.54	3.25	-0.04
134.5	125.0	2520.	6.111E-03	12.59	12.10	9.53	6.48	3.42	0.37
138.5	127.0	2586.	5.767E-03	12.26	11.80	9.38	6.49	3.61	0.73
144.6	130.0	2684.	4.664E-03	10.37	10.00	8.04	5.71	3.38	1.04
150.6	132.9	2780.	3.661E-03	8.49	8.20	6.66	4.83	3.00	1.17
150.6	132.9	2780.	8.929E-05	0.21	0.20	0.16	0.12	0.07	0.03
158.9	136.9	2930.	8.360E-05	0.21	0.20	0.16	0.12	0.08	0.04
177.4	146.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
495.6	393.0	2950.	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
498.7	403.0	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00
501.1	421.9	2500.	1.020E-04	0.21	0.20	0.16	0.11	0.06	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6643.49 (BTU/FT2)

Table 31: 1.5 Stage Convective Environments for Body Point 210

1[illegible].5 STAGE REFERENCE VEHICLE
BODY POINT # 210 -- OUTBD STME NOZZLE (LIF)
C/L HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	4.654E-03	8.97	8.60	6.65	4.32	1.99	-0.34
130.6	123.0	2454.	4.441E-03	8.86	8.50	6.63	4.41	2.19	-0.03
134.5	125.0	2520.	4.192E-03	8.64	8.30	6.54	4.44	2.35	0.25
138.5	127.0	2586.	3.812E-03	8.10	7.80	6.20	4.29	2.39	0.48
144.6	130.0	2684.	3.218E-03	7.16	6.90	5.55	3.94	2.33	0.72
150.6	132.9	2780.	2.411E-03	5.59	5.40	4.39	3.18	1.98	0.77
150.6	132.9	2780.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
158.9	136.9	2930.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
177.4	146.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
495.6	393.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
498.7	403.0	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
501.1	421.9	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6540.23 (BTU/FT2)

Table 32: 1.5 Stage Convective Environments for Body Point 211

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 211 -- OUTBD STME NOZZLE (LIP)
[illegible] HIGH FLOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EP 55 (91-126) SEP. 26, 1991

ALT (FEET)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	6.439E-03	12.42	11.90	9.20	5.98	2.76	-0.46
130.6	123.0	2454.	6.113E-03	12.19	11.70	9.13	6.08	3.02	-0.04
134.5	125.0	2520.	5.707E-03	11.76	11.30	8.90	6.05	3.20	0.34
138.5	127.0	2586.	5.230E-03	11.12	10.70	8.50	5.89	3.27	0.66
144.6	130.0	2684.	4.338E-03	9.65	9.30	7.48	5.31	3.14	0.97
150.6	132.9	2780.	3.348E-03	7.77	7.50	6.09	4.42	2.75	1.07
150.6	132.9	2780.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
158.9	136.9	2930.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
177.4	146.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
495.6	393.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
498.7	403.0	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
501.1	421.9	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R

PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6574.96 (BTU/FT2)

Table 33: 1.5 Stage Convective Environments for Body Point 212

NLS 1.5 STAGE REFERENCE VEHICLE
BODY POINT # 212 -- OUTBD STME NOZZLE (LIP)
[illegible] HIGH LOW, LONG BURN CONVECTIVE PLUME HEATING TRAJECTORY FROM EI 55 (91-126) SEP, 26, 1991

ALT (KFT)	TIME (SEC)	TR (DEG R)	FILM COEFF. (BTU/FT2* SEC-DEG R)	CONVECTIVE HEATING RATE (BTU/FT2*SEC) FOR VARIOUS WALL TEMPERATURES (DEG R)					
				460	540	960	1460	1960	2460
0.0	0.0	4190.	2.200E-02	82.06	80.30	71.06	60.06	49.06	38.06
0.8	10.0	4180.	2.170E-02	80.72	78.99	69.87	59.02	48.17	37.32
3.2	20.0	4165.	2.110E-02	78.18	76.49	67.63	57.08	46.53	35.98
7.7	30.0	4145.	2.060E-02	75.91	74.26	65.61	55.31	45.01	34.71
12.1	37.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
12.9	38.0	4130.	2.000E-02	73.40	71.80	63.40	53.40	43.40	33.40
22.8	50.0	4110.	1.950E-02	71.17	69.61	61.42	51.67	41.92	32.17
32.7	60.0	4085.	1.650E-02	59.81	58.49	51.56	43.31	35.06	26.81
44.2	70.0	4065.	1.400E-02	50.47	49.35	43.47	36.47	29.47	22.47
57.4	80.0	4045.	1.200E-02	43.02	42.06	37.02	31.02	25.02	19.02
72.3	90.0	3960.	9.600E-03	33.60	32.83	28.80	24.00	19.20	14.40
88.6	100.0	3880.	7.600E-03	25.99	25.38	22.19	18.39	14.59	10.79
106.1	110.0	3765.	5.800E-03	19.17	18.70	16.27	13.37	10.47	7.57
124.8	120.0	3645.	4.300E-03	13.70	13.35	11.55	9.40	7.25	5.10
124.8	120.0	2355.	4.300E-03	8.15	7.80	6.00	3.85	1.70	-0.45
126.7	121.0	2388.	3.084E-03	5.95	5.70	4.40	2.86	1.32	-0.22
130.6	123.0	2454.	2.926E-03	5.83	5.60	4.37	2.91	1.45	-0.02
134.5	125.0	2520.	2.778E-03	5.72	5.50	4.33	2.94	1.56	0.17
138.5	127.0	2586.	2.493E-03	5.30	5.10	4.05	2.81	1.56	0.31
144.6	130.0	2684.	2.099E-03	4.67	4.50	3.62	2.57	1.52	0.47
150.6	132.9	2780.	1.607E-03	3.73	3.60	2.92	2.12	1.32	0.51
150.6	132.9	2780.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
158.9	136.9	2930.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
177.4	146.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
495.6	393.0	2950.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
498.7	403.0	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
501.1	421.9	2500.	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY @ Tw = 540 R
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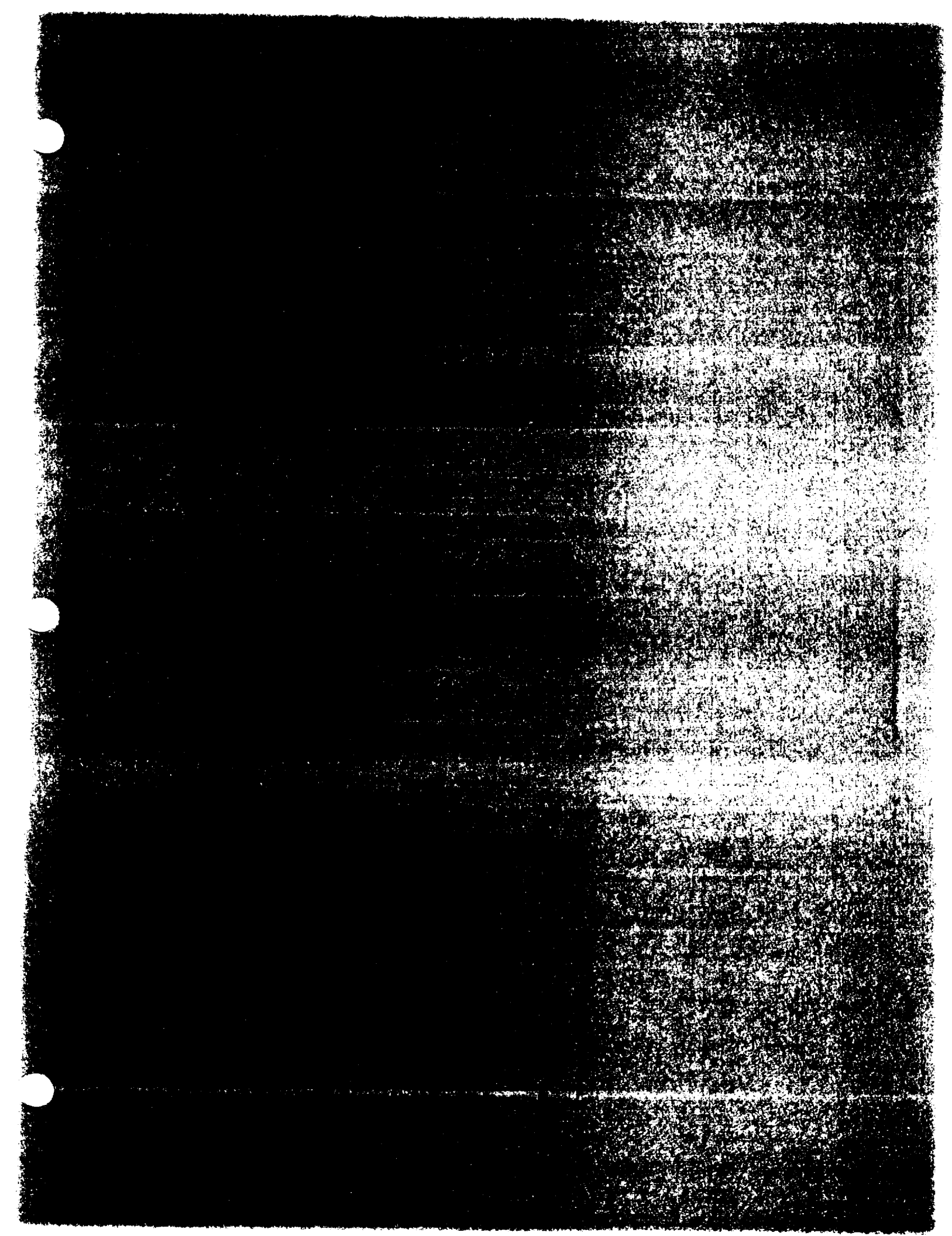
PEAK HEATING RATE: 80.30 (BTU/FT2*SEC)

TOTAL HEAT LOAD: 6508.04 (BTU/FT2)



REMTECH TECHNICAL NOTE

SUBJECT:	August 1992 NLS 2 650K STME Base Heating Environments
DATE:	August 7, 1992
AUTHORS:	Robert L. Bender, John E. Reardon, Craig P. Schmitz and John R. Brown
CONTRACT NO.:	NAS8-39235
PREPARED FOR:	George C. Marshall Space Flight Center

INTRODUCTION

Cycle 1 base heating environments for the NLS 1.5 stage vehicle were previously reported in Ref. [1]. Those environments were based upon "upper limit" methodology and conservative assumptions and, consequently, had significant impact on selection of the thermal protection system (TPS) for the base region. Following publication of Ref. [1], analyses continued in an attempt to improve our understanding of the low altitude convective base heating which was the largest contributor to the high heating levels specified for Cycle 1. A working group was formed at MSFC to direct this follow-on analysis and to coordinate the combined activities of the flowfield, environment, and thermal response analysts.

REMTECH participated in this working group and developed the engineering approach (updated methodology) used to generate the NLS 2 650K STME environments. The NLS 2 environments are specified for 13 body point locations in the base region of the NLS 2 vehicle which is the latest designation for the six-engine 1.5 stage concept. The NLS 2 engineering approach utilizes scaled Saturn V flight data and results in environments substantially lower than Cycle 1.

INPUTS

The Cycle 2 environments have been specifically determined for the August 1992 NLS 2 vehicle with 650K thrust STMEs and trajectories [2–3] reflecting summer 1992 design and performance estimates. It was assumed that the May 1991 reference 1.5 stage vehicle base geometry was essentially unchanged for NLS 2. Base diameter, engine arrangement, and engine spacing are shown in Fig. 1. The base heat shield, engine heat shield, and nozzle closure configurations are similar to those considered in Cycle 1 and shown in Fig. 2. These schematics do not reflect the slightly larger nozzle resulting from the thrust upgrade from 583K to 650K.

The 650K STME, Rev. 26b, operates at 2250 psia chamber pressure (at full thrust) with a nozzle expansion ratio of 44/1. Increased thrust is partially accomplished by enlarging the throat which results in a larger diameter exit plane than the Cycle 1 583K engine. Essential features of the inviscid exhaust plume are unchanged from the earlier 583K STME. However, the larger nozzle does affect radiation viewfactors and reduces the spacing between the six engines which impacts the reversed plume flowfields and intensity of the resulting convection. A summary of STME 650K engine characteristics based upon engine cycle Rev. 26b is presented in Fig. 3.

The updated trajectories for NLS 2 were obtained from MSFC EP-55. Four trajectories were provided: Mission 1 nominal and engine-out, and Mission 2 nominal and engine-out. The NLS 2 nominal trajectories generally lofted more than the Cycle 1 trajectory as shown in the comparisons of Fig. 4.

BODY POINT SELECTION

The 1.5 stage body points selected for Cycle 1 base heating analysis were retained for NLS 2. One additional point was added so environments could be specified to the sustainer thrust structure following separation of the outboard booster engines and associated heat shield/booster thrust structure. The original body point locations are shown in Fig. 5 and the new point on the schematic of Fig. 6. These locations were originally selected to provide environments at maximum heating locations on both the booster and sustainer engines as well as the heat shield. These conditions are also met for NLS 2.

METHODOLOGY

The methodology for predicting base heating during ascent for the NLS 2 was dramatically altered following publication of Cycle 1. Of the two heating components, radiation and convective, heavy emphasis was placed on understanding and improving the convective component, particularly during the first 100 seconds of flight when burning of the STME turbine exhaust in the base region could occur. Cycle 1 convective environments were essentially upper limit estimates reflecting stoichiometric burning of the turbine exhaust with air in the base from liftoff to 100,000 ft. For NLS 2, the burning potential was addressed in detail to assess the likelihood of the stoichiometric assumption and to relate previous flight vehicle turbine exhaust disposal experience to the NLS 2 vehicle.

Since the NLS 2 is an all-liquid propellant vehicle, radiation from solid propellant boosters is not an issue and overall levels of radiation are reduced from that previously reported for the HLLV concept. However, the six engines do produce substantial levels of radiation at low altitudes for points in the base which can see the highly radiating Mach discs in the plumes from several STMEs. For this study the plume radiation models were generated by the Base Heating Design Code currently under development for NASA MSFC ED-22 [4]. A summary of previously published base heating environment reports

for NLS is presented in Fig. 7. Overviews of the radiation and convective methodologies for NLS 2 are presented in the following paragraphs.

CONVECTION

Conventional convective base heating from plume-to-plume interactions normally begins at higher altitudes and can be determined by judicious scaling of existing launch vehicle flight environment data from vehicles with similar engines. This methodology was followed for NLS 2 where higher altitude environments were scaled from Shuttle Orbiter and Saturn V/S-II flight data as reported in Ref. [5]. The important question for NLS 2 was how to extend the methodology to treat potential heating which may result from STME turbine exhaust burning at the lower altitude, which may be substantially higher than conventional heating as depicted in the schematic of Fig. 8. In order to understand this "base burning" phenomenon better and in an attempt to verify or improve the Cycle 1 estimates, a detailed review of applicable Saturn flight data during early ascent was recommended. The Saturn vehicles utilized gas generator cycle LO_2/RP-1 engines with various turbine exhaust disposal schemes during first stage ascent, so their flight experience was germane to the NLS 2 STME problem.

Defining convection requires a definition of the local heat transfer coefficient (h_c) in the base as well as a definition of the gas temperature (T_g) which drives the heat transfer. Following Cycle 1, the convective methodology development was conducted as shown in Fig. 9. The primary paths followed utilized Saturn flight data for h_c and Saturn gas temperature envelopes for T_g. The specific objectives of the Saturn flight data review were:

OBJECTIVE 1: Reduce heat load accumulated early in flight by refining Cycle 1 film heat transfer coefficient (h_2) based on Saturn flight data

$$h_c = \frac{Q_{Total} - Q_{Radiation}}{T_{Gas} - T_{Wall\ of\ Total\ Cal}}$$

OBJECTIVE 2: Based on Saturn flight data, develop a methodology to reduce base gas temperature early in flight below stoichiometric if possible.

The Cycle 1 heat transfer coefficient was taken from Ref. [6] and was essentially a flight deduced h_c from the Saturn I Block II flight data. REMTECH's review of all Saturn flight data was targeted at verifying or replacing the Cycle 1 h_c; however, because the flight data were based on measurements with large uncertainty and inherent error, this effort was, for the most part, inconclusive. The salient results of the Objective 1 effort are summarized in Fig. 10. In general, the flight data were not useful in defining a "better" value of h_c at lower altitudes and a different approach was indicated.

The Saturn gas temperature data (investigated under Objective 2) were relatively consistent and repeatable, and were more useful to the NLS study. The data were separated into two main groups: the base heat shield data and the engine data. Envelopes of all data were determined as well as the statistical mean and 1σ, 2σ, and 3σ

standard deviations. These envelopes showed that, early in flight, base gas temperatures are greater than the free-stream air total temperature so recirculation of some hot plume gases or turbine exhaust discharge gases had to occur. After reviewing all the flight data, it was evident that the Saturn V/S-1C stage data were more appropriate for comparison with NLS since they did not have the center cluster of four engines which affected the flowfields as do the Saturn 1 and 1B vehicles. As a result of these comparisons and after a detailed look at the S-1C stage F-1 engine turbine exhaust discharge, methodology to scale the Saturn V data to NLS conditions to predict a better base gas temperature for NLS 2 was pursued.

Details of the Saturn flight data review and comparisons of the Saturn V/S-1C stage with NLS 2 will be presented in a REMTECH technical note scheduled for release in September 1992. Some of the more important similarities in NLS 2 and the S-1C stage are summarized in Fig. 11. The basic rationale for Saturn V to NLS scaling involved the fundamental assumption that the volumetric mixing of turbine exhaust with air at the plume boundary was similar between the two vehicles, or

$$\left(\frac{\dot{V}_{AIR}}{\dot{V}_{FUEL}}\right)_{SAT\,V} = \left(\frac{\dot{V}_{AIR}}{\dot{V}_{FUEL}}\right)_{NLS}$$

Shear layer development/mixing along the plume boundary is assumed to be independent of turbine exhaust disposal scheme. It was also assumed that mixing differences are driven by exhaust product density differences. Justification for these assumptions and background for the scaling rationale can be summarized as follows:

Similar Base Geometry

— Engine spacing, total engine exit area/base area, engine length/base diameter

Similar External Flow

— Trajectories are comparable below 100 kft, free-stream approach flow to plume boundary shear layer, and expansion into base are similar

Turbine Exhaust Disposal Schemes

— Combustible turbine exhaust/total engine flow approximately equal, total turbine exhaust/total engine flow comparable

Step-by-step methodology for applying the Saturn trends to NLS 2 are described in the following paragraphs.

As noted in Fig. 10, above 40,000 ft the h_c used in Cycle 1 did envelope the flight data and was, therefore, retained for NLS 2. Below 40,000 ft, a base region Reynolds number correlation was developed to adjust h_c to a more realistic trend accounting for the simultaneous drop in base region density as altitude increases and the increase in base region velocity as the vehicle accelerates. Instead of computing specific values of local Reynolds number which requires a length or size estimate, it was decided to compute the relative change in unit Reynolds number versus the unit value at 40,000 ft, which corresponds to the initial attitude where the value of h_c was acceptable.

Using the Colburn analogy for turbulent flow where the heat transfer coefficient is proportional to Reynolds number to the 0.8 power, the local density and velocity terms in the Reynolds number were estimated and the ratios computed for various times in the trajectory between sea level and 40,000 ft. The steps are defined in Fig. 12. NLS 2 velocity was assumed to be equal at corresponding altitudes to flight deduced Saturn V velocities measured on the center F-1 engine nozzle near the lip. Measured Saturn gas temperature and pressure were used to compute base region density at each altitude considered. After applying the Reynolds number correlation to the coefficient at 40,000 ft (step 3 in Fig. 12), a coefficient history with altitude was developed as shown in Fig. 13. REMTECH and the working group agreed that this more accurately represents the variation in h_c at low altitude than the h_c previously considered in Cycle 1.

The methodology for applying the Saturn V/S-1C stage flight data to the NLS 2 gas temperature involved eight (8) distinct steps as shown schematically in Fig. 14. The starting-point was to select the Saturn flight data envelopes (from all flights where measurements were made) as reasonable upper limits on the base gas temperature for that vehicle. In step 2, the flight envelopes were corrected for gas probe errors as discussed in Ref. [7]. Next, chemical equilibrium composition (CEC) code runs were made to construct a series of combustion gas temperature curves versus air/fuel ratios for the Saturn vehicle (step 3). Fuel for these computations was assumed to be the turbine exhaust products of the F-1 engine. By comparing the envelope values of gas temperature with the combustion temperatures, it was possible to deduce a value of air-to-turbine exhaust ratio occurring in the Saturn V/S-1C base region at various altitudes as shown in step 4.

From Ref. [8], the differences in the plume shear layer mixing between the F-1 engine (Saturn) and the STME (NLS) are essentially correlatable to differences in density of the mixing gases. Thus the air-fuel ratio determined from Saturn V flight data can be scaled to NLS 2 by applying the Saturn to NLS turbine exhaust density ratio at the nozzle lip as illustrated in step 5. This produces a new air-fuel ratio for NLS 2 versus altitude as shown in step 7 which, when combined with CEC combustion temperatures for STME turbine exhaust with air, step 6, produced an estimate of gas temperature for NLS 2 as depicted in step 8.

This scaling process is more easily understood by referring to the flowfield schematic in Fig. 15. We are assuming that the mixing processes at location Ⓐ in Fig. 15 are similar between Saturn V and NLS 2. The measured gas temperatures for Saturn V at locations Ⓑ and Ⓒ were used to define the amount of air mixed and burned with turbine exhaust at location Ⓐ Conservatism was added by computing the combustion temperatures for Saturn V (step 3 in Fig. 14) turbine exhaust excluding the heat released by burning the free carbon constituent. Typical values of gas temperature for the NLS 2 STME nozzle and heat shield utilizing the methodology of Fig. 14 are shown in the right-hand graph of Fig. 15. Those temperatures represent application of the methodology to earlier 583K STME turbine exhaust composition. Temperatures utilized to compute heating rates for this report were derived from the same methodology updated to 650K STME turbine exhaust density and composition. These latest temperatures are shown in Fig. 16.

Plume Radiation

The band-model radiation codes [9–10] which have been used for predictions of the Space Shuttle Main Engines have proven to be very reliable, but there is usually a problem obtaining the necessary flowfield descriptions for preliminary design predictions. Proper treatment of 1.5-Stage plume radiation would require a 3-D flowfield with booster and main engines at the proper thrust levels and radiation models for the burning gases in the base regions. With relative minor modification of an existing code [10], a good approximation could be made at low altitude using axisymmetric plumes representing the three radiation sources, but it would require property predictions of all three sources (booster STMEs, main-stage STMEs, and the base gas) at the same altitudes. These data were not available for this analysis, so each source was evaluated individually and the radiation from each was summed.. This is a reasonable approximation for some base locations, but is generally conservative. Because of this conservatism, no safety margins were added to the predictions.

Previous work had provided STME nozzle axisymmetric plumes with a mixture ratio (MR = O2/H2) of 6 at both 75 and 100 percent thrust. These predictions were used with scaling procedures described below and estimates of the base-gas properties for the current radiation predictions. The methods used to provide estimates of the complex flowfields using these data are described below.

The STME and the application have changed slightly since the previous predictions. The nozzle size has increased slightly, and the throttled condition is now 70-percent instead of the previous 75 percent. It also appears more appropriate to use an MR of 7 rather than 6 for the main chamber.

The change in dimensions of the nozzle were made by a simple geometric scaling of the plumes to match the current nozzle exit diameter, and the 70 percent thrust condition was accommodated by pressure scaling. The pressure scaling essentially uses the previous plumes with scaled pressures which then represent plumes at a slightly higher altitude. Scaling for the change in MR was based on an evaluation of equilibrium plume conditions which indicated that a 20 percent increase in plume temperatures could be expected for the change in mixture ratio from 6 to 7. However, it was found that the 20 percent increase was too great in regions behind strong shocks, so the adjustment was reduced as the temperature increased above 3000 R so that the increase was only 5 percent at 6000 R. The H_2O mole fraction was increased along with the temperature to the correct fraction for MR = 7. In order to limit the temperature and mole fraction adjustments to the unmixed portion of the plume, they were only applied to points with an N_2 mole fraction of less than 0.01. Conditions in the mixing layer are rather complex because of the multiple turbine exhaust injections, but the expected results of these streams are conservatively treated in the base burning model used for convection and radiation. The current plume predictions with MR=6 are conservative in mixing layer temperatures compared with an MR=7 prediction because of the increase H_2 fraction at MR=6.

The base burning gas properties used for radiation were those developed for the convection predictions. It was conservatively assumed that the gas extended from the

base heat shield to the nozzle exits with a diameter of 330 inches, which is approximately equal to the stage diameter. The properties were obtained from sea level to 100 kft at 20 kft intervals. Above 100 kft it is assumed that all burning stops and at 120 kft and above, the base gas is modeled as the reversed flow from the plume cluster. This is also terminated at staging.

The radiation from the plumes is most significant at low altitudes, and radiation from the base gases is most significant at 40 kft. As altitude increases, radiation from both sources decays rapidly. Mission 1 trajectories were used for all predictions, and predictions with booster engines at 100 percent and 70 percent were pieced together to represent the nominal mission without engine failure.

1.7 RESULTS

The radiation and convective environments are presented in both graphical and tabular format. Both nominal and engine-out Mission 1 trajectories were considered; Mission 2 was not specifically addressed since it was very close to Mission 1 for those parameters affecting base heating. The graphical results combining the radiation and convection components for cold wall conditions of 540 R are presented in Figs. 17 through 29 for the nominal engine-out Mission 1.

Convective heating rate predictions for various wall temperatures are presented versus time in Tables 1 through 26. Heat transfer coefficient and base gas temperature are included in these tables to assist the thermal analyst in assessing TPS temperature response and ablation rates. For those body points on structure (heat shield or STME TPS) which is jettisoned at separation, the environment is shown as zero after separation. Plume impingement heating and aerodynamic heating affects after separation were not addressed in this analysis. In general, peak convective heating rates now occur about 50 sec into flight and are reduced below sea level Cycle 1 heating rates by about 40 percent. Convective heat load is substantially reduced for these latest environments to magnitudes about one-third of those associated with Cycle 1.

The predictions for plume radiation for the nominal and engine-out missions are shown in Tables 27 and 28. In each table the body points on the booster engine structure are presented separately, so heating is terminated at separation. Since the peak plume radiation rate occurs at sea level, the peak plume radiation is identical for both trajectories. The heating rates for the normal trajectory generally rise when the booster engines are throttled, but the longer-duration engine-out trajectory produces the highest radiation heating loads. The increase in radiation with throttling at low altitude is caused by a reduction in expansion ratio which increases the temperatures in the plume. At high altitude, the higher thrust plume often has higher radiation.

The predictions for radiation from the base gases for the nominal and engine-out missions are shown in Tables 29 and 30. The same radiation model was used for both the nominal and engine-out missions because current knowledge of the base gas is limited. Currently, there is no effect modeled in one region of the base for the loss of a booster engine on the far corner of the base. The reverse gas rate peak occurs at 40 kft,

so the trajectory that has an increment closest to 40 kft will appear to have a slightly higher rate. The longer duration of the engine-out trajectory produced the highest heat load.

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[1] MSFC Memo ED33(15–92), "Cycle 1 NLS Base Heating Environments," Feb. 2, 1992 (also REMTECH RTN 218–04, Jan. 24, 1992).
[2] MSFC ED55 Note from Dan Adams to David Anderson, "Summary of NLS 2 Mission 2 Reference Trajectories," July 6, 1992.
[3] MSFC ED55 Note from Ray Bailey to David Anderson, "Summary of NLS 2 Mission 1 Reference Trajectories," July 1992.
[4] NASA Contract NAS8–38141, "Base Heating Methodology Improvements," initiated September 8, 1989.
[5] MSFC Memo ED33(98–91), "Preliminary Cycle 1 NLS Base Heating Environments," Sep. 25, 1991 (also REMTECH RTN 218–03, Sep. 13, 1991).
[6] Mullen, C. R. et al., "Saturn Base Heating Handbook," The Boeing Company, NASA/MSFC CR-61390, May 1, 1972.
[7] McAnelly, W. B. and Young, C. T. K., "Space Vehicle Engine and Heat Shield Environment Review," Volume I — Engineering Analysis, Teledyne Brown Report EE-MSFC-1774, Dec. 1973.
[8] Dimotakis, P. E., "Turbulent Free Shear Layer Mixing and Combustion," Chapter 5, Volume 137, *High-Speed Flight Propulsion Systems,* Progress In Astronautics and Aeronautics, 1991.
[9] Reardon, J. E. and Lee, Y. C., "A Computer Program for Thermal Radiation from Gaseous Rocket Exhaust Plumes (GASRAD)," REMTECH RTR 014–09, Dec. 1979.
[10] Reardon, J. E., "A Computer Program for Thermal Radiation from Shuttle Exhaust Plumes (SEPRAD)," REMTECH RTR 109–01, July 1987.

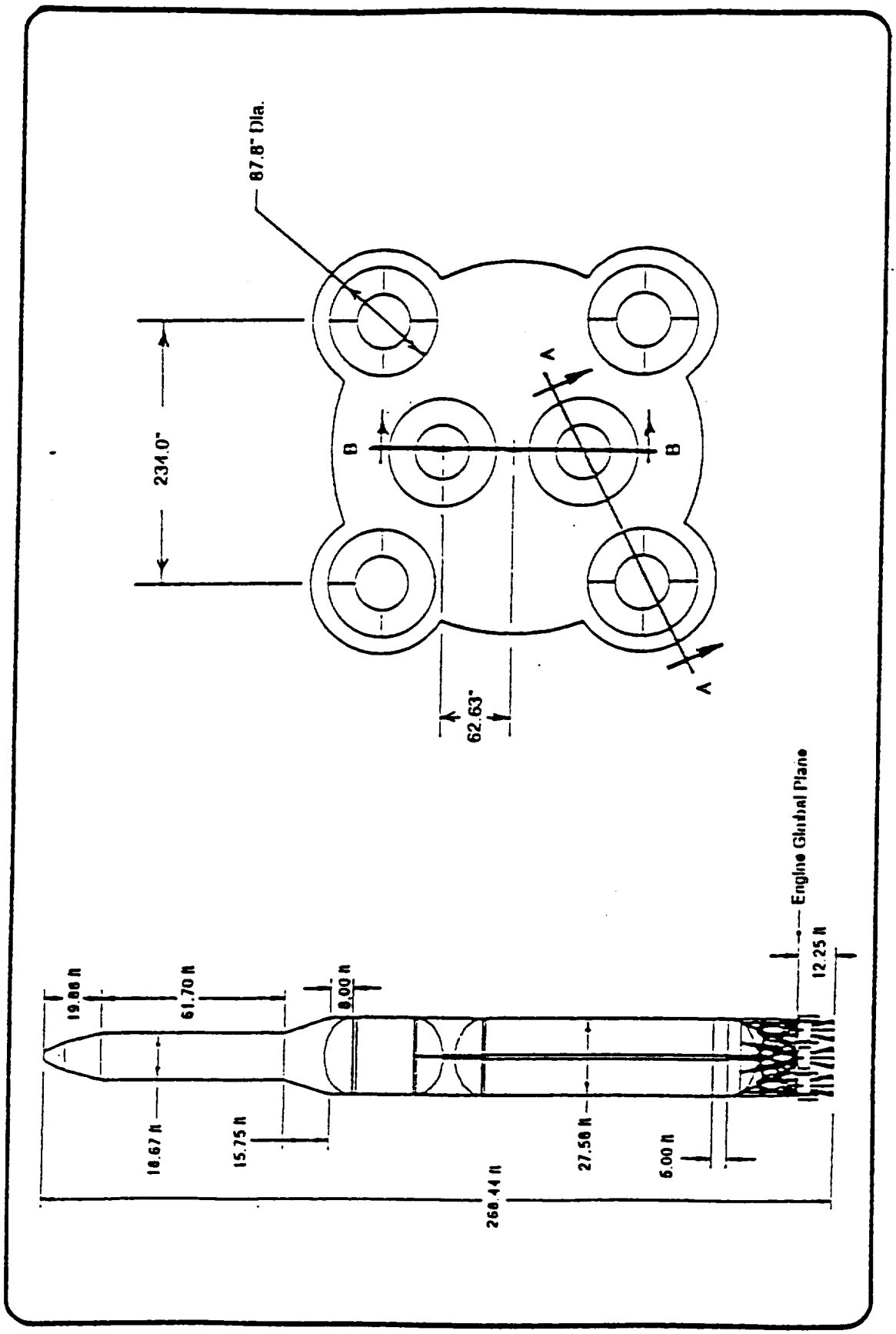


Figure 1: NLS 2 Launch Vehicle Base Geometry

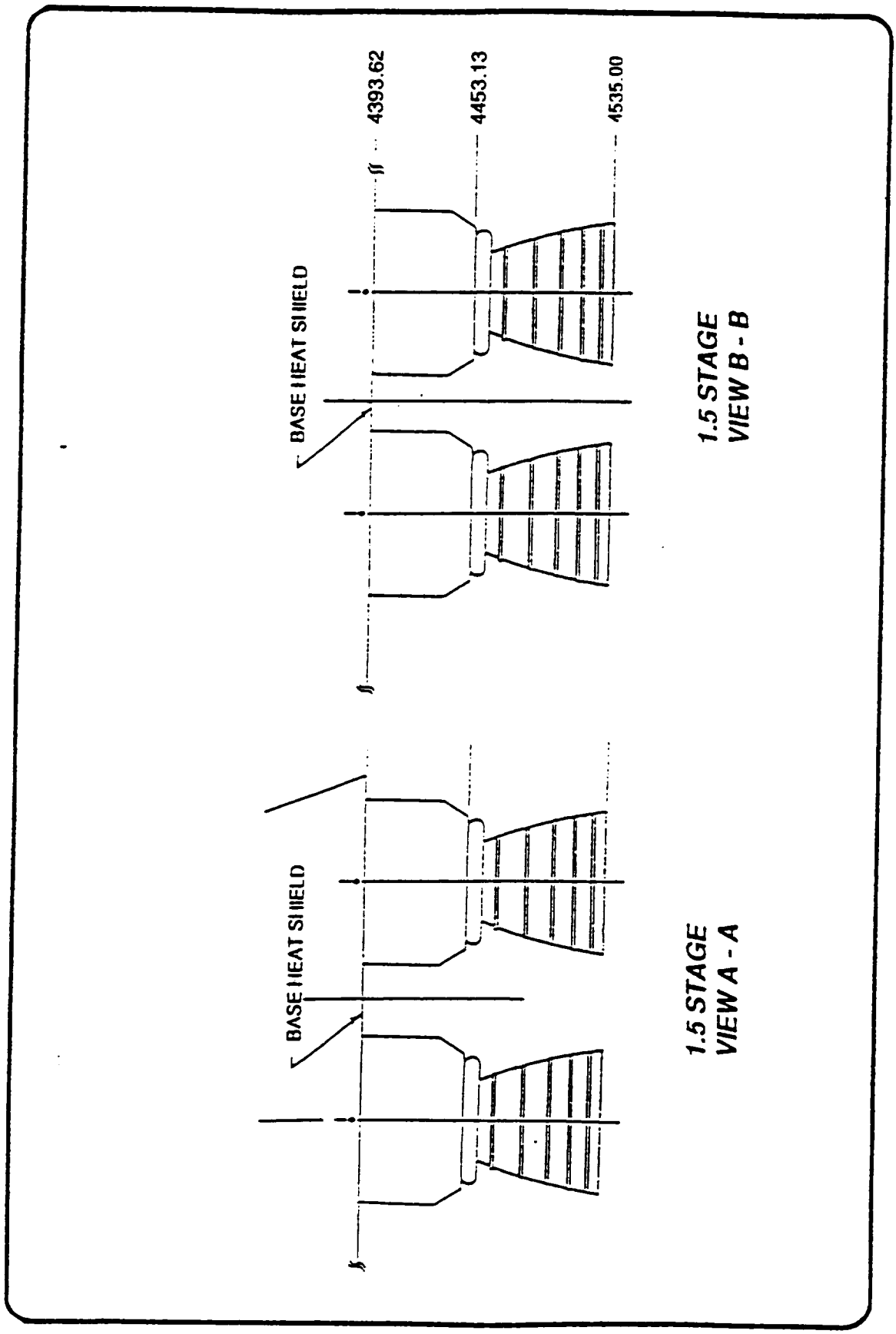


Figure 2: NLS 2 Launch Vehicle Base Region Side Views

STME 650K Design Data
(Rev. 26b)

Power, %	100	70
Gas Gen. Temp. °R	1580	1200
Nozzle Manifold:		
Pressure, psia	257	140
Temp., °R	1165	920
Flow, pps	65.9	37.7
Mixture Ratio, lb./lb.	0.868	0.658
Primary Film Injector:		
Total Thrust Pressure psia	216	118
Static Exit Pressure, psia	65	35
Temp., °R	1165	920
Flow, pps	33.1	18.9
Secondary Film Injector:		
Total Inlet Pressure, psia	80	52
Static Exit Pressure, psia	65	45
Temp., °R	1165	920
Flow, pps	6.6	3.8
Nozzlettes:		
Total Thrust Pressure, psia	77.2	43.9
Static Exit Pressure, psia	7.8	5.5
Temp., °R	1458	1264
Flow, pps	26.2	15.0
Main Stream Static Pressure, psia	57	40
Main Chamber:		
pc, psia	2250	1581
MR, lb./lb.	6.993	6.935
Flow, pps	1447.0	1020.6
Geometry:		
Chamber:		
Throat Area, in^2	149.45	
Exit Area, in^2	6577.0	
Nozzlettes:		
Throat Area, in^2	67.83	
Exit Area, in^2	145.16	

Figure 3: STME 650K Engine Characteristics (Rev. 26b)

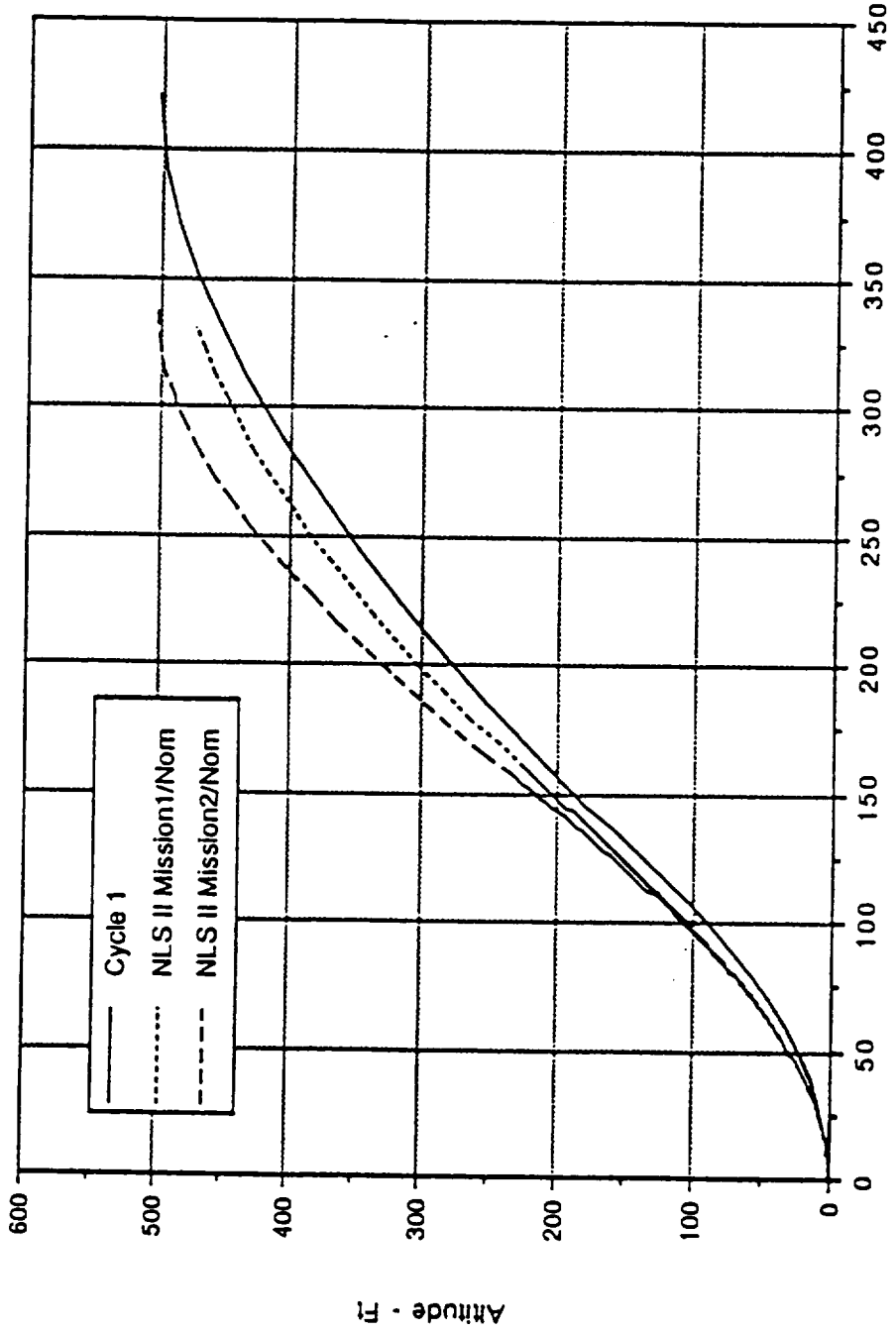


Figure 4: NLS 2 Trajectories Compared with Cycle 1 1.5 Stage Vehicle

			X	Y	Z
BP	201	1.5 Stage Base HS Center	4393.62	0.00	0.00
BP	202	1.5 Stage Base HS	4393.62	-58.50	0.00
BP	203	1.5 Stage Base HS	4393.62	-117.00	0.00
BP	204	1.5 Stage Base HS	4393.62	-58.51	89.83
BP	205	1.5 Stage STME 1 HS at 180 deg	4453.13	0.00	21.63
BP	206	1.5 Stage STME 1 HS at 295 deg	4453.13	-37.18	79.91
BP	207	1.5 Stage STME 3 HS at 155 deg	4453.13	-79.85	99.75
BP	208	1.5 Stage STME 1 Exit Lip Top at 180 deg	4535.00	0.00	14.93
BP	209	1.5 Stage STME 1 Exit Lip Top at 295 deg	4535.00	-43.26	82.74
BP	210	1.5 Stage STME 3 Exit Lip Top at 135 deg	4535.00	-69.32	117.02
BP	211	1.5 Stage STME 3 Exit Lip Top at 155 deg	4535.00	-73.66	97.14
BP	212	1.5 Stage STME 3 Exit Lip Top at 225 deg	4535.00	-117.02	69.32
BP	213	1.5 Stage Second Stage Thrust Cone	4315.50	114.07	0.00

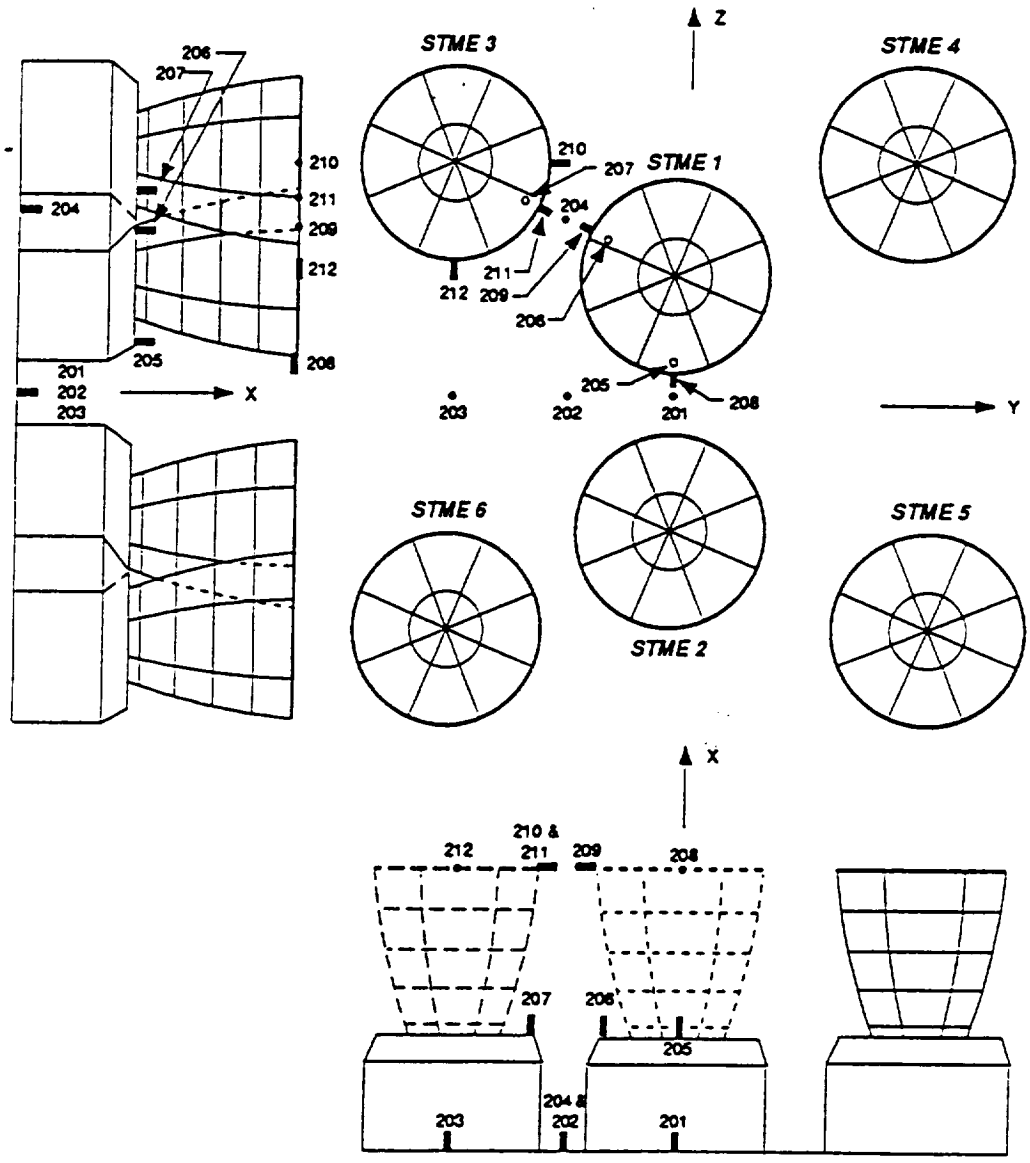


Figure 5: NLS 2 Body Points Selected for Base Heating Analysis

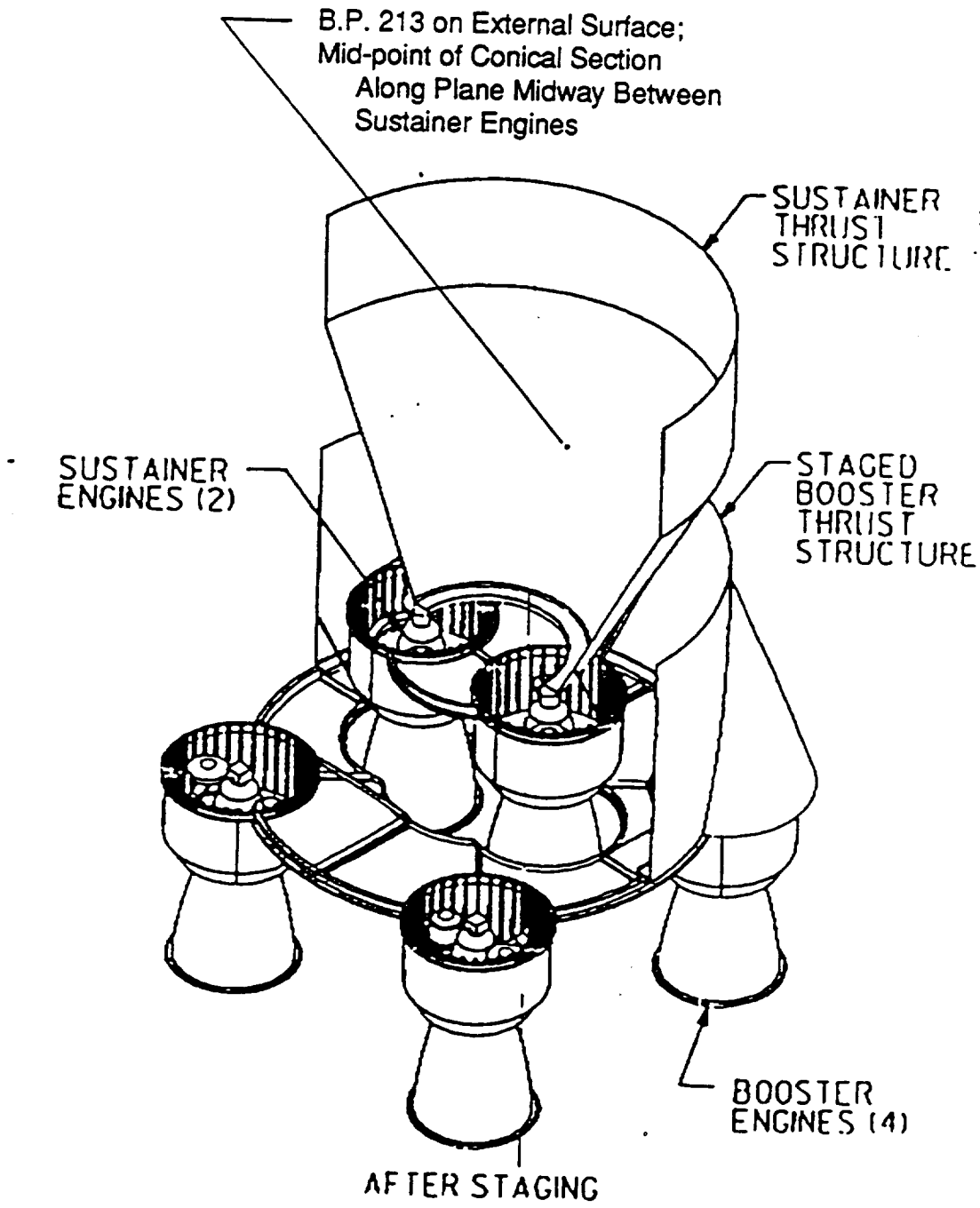


Figure 6: Body Point 213 Location on Sustainer Thrust Structure

C-2

PRELIMINARY CYCLE 1: ED33 (98 - 91) September 1991

- Base burning effect on convection not considered
- Base burning effect on radiation approximated

PRELIMINARY CYCLE 1 UPDATE: ED33 (03 - 92) JANUARY 1992

- Base burning effect on convection from ED31 (06 - 89) gas temperature and Saturn I heat transfer coefficient
- base burning effect on radiation same as ED33 (98 - 91)

CYCLE 1 ENVIRONMENT ED33 (15 - 92) February 1992

- Base burning effect on convection updated to stoichiometric air - T.E. exhaust mixture at estimated base pressure; Saturn I heat transfer coefficient retained. (Reduction in Δ enthalpy from ED33 [03 - 92])
- Local radiation in base estimated from base burning gas composition and thermodynamic properties
- Main plumes radiation from updated plume models

Figure 7: NLS Base Heating Environment Prediction Chronology

- Base burning convection may be large in relation to conventional convection

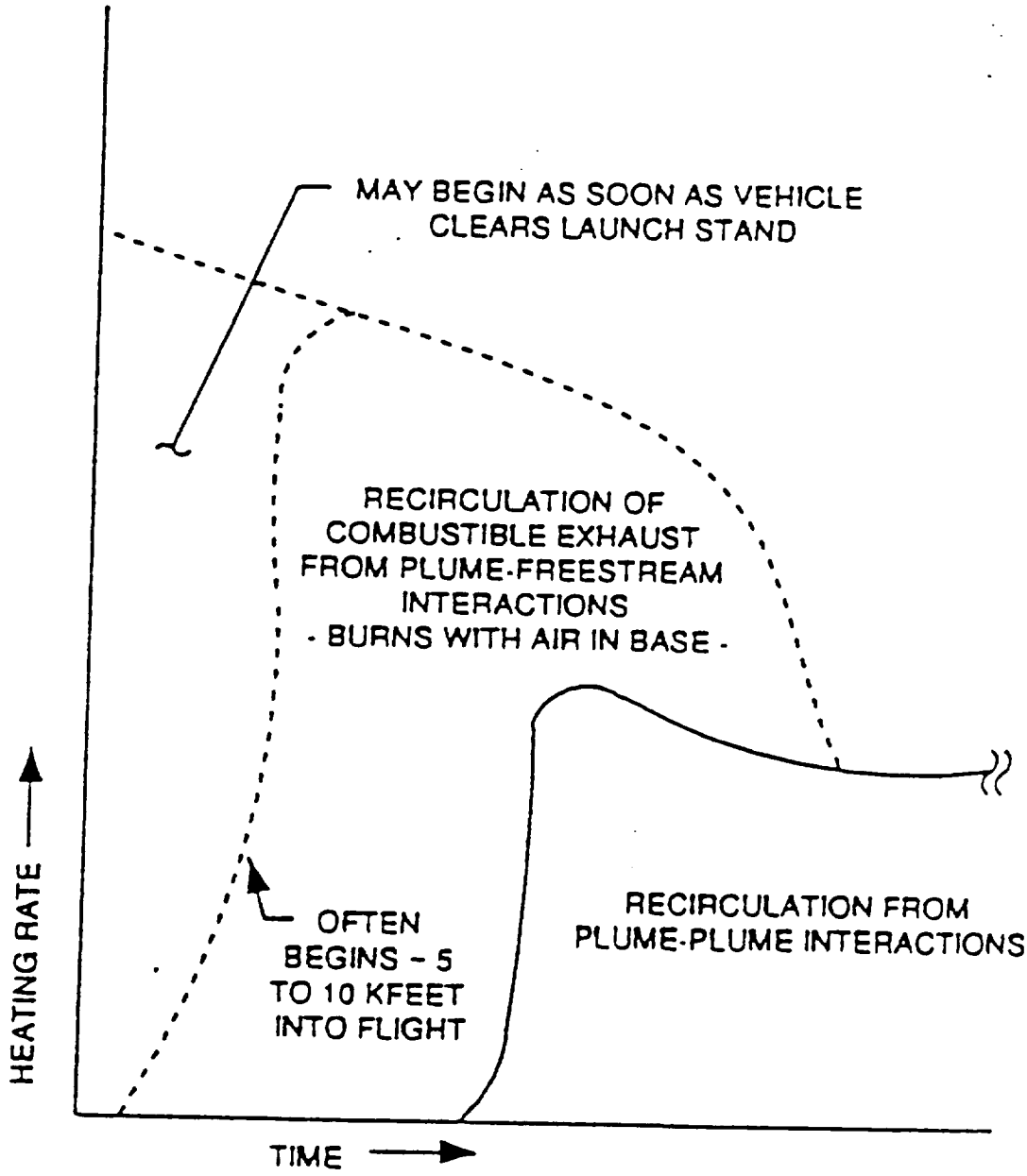


Figure 8: Low Altitude versus High Altitude Convective Base Heating

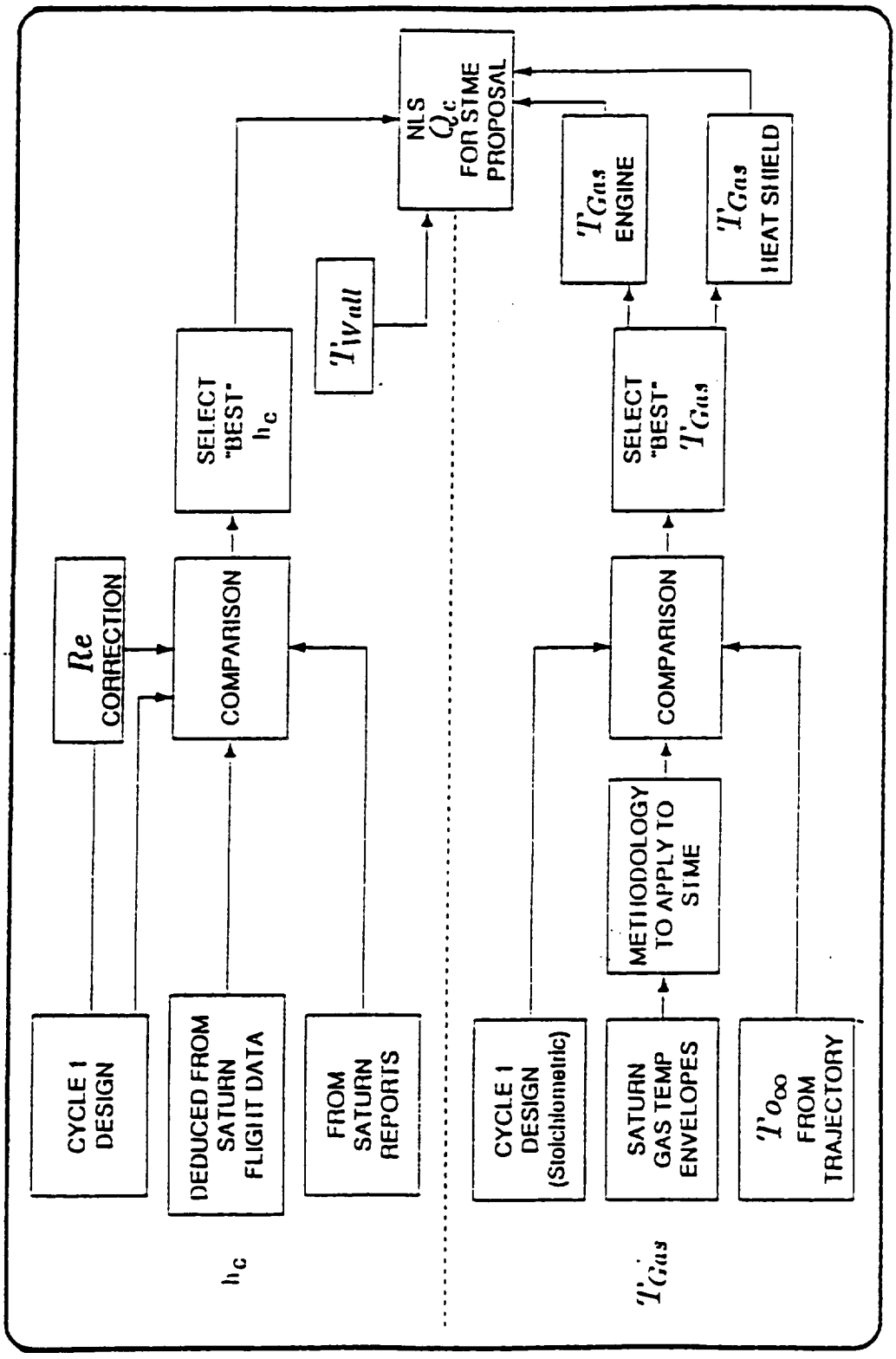
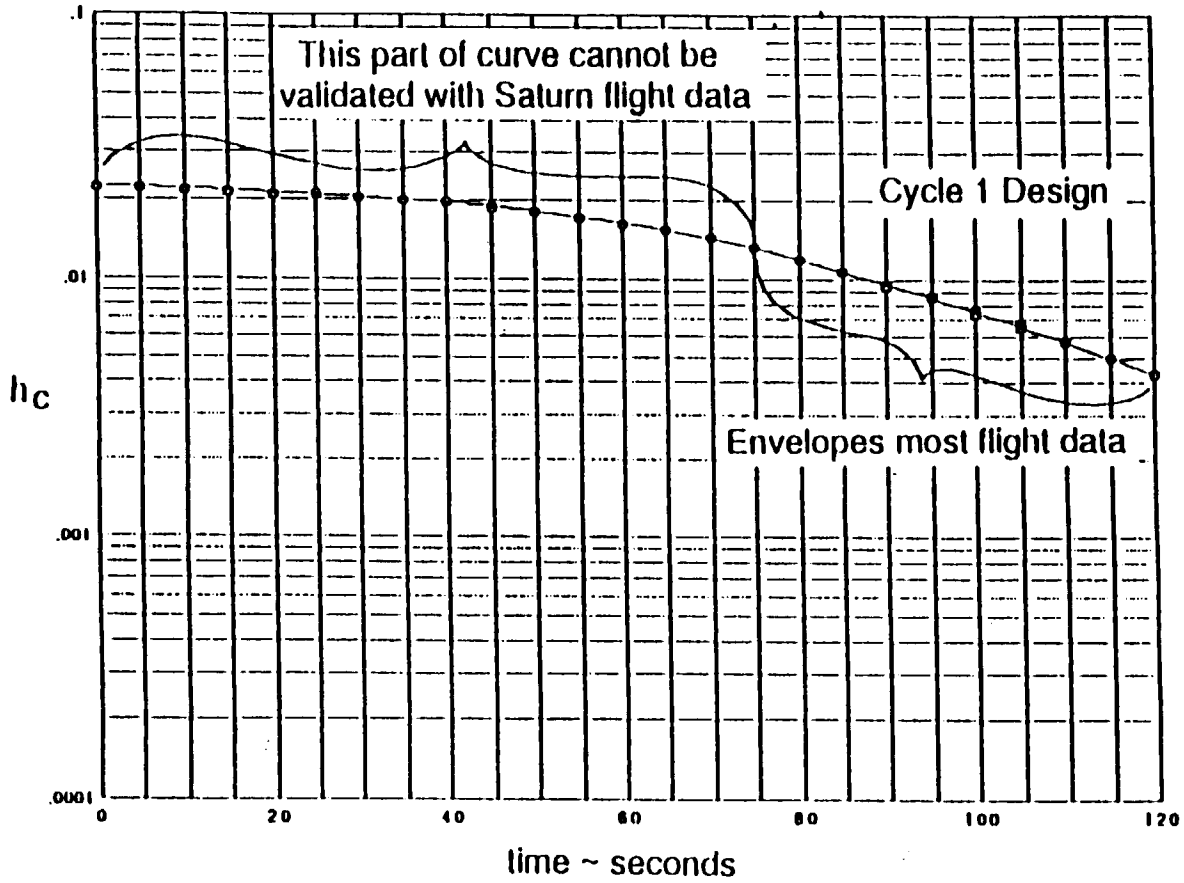
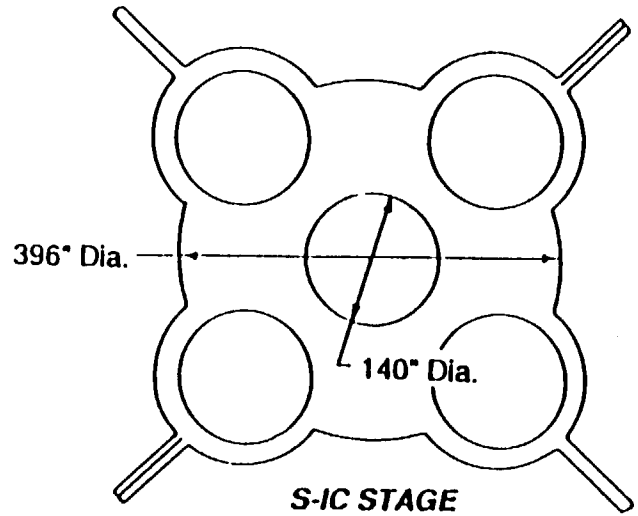


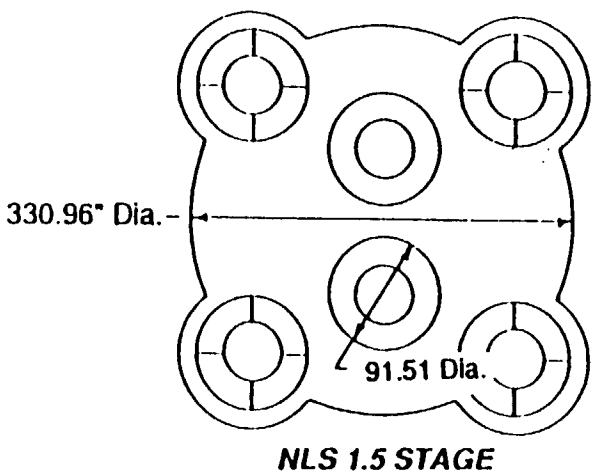
Figure 9: Application of Saturn Flight Data Review Results to NLS 2 Vehicle



- Above 40,000 Kft, Cycle 1 h_c envelopes Saturn flight data and is valid for NLS 1.5 stage.
- A technique to correlate h_c with base flow conditions for altitudes below 40,000 feet was indicated.

Figure 10: Results of Objective 1 — Flight Deduced h_c





Turbine Exhaust Composition

	F1 (lb/sec)	STME 650k (lb/sec)
H_2	13.40	36.51
CH_4	7.79	— —
CO	54.49	— —
C	69.31	— —
H_2	10.80	29.39
CO_2	11.51	— —

	F-1 Engine	STME
Flow Rate		
Main Chamber, lbm/sec	5564.40	1447.0
Turbine Exhaust Total, lbm/sec	170.50	65.9
RATIOS		
Total Turbine Exhaust / Total Engine Flow	0.0306	0.0455
Combustible Turbine Exhaust / Total Engine Flow	0.0163	0.0252
Total Eng. Exit Area / Base Area	0.6249	0.4405
Engine Length / Base Diameter	0.5742	0.4442
Nozzle Exit Diamter / Engine Length	0.6200	0.6225

Figure 11: Similarities in NLS 2 and Saturn V S-1C Stage

- Below 40,000 feet

BASE REGION REYNOLDS NUMBER LOW ALTITUDE CORRELATION

$h_c \propto Re_B^{.8} Pr^{.33}$ (Colburn Analogy for Turbulent Flow)

Steps:

1. Use velocity deduced from Saturn V pitot-static pressure data and compute $(\rho_B V_B)^{0.8}_{REF}$ at initial plume-to-plume recirculation assuming $P_B = P_\infty$ and T_B = measured base gas temperature.

2. Compute ratio $\frac{(\rho_B V_B)^{0.8}}{(\rho_B V_B)^{0.8}_{REF}}$

3. Then $h_c = \frac{(\rho_B V_B)^{0.8}}{(\rho_B V_B)^{0.8}_{REF}} h_{c_{REF}}$ for $0 \leq$ altitude $\leq$ 40 Kft

- Above 40,000 feet

h_c envelopes Saturn flight data

Figure 12: Methodology for Improving h_c Early in Flight

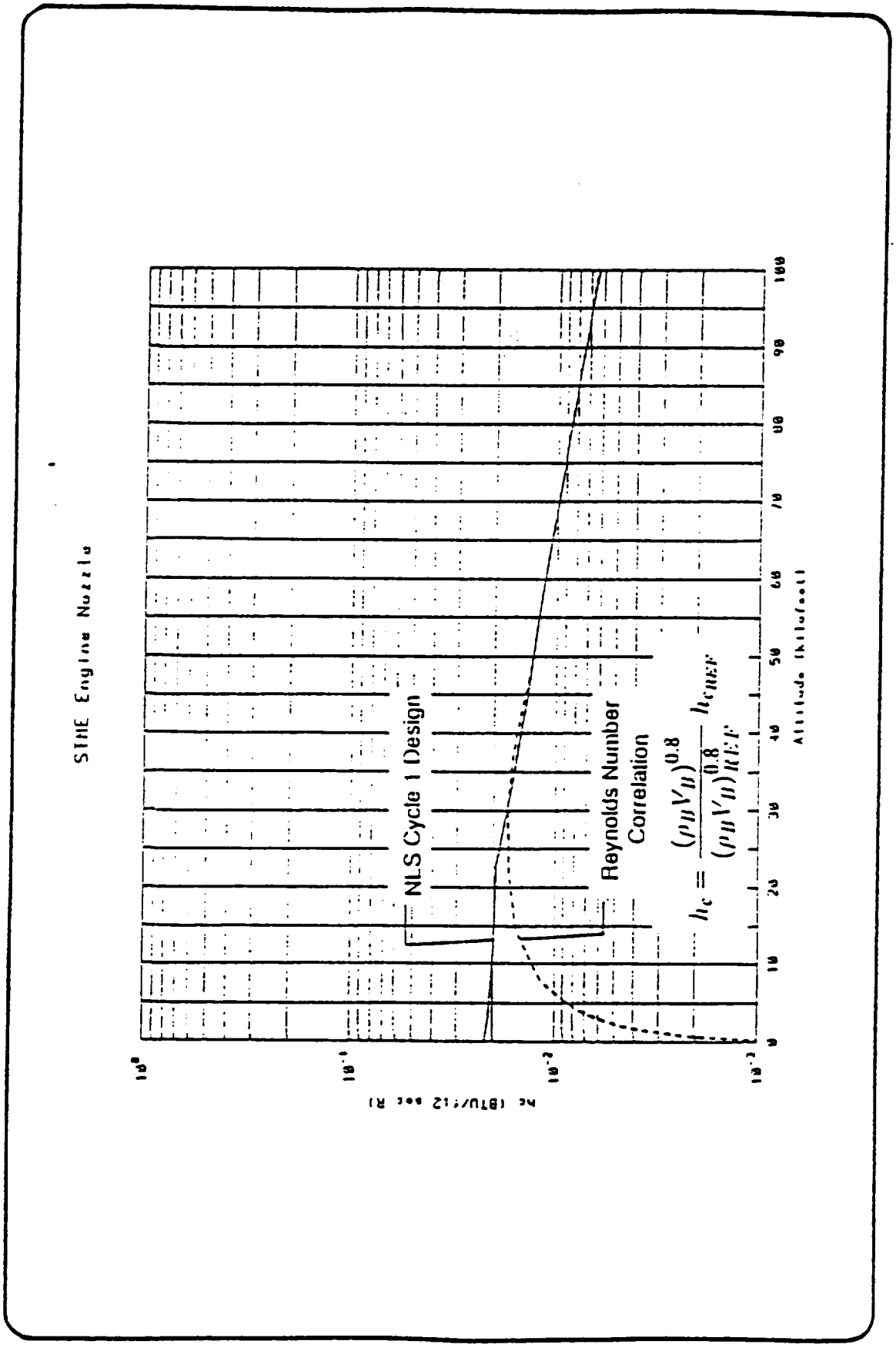


Figure 13: Low Altitude Reynolds Number Correlation for h_c

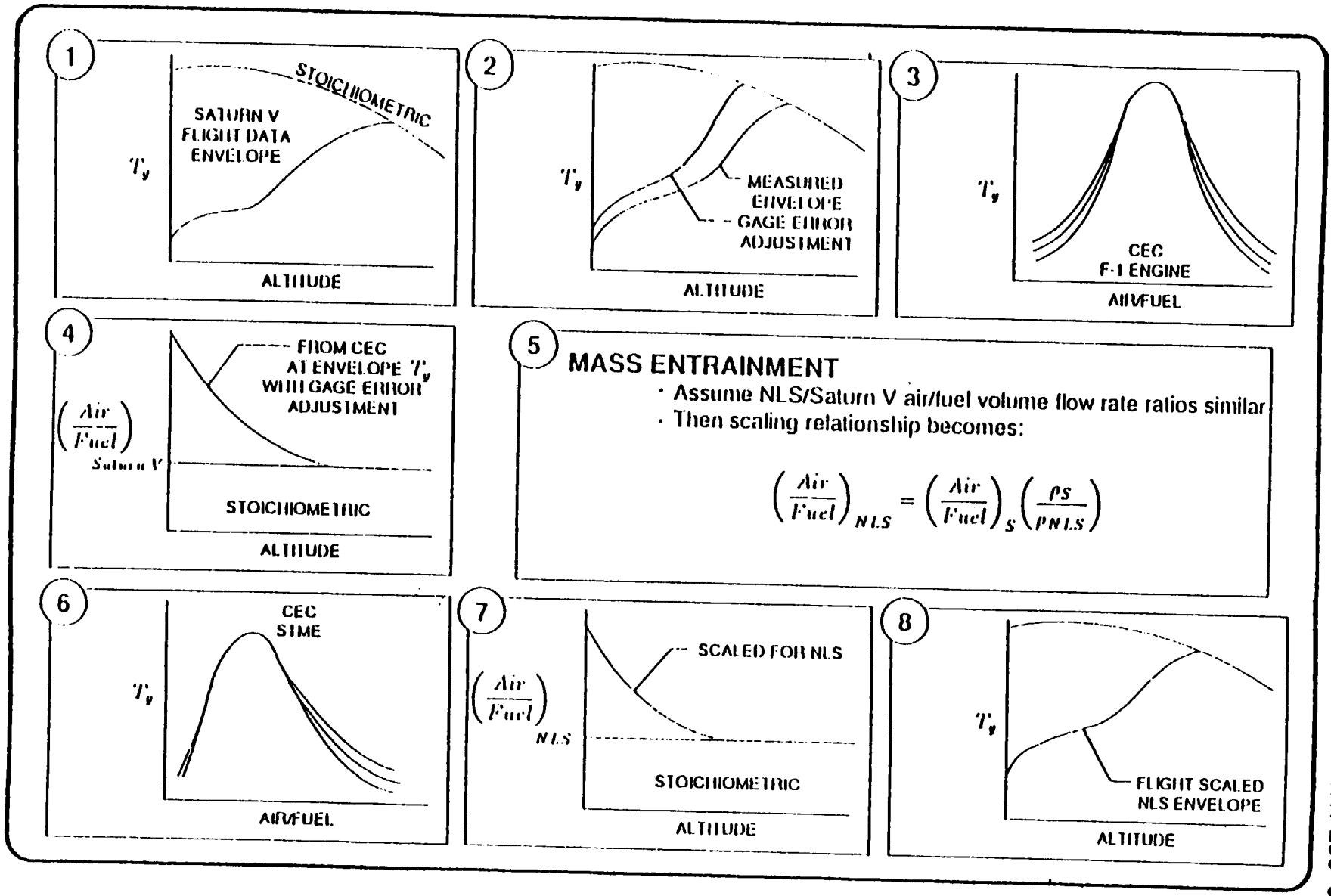


Figure 14: Methodology for Applying Saturn Flight Data to NLS 2 Gas Temperature Predictions

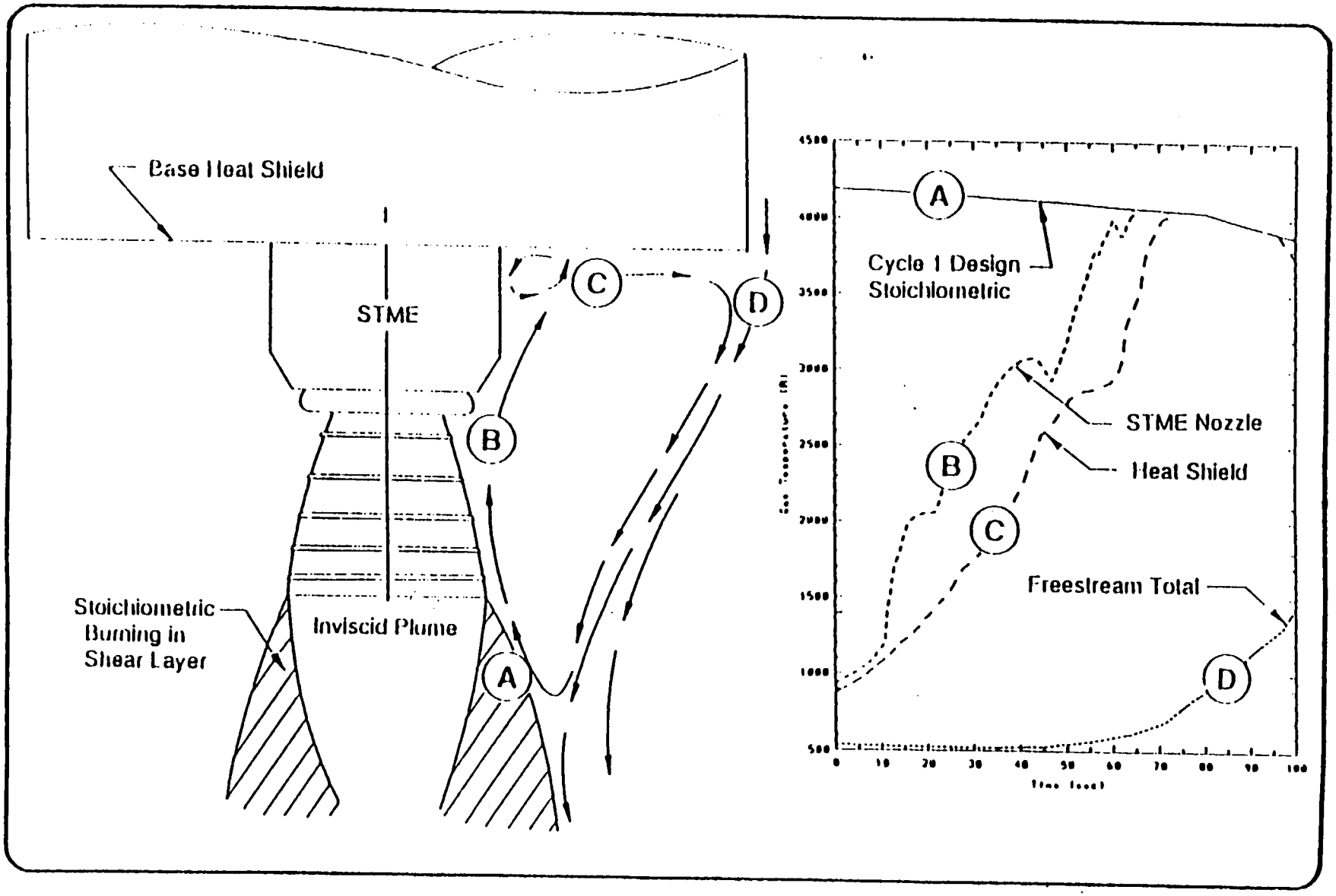


Figure 15: NLS Simplified Base Region Flowfield at Low Altitude

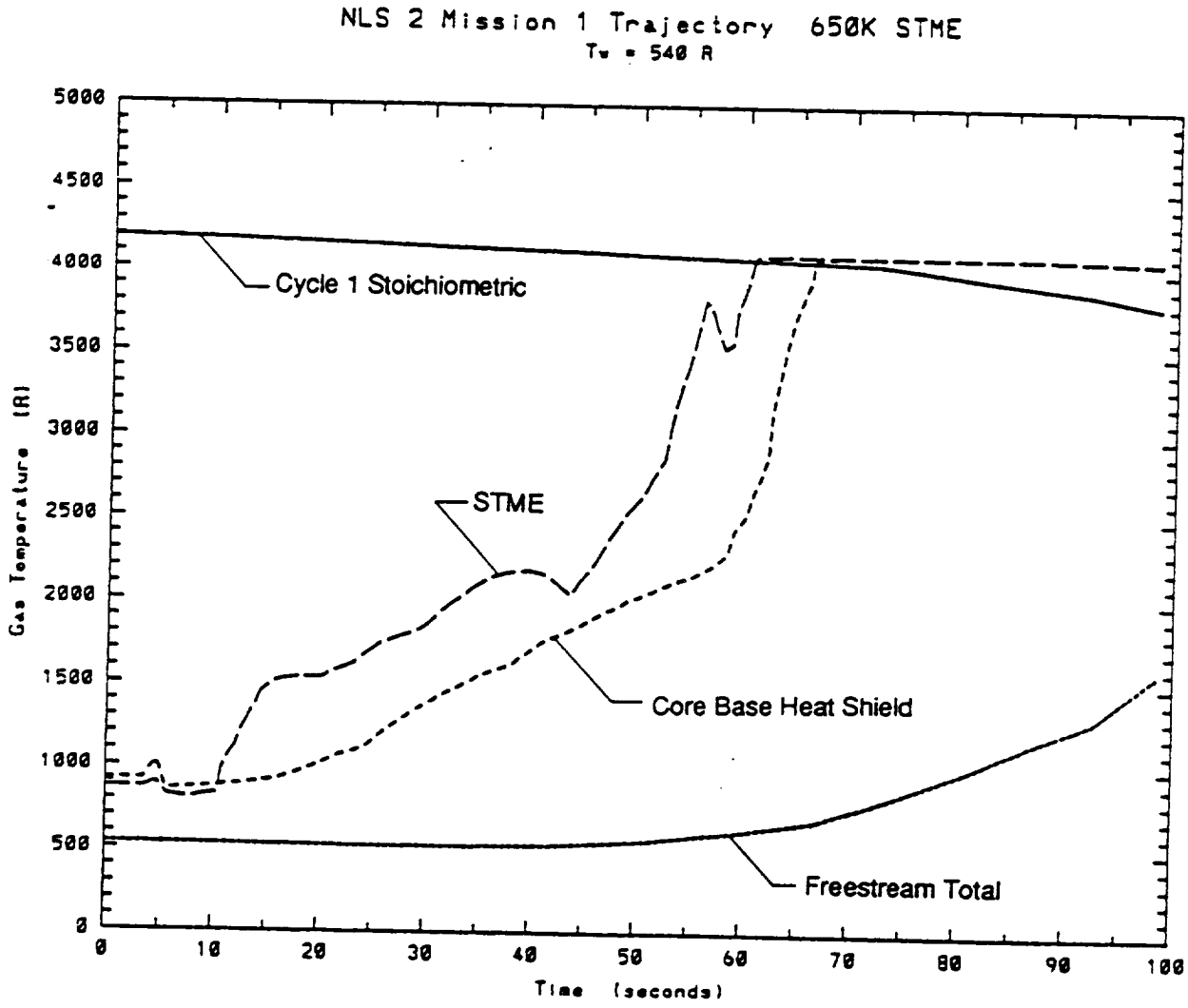
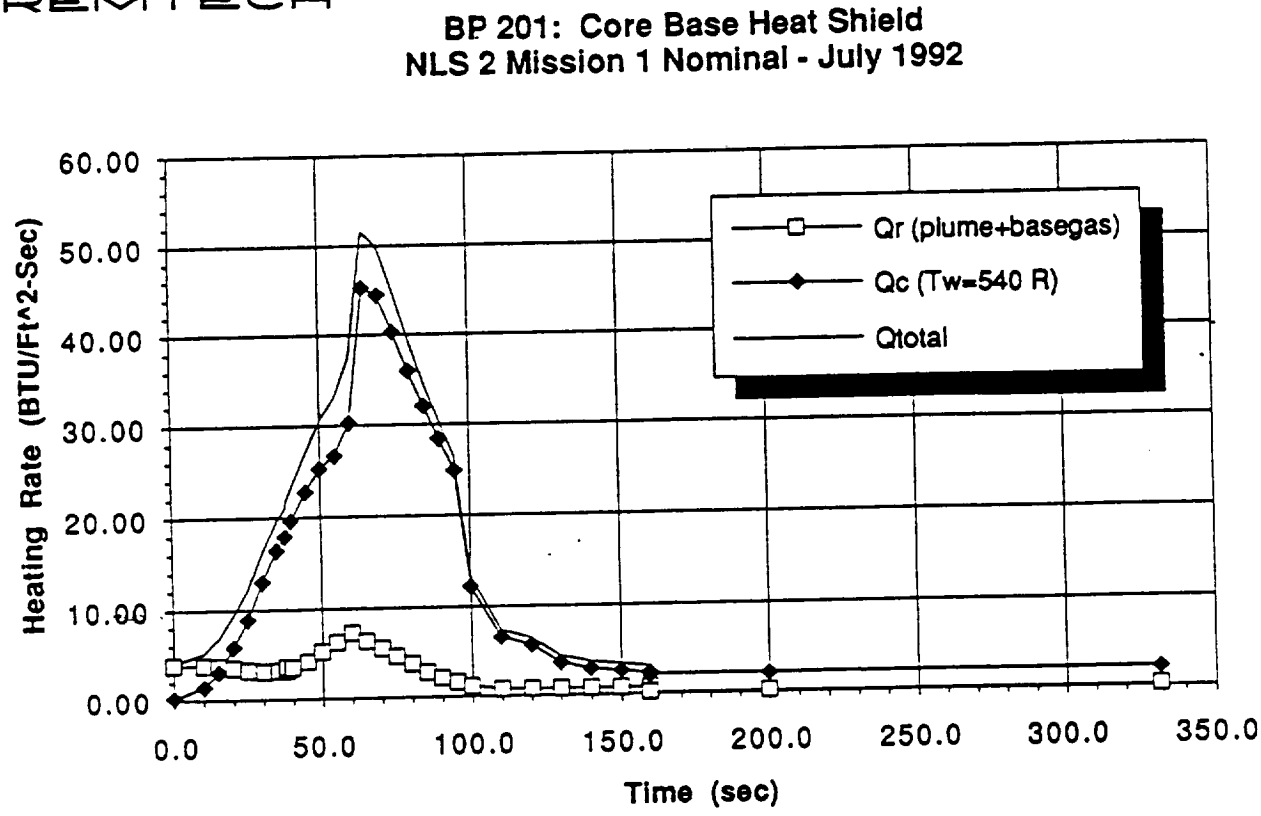


Figure 16: NLS 2 Base Gas Temperature Estimates



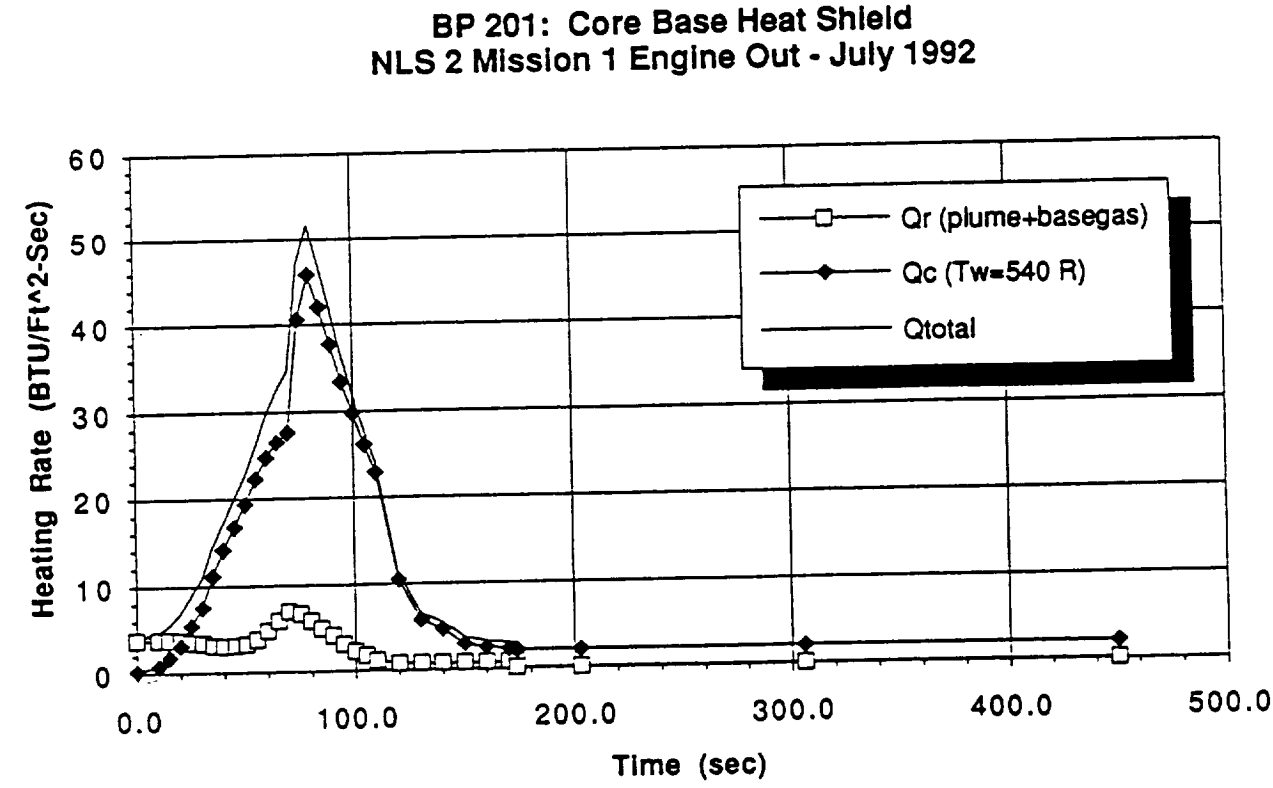
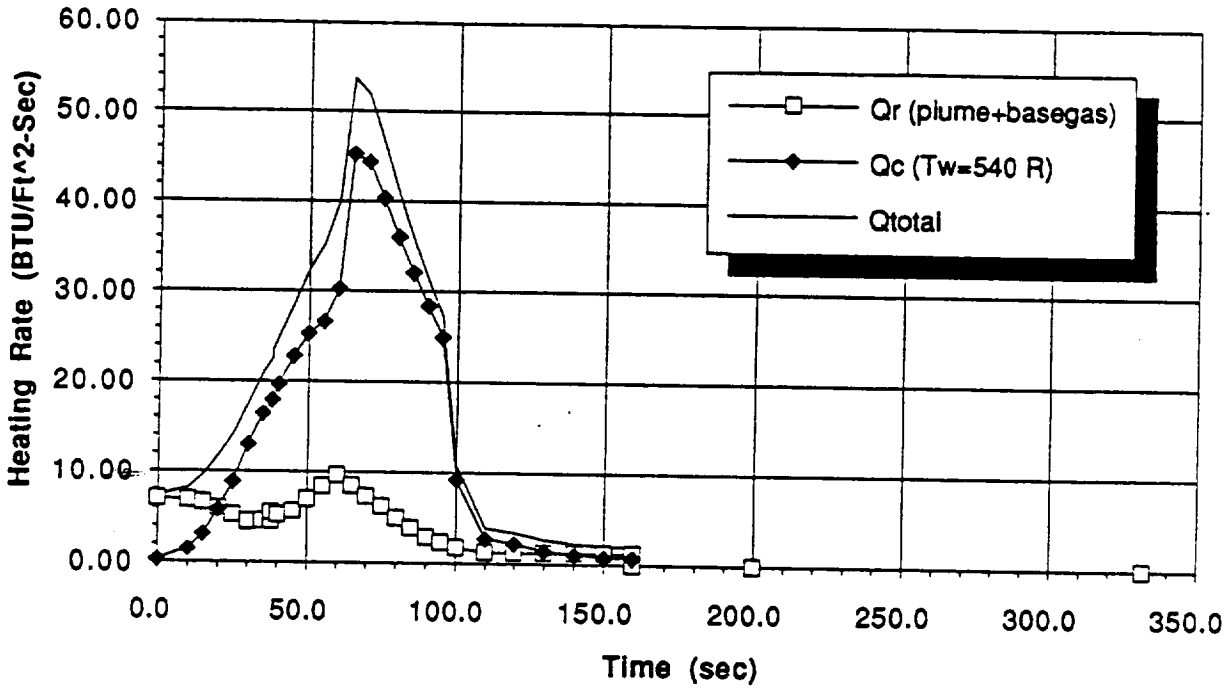


Figure 17: NLS 2 Mission 1 Base Heating Environment — Body Point 201



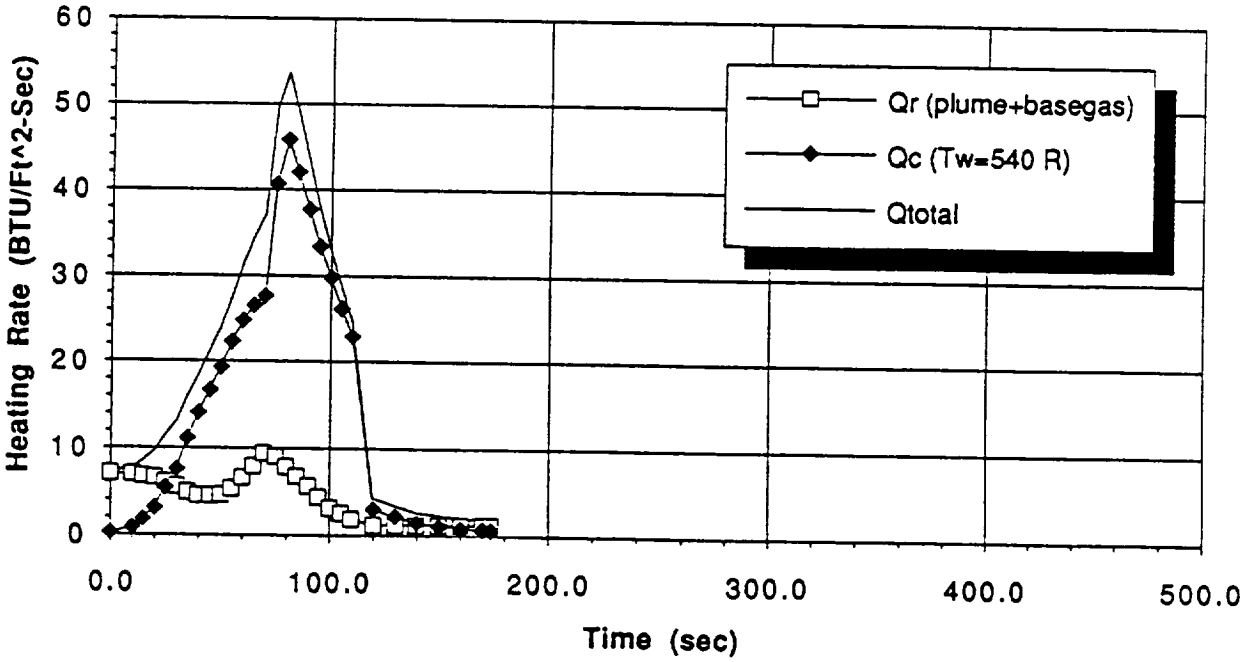
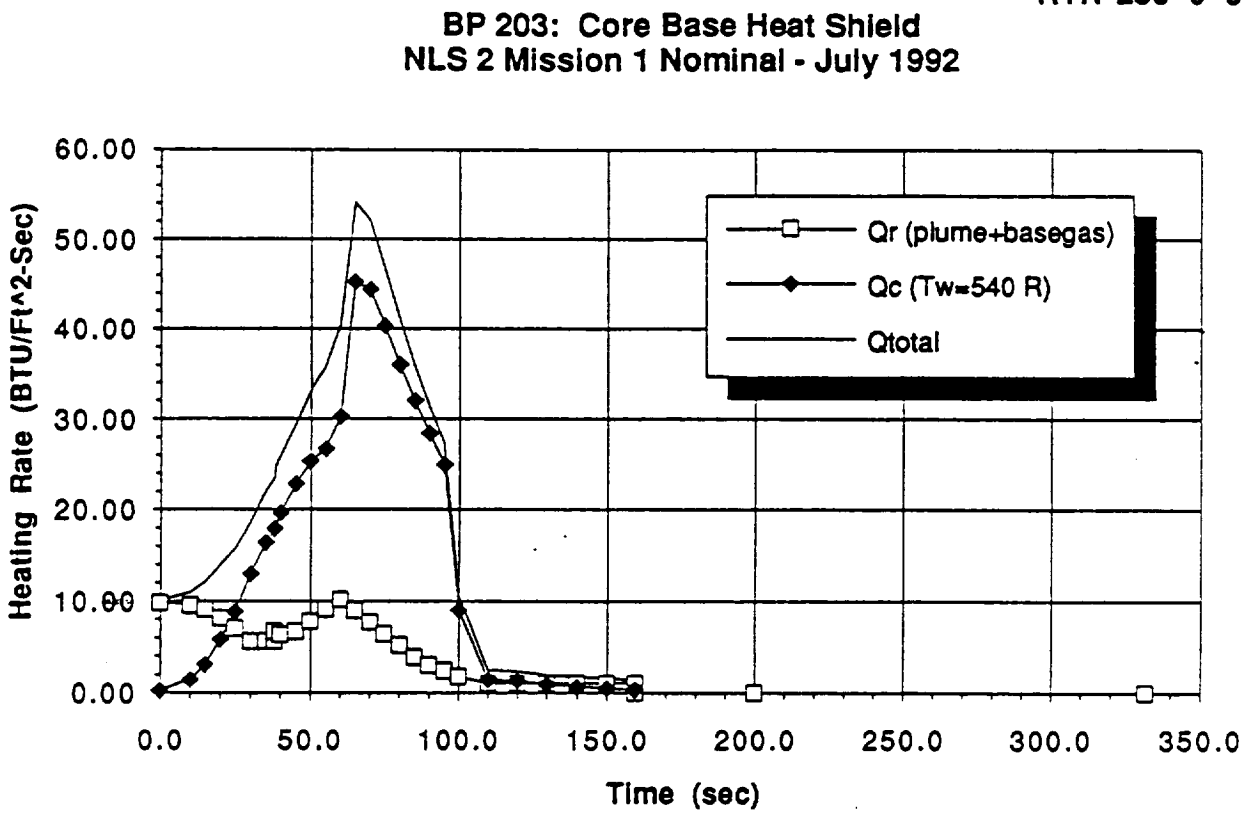


Figure 18: NLS 2 Mission 1 Base Heating Environment — Body Point 202



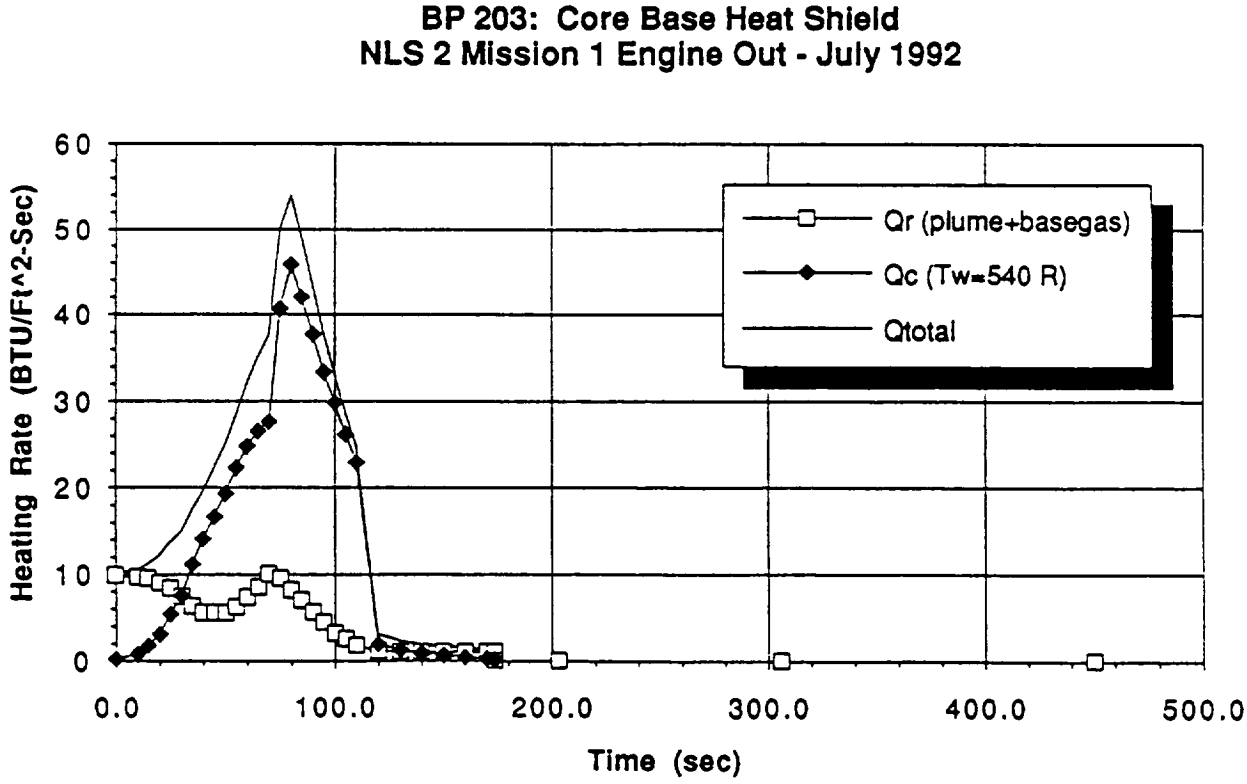
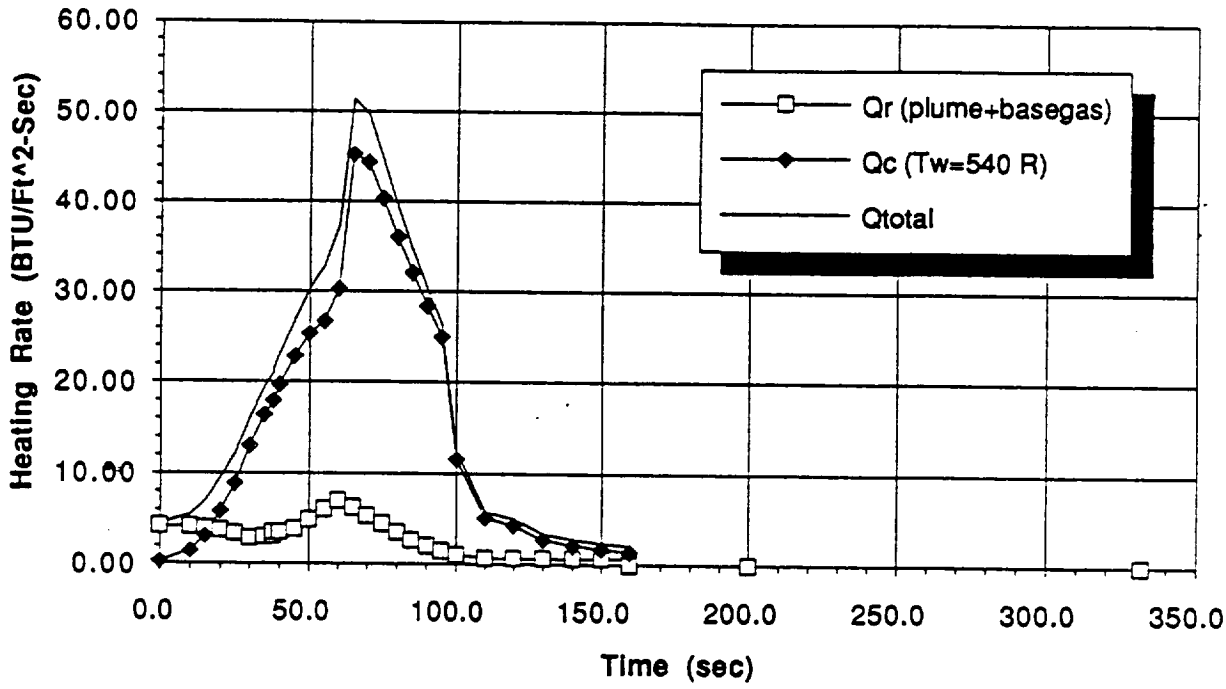


Figure 19: NLS 2 Mission 1 Base Heating Environment — Body Point 203



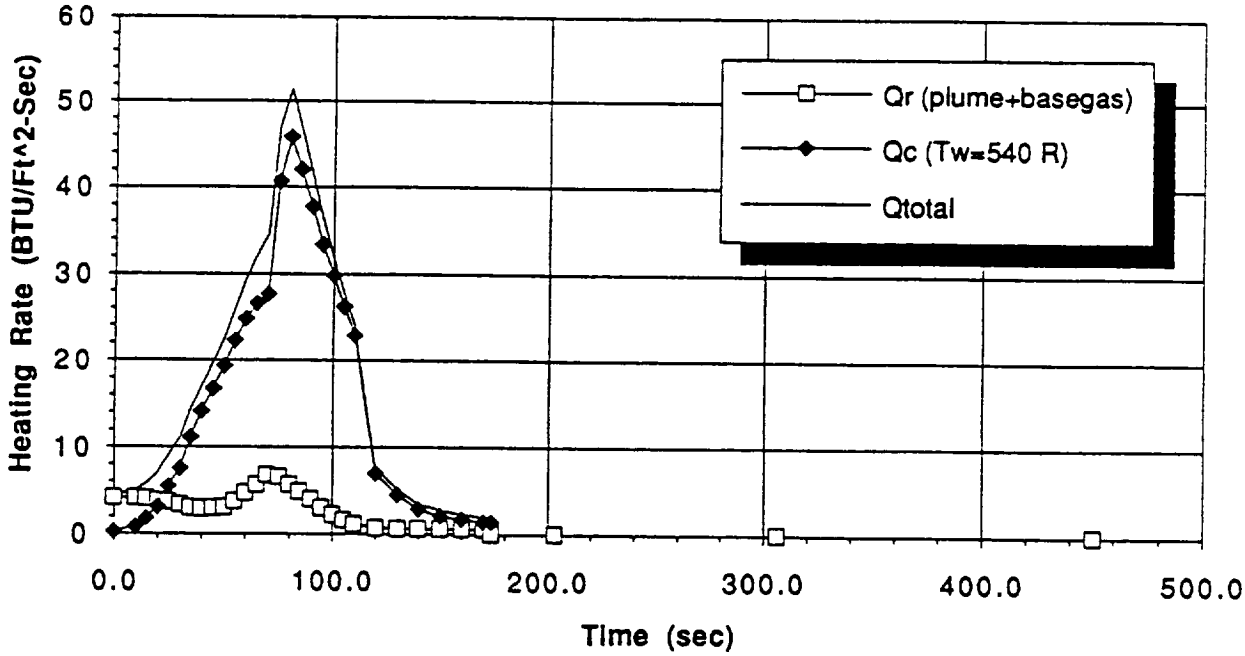
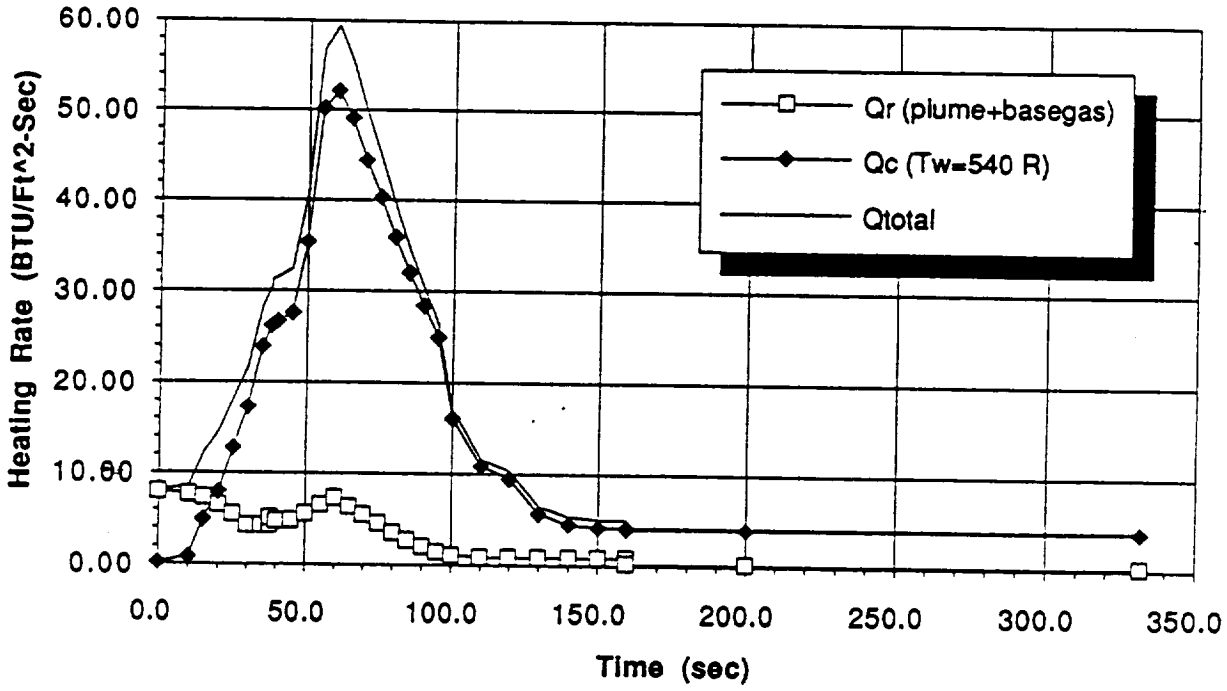


Figure 20: NLS 2 Mission 1 Base Heating Environment — Body Point 204



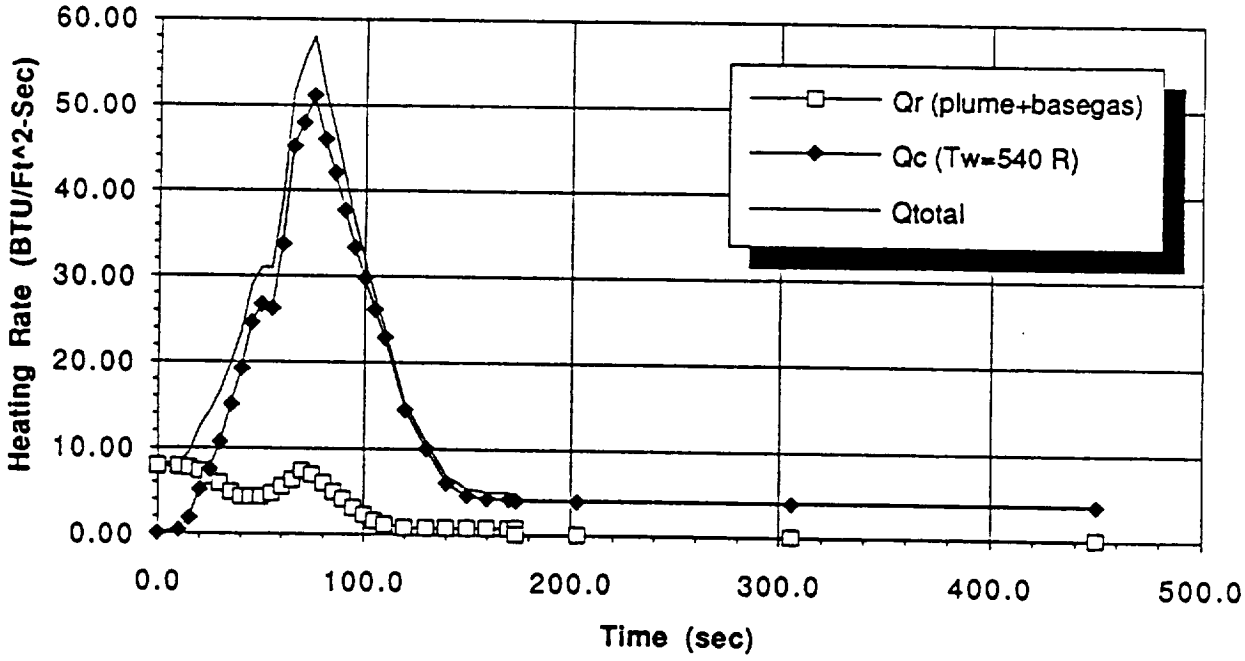
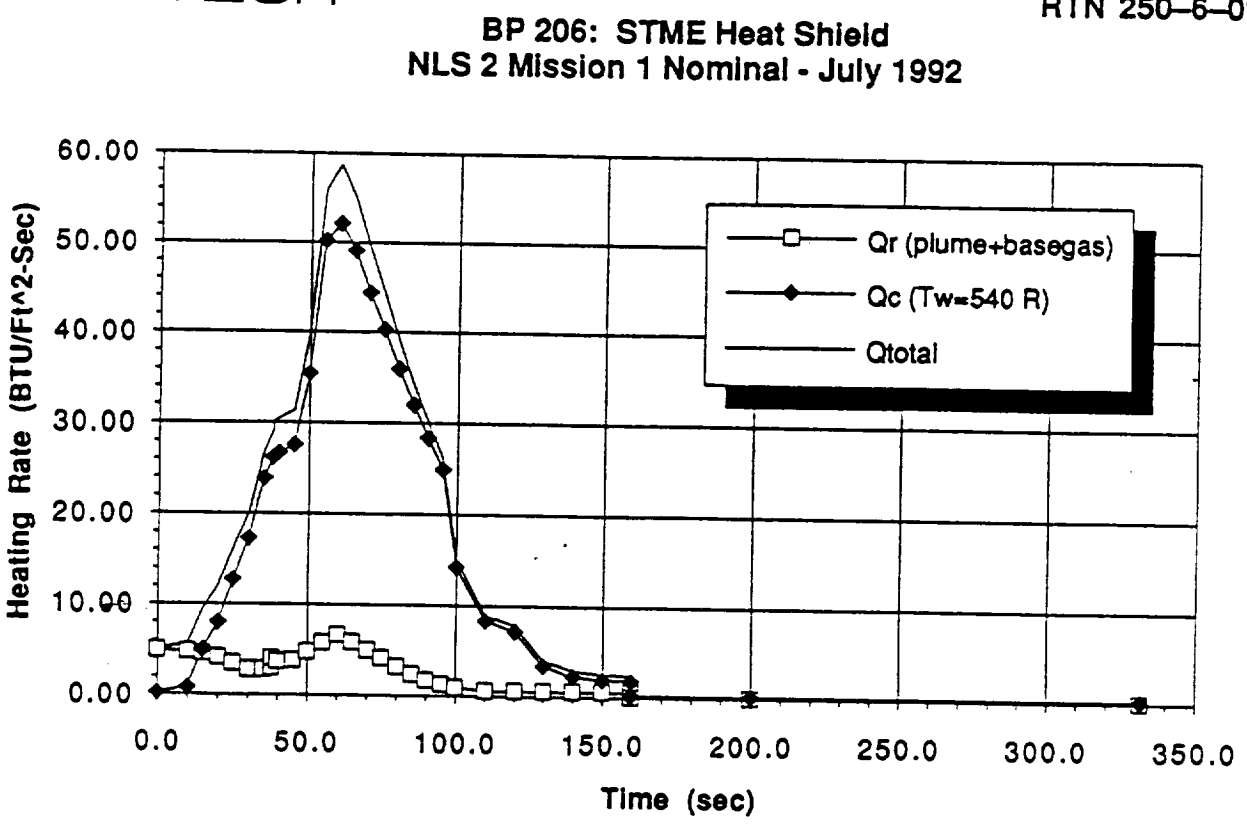


Figure 21: NLS 2 Mission 1 Base Heating Environment — Body Point 205



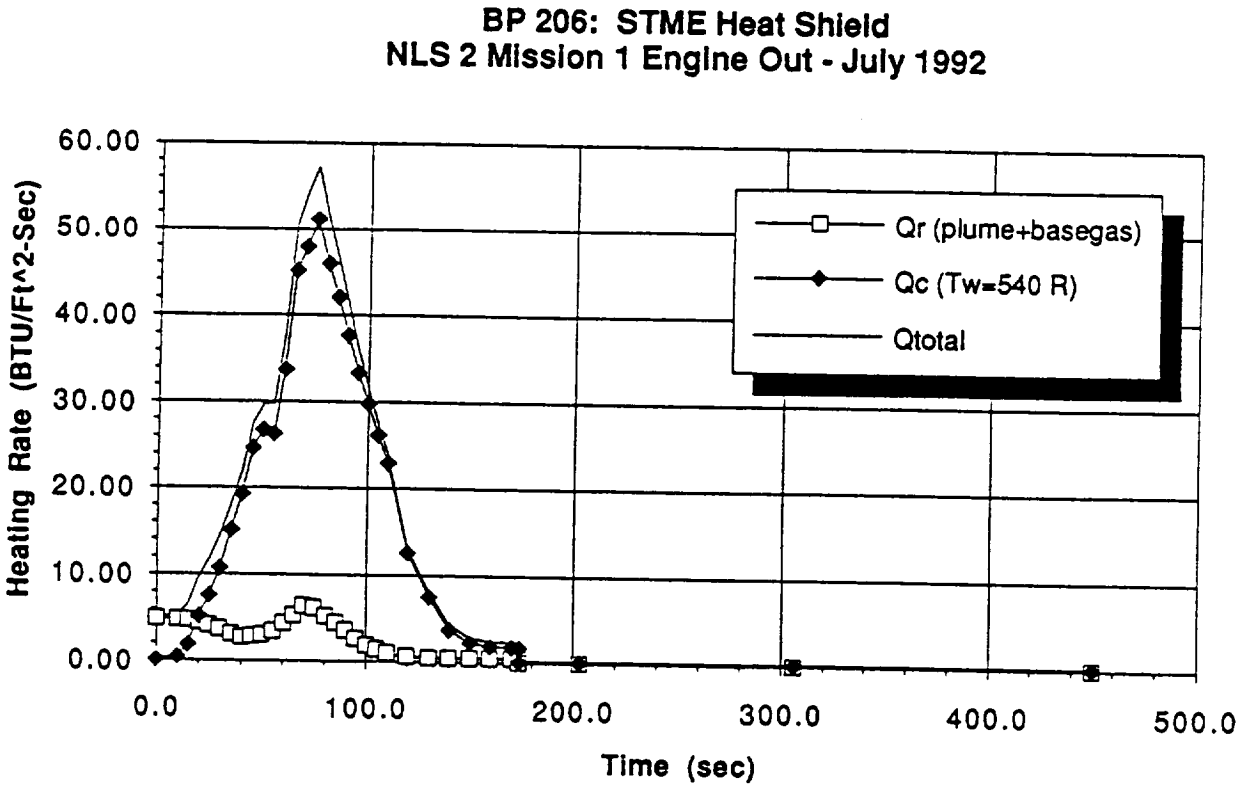
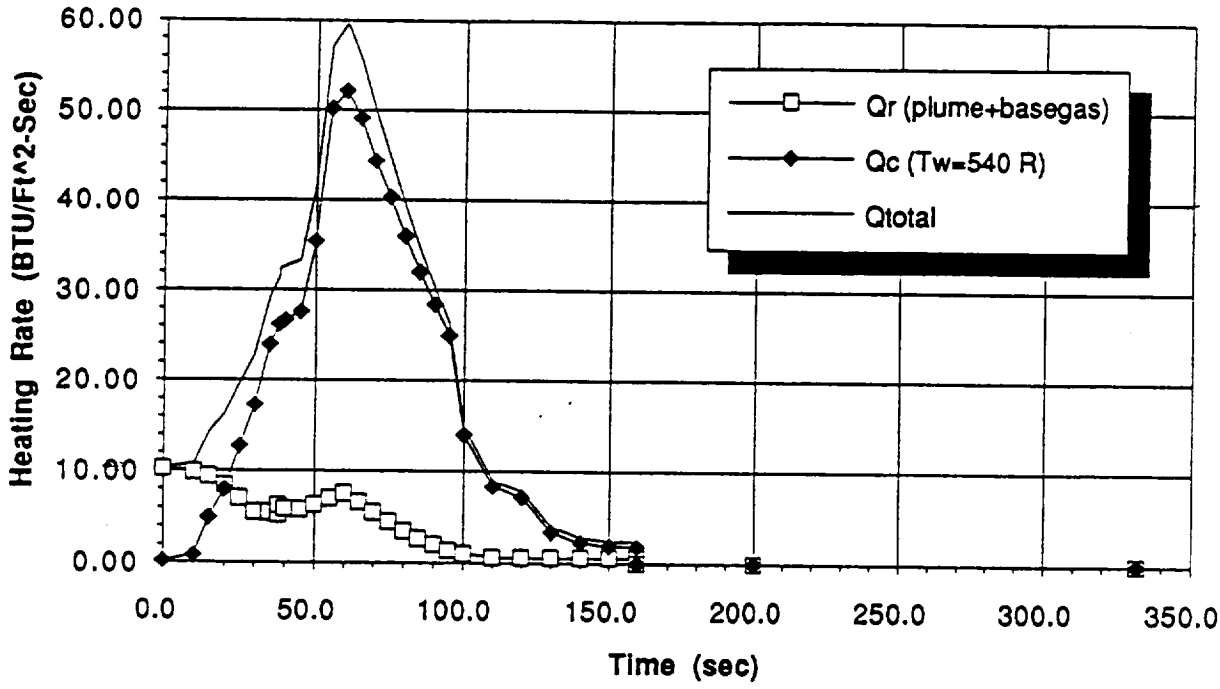


Figure 22: NLS 2 Mission 1 Base Heating Environment — Body Point 206



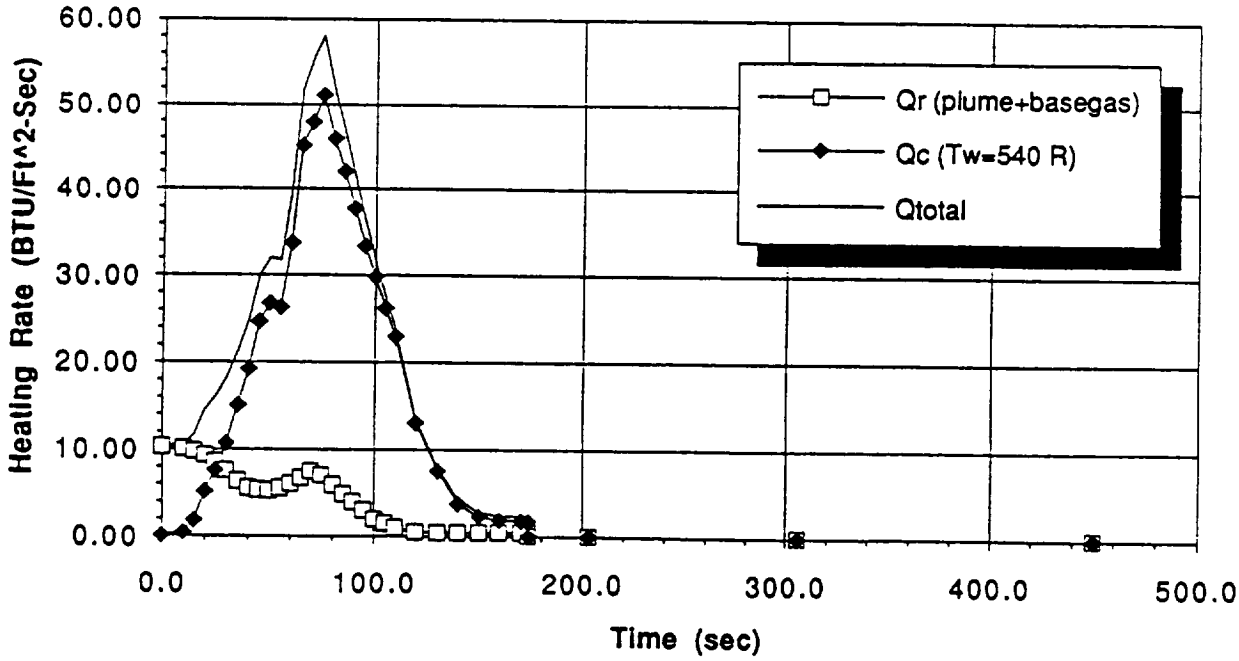
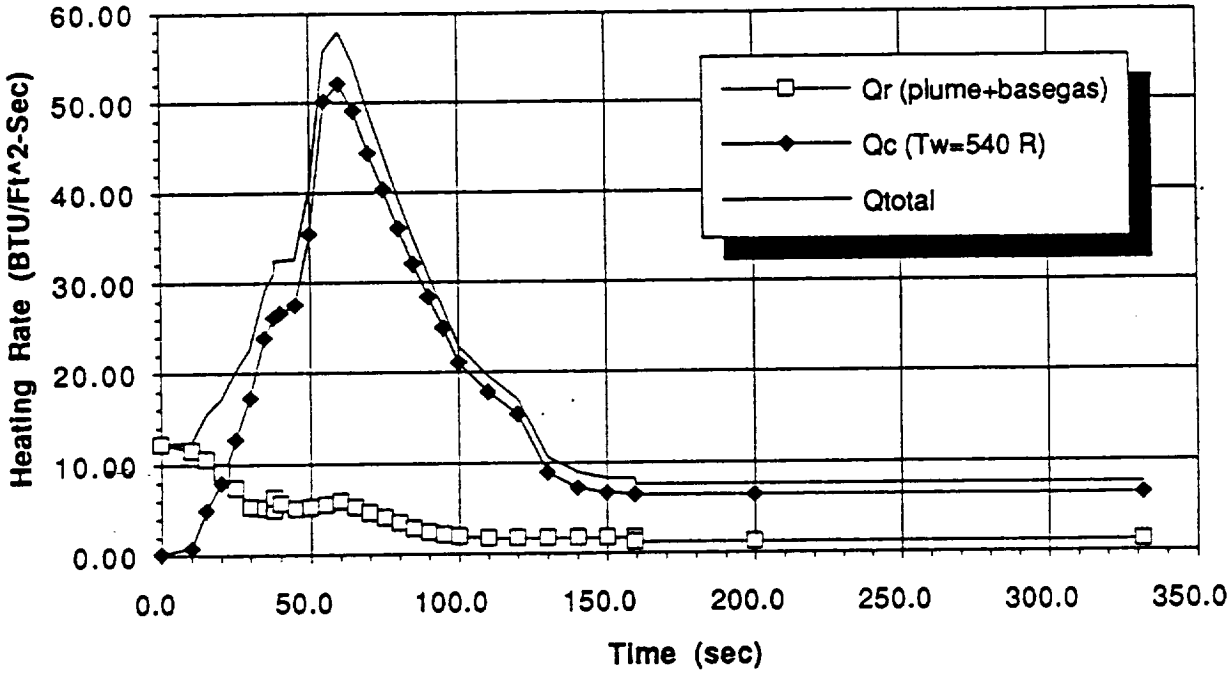


Figure 23: NLS 2 Mission 1 Base Heating Environment — Body Point 207



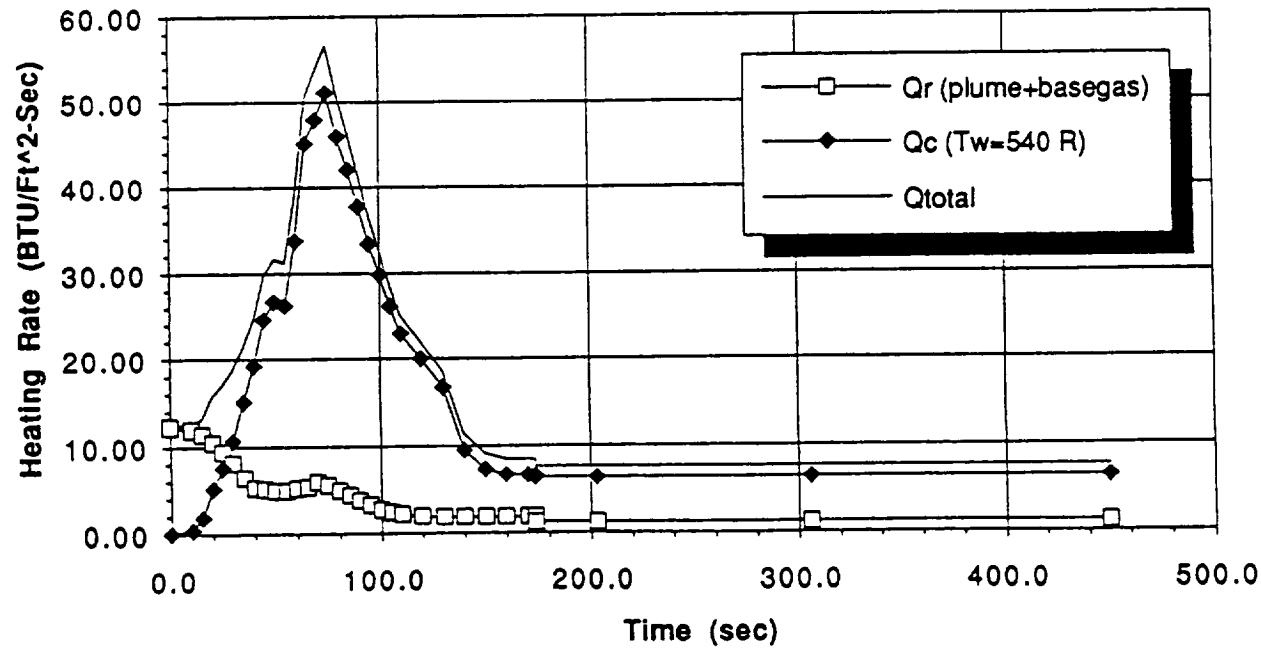
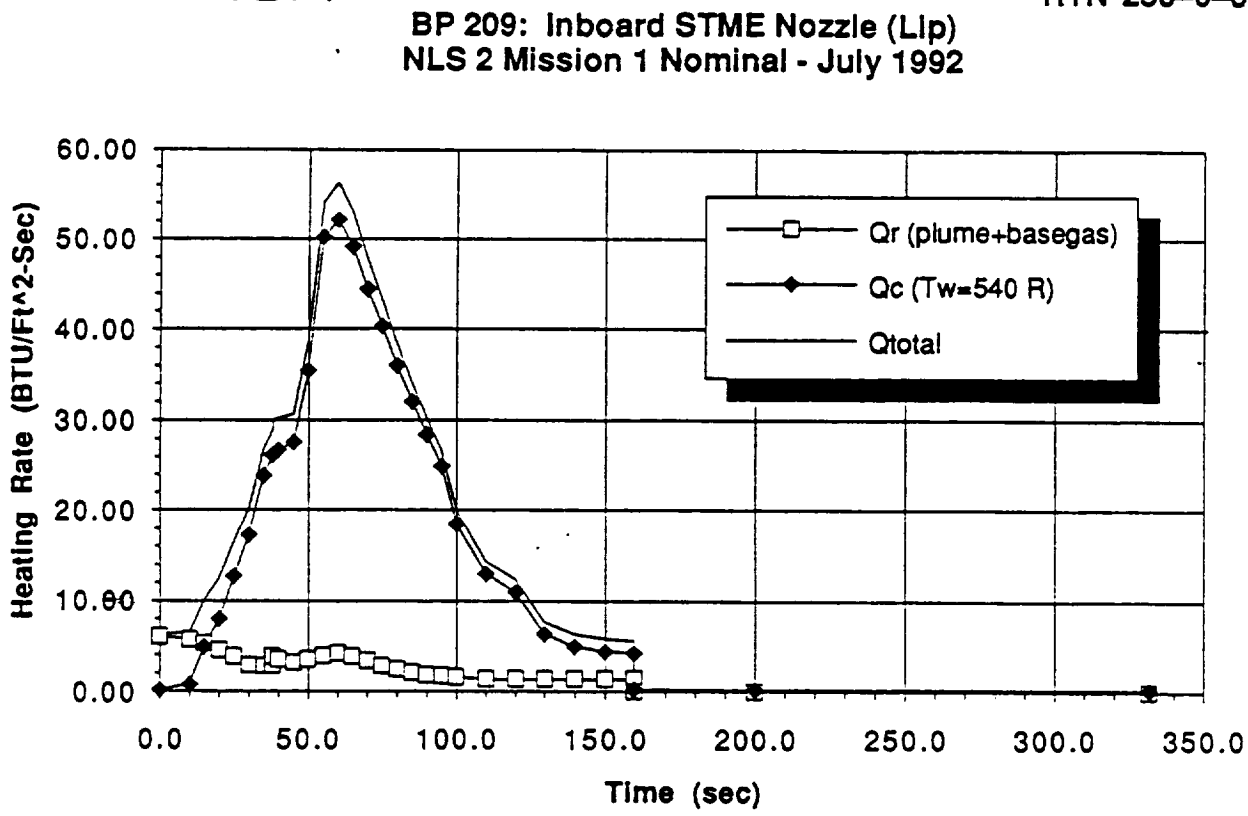


Figure 24: NLS 2 Mission 1 Base Heating Environment — Body Point 208



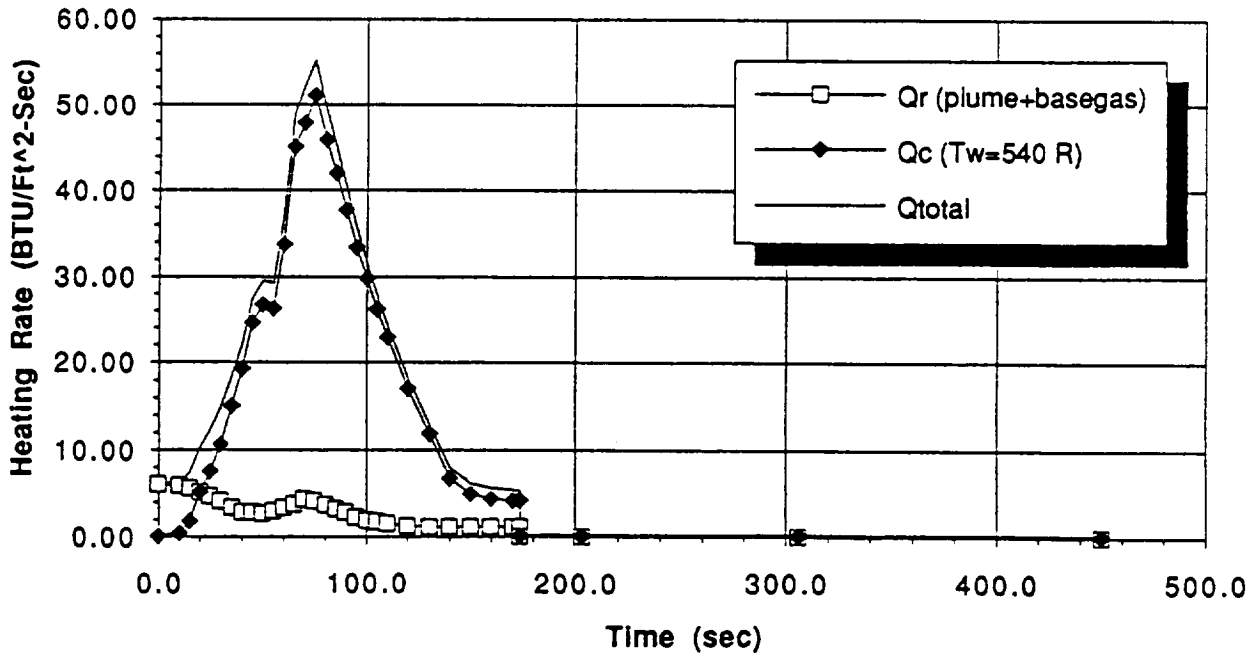
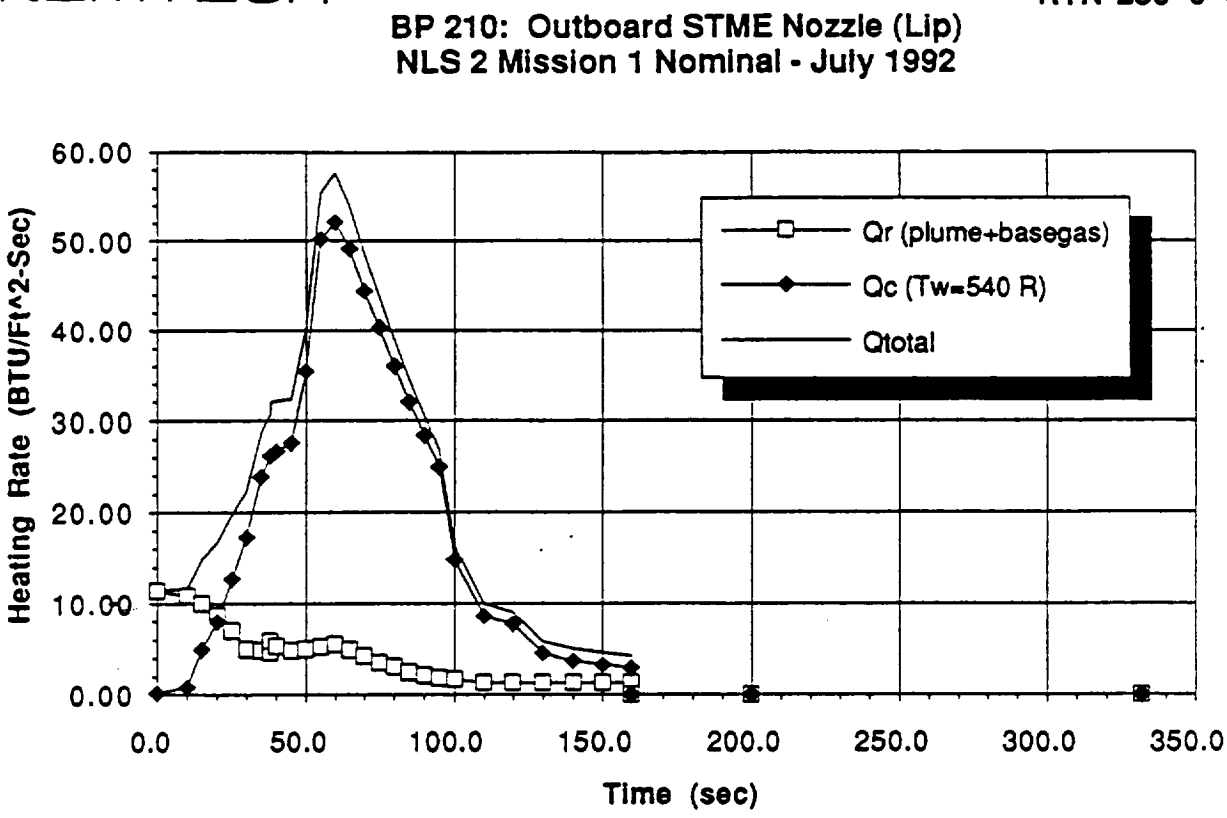


Figure 25: NLS 2 Mission 1 Base Heating Environment — Body Point 209



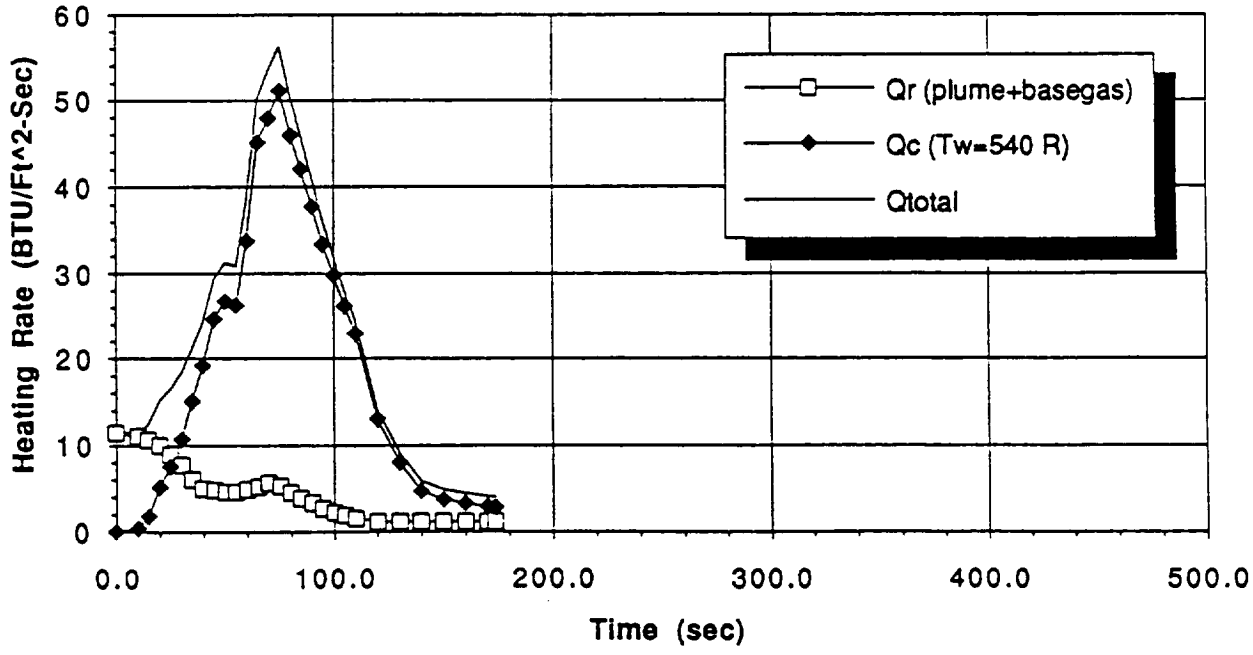
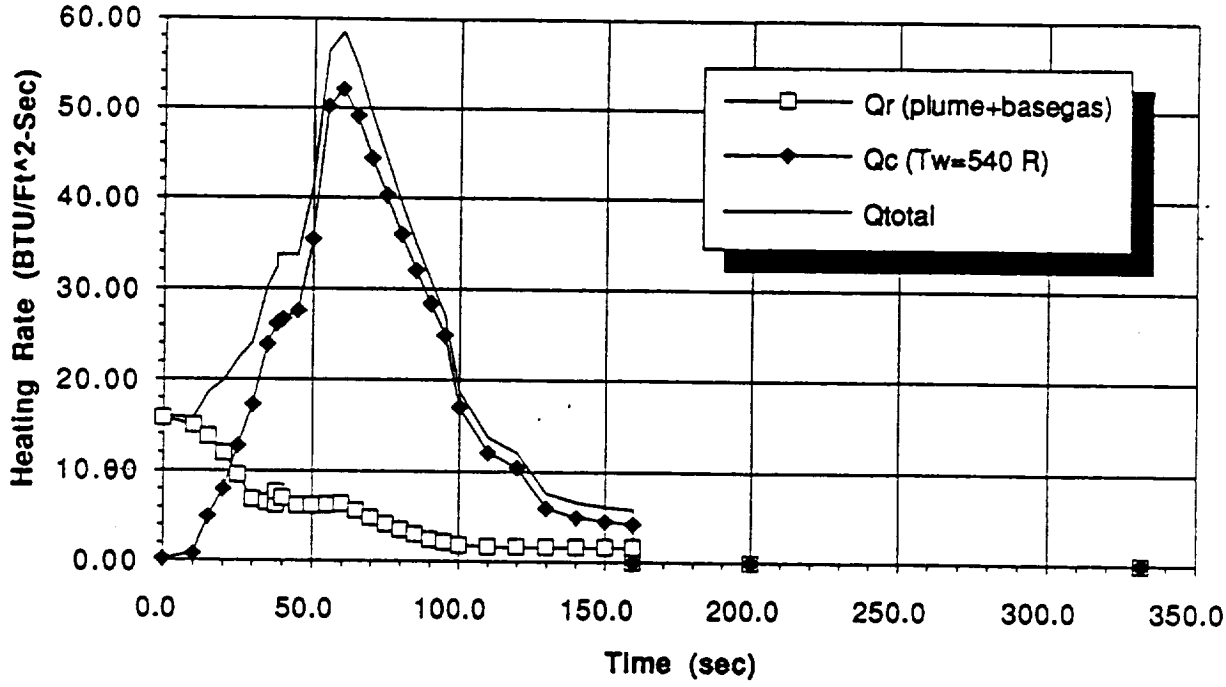


Figure 26: NLS 2 Mission 1 Base Heating Environment — Body Point 210

BP 211: Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992



BP 211: Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

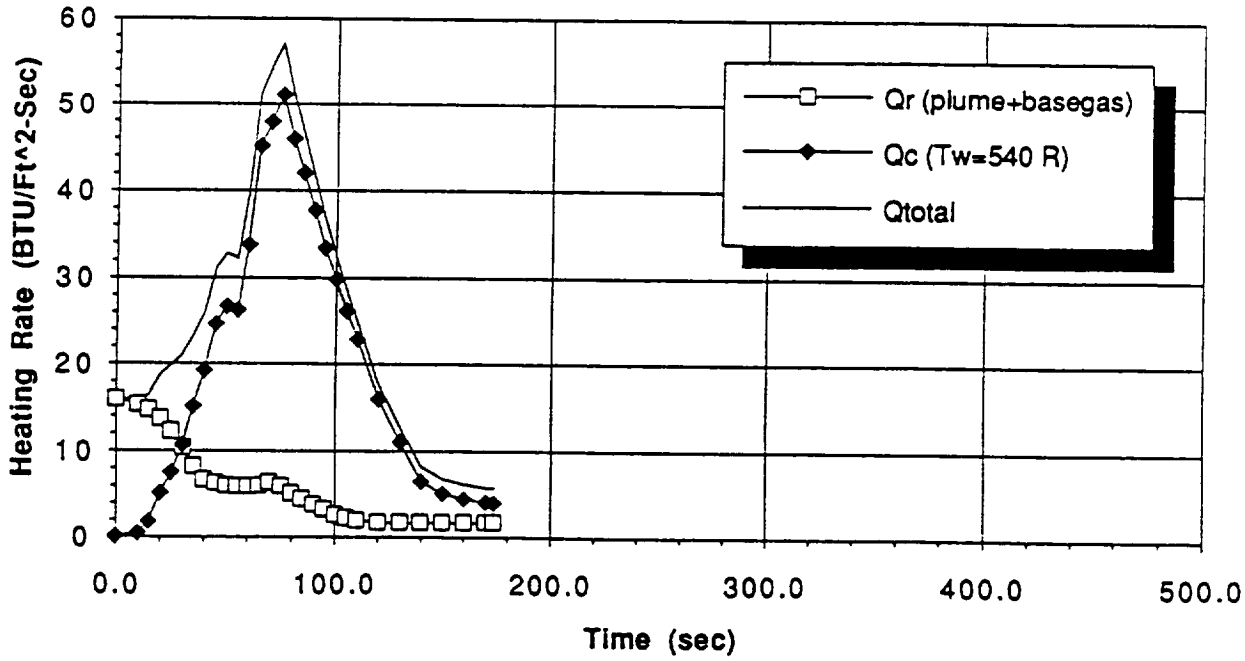
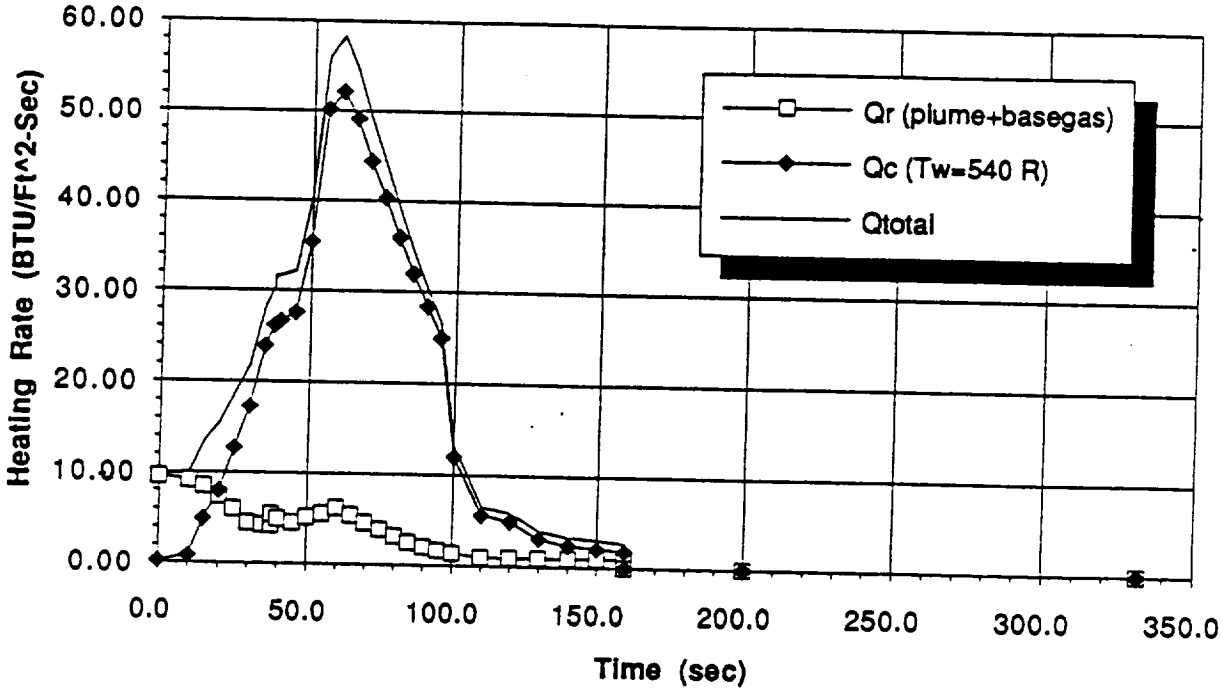


Figure 27: NLS 2 Mission 1 Base Heating Environment — Body Point 211



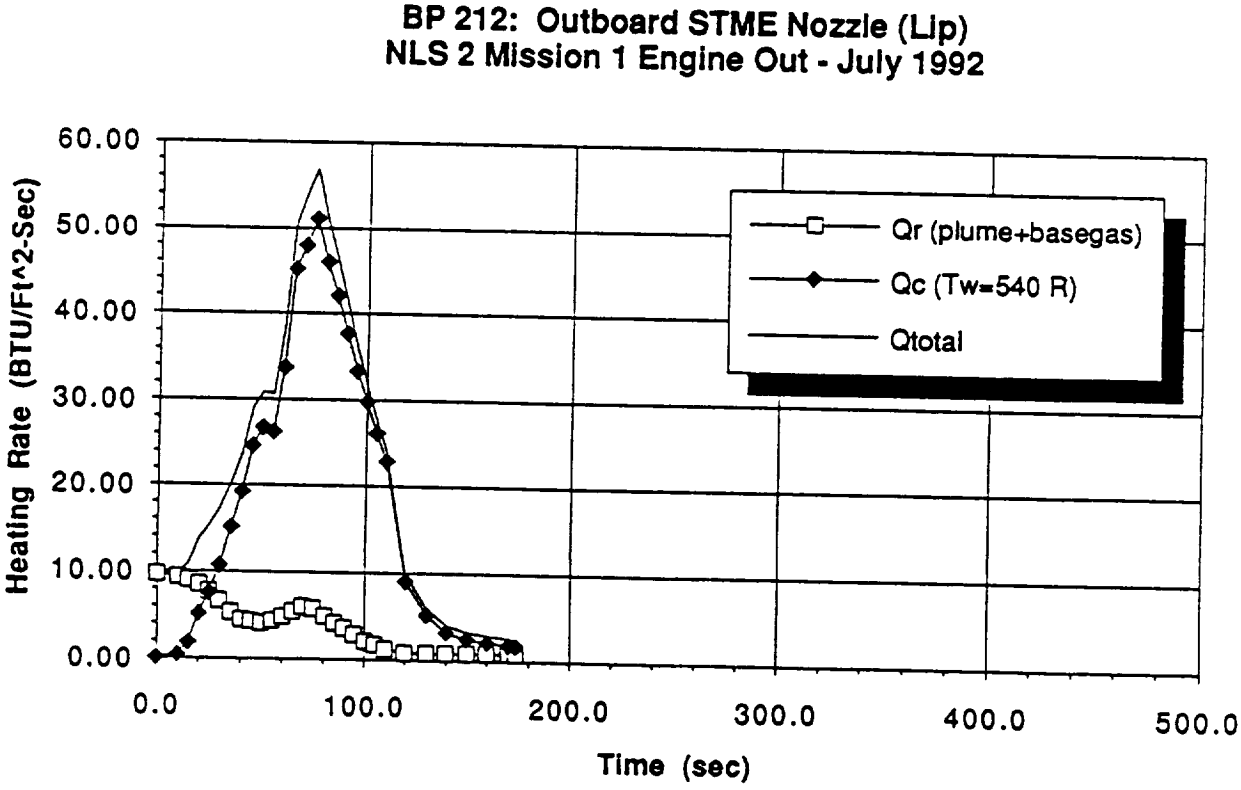
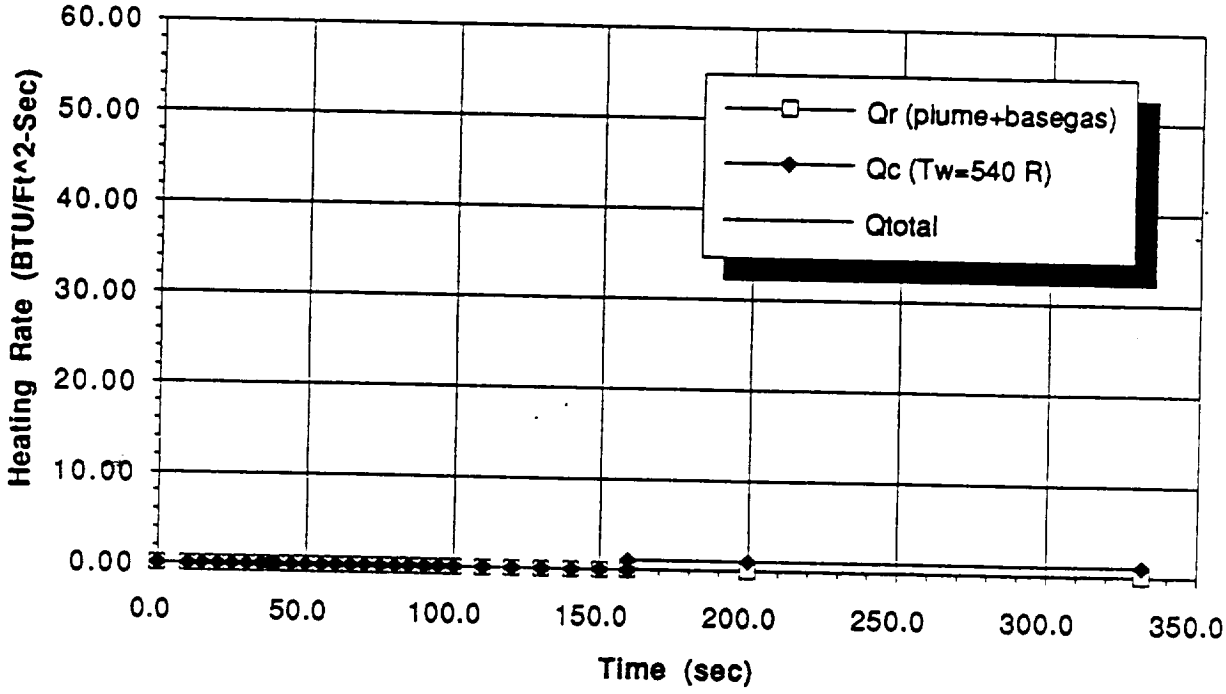


Figure 28: NLS 2 Mission 1 Base Heating Environment — Body Point 212

BP 213: Sustainer Thrust Structure (External Conical Section)
NLS 2 Mission 1 Nominal - July 1992



BP 213: Sustainer Thrust Structure (External Conical Section)
NLS 2 Mission 1 Engine Out - July 1992

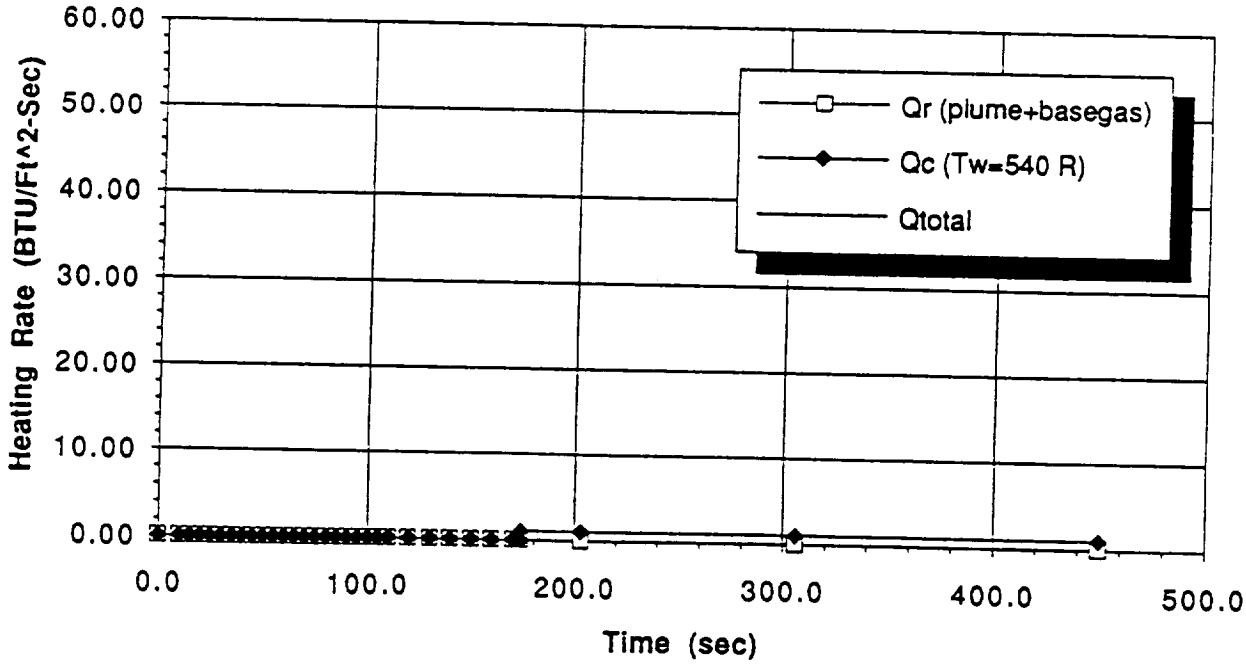


Figure 29: NLS 2 Mission 1 Base Heating Environment — Body Point 213

Table 1

1.5 Stage Cycle 2 Convective Base Heating
BP 201 - Core Base Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
1.0	10.0	878	4.081E-03	1.71	1.38	-0.33	-2.37	-4.41	-6.45
2.4	15.0	917	7.985E-03	3.65	3.01	-0.35	-4.34	-8.33	-12.33
4.4	20.0	1019	1.211E-02	6.76	5.80	0.71	-5.34	-11.40	-17.45
7.0	25.0	1158	1.433E-02	10.00	8.86	2.84	-4.33	-11.49	-18.66
10.2	30.0	1380	1.551E-02	14.27	13.03	6.52	-1.24	-9.00	-16.75
14.1	35.0	1552	1.619E-02	17.68	16.38	9.58	1.49	-6.61	-14.70
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
18.6	40.0	1711	1.672E-02	20.92	19.58	12.56	4.20	-4.16	-12.53
23.6	45.0	1874	1.707E-02	24.14	22.77	15.60	7.07	-1.47	-10.00
28.9	50.0	2030	1.696E-02	26.63	25.27	18.15	9.67	1.19	-7.29
34.6	55.0	2157	1.652E-02	28.03	26.71	19.77	11.51	3.25	-5.01
40.7	60.0	2515	1.532E-02	31.49	30.26	23.83	16.17	8.50	0.84
47.2	65.0	3813	1.381E-02	46.31	45.21	39.41	32.50	25.60	18.69
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	3.496E-03	12.48	12.20	10.73	8.98	7.24	5.49
121.2	110.0	3750	2.025E-03	6.66	6.50	5.65	4.64	3.62	2.61
140.5	120.0	3360	1.986E-03	5.76	5.60	4.77	3.77	2.78	1.79
160.3	130.0	3120	1.395E-03	3.71	3.60	3.01	2.32	1.62	0.92
180.7	140.0	3000	1.179E-03	2.99	2.90	2.40	1.82	1.23	0.64
201.4	150.0	2950	1.079E-03	2.69	2.60	2.15	1.61	1.07	0.53
221.5	159.6	2950	9.544E-04	2.38	2.30	1.90	1.42	0.94	0.47
221.5	159.6	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
301.1	200.0	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
471.1	331.8	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43

Summary @Twall = 540 R

Peak Heating Rate: 45.21 BTU/Ft^2-S
Total Heat Load: 2800.77 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 201 - Core Base Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 2

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
0.6	10.0	866	2.620E-03	1.06	0.85	-0.25	-1.56	-2.87	-4.18
1.4	15.0	888	5.109E-03	2.19	1.78	-0.37	-2.92	-5.48	-8.03
2.5	20.0	920	8.278E-03	3.81	3.15	-0.33	-4.47	-8.61	-12.75
4.1	25.0	1000	1.175E-02	6.34	5.40	0.47	-5.41	-11.28	-17.16
6.0	30.0	1097	1.351E-02	8.61	7.53	1.86	-4.90	-11.65	-18.41
8.4	35.0	1272	1.519E-02	12.34	11.12	4.74	-2.86	-10.45	-18.05
11.3	40.0	1434	1.569E-02	15.29	14.03	7.44	-0.41	-8.25	-16.10
14.6	45.0	1569	1.628E-02	18.04	16.74	9.91	1.77	-6.37	-14.51
18.4	50.0	1700	1.670E-02	20.70	19.36	12.35	4.00	-4.35	-12.70
22.7	55.0	1844	1.709E-02	23.65	22.28	15.10	6.56	-1.99	-10.53
27.5	60.0	1998	1.699E-02	26.13	24.77	17.64	9.14	0.65	-7.85
32.7	65.0	2124	1.676E-02	27.89	26.55	19.51	11.13	2.75	-5.63
38.5	70.0	2286	1.585E-02	28.95	27.68	21.02	13.09	5.17	-2.76
44.7	75.0	3364	1.438E-02	41.76	40.61	34.57	27.38	20.19	13.00
51.3	80.0	4085	1.292E-02	46.83	45.80	40.37	33.91	27.45	20.99
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	3.201E-03	10.76	10.50	9.16	7.55	5.95	4.35
137.6	130.0	3400	2.028E-03	5.96	5.80	4.95	3.93	2.92	1.91
158.0	140.0	3130	1.815E-03	4.85	4.70	3.94	3.03	2.12	1.22
179.0	150.0	3000	1.199E-03	3.05	2.95	2.45	1.85	1.25	0.65
200.6	160.0	2950	1.037E-03	2.58	2.50	2.06	1.55	1.03	0.51
222.9	170.0	2950	9.544E-04	2.38	2.30	1.90	1.42	0.94	0.47
231.5	173.8	2950	9.129E-04	2.27	2.20	1.82	1.36	0.90	0.45
231.5	173.8	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
292.4	203.0	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
422.2	306.0	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
469.8	450.2	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43

Summary @Twall = 540 R

Peak Heating Rate: 45.80 BTU/Ft^2-S
Total Heat Load: 3224.44 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 202 - Core Base Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Table 3

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
1.0	10.0	878	4.081E-03	1.71	1.38	-0.33	-2.37	-4.41	-6.45
2.4	15.0	917	7.985E-03	3.65	3.01	-0.35	-4.34	-8.33	-12.33
4.4	20.0	1019	1.211E-02	6.76	5.80	0.71	-5.34	-11.40	-17.45
7.0	25.0	1158	1.433E-02	10.00	8.86	2.84	-4.33	-11.49	-18.66
10.2	30.0	1380	1.551E-02	14.27	13.03	6.52	-1.24	-9.00	-16.75
14.1	35.0	1552	1.619E-02	17.68	16.38	9.58	1.49	-6.61	-14.70
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
18.6	40.0	1711	1.672E-02	20.92	19.58	12.56	4.20	-4.16	-12.53
23.6	45.0	1874	1.707E-02	24.14	22.77	15.60	7.07	-1.47	-10.00
28.9	50.0	2030	1.696E-02	26.63	25.27	18.15	9.67	1.19	-7.29
34.6	55.0	2157	1.652E-02	28.03	26.71	19.77	11.51	3.25	-5.01
40.7	60.0	2515	1.532E-02	31.49	30.26	23.83	16.17	8.50	0.84
47.2	65.0	3813	1.381E-02	46.31	45.21	39.41	32.50	25.60	18.69
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	2.636E-03	9.41	9.20	8.09	6.77	5.46	4.14
121.2	110.0	3750	8.411E-04	2.77	2.70	2.35	1.93	1.51	1.09
140.5	120.0	3360	7.801E-04	2.26	2.20	1.87	1.48	1.09	0.70
160.3	130.0	3120	5.426E-04	1.44	1.40	1.17	0.90	0.63	0.36
180.7	140.0	3000	4.268E-04	1.08	1.05	0.87	0.66	0.44	0.23
201.4	150.0	2950	3.320E-04	0.83	0.80	0.66	0.49	0.33	0.16
221.5	159.6	2950	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 45.21 BTU/Ft^2-S
Total Heat Load: 2278.80 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 202 - Core Base Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 4

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
0.6	10.0	866	2.620E-03	1.06	0.85	-0.25	-1.56	-2.87	-4.18
1.4	15.0	888	5.109E-03	2.19	1.78	-0.37	-2.92	-5.48	-8.03
2.5	20.0	920	8.278E-03	3.81	3.15	-0.33	-4.47	-8.61	-12.75
4.1	25.0	1000	1.175E-02	6.34	5.40	0.47	-5.41	-11.28	-17.16
6.0	30.0	1097	1.351E-02	8.61	7.53	1.86	-4.90	-11.65	-18.41
8.4	35.0	1272	1.519E-02	12.34	11.12	4.74	-2.86	-10.45	-18.05
11.3	40.0	1434	1.569E-02	15.29	14.03	7.44	-0.41	-8.25	-16.10
14.6	45.0	1569	1.628E-02	18.04	16.74	9.91	1.77	-6.37	-14.51
18.4	50.0	1700	1.670E-02	20.70	19.36	12.35	4.00	-4.35	-12.70
22.7	55.0	1844	1.709E-02	23.65	22.28	15.10	6.56	-1.99	-10.53
27.5	60.0	1998	1.699E-02	26.13	24.77	17.64	9.14	0.65	-7.85
32.7	65.0	2124	1.676E-02	27.89	26.55	19.51	11.13	2.75	-5.63
38.5	70.0	2286	1.585E-02	28.95	27.68	21.02	13.09	5.17	-2.76
44.7	75.0	3364	1.438E-02	41.76	40.61	34.57	27.38	20.19	13.00
51.3	80.0	4085	1.292E-02	46.83	45.80	40.37	33.91	27.45	20.99
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	9.146E-04	3.07	3.00	2.62	2.16	1.70	1.24
137.6	130.0	3400	7.692E-04	2.26	2.20	1.88	1.49	1.11	0.72
158.0	140.0	3130	5.598E-04	1.49	1.45	1.21	0.93	0.66	0.38
179.0	150.0	3000	4.472E-04	1.14	1.10	0.91	0.69	0.47	0.24
200.6	160.0	2950	3.320E-04	0.83	0.80	0.66	0.49	0.33	0.16
222.9	170.0	2950	2.905E-04	0.72	0.70	0.58	0.43	0.29	0.14
231.5	173.8	2950	2.490E-04	0.62	0.60	0.50	0.37	0.25	0.12
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 45.80 BTU/Ft^2-S
Total Heat Load: 2450.78 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 203 - Core Base Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Table 5

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
1.0	10.0	878	4.081E-03	1.71	1.38	-0.33	-2.37	-4.41	-6.45
2.4	15.0	917	7.985E-03	3.65	3.01	-0.35	-4.34	-8.33	-12.33
4.4	20.0	1019	1.211E-02	6.76	5.80	0.71	-5.34	-11.40	-17.45
7.0	25.0	1158	1.433E-02	10.00	8.86	2.84	-4.33	-11.49	-18.66
10.2	30.0	1380	1.551E-02	14.27	13.03	6.52	-1.24	-9.00	-16.75
14.1	35.0	1552	1.619E-02	17.68	16.38	9.58	1.49	-6.61	-14.70
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
18.6	40.0	1711	1.672E-02	20.92	19.58	12.56	4.20	-4.16	-12.53
23.6	45.0	1874	1.707E-02	24.14	22.77	15.60	7.07	-1.47	-10.00
28.9	50.0	2030	1.696E-02	26.63	25.27	18.15	9.67	1.19	-7.29
34.6	55.0	2157	1.652E-02	28.03	26.71	19.77	11.51	3.25	-5.01
40.7	60.0	2515	1.532E-02	31.49	30.26	23.83	16.17	8.50	0.84
47.2	65.0	3813	1.381E-02	46.31	45.21	39.41	32.50	25.60	18.69
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	2.579E-03	9.21	9.00	7.92	6.63	5.34	4.05
121.2	110.0	3750	4.361E-04	1.43	1.40	1.22	1.00	0.78	0.56
140.5	120.0	3360	4.433E-04	1.29	1.25	1.06	0.84	0.62	0.40
160.3	130.0	3120	3.488E-04	0.93	0.90	0.75	0.58	0.40	0.23
180.7	140.0	3000	2.642E-04	0.67	0.65	0.54	0.41	0.27	0.14
201.4	150.0	2950	2.075E-04	0.52	0.50	0.41	0.31	0.21	0.10
221.5	159.6	2950	1.245E-04	0.31	0.30	0.25	0.19	0.12	0.06
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 45.21 BTU/Ft^2-S
Total Heat Load: 2240.95 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 203 - Core Base Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 6

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
0.6	10.0	866	2.620E-03	1.06	0.85	-0.25	-1.56	-2.87	-4.18
1.4	15.0	888	5.109E-03	2.19	1.78	-0.37	-2.92	-5.48	-8.03
2.5	20.0	920	8.278E-03	3.81	3.15	-0.33	-4.47	-8.61	-12.75
4.1	25.0	1000	1.175E-02	6.34	5.40	0.47	-5.41	-11.28	-17.16
6.0	30.0	1097	1.351E-02	8.61	7.53	1.86	-4.90	-11.65	-18.41
8.4	35.0	1272	1.519E-02	12.34	11.12	4.74	-2.86	-10.45	-18.05
11.3	40.0	1434	1.569E-02	15.29	14.03	7.44	-0.41	-8.25	-16.10
14.6	45.0	1569	1.628E-02	18.04	16.74	9.91	1.77	-6.37	-14.51
18.4	50.0	1700	1.670E-02	20.70	19.36	12.35	4.00	-4.35	-12.70
22.7	55.0	1844	1.709E-02	23.65	22.28	15.10	6.56	-1.99	-10.53
27.5	60.0	1998	1.699E-02	26.13	24.77	17.64	9.14	0.65	-7.85
32.7	65.0	2124	1.676E-02	27.89	26.55	19.51	11.13	2.75	-5.63
38.5	70.0	2286	1.585E-02	28.95	27.68	21.02	13.09	5.17	-2.76
44.7	75.0	3364	1.438E-02	41.76	40.61	34.57	27.38	20.19	13.00
51.3	80.0	4085	1.292E-02	46.83	45.80	40.37	33.91	27.45	20.99
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	6.098E-04	2.05	2.00	1.74	1.44	1.13	0.83
137.6	130.0	3400	4.545E-04	1.34	1.30	1.11	0.88	0.65	0.43
158.0	140.0	3130	3.475E-04	0.93	0.90	0.75	0.58	0.41	0.23
179.0	150.0	3000	2.846E-04	0.72	0.70	0.58	0.44	0.30	0.15
200.6	160.0	2950	2.075E-04	0.52	0.50	0.41	0.31	0.21	0.10
222.9	170.0	2950	1.037E-04	0.26	0.25	0.21	0.15	0.10	0.05
231.5	173.8	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 45.80 BTU/Ft^2-S
Total Heat Load: 2415.43 BTU/Ft^2

Table 7

1.5 Stage Cycle 2 Convective Base Heating
BP 204 - Core Base Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
1.0	10.0	878	4.081E-03	1.71	1.38	-0.33	-2.37	-4.41	-6.45
2.4	15.0	917	7.985E-03	3.65	3.01	-0.35	-4.34	-8.33	-12.33
4.4	20.0	1019	1.211E-02	6.76	5.80	0.71	-5.34	-11.40	-17.45
7.0	25.0	1158	1.433E-02	10.00	8.86	2.84	-4.33	-11.49	-18.66
10.2	30.0	1380	1.551E-02	14.27	13.03	6.52	-1.24	-9.00	-16.75
14.1	35.0	1552	1.619E-02	17.68	16.38	9.58	1.49	-6.61	-14.70
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
16.8	38.0	1622	1.653E-02	19.21	17.89	10.94	2.68	-5.59	-13.85
18.6	40.0	1711	1.672E-02	20.92	19.58	12.56	4.20	-4.16	-12.53
23.6	45.0	1874	1.707E-02	24.14	22.77	15.60	7.07	-1.47	-10.00
28.9	50.0	2030	1.696E-02	26.63	25.27	18.15	9.67	1.19	-7.29
34.6	55.0	2157	1.652E-02	28.03	26.71	19.77	11.51	3.25	-5.01
40.7	60.0	2515	1.532E-02	31.49	30.26	23.83	16.17	8.50	0.84
47.2	65.0	3813	1.381E-02	46.31	45.21	39.41	32.50	25.60	18.69
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	3.295E-03	11.76	11.50	10.12	8.47	6.82	5.17
121.2	110.0	3750	1.589E-03	5.23	5.10	4.43	3.64	2.84	2.05
140.5	120.0	3360	1.525E-03	4.42	4.30	3.66	2.90	2.13	1.37
160.3	130.0	3120	1.047E-03	2.78	2.70	2.26	1.74	1.21	0.69
180.7	140.0	3000	8.537E-04	2.17	2.10	1.74	1.31	0.89	0.46
201.4	150.0	2950	7.054E-04	1.76	1.70	1.40	1.05	0.70	0.35
221.5	159.6	2950	5.809E-04	1.45	1.40	1.16	0.87	0.58	0.28
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: **45.21** BTU/Ft^2-S
Total Heat Load: **2376.70** BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 204 - Core Base Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 8

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	6.000E-04	0.28	0.23	-0.02	-0.32	-0.62	-0.92
0.6	10.0	866	2.620E-03	1.06	0.85	-0.25	-1.56	-2.87	-4.18
1.4	15.0	888	5.109E-03	2.19	1.78	-0.37	-2.92	-5.48	-8.03
2.5	20.0	920	8.278E-03	3.81	3.15	-0.33	-4.47	-8.61	-12.75
4.1	25.0	1000	1.175E-02	6.34	5.40	0.47	-5.41	-11.28	-17.16
6.0	30.0	1097	1.351E-02	8.61	7.53	1.86	-4.90	-11.65	-18.41
8.4	35.0	1272	1.519E-02	12.34	11.12	4.74	-2.86	-10.45	-18.05
11.3	40.0	1434	1.569E-02	15.29	14.03	7.44	-0.41	-8.25	-16.10
14.6	45.0	1569	1.628E-02	18.04	16.74	9.91	1.77	-6.37	-14.51
18.4	50.0	1700	1.670E-02	20.70	19.36	12.35	4.00	-4.35	-12.70
22.7	55.0	1844	1.709E-02	23.65	22.28	15.10	6.56	-1.99	-10.53
27.5	60.0	1998	1.699E-02	26.13	24.77	17.64	9.14	0.65	-7.85
32.7	65.0	2124	1.676E-02	27.89	26.55	19.51	11.13	2.75	-5.63
38.5	70.0	2286	1.585E-02	28.95	27.68	21.02	13.09	5.17	-2.76
44.7	75.0	3364	1.438E-02	41.76	40.61	34.57	27.38	20.19	13.00
51.3	80.0	4085	1.292E-02	46.83	45.80	40.37	33.91	27.45	20.99
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	2.134E-03	7.17	7.00	6.10	5.04	3.97	2.90
137.6	130.0	3400	1.573E-03	4.63	4.50	3.84	3.05	2.27	1.48
158.0	140.0	3130	1.081E-03	2.89	2.80	2.35	1.81	1.26	0.72
179.0	150.0	3000	8.537E-04	2.17	2.10	1.74	1.31	0.89	0.46
200.6	160.0	2950	7.054E-04	1.76	1.70	1.40	1.05	0.70	0.35
222.9	170.0	2950	5.809E-04	1.45	1.40	1.16	0.87	0.58	0.28
231.5	173.8	2950	5.809E-04	1.45	1.40	1.16	0.87	0.58	0.28
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 45.80 BTU/Ft^2-S
Total Heat Load: 2552.61 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 205 - STME Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Table 9

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	4.585E-03	16.37	16.00	14.07	11.78	9.49	7.20
121.2	110.0	3750	3.364E-03	11.07	10.80	9.39	7.70	6.02	4.34
140.5	120.0	3360	3.369E-03	9.77	9.50	8.09	6.40	4.72	3.03
160.3	130.0	3120	2.209E-03	5.88	5.70	4.77	3.67	2.56	1.46
180.7	140.0	3000	1.829E-03	4.65	4.50	3.73	2.82	1.90	0.99
201.4	150.0	2950	1.763E-03	4.39	4.25	3.51	2.63	1.75	0.86
221.5	159.6	2950	1.722E-03	4.29	4.15	3.43	2.57	1.70	0.84
221.5	159.6	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
301.1	200.0	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
471.1	331.8	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 3752.74 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 205 - STME Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 10

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	4.421E-03	14.85	14.50	12.64	10.43	8.22	6.01
137.6	130.0	3400	3.497E-03	10.28	10.00	8.53	6.78	5.03	3.29
158.0	140.0	3130	2.355E-03	6.29	6.10	5.11	3.93	2.76	1.58
179.0	150.0	3000	1.870E-03	4.75	4.60	3.81	2.88	1.94	1.01
200.6	160.0	2950	1.763E-03	4.39	4.25	3.51	2.63	1.75	0.86
222.9	170.0	2950	1.743E-03	4.34	4.20	3.47	2.60	1.73	0.85
231.5	173.8	2950	1.701E-03	4.24	4.10	3.39	2.53	1.68	0.83
231.5	173.8	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
292.4	203.0	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
422.2	306.0	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81
469.8	450.2	2950	1.660E-03	4.13	4.00	3.30	2.47	1.64	0.81

Summary @Twall = 540 R

Peak Heating Rate: **51.11** BTU/Ft^2-S
Total Heat Load: **4363.41** BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating — Table 11
BP 206 - STME Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	4.069E-03	14.53	14.20	12.49	10.46	8.42	6.39
121.2	110.0	3750	2.586E-03	8.51	8.30	7.21	5.92	4.63	3.34
140.5	120.0	3360	2.553E-03	7.40	7.20	6.13	4.85	3.57	2.30
160.3	130.0	3120	1.318E-03	3.51	3.40	2.85	2.19	1.53	0.87
180.7	140.0	3000	9.146E-04	2.32	2.25	1.87	1.41	0.95	0.49
201.4	150.0	2950	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
221.5	159.6	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
221.5	159.6	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
301.1	200.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
471.1	331.8	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

Summary @Twall = 540 R

Peak Heating Rate: **52.11** BTU/Ft^2-S
Total Heat Load: **2956.91** BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 206 - STME Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 12

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	3.811E-03	12.80	12.50	10.90	8.99	7.09	5.18
137.6	130.0	3400	2.640E-03	7.76	7.55	6.44	5.12	3.80	2.48
158.0	140.0	3130	1.467E-03	3.92	3.80	3.18	2.45	1.72	0.98
179.0	150.0	3000	9.553E-04	2.43	2.35	1.95	1.47	0.99	0.52
200.6	160.0	2950	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
222.9	170.0	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
231.5	173.8	2950	7.261E-04	1.81	1.75	1.45	1.08	0.72	0.36
231.5	173.8	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
292.4	203.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
422.2	306.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
469.8	450.2	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

Summary @Twall = 540 R

Peak Heating Rate: **51.11** BTU/Ft^2-S
Total Heat Load: **3178.18** BTU/Ft^2

Table 13

1.5 Stage Cycle 2 Convective Base Heating
BP 207 - STME Heat Shield
NLS 2 Mission 1 Nominal - July 1992

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	4.011E-03	14.32	14.00	12.32	10.31	8.30	6.30
121.2	110.0	3750	2.586E-03	8.51	8.30	7.21	5.92	4.63	3.34
140.5	120.0	3360	2.553E-03	7.40	7.20	6.13	4.85	3.57	2.30
160.3	130.0	3120	1.318E-03	3.51	3.40	2.85	2.19	1.53	0.87
180.7	140.0	3000	9.146E-04	2.32	2.25	1.87	1.41	0.95	0.49
201.4	150.0	2950	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
221.5	159.6	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 2920.96 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 207 - STME Heat Shield
NLS 2 Mission 1 Engine Out - July 1992

Table 14

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	3.963E-03	13.32	13.00	11.34	9.35	7.37	5.39
137.6	130.0	3400	2.640E-03	7.76	7.55	6.44	5.12	3.80	2.48
158.0	140.0	3130	1.467E-03	3.92	3.80	3.18	2.45	1.72	0.98
179.0	150.0	3000	9.553E-04	2.43	2.35	1.95	1.47	0.99	0.52
200.6	160.0	2950	7.884E-04	1.96	1.90	1.57	1.17	0.78	0.39
222.9	170.0	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
231.5	173.8	2950	7.261E-04	1.81	1.75	1.45	1.08	0.72	0.36
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S

Total Heat Load: 3127.99 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 208 - Inboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992

Table 15

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	6.017E-03	21.48	21.00	18.47	15.46	12.46	9.45
121.2	110.0	3750	5.545E-03	18.24	17.80	15.47	12.70	9.93	7.15
140.5	120.0	3360	5.426E-03	15.73	15.30	13.02	10.31	7.60	4.88
160.3	130.0	3120	3.450E-03	9.18	8.90	7.45	5.73	4.00	2.28
180.7	140.0	3000	2.927E-03	7.43	7.20	5.97	4.51	3.04	1.58
201.4	150.0	2950	2.739E-03	6.82	6.60	5.45	4.08	2.71	1.34
221.5	159.6	2950	2.697E-03	6.72	6.50	5.37	4.02	2.67	1.32
221.5	159.6	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30
301.1	200.0	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30
471.1	331.8	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 4424.90 BTU/Ft^2

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REMTECH

ATTN: JOHN BROWN

FAX# 536-8599

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OF POOR QUALITY

NASA FORM 1378 PREVIOUS EDITION MAY BE USED

BASE THERMAL ENVIRONMENT SUMMARY

① CONVECTIVE HTG RATE

		BHS	STME
PEAK CONVECTIVE HTG RATE		47.4 Btu/ft²sec	54.1 Btu/ft²-sec
ALTITUDE		—	35.8 kft
time	NOM	—	—
	EO	—	—

② PEAK TOTAL HTG RATE (CONV+ALL RAD) AND BP LOCATION ON NOZZLE & BHS

	BHS BPXXX	STME BPXXX
TOTAL HTG RATE	—	—

③ MAX TOTAL HEAT LOAD (CONV+ALL RAD) AND BP LOCATION ON NOZZLE & BHS FOR NOM & EO CASE

	BHS BPXXX	STME BPXXX
TOTAL HEAT LOAD (NOM)	—	—
" " " (EO)	—	—

	A	B	C	E	F	H	I	K	L
1	NLS 2 Mission 1 Nominal			Base Heat Shield Conv Peaks @ 66.4 sec (49.0 Kft)					
2	Cycle 2 Environments			STME Conv Peaks @ 56.0 sec (35.8 Kft)					
3		Qconv@540		Qrad_basegas		Qrad_plume		Qconv@540+Qrad_basegas+Qrad_plume	
4									
5	BP	Peak Rate	Heat Load	Heat Rate	Heat Load	Heat Rate	Heat Load	Total Peak Rate	Total Heat Load
6		BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2
7	201	47.4	2800.77	5.10	229.81	0.97	242.33	53.47	3272.91
8	202	47.4	2278.8	6.83	305.76	1.37	353.74	55.60	2938.30
9	203	47.4	2240.95	6.87	297.74	1.72	458.80	55.99	2997.49
10	204	47.4	2376.7	4.98	220.05	0.96	212.74	53.34	2809.49
11	205	54.1	3752.74	4.86	222.52	1.84	381.00	60.80	4356.26
12	206	54.1	2956.91	4.66	209.48	1.26	236.12	60.02	3402.51
13	207	54.1	2920.96	4.56	197.84	2.52	438.65	**61.18**	3557.45
14	208	54.1	4424.9	2.90	133.96	2.68	779.12	59.68	**5337.98**
15	209	54.1	3165.58	2.57	114.36	1.40	337.86	58.07	3617.80
16	210	54.1	2978.92	2.92	127.51	2.38	509.95	59.40	3616.38
17	211	54.1	3102.86	3.01	136.39	3.24	686.66	60.35	3925.91
18	212	54.1	2857.41	3.74	167.99	2.02	411.73	59.86	3437.13
19	213	1.05	180.86	0.00	0.00	0.00	17.20	1.05	198.06
20									
21	NLS 2 Mission 1 Engine-Out			Base Heat Shield Conv Peaks @ 78.3 sec (49.0 Kft)					
22	Cycle 2 Environments			STME Conv Peaks @ 67.7 sec (35.8 Kft)					
23		Qconv@540		Qrad_basegas		Qrad_plume		Qconv@540+Qrad_basegas+Qrad_plume	
24									
25	BP	Peak Rate	Heat Load	Heat Rate	Heat Load	Heat Rate	Heat Load	Total Peak Rate	Total Heat Load
26		BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2	BTU/Ft^2-S	BTU/FT^2
27	201	47.4	3224.44	5.11	242.81	0.99	298.47	53.50	3765.72
28	202	47.4	2450.78	6.84	316.88	1.42	411.95	55.66	3179.61
29	203	47.4	2415.43	6.87	308.55	1.73	540.31	56.00	3264.29
30	204	47.4	2552.61	4.99	228.26	0.98	248.83	53.37	3029.70
31	205	54.1	4363.41	4.91	235.38	1.97	477.67	60.98	5076.46
32	206	54.1	3178.18	4.71	220.99	1.22	284.84	60.03	3684.01
33	207	54.1	3127.89	4.60	205.41	2.51	514.19	**61.21**	3847.49
34	208	54.1	5255.1	2.93	141.53	2.68	1018.02	59.71	**6414.65**
35	209	54.1	3368.32	2.60	120.14	1.47	409.85	58.17	3898.31
36	210	54.1	3178.03	2.96	132.22	2.38	594.75	59.44	3905.00
37	211	54.1	3293.05	3.04	141.39	3.23	821.68	60.37	4256.12
38	212	54.1	3061.89	3.78	173.93	2.01	481.28	59.89	3717.10
39	213	1.05	290.31	0.00	0.00	0.00	27.64	1.05	317.95

	A	B	C	D	E	F	G	H
1	NLS 2 Mission 1 Nominal							
2	Cycle 2 Radiation Environments							
3								
4	Heat Shield		Qrad_basegas				Qrad_plume	
5	Body Points	@65sec	@70 sec	@66.4 sec		@65sec	@70 sec	@66.4 sec
6	201	5.29	4.61	5.10		1.03	0.83	0.97
7	202	7.08	6.19	6.83		1.45	1.17	1.37
8	203	7.12	6.22	6.87		1.84	1.42	1.72
9	204	5.17	4.49	4.98		1.01	0.83	0.96
10	213	0.00	0.00	0.00		0.00	0.00	0.00
11								
12	STME		Qrad_basegas				Qrad_plume	
13	Body Points	@55sec	@60 sec	@56.0 sec		@55sec	@60 sec	@56.0 sec
14	205	4.63	5.79	4.86		1.92	1.54	1.84
15	206	4.44	5.54	4.66		1.31	1.06	1.26
16	207	4.34	5.42	4.56		2.62	2.12	2.52
17	208	2.76	3.46	2.90		2.76	2.37	2.68
18	209	2.45	3.07	2.57		1.46	1.18	1.40
19	210	2.78	3.49	2.92		2.47	2.04	2.38
20	211	2.86	3.59	3.01		3.35	2.79	3.24
21	212	3.55	4.48	3.74		2.11	1.68	2.02
22								
23								
24	NLS 2 Mission 1 Engine-Out							
25	Cycle 2 Radiation Environments							
26								
27	Heat Shield		Qrad_basegas				Qrad_plume	
28	Body Points	@75sec	@80 sec	@78.3 sec		@75sec	@80 sec	@78.3 sec
29	201	5.54	4.89	5.11		1.14	0.92	0.99
30	202	7.41	6.55	6.84		1.62	1.31	1.42
31	203	7.44	6.58	6.87		2.03	1.57	1.73
32	204	5.42	4.77	4.99		1.11	0.92	0.98
33	213	0.00	0.00	0.00		0.00	0.00	0.00
34								
35	STME		Qrad_basegas				Qrad_plume	
36	Body Points	@65sec	@70 sec	@67.7 sec		@65sec	@70 sec	@67.7 sec
37	205	4.20	5.51	4.91		2.13	1.83	1.97
38	206	4.03	5.28	4.71		1.31	1.14	1.22
39	207	3.95	5.16	4.60		2.74	2.32	2.51
40	208	2.50	3.29	2.93		2.84	2.55	2.68
41	209	2.23	2.92	2.60		1.54	1.41	1.47
42	210	2.53	3.32	2.96		2.56	2.22	2.38
43	211	2.60	3.41	3.04		3.47	3.02	3.23
44	212	3.22	4.25	3.78		2.18	1.86	2.01

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To J REGRUN	From J. ERLIN
Co.	Co.
Dept.	Phone #
Fax #	Fax #

8-16-92

Bob,

Mark Seaford reviewed the Cycle 2 environments & wanted to know why qc-us-alt was different in the first 100 kft for engine-out & nominal.

After discussing with Craig, we discovered that the 5sec intervals we tabulated in the report missed some of the peaks & valleys in Craig's "master" curves.

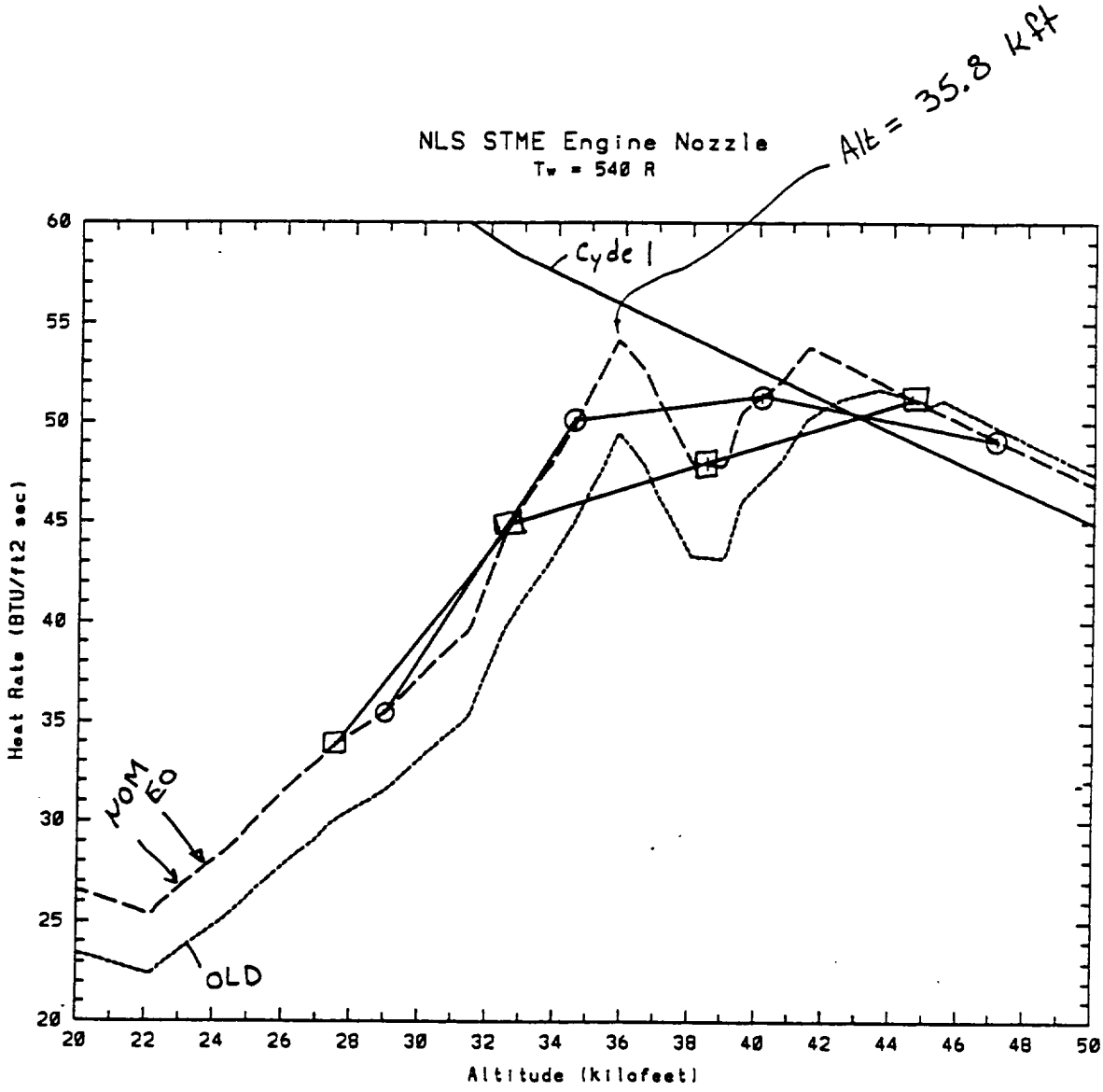
Craig & I faxed some backup material to Mark & discussed via telecon Monday (16th) afternoon. Mark said it wasn't a big issue; he just wanted to be clear. After offering to smooth Craig's curves & ~~redoing~~ re-doing the environments, Mark said it wasn't necessary.

I'm leaving a copy of all the backup material we faxed back & forth.

j.b.

○ Nom

□ EO


NLS STME Engine Nozzle
Tw = 540 R
Alt = 35.8 Kft
Cyde 1
NOM
EO
OLD
Heat Rate (BTU/ft2 sec)
Altitude (kilofeet)
60
55
50
45
40
35
30
25
20
20
22
24
26
28
30
32
34
36
38
40
42
44
46
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Huntsville, AL 35805

FACSIMILE (FAX) COVER SHEET

GROUP 3 COMPATIBILITY

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SUBJECT: NLS Cycle 2 Convection

DATE: AUG 16, 1992 FAX NO.: 544-1215

PLEASE DELIVER THE ATTACHED MESSAGE TO:

NAME: MARK SEAFORD
LOCATION: ED33
PHONE: 544-1596

FROM: John Brown PHONE: 536-8581
TOTAL NUMBER OF PAGES INCLUDING THIS COVER SHEET: 4 + cover

TRANSMISSION/LEGIBILITY PROBLEMS? CALL (205) 536-3581
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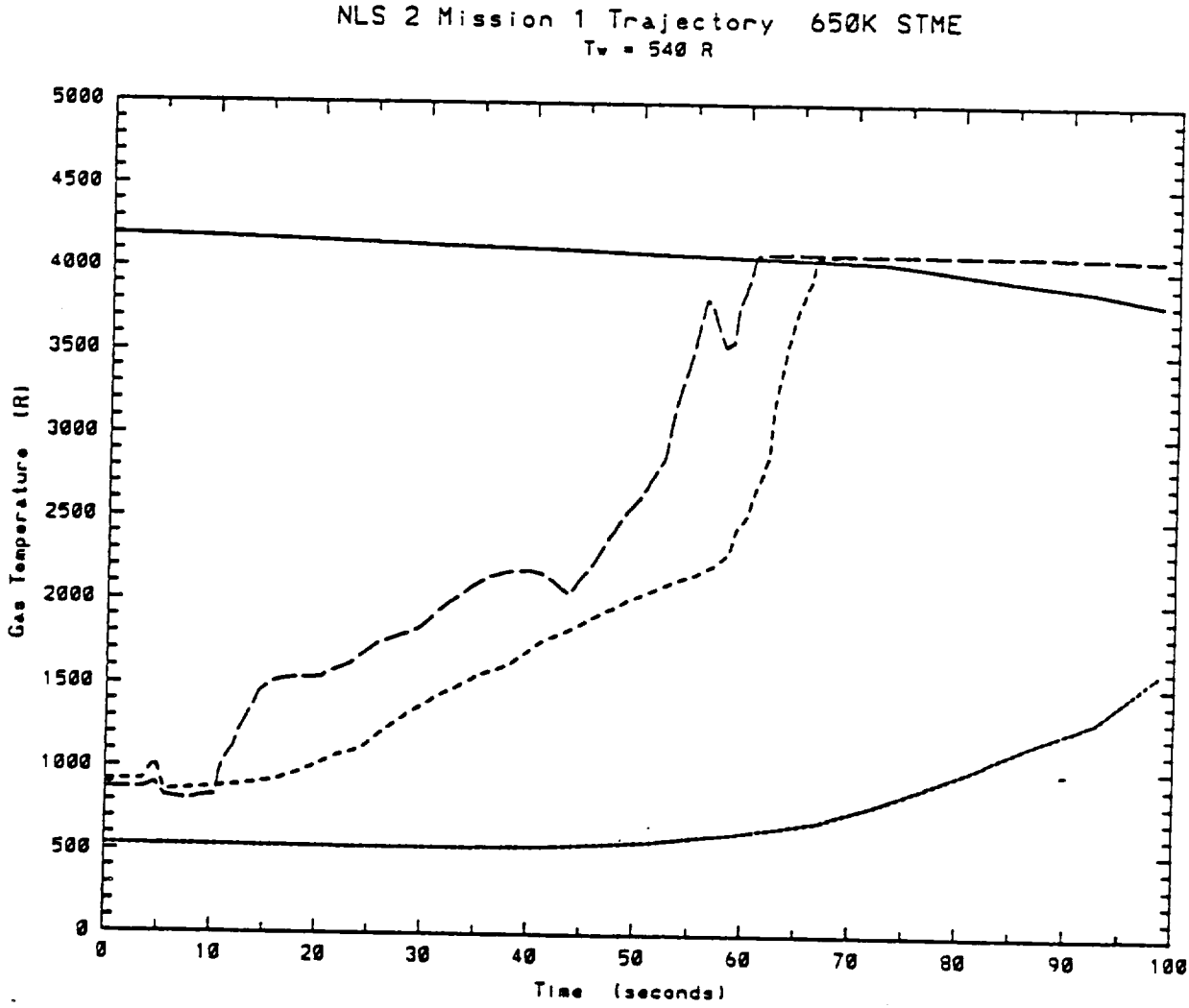


Figure 16: NLS 2 Base Gas Temperature Estimates

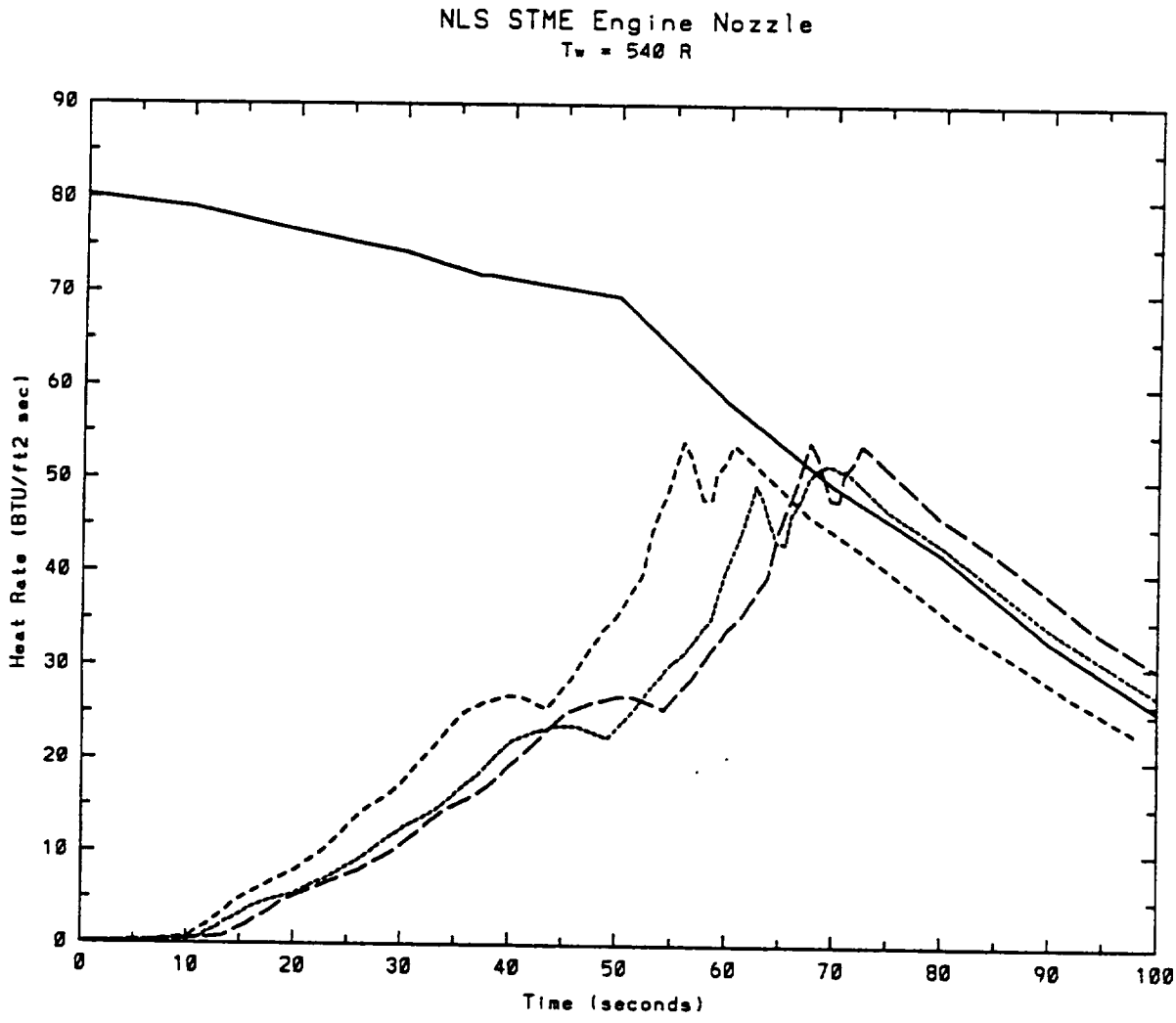
sol 1 7

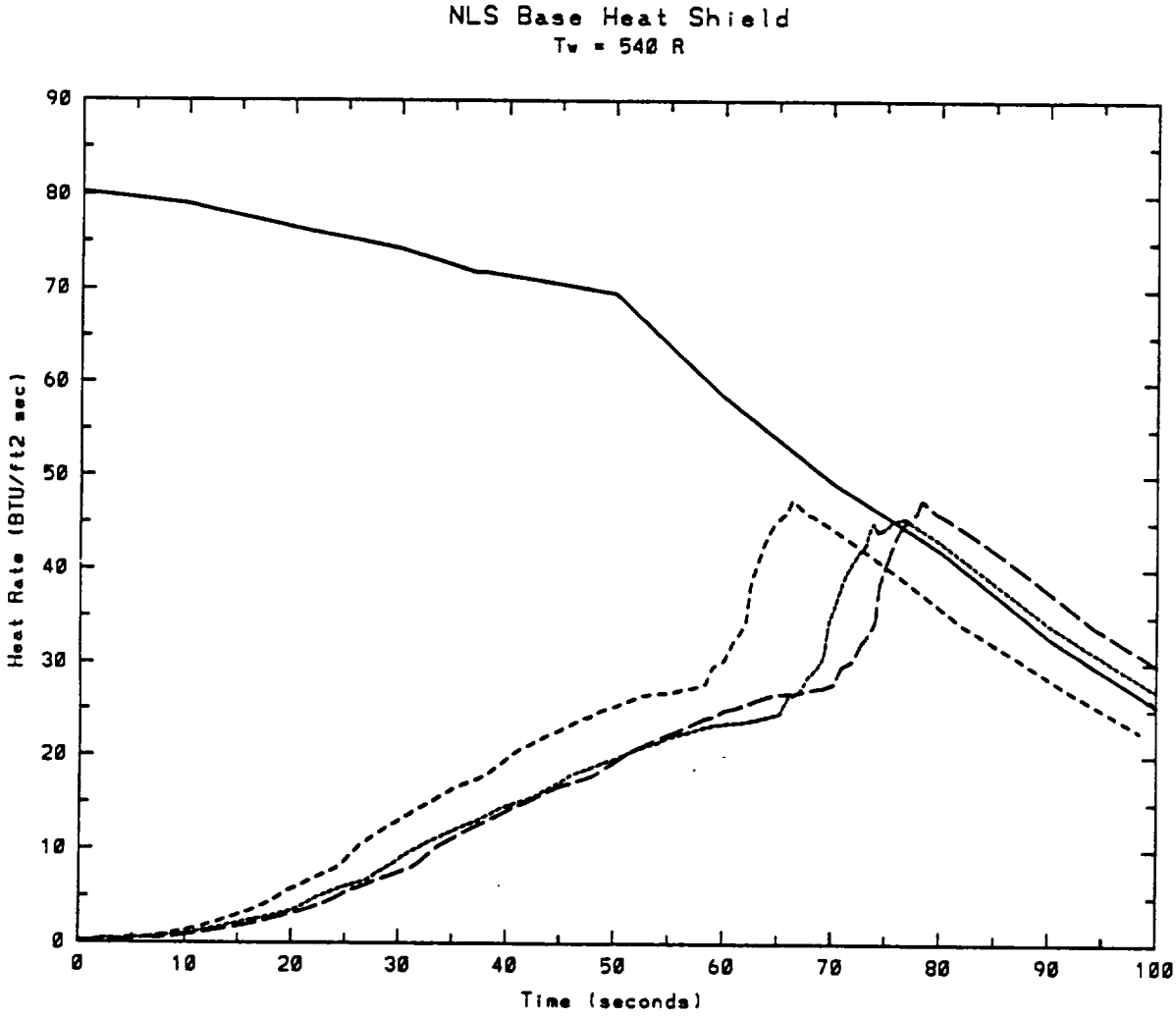
	NOM		Eff 0.1	
	$\dot{q}$	Q	$\dot{q}$	Q
BTS	47.4	2150	47.4	2254
ENS	54.1	2593	54.1	2738

681-2822

7/28/92
NOON

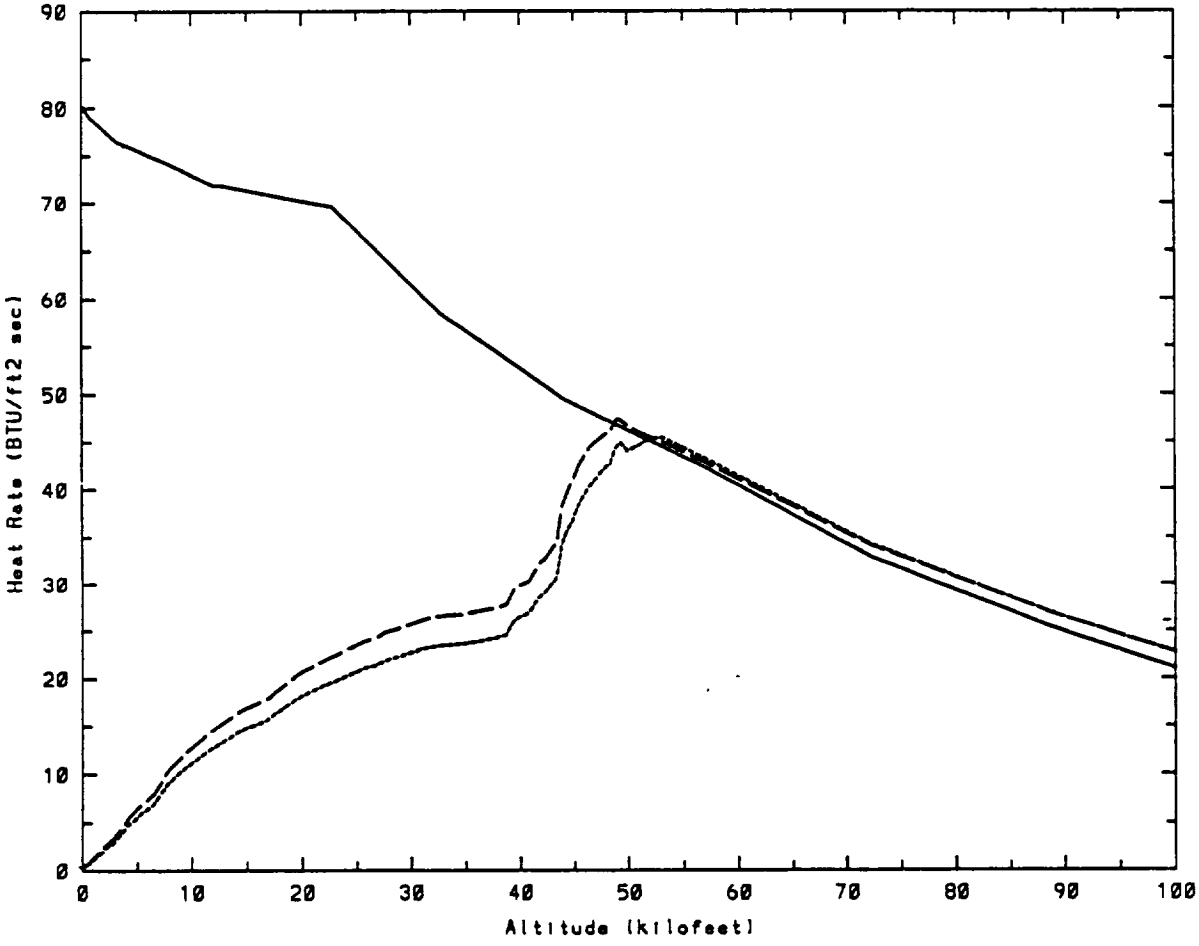
- $\rho/\rho = 2.224$ for complete nominal flight
- CEC up-dated for 650K

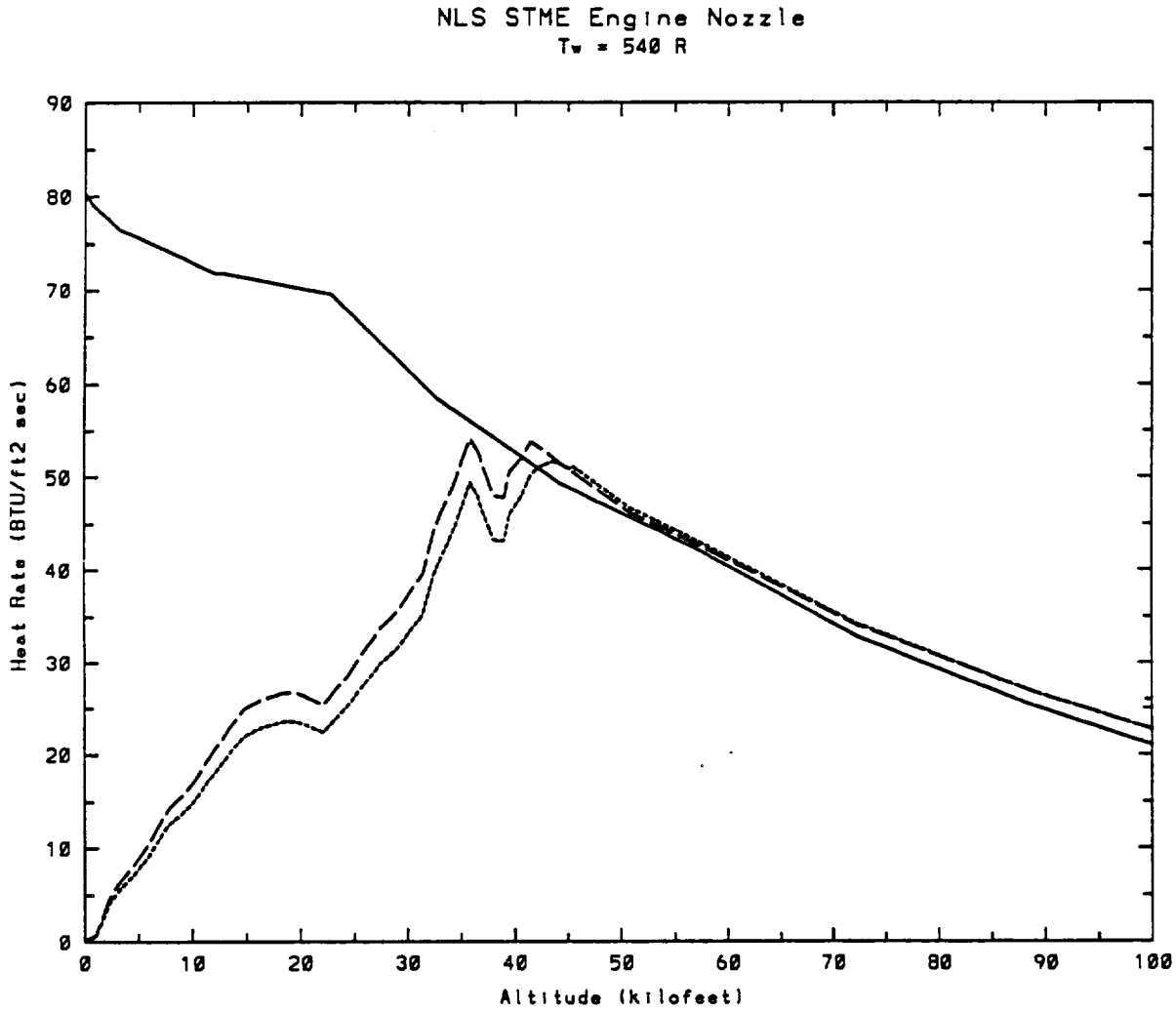

NLS STME Engine Nozzle
Tw = 540 R
Heat Rate (BTU/ft2 sec)
Time (seconds)
0
10
20
30
40
50
60
70
80
90
100


NLS Base Heat Shield
Tw = 540 R
Heat Rate (BTU/ft2 sec)
Time (seconds)
0
10
20
30
40
50
60
70
80
90
100

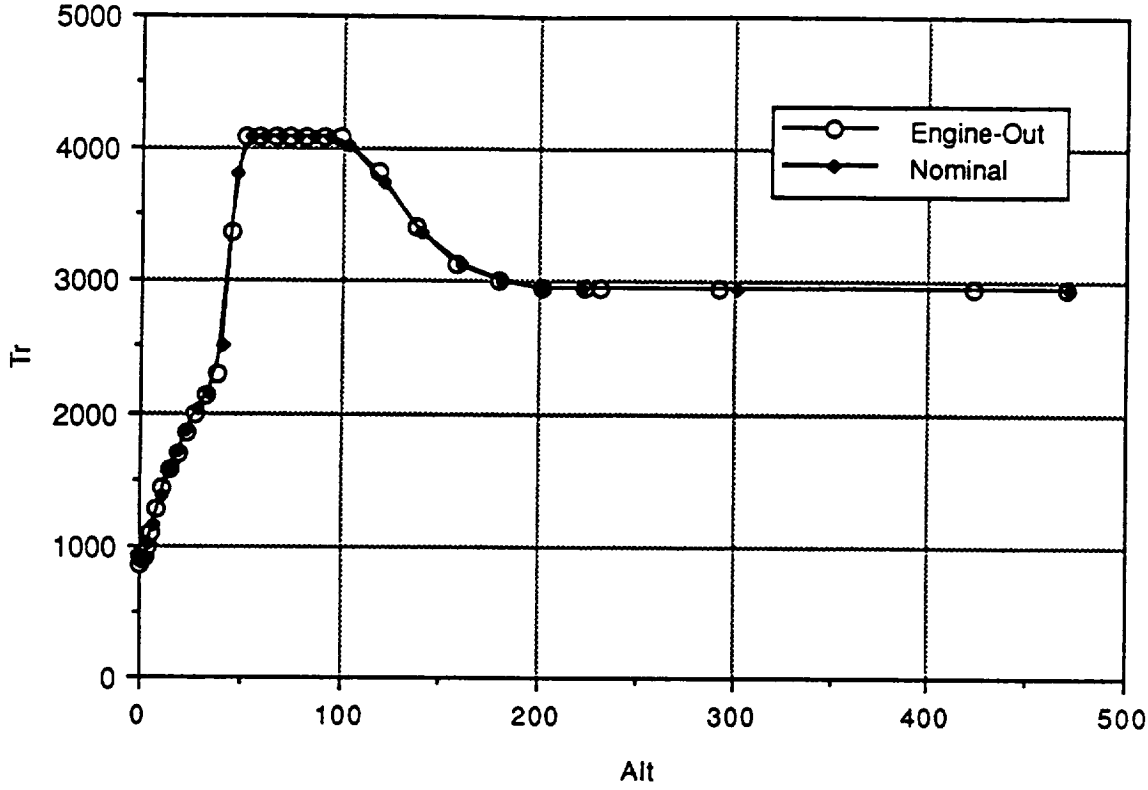
NLS Base Heat Shield

T_w = 540 R

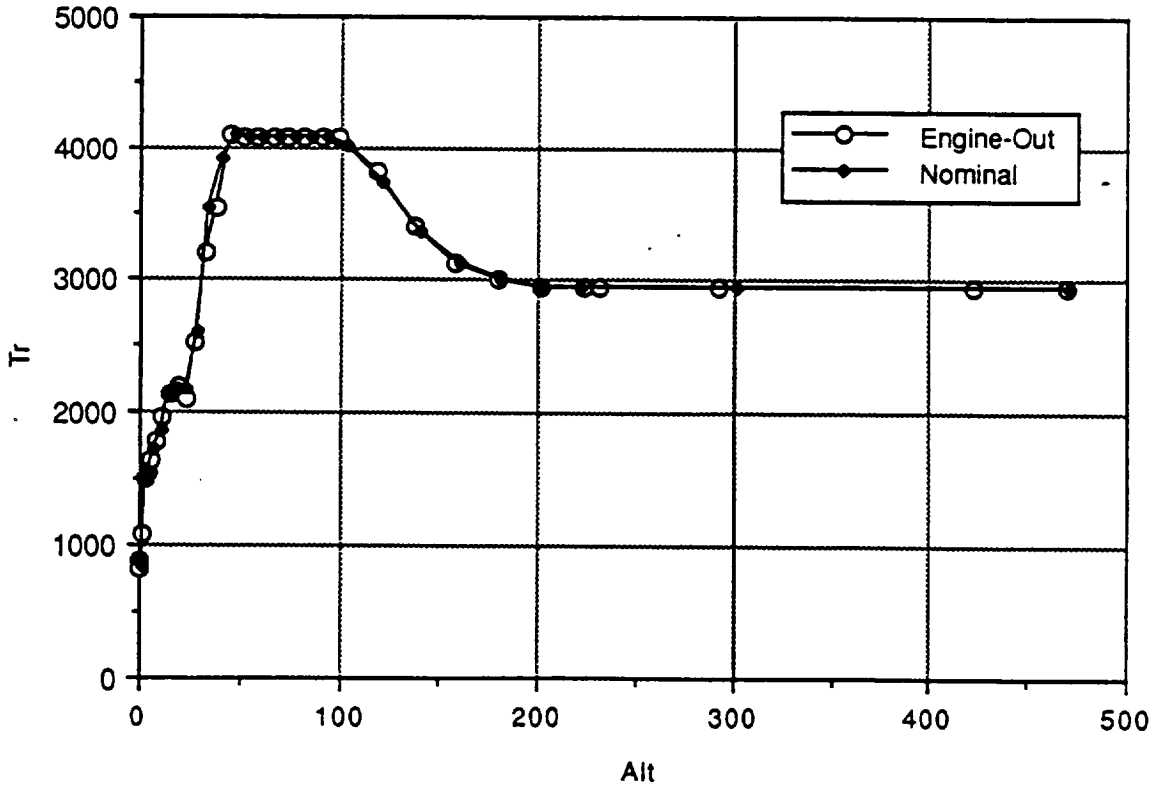



NLS STME Engine Nozzle
Tw = 540 R
Heat Rate (BTU/ft2 sec)
Altitude (kilofeet)
0
10
20
30
40
50
60
70
80
90
100

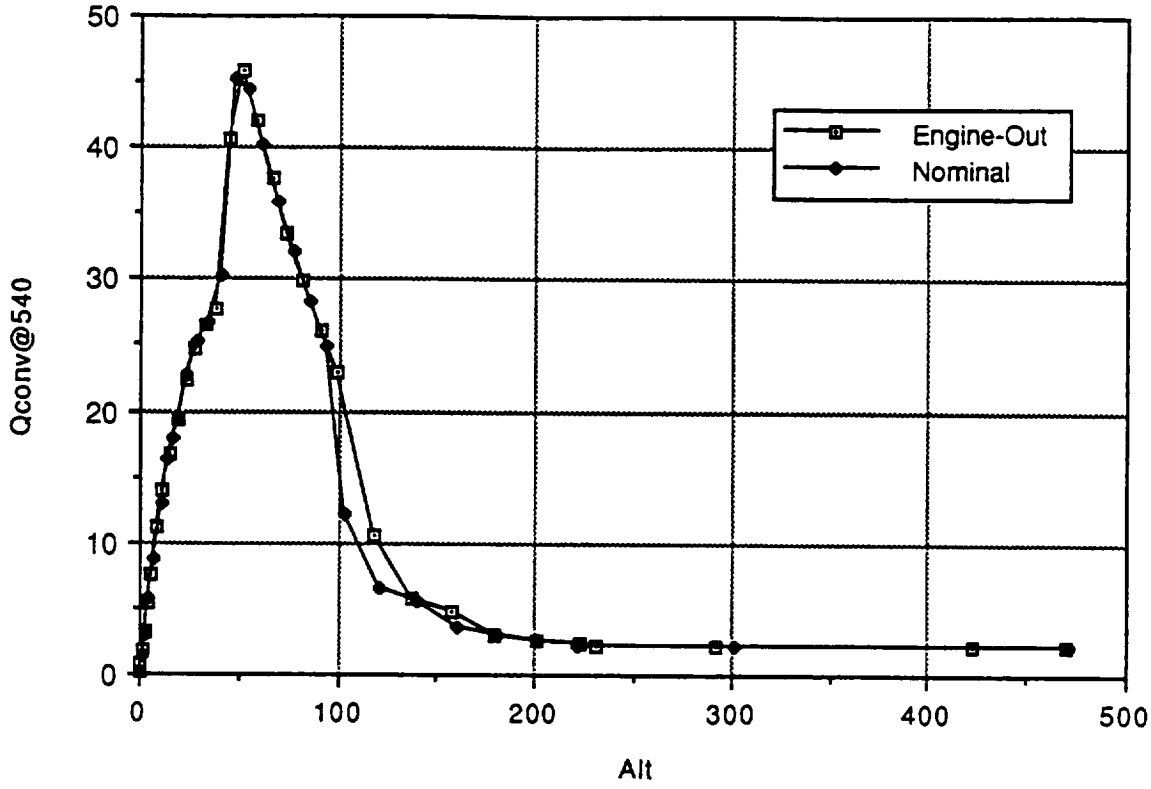
NLS 2 Mission 1
Core Base Heat Shield



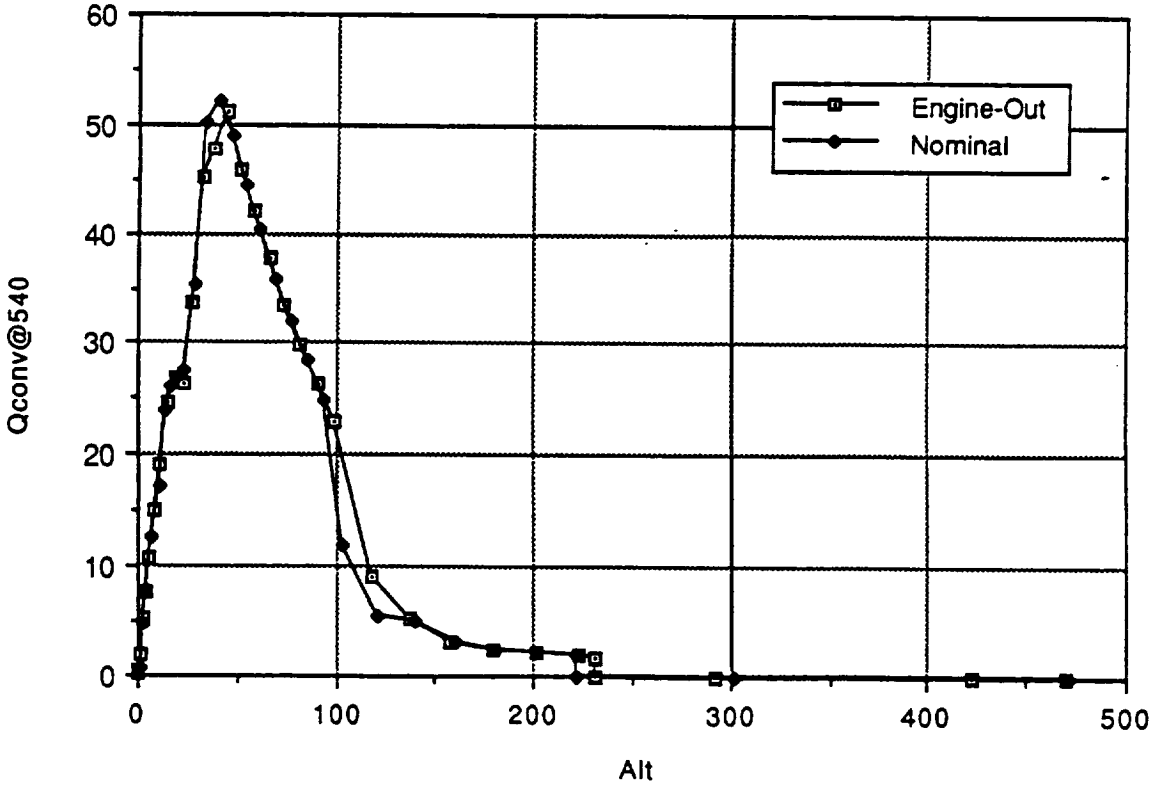
NLS 2 Mission 1
STME



NLS 2 Mission 1
BP 201: Core Base Heat Shield



NLS 2 Mission 1
BP 212: STME Nozzle Lip



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8. OFFICE PHONE NO.

544-1596

9. TO (Include Office Code and telephone number.) (May also be used for remarks):

REMTECH

ATTN: JOHN BROWN

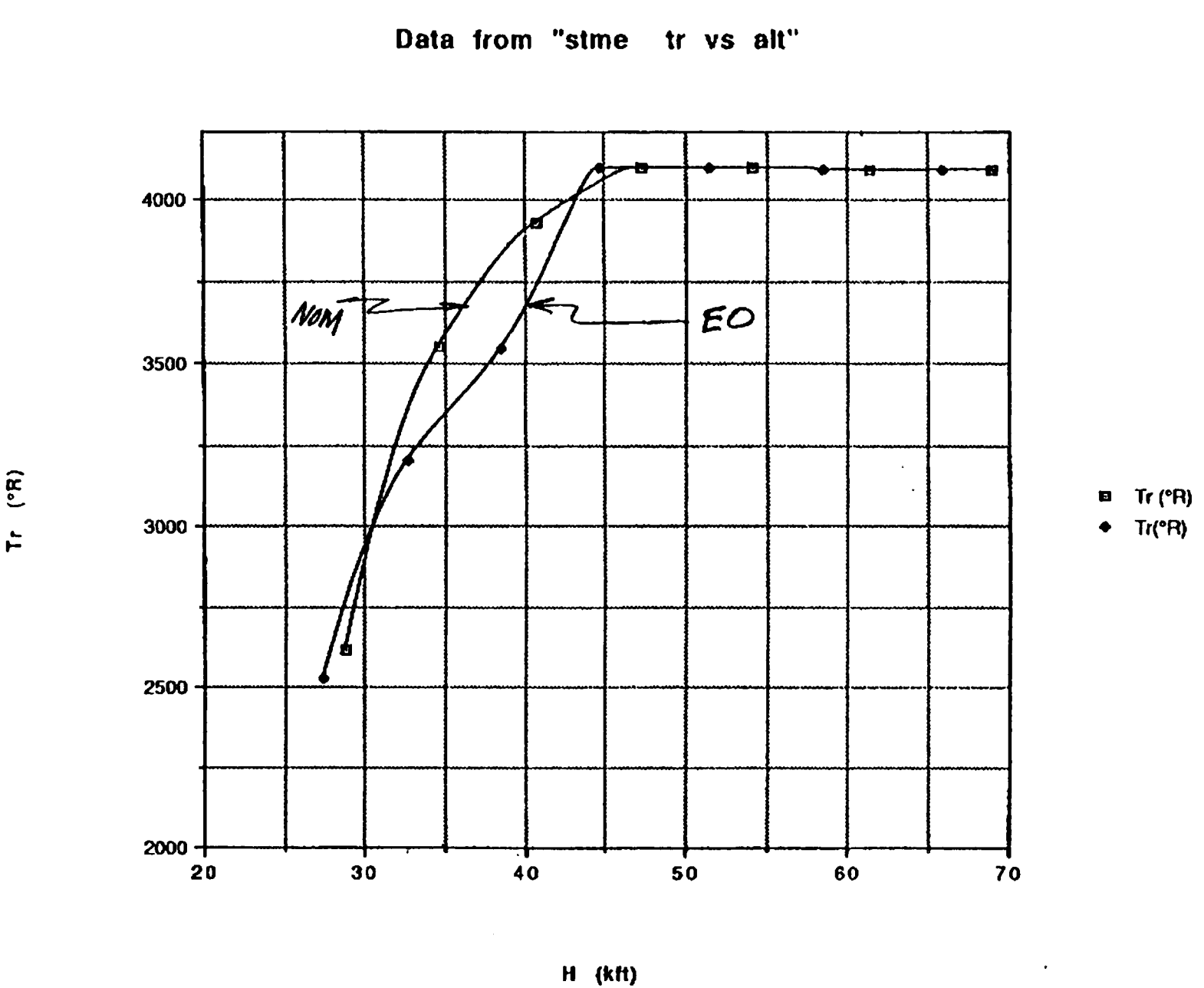
FAX # 536-8599

	H (kft)	Tr (°R)	hc(Btu/ft2-s-r
1	28.900	2618.000	0.01704
2	34.600	3551.000	0.01666
3	40.700	3930.000	0.01537
4	47.200	4095.000	0.01381
5	54.100	4091.000	0.01251
6	61.400	4088.000	0.01136
7	69.000	4089.000	0.01013

NOM

H(kft)-eo	Tr(°R)	hc(Btu/ft2-s-r
27.500	2527.000	0.01701
32.700	3202.000	0.01694
38.500	3546.000	0.01593
44.700	4094.000	0.01438
51.300	4093.000	0.01292
58.400	4089.000	0.01184
65.900	4089.000	0.01063

EO



1.5 Stage Cycle 2 Convective Base Heating
BP 208 - Inboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

Table 16

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	6.098E-03	20.49	20.00	17.44	14.39	11.34	8.29
137.6	130.0	3400	5.839E-03	17.17	16.70	14.25	11.33	8.41	5.49
158.0	140.0	3130	3.668E-03	9.79	9.50	7.96	6.13	4.29	2.46
179.0	150.0	3000	2.967E-03	7.54	7.30	6.05	4.57	3.09	1.60
200.6	160.0	2950	2.759E-03	6.87	6.65	5.49	4.11	2.73	1.35
222.9	170.0	2950	2.739E-03	6.82	6.60	5.45	4.08	2.71	1.34
231.5	173.8	2950	2.697E-03	6.72	6.50	5.37	4.02	2.67	1.32
231.5	173.8	2950	2.656E-03	6.61	6.40	5.28	3.96	2.63	1.30
292.4	203.0	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30
422.2	306.0	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30
469.8	450.2	2950	2.656E-03	6.61	6.40	5.29	3.96	2.63	1.30

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S
Total Heat Load: 5255.10 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 209 - Inboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992

Table 17

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	5.301E-03	18.92	18.50	16.27	13.62	10.97	8.32
121.2	110.0	3750	4.050E-03	13.32	13.00	11.30	9.27	7.25	5.22
140.5	120.0	3360	3.901E-03	11.31	11.00	9.36	7.41	5.46	3.51
160.3	130.0	3120	2.442E-03	6.50	6.30	5.27	4.05	2.83	1.61
180.7	140.0	3000	1.992E-03	5.06	4.90	4.06	3.07	2.07	1.08
201.4	150.0	2950	1.826E-03	4.55	4.40	3.63	2.72	1.81	0.89
221.5	159.6	2950	1.743E-03	4.34	4.20	3.47	2.60	1.73	0.85
221.5	159.6	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
301.1	200.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
471.1	331.8	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 3165.58 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 209 - Inboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

Table 18

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	5.183E-03	17.41	17.00	14.82	12.23	9.64	7.05
137.6	130.0	3400	4.161E-03	12.23	11.90	10.15	8.07	5.99	3.91
158.0	140.0	3130	2.606E-03	6.96	6.75	5.66	4.35	3.05	1.75
179.0	150.0	3000	2.012E-03	5.11	4.95	4.10	3.10	2.09	1.09
200.6	160.0	2950	1.826E-03	4.55	4.40	3.63	2.72	1.81	0.89
222.9	170.0	2950	1.743E-03	4.34	4.20	3.47	2.60	1.73	0.85
231.5	173.8	2950	1.743E-03	4.34	4.20	3.47	2.60	1.73	0.85
231.5	173.8	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
292.4	203.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
422.2	306.0	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04
469.8	450.2	2950	8.299E-05	0.21	0.20	0.17	0.12	0.08	0.04

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S
Total Heat Load: 3368.32 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 210 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992

Table 19

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	4.241E-03	15.14	14.80	13.02	10.90	8.78	6.66
121.2	110.0	3750	2.679E-03	8.81	8.60	7.47	6.14	4.80	3.46
140.5	120.0	3360	2.730E-03	7.92	7.70	6.55	5.19	3.82	2.46
160.3	130.0	3120	1.744E-03	4.64	4.50	3.77	2.90	2.02	1.15
180.7	140.0	3000	1.504E-03	3.82	3.70	3.07	2.32	1.56	0.81
201.4	150.0	2950	1.349E-03	3.36	3.25	2.68	2.01	1.34	0.66
221.5	159.6	2950	1.203E-03	3.00	2.90	2.39	1.79	1.19	0.59
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 2978.92 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 210 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

Table 20

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	3.963E-03	13.32	13.00	11.34	9.35	7.37	5.39
137.6	130.0	3400	2.797E-03	8.22	8.00	6.83	5.43	4.03	2.63
158.0	140.0	3130	1.815E-03	4.85	4.70	3.94	3.03	2.12	1.22
179.0	150.0	3000	1.504E-03	3.82	3.70	3.07	2.32	1.56	0.81
200.6	160.0	2950	1.349E-03	3.36	3.25	2.68	2.01	1.34	0.66
222.9	170.0	2950	1.203E-03	3.00	2.90	2.39	1.79	1.19	0.59
231.5	173.8	2950	1.183E-03	2.94	2.85	2.35	1.76	1.17	0.58
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S
Total Heat Load: 3178.03 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 211 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992

Table 21

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	4.871E-03	17.39	17.00	14.95	12.52	10.08	7.65
121.2	110.0	3750	3.738E-03	12.30	12.00	10.43	8.56	6.69	4.82
140.5	120.0	3360	3.688E-03	10.70	10.40	8.85	7.01	5.16	3.32
160.3	130.0	3120	2.326E-03	6.19	6.00	5.02	3.86	2.70	1.53
180.7	140.0	3000	2.033E-03	5.16	5.00	4.15	3.13	2.11	1.10
201.4	150.0	2950	1.867E-03	4.65	4.50	3.72	2.78	1.85	0.91
221.5	159.6	2950	1.743E-03	4.34	4.20	3.47	2.60	1.73	0.85
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 52.11 BTU/Ft^2-S
Total Heat Load: 3102.86 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 211 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

Table 22

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	4.878E-03	16.39	16.00	13.95	11.51	9.07	6.63
137.6	130.0	3400	3.846E-03	11.31	11.00	9.38	7.46	5.54	3.62
158.0	140.0	3130	2.510E-03	6.70	6.50	5.45	4.19	2.94	1.68
179.0	150.0	3000	2.073E-03	5.27	5.10	4.23	3.19	2.16	1.12
200.6	160.0	2950	1.867E-03	4.65	4.50	3.72	2.78	1.85	0.91
222.9	170.0	2950	1.701E-03	4.24	4.10	3.39	2.53	1.68	0.83
231.5	173.8	2950	1.680E-03	4.18	4.05	3.34	2.50	1.66	0.82
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S
Total Heat Load: 3293.05 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 212 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Nominal - July 1992

Table 23

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
1.0	10.0	831	2.725E-03	1.01	0.79	-0.35	-1.72	-3.08	-4.44
2.4	15.0	1486	5.178E-03	5.31	4.90	2.72	0.14	-2.45	-5.04
4.4	20.0	1538	7.968E-03	8.59	7.95	4.61	0.62	-3.36	-7.35
7.0	25.0	1715	1.082E-02	13.58	12.71	8.17	2.76	-2.65	-8.06
10.2	30.0	1859	1.310E-02	18.32	17.27	11.77	5.22	-1.33	-7.88
14.1	35.0	2107	1.526E-02	25.13	23.91	17.50	9.87	2.24	-5.39
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
16.8	38.0	2177	1.596E-02	27.40	26.13	19.42	11.44	3.46	-4.52
18.6	40.0	2180	1.629E-02	28.03	26.73	19.88	11.73	3.59	-4.56
23.6	45.0	2168	1.693E-02	28.92	27.56	20.45	11.99	3.52	-4.94
28.9	50.0	2618	1.704E-02	36.77	35.41	28.25	19.73	11.21	2.69
34.6	55.0	3551	1.666E-02	51.50	50.16	43.17	34.84	26.51	18.18
40.7	60.0	3930	1.537E-02	53.34	52.11	45.65	37.97	30.28	22.59
47.2	65.0	4095	1.381E-02	50.21	49.10	43.30	36.40	29.49	22.58
54.1	70.0	4091	1.251E-02	45.41	44.41	39.16	32.90	26.65	20.40
61.4	75.0	4088	1.136E-02	41.23	40.32	35.55	29.87	24.18	18.50
69.0	80.0	4089	1.013E-02	36.76	35.95	31.70	26.63	21.57	16.50
77.0	85.0	4090	9.023E-03	32.75	32.03	28.24	23.73	19.22	14.71
85.3	90.0	4085	8.005E-03	29.02	28.38	25.02	21.01	17.01	13.01
93.9	95.0	4078	7.055E-03	25.52	24.96	22.00	18.47	14.94	11.41
102.8	100.0	4030	3.438E-03	12.28	12.00	10.56	8.84	7.12	5.40
121.2	110.0	3750	1.745E-03	5.74	5.60	4.87	4.00	3.12	2.25
140.5	120.0	3360	1.773E-03	5.14	5.00	4.26	3.37	2.48	1.60
160.3	130.0	3120	1.202E-03	3.20	3.10	2.60	1.99	1.39	0.79
180.7	140.0	3000	9.756E-04	2.48	2.40	1.99	1.50	1.01	0.53
201.4	150.0	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
221.5	159.6	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
301.1	200.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
471.1	331.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: **52.11** BTU/Ft^2-S
Total Heat Load: **2857.41** BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 212 - Outboard STME Nozzle (Lip)
NLS 2 Mission 1 Engine Out - July 1992

Table 24

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	871	4.000E-04	0.16	0.13	-0.04	-0.24	-0.44	-0.64
0.6	10.0	810	1.764E-03	0.62	0.48	-0.26	-1.15	-2.03	-2.91
1.4	15.0	1078	3.369E-03	2.08	1.81	0.40	-1.29	-2.97	-4.65
2.5	20.0	1502	5.366E-03	5.59	5.16	2.91	0.22	-2.46	-5.14
4.1	25.0	1536	7.602E-03	8.18	7.57	4.38	0.58	-3.22	-7.03
6.0	30.0	1635	9.761E-03	11.47	10.69	6.59	1.71	-3.17	-8.05
8.4	35.0	1780	1.209E-02	15.96	14.99	9.91	3.87	-2.18	-8.22
11.3	40.0	1946	1.368E-02	20.33	19.23	13.49	6.65	-0.19	-7.03
14.6	45.0	2126	1.553E-02	25.88	24.64	18.12	10.35	2.59	-5.18
18.4	50.0	2184	1.625E-02	28.01	26.71	19.89	11.77	3.64	-4.48
22.7	55.0	2092	1.691E-02	27.60	26.25	19.15	10.69	2.24	-6.22
27.5	60.0	2527	1.701E-02	35.15	33.79	26.65	18.14	9.64	1.13
32.7	65.0	3202	1.694E-02	46.45	45.10	37.98	29.51	21.04	12.57
38.5	70.0	3546	1.593E-02	49.16	47.88	41.19	33.22	25.26	17.29
44.7	75.0	4094	1.438E-02	52.26	51.11	45.07	37.88	30.69	23.50
51.3	80.0	4093	1.292E-02	46.93	45.90	40.47	34.01	27.56	21.10
58.4	85.0	4089	1.184E-02	42.97	42.02	37.05	31.13	25.21	19.29
65.9	90.0	4089	1.063E-02	38.58	37.73	33.26	27.95	22.63	17.32
73.8	95.0	4089	9.418E-03	34.18	33.42	29.47	24.76	20.05	15.34
82.0	100.0	4088	8.398E-03	30.47	29.80	26.27	22.07	17.87	13.67
90.6	105.0	4081	7.394E-03	26.77	26.18	23.08	19.38	15.68	11.99
99.5	110.0	4074	6.489E-03	23.45	22.93	20.21	16.96	13.72	10.47
118.1	120.0	3820	2.744E-03	9.22	9.00	7.85	6.48	5.10	3.73
137.6	130.0	3400	1.818E-03	5.35	5.20	4.44	3.53	2.62	1.71
158.0	140.0	3130	1.236E-03	3.30	3.20	2.68	2.06	1.45	0.83
179.0	150.0	3000	1.016E-03	2.58	2.50	2.07	1.57	1.06	0.55
200.6	160.0	2950	8.714E-04	2.17	2.10	1.73	1.30	0.86	0.43
222.9	170.0	2950	7.469E-04	1.86	1.80	1.49	1.11	0.74	0.37
231.5	173.8	2950	7.261E-04	1.81	1.75	1.45	1.08	0.72	0.36
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
292.4	203.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
422.2	306.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
469.8	450.2	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00

Summary @Twall = 540 R

Peak Heating Rate: 51.11 BTU/Ft^2-S
Total Heat Load: 3061.89 BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating

Table 25

BP 213 - Sustainer Thrust Structure (External Conical Section)

NLS 2 Mission 1 Nominal - July 1992

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1.0	10.0	878	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
2.4	15.0	917	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
4.4	20.0	1019	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
7.0	25.0	1158	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
10.2	30.0	1380	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
14.1	35.0	1552	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
16.8	38.0	1622	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
16.8	38.0	1622	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
18.6	40.0	1711	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
23.6	45.0	1874	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
28.9	50.0	2030	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
34.6	55.0	2157	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
40.7	60.0	2515	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
47.2	65.0	3813	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
54.1	70.0	4091	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
61.4	75.0	4088	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
69.0	80.0	4089	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
77.0	85.0	4090	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
85.3	90.0	4085	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
93.9	95.0	4078	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
102.8	100.0	4030	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
121.2	110.0	3750	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
140.5	120.0	3360	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
160.3	130.0	3120	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
180.7	140.0	3000	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
201.4	150.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
221.5	159.6	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
221.5	159.6	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21
301.1	200.0	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21
471.1	331.8	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21

Summary @Twall = 540 R

Peak Heating Rate: **1.05** BTU/Ft^2-S

Total Heat Load: **180.86** BTU/Ft^2

1.5 Stage Cycle 2 Convective Base Heating
BP 213 - Sustainer Thrust Structure (External Conical Section)
NLS 2 Mission 1 Engine Out - July 1992

Table 26

Alt	Time	Tr	Hc	Convective Heating Rate (BTU/Ft^2-S) for Various Wall Temperatures					
Kft	*Sec*	*deg R*	*BTU/FT^2-S-R*	*qc@460 R*	*qc@540 R*	*qc@960 R*	*qc@1460 R*	*qc@1960 R*	*qc@2460 R*
0.0	0.0	921	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
0.6	10.0	866	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
1.4	15.0	888	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	20.0	920	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
4.1	25.0	1000	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	30.0	1097	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
8.4	35.0	1272	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
11.3	40.0	1434	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
14.6	45.0	1569	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
18.4	50.0	1700	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
22.7	55.0	1844	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
27.5	60.0	1998	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
32.7	65.0	2124	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
38.5	70.0	2286	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
44.7	75.0	3364	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
51.3	80.0	4085	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
58.4	85.0	4089	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
65.9	90.0	4089	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
73.8	95.0	4089	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
82.0	100.0	4088	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
90.6	105.0	4081	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
99.5	110.0	4074	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
118.1	120.0	3820	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
137.6	130.0	3400	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
158.0	140.0	3130	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
179.0	150.0	3000	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
200.6	160.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
222.9	170.0	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
231.5	173.8	2950	0.000E+00	0.00	0.00	0.00	0.00	0.00	0.00
231.5	173.8	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21
292.4	203.0	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21
422.2	306.0	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21
469.8	450.2	2950	4.357E-04	1.08	1.05	0.87	0.65	0.43	0.21

Summary @Twall = 540 R

Peak Heating Rate: 1.05 BTU/Ft^2-S
Total Heat Load: 290.31 BTU/Ft^2

Table 27

TOTAL PLUME RADIATION FOR:
1.5-Stage Booster Surfaces - 100% & 70% Booster Thrust - July 1992
1.5-Stage Main Engine STME 100% Altitude Adjustment Functions - July 1992
1.5-Stage Booster STME 100% & 70% Altitude Adjustment Functions - July 1992
1.5-Stage 650k STME Mission 1 Nominal - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 202	203	204	207	210	211	212	
0.0	0.	6.98	9.84	4.14	10.23	11.38	15.79	9.54	
10.0	1.	6.71	9.47	3.98	9.82	10.76	14.88	9.08	
15.0	2.	6.30	8.90	3.75	9.20	9.90	13.64	8.41	
20.0	4.	5.60	7.81	3.34	8.08	8.52	11.76	7.26	
25.0	7.	4.67	6.38	2.82	6.61	6.72	9.29	5.74	
30.0	10.	3.59	4.72	2.20	4.89	4.62	6.41	3.98	
35.0	14.	3.34	4.40	2.07	4.52	4.26	5.91	3.67	
38.0	17.	3.18	4.18	1.99	4.27	4.02	5.56	3.46	<-100%
38.0	17.	4.11	5.21	2.45	5.14	5.20	6.95	4.63	<- 70%
40.0	19.	3.71	4.74	2.23	4.70	4.64	6.26	4.10	
45.0	24.	2.90	3.76	1.78	3.74	3.50	4.80	3.02	
50.0	29.	2.53	3.27	1.59	3.20	3.00	4.09	2.58	
55.0	35.	2.14	2.75	1.38	2.62	2.47	3.35	2.11	
60.0	41.	1.73	2.24	1.18	2.12	2.04	2.79	1.68	
65.0	47.	1.45	1.84	1.01	1.73	1.76	2.40	1.40	
70.0	54.	1.17	1.42	0.83	1.32	1.46	2.01	1.11	
75.0	61.	1.00	1.15	0.68	1.03	1.27	1.77	0.90	
80.0	69.	0.96	1.07	0.62	0.90	1.25	1.70	0.87	
85.0	77.	0.93	1.02	0.57	0.79	1.25	1.65	0.84	
90.0	85.	0.89	0.96	0.52	0.68	1.24	1.59	0.82	
95.0	94.	0.86	0.89	0.47	0.56	1.24	1.53	0.80	
100.0	103.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
110.0	121.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
120.0	140.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
130.0	160.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
140.0	181.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
150.0	201.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	
159.6	221.	0.80	0.84	0.44	0.49	1.24	1.47	0.80	<-SEP
Heat Load **		353.74	458.80	212.74	438.65	509.95	686.66	411.73	

* Approximate time from launch
** Heat load includes 0.00 to 159.56 seconds.
BECO at 159.56 seconds.

Table 27 (Concluded)

TOTAL PLUME RADIATION FOR:
1.5-Stage Main-Stage Surfaces - 100% & 70% Booster Thrust - July 1992
1.5-Stage Main Engine STME 100% Power Altitude Adjustment Functions - July 1992
1.5-Stage Booster STME 100% & 70% Altitude Adjustment Functions - July 1992
1.5-Stage 650k STME Mission 1 Nominal - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 201	205	206	208	209	213	
0.0	0.	3.81	7.94	4.85	12.26	6.05	0.00	
10.0	1.	3.68	7.61	4.66	11.50	5.63	0.00	
15.0	2.	3.49	7.12	4.36	10.49	5.10	0.00	
20.0	4.	3.19	6.22	3.77	9.05	4.43	0.00	
25.0	7.	2.79	5.03	2.99	7.15	3.54	0.00	
30.0	10.	2.33	3.65	2.09	4.94	2.51	0.00	
35.0	14.	2.19	3.39	1.96	4.58	2.34	0.00	
38.0	17.	2.10	3.21	1.87	4.33	2.23	0.00	<-100%
38.0	17.	2.50	3.95	2.92	5.61	3.28	0.00	<- 70%
40.0	19.	2.32	3.53	2.52	5.02	2.83	0.00	
45.0	24.	1.95	2.67	1.74	3.81	1.96	0.00	
50.0	29.	1.73	2.31	1.53	3.30	1.72	0.00	
55.0	35.	1.50	1.92	1.31	2.76	1.46	0.00	
60.0	41.	1.22	1.54	1.06	2.37	1.18	0.00	
65.0	47.	1.03	1.28	0.90	2.15	1.08	0.00	
70.0	54.	0.83	1.01	0.74	1.92	0.98	0.00	
75.0	61.	0.67	0.81	0.56	1.74	0.88	0.00	
80.0	69.	0.62	0.74	0.51	1.70	0.93	0.00	
85.0	77.	0.58	0.68	0.47	1.66	1.01	0.00	
90.0	85.	0.54	0.62	0.44	1.62	1.08	0.00	
95.0	94.	0.50	0.56	0.40	1.58	1.16	0.00	
100.0	103.	0.48	0.52	0.37	1.54	1.24	0.00	
110.0	121.	0.48	0.52	0.37	1.54	1.24	0.00	
120.0	140.	0.48	0.52	0.37	1.54	1.24	0.00	
130.0	160.	0.48	0.52	0.37	1.54	1.24	0.00	
140.0	181.	0.48	0.52	0.37	1.54	1.24	0.00	
150.0	201.	0.48	0.52	0.37	1.54	1.24	0.00	
159.6	221.	0.48	0.52	0.37	1.54	1.24	0.00	<-SEP
160.0	222.	0.17	0.21	0.10	1.20	0.10	0.10	
200.0	301.	0.17	0.21	0.10	1.20	0.10	0.10	
331.8	471.	0.17	0.21	0.10	1.20	0.10	0.10	
Heat Load **		242.33	381.00	236.12	779.12	337.86	17.20	

* Approximate time from launch
** Heat load includes 0.00 to 331.80 seconds.
BECO at 159.56 and MECO at 331.18 seconds.

Table 28

TOTAL PLUME RADIATION FOR:
1.5-Stage Booster Surfaces - 100% Booster & Main Engine Thrust -July 1992
1.5-Stage Main Engine STME 100% Power Altitude Adjustment Functions -July 1992
1.5-Stage Booster STME 100% Power Altitude Adjustment Functions - July1992
1.5 Stage 650k STME Mission 1 Engine Out - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 202	203	204	207	210	211	212	
0.0	0.	6.98	9.84	4.14	10.23	11.38	15.79	9.54	
10.0	1.	6.83	9.63	4.05	10.00	11.03	15.28	9.28	
15.0	1.	6.61	9.34	3.93	9.68	10.55	14.57	8.93	
20.0	3.	6.26	8.83	3.72	9.13	9.81	13.52	8.34	
25.0	4.	5.71	7.98	3.41	8.25	8.74	12.06	7.44	
30.0	6.	5.01	6.91	3.01	7.15	7.39	10.20	6.31	
35.0	8.	4.16	5.60	2.53	5.80	5.73	7.94	4.92	
40.0	11.	3.52	4.64	2.17	4.79	4.52	6.27	3.90	
45.0	15.	3.31	4.36	2.06	4.47	4.22	5.84	3.63	
50.0	18.	3.08	4.04	1.94	4.11	3.87	5.35	3.33	
55.0	23.	2.81	3.69	1.80	3.70	3.48	4.78	2.98	
60.0	27.	2.51	3.29	1.64	3.24	3.04	4.16	2.60	
65.0	33.	2.19	2.85	1.47	2.74	2.56	3.47	2.18	
70.0	38.	1.90	2.45	1.30	2.32	2.22	3.02	1.86	
75.0	45.	1.62	2.03	1.11	1.91	1.92	2.61	1.56	
80.0	51.	1.31	1.57	0.92	1.47	1.60	2.18	1.24	
85.0	58.	1.11	1.28	0.77	1.15	1.39	1.91	1.03	
90.0	66.	1.04	1.18	0.70	0.98	1.34	1.84	0.96	
95.0	74.	0.97	1.08	0.62	0.81	1.28	1.76	0.88	
100.0	82.	0.89	0.97	0.54	0.63	1.22	1.69	0.81	
105.0	91.	0.81	0.86	0.45	0.44	1.16	1.61	0.73	
110.0	99.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
120.0	118.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
130.0	138.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
140.0	158.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
150.0	179.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
160.0	201.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
170.0	223.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	
173.8	232.	0.78	0.82	0.41	0.37	1.13	1.57	0.69	<-SEP
Heat Load **		411.95	540.31	248.83	514.19	594.75	821.68	481.28	

* Approximate time from launch
** Heat load includes 0.00 to 173.77 seconds.
BECO at 173.77 seconds.

Table 28 (Concluded)

TOTAL PLUME RADIATION FOR:
1.5-Stage Main-Stg Surfaces - 100% Booster & Main Engine Thrust - July 1992
1.5-Stage Main Engine STME 100% Power Altitude Adjustment Functions - July 1992
1.5-Stage Booster STME 100% Power Altitude Adjustment Functions - July 1992
1.5 Stage 650k STME Mission 1 Engine Out - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 201	205	206	208	209	213	
0.0	0.	3.81	7.94	4.85	12.26	6.05	0.00	
10.0	1.	3.74	7.76	4.74	11.83	5.81	0.00	
15.0	1.	3.63	7.50	4.60	11.25	5.49	0.00	
20.0	3.	3.47	7.06	4.32	10.40	5.06	0.00	
25.0	4.	3.24	6.36	3.86	9.27	4.53	0.00	
30.0	6.	2.94	5.47	3.28	7.85	3.87	0.00	
35.0	8.	2.58	4.38	2.57	6.11	3.06	0.00	
40.0	11.	2.29	3.58	2.06	4.84	2.47	0.00	
45.0	15.	2.18	3.36	1.94	4.53	2.32	0.00	
50.0	18.	2.04	3.10	1.81	4.18	2.16	0.00	
55.0	23.	1.89	2.81	1.66	3.78	1.98	0.00	
60.0	27.	1.72	2.48	1.50	3.33	1.77	0.00	
65.0	33.	1.54	2.13	1.31	2.84	1.54	0.00	
70.0	38.	1.34	1.83	1.14	2.55	1.41	0.00	
75.0	45.	1.14	1.54	0.97	2.30	1.29	0.00	
80.0	51.	0.92	1.22	0.78	2.04	1.17	0.00	
85.0	58.	0.76	1.00	0.64	1.87	1.10	0.00	
90.0	66.	0.70	0.89	0.58	1.83	1.11	0.00	
95.0	74.	0.63	0.78	0.51	1.78	1.11	0.00	
100.0	82.	0.56	0.67	0.44	1.72	1.12	0.00	
105.0	91.	0.49	0.55	0.36	1.67	1.13	0.00	
110.0	99.	0.46	0.50	0.34	1.65	1.13	0.00	
120.0	118.	0.46	0.50	0.34	1.65	1.13	0.00	
130.0	138.	0.46	0.50	0.34	1.65	1.13	0.00	
140.0	158.	0.46	0.50	0.34	1.65	1.13	0.00	
150.0	179.	0.46	0.50	0.34	1.65	1.13	0.00	
160.0	201.	0.46	0.50	0.34	1.65	1.13	0.00	
170.0	223.	0.46	0.50	0.34	1.65	1.13	0.00	
173.8	232.	0.46	0.50	0.34	1.65	1.13	0.00	<--SEP
203.0	292.	0.17	0.21	0.10	1.20	0.10	0.10	
306.0	422.	0.17	0.21	0.10	1.20	0.10	0.10	
450.2	470.	0.17	0.21	0.10	1.20	0.10	0.10	
Heat Load **		298.47	477.67	284.84	1018.02	409.85	27.64	

* Approximate time from launch
** Heat load includes 0.00 to 450.25 seconds.
BECO at 173.77 and MECO at 450.20 seconds.

Table 29

BASE GAS RADIATION FOR:
1.5-Stage Booster Surfaces - July 1992
1.5-Stage Base Gas Nominal Mission 1 Alt Adj Functions - July 1992
1.5-Stage 650k STME Mission 1 Nominal - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 202	203	204	207	210	211	212	
0.0	0.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
10.0	1.	0.10	0.10	0.08	0.07	0.05	0.05	0.06	
15.0	2.	0.22	0.22	0.17	0.16	0.10	0.10	0.12	
20.0	4.	0.38	0.38	0.29	0.28	0.17	0.18	0.21	
25.0	7.	0.60	0.60	0.46	0.44	0.27	0.28	0.33	
30.0	10.	0.87	0.88	0.66	0.64	0.39	0.40	0.48	
35.0	14.	1.20	1.20	0.91	0.88	0.54	0.55	0.66	
38.0	17.	1.42	1.43	1.08	1.04	0.64	0.65	0.78	
38.0	17.	1.42	1.43	1.08	1.04	0.64	0.65	0.78	
40.0	19.	1.58	1.59	1.20	1.16	0.71	0.72	0.86	
45.0	24.	2.83	2.84	2.12	2.00	1.26	1.29	1.57	
50.0	29.	4.51	4.53	3.34	3.13	2.00	2.05	2.53	
55.0	35.	6.30	6.34	4.64	4.34	2.78	2.86	3.55	
60.0	41.	7.92	7.96	5.81	5.42	3.49	3.59	4.48	
65.0	47.	7.08	7.12	5.17	4.80	3.11	3.21	4.02	
70.0	54.	6.19	6.22	4.49	4.14	2.70	2.80	3.54	
75.0	61.	5.22	5.24	3.76	3.43	2.26	2.35	3.01	
80.0	69.	4.07	4.08	2.92	2.65	1.76	1.83	2.35	
85.0	77.	2.86	2.86	2.04	1.83	1.23	1.28	1.67	
90.0	85.	2.02	2.02	1.44	1.28	0.86	0.91	1.19	
95.0	94.	1.41	1.41	1.00	0.88	0.60	0.63	0.83	
100.0	103.	0.90	0.87	0.63	0.54	0.36	0.40	0.52	
110.0	121.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
120.0	140.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
130.0	160.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
140.0	181.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
150.0	201.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
159.6	221.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	<-SEP
Heat Load **		305.76	297.74	220.05	197.84	127.51	136.39	167.99	

* Approximate time from launch
** Heat load includes 0.00 to 159.56 seconds.
BECO at 159.56 seconds.

Table 29 (Concluded)

BASE GAS RADIATION FOR:
1.5-Stage Main-Stage Surfaces - July 1992
1.5-Stage Base Gas Nominal Mission 1 Alt Adj Functions - July 1992
1.5-Stage 650k STME Mission 1 Nominal - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 201	205	206	208	209	213	
0.0	0.	0.01	0.01	0.01	0.01	0.01	0.00	
10.0	1.	0.08	0.08	0.08	0.05	0.04	0.00	
15.0	2.	0.17	0.17	0.16	0.10	0.09	0.00	
20.0	4.	0.29	0.29	0.29	0.17	0.16	0.00	
25.0	7.	0.46	0.46	0.45	0.27	0.25	0.00	
30.0	10.	0.67	0.67	0.65	0.39	0.36	0.00	
35.0	14.	0.92	0.92	0.89	0.53	0.49	0.00	
38.0	17.	1.09	1.09	1.06	0.63	0.58	0.00	
38.0	17.	1.09	1.09	1.06	0.63	0.58	0.00	
40.0	19.	1.21	1.21	1.18	0.70	0.64	0.00	
45.0	24.	2.15	2.12	2.04	1.25	1.12	0.00	
50.0	29.	3.39	3.33	3.20	1.98	1.77	0.00	
55.0	35.	4.73	4.63	4.44	2.76	2.45	0.00	
60.0	41.	5.93	5.79	5.54	3.46	3.07	0.00	
65.0	47.	5.29	5.14	4.91	3.09	2.72	0.00	
70.0	54.	4.61	4.45	4.23	2.69	2.36	0.00	
75.0	61.	3.88	3.70	3.51	2.27	1.96	0.00	
80.0	69.	3.02	2.86	2.70	1.76	1.51	0.00	
85.0	77.	2.12	1.98	1.87	1.23	1.05	0.00	
90.0	85.	1.50	1.39	1.30	0.87	0.73	0.00	
95.0	94.	1.05	0.96	0.90	0.61	0.51	0.00	
100.0	103.	0.67	0.61	0.57	0.39	0.31	0.00	
110.0	121.	0.31	0.31	0.24	0.18	0.10	0.00	
120.0	140.	0.31	0.31	0.24	0.18	0.10	0.00	
130.0	160.	0.31	0.31	0.24	0.18	0.10	0.00	
140.0	181.	0.31	0.31	0.24	0.18	0.10	0.00	
150.0	201.	0.31	0.31	0.24	0.18	0.10	0.00	
159.6	221.	0.31	0.31	0.24	0.18	0.10	0.00	<-SEP
160.0	222.	0.00	0.00	0.00	0.00	0.00	0.00	
200.0	301.	0.00	0.00	0.00	0.00	0.00	0.00	
331.8	471.	0.00	0.00	0.00	0.00	0.00	0.00	
Heat Load **		229.81	222.52	209.48	133.96	114.36	0.00	

* Approximate time from launch
** Heat load includes 0.00 to 331.80 seconds.
BECO at 159.56 and MECO at 331.18 seconds.

Table 30

BASE GAS RADIATION FOR:
1.5-Stage Booster Surfaces - July 1992
1.5-Stage Base-Gas Eng-Out Mission 1 Alt Adj Functions - July 1992
1.5 Stage 650k STME Mission 1 Engine Out - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 202	203	204	207	210	211	212	
0.0	0.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
10.0	1.	0.06	0.06	0.05	0.05	0.03	0.03	0.03	
15.0	1.	0.13	0.13	0.10	0.10	0.06	0.06	0.07	
20.0	3.	0.23	0.23	0.17	0.17	0.10	0.10	0.12	
25.0	4.	0.36	0.36	0.27	0.26	0.16	0.16	0.20	
30.0	6.	0.52	0.52	0.40	0.38	0.24	0.24	0.29	
35.0	8.	0.72	0.72	0.55	0.53	0.33	0.33	0.39	
40.0	11.	0.96	0.96	0.73	0.70	0.43	0.44	0.53	
45.0	15.	1.24	1.24	0.94	0.91	0.56	0.57	0.68	
50.0	18.	1.56	1.56	1.19	1.14	0.70	0.71	0.85	
55.0	23.	2.54	2.56	1.91	1.81	1.14	1.16	1.41	
60.0	27.	4.05	4.08	3.01	2.83	1.80	1.84	2.27	
65.0	33.	5.71	5.74	4.21	3.95	2.53	2.60	3.22	
70.0	38.	7.52	7.56	5.53	5.16	3.32	3.41	4.25	
75.0	45.	7.41	7.44	5.42	5.04	3.26	3.36	4.20	
80.0	51.	6.55	6.58	4.77	4.40	2.87	2.96	3.73	
85.0	58.	5.64	5.66	4.07	3.72	2.45	2.54	3.24	
90.0	66.	4.54	4.55	3.26	2.96	1.96	2.04	2.62	
95.0	74.	3.34	3.35	2.39	2.16	1.44	1.50	1.94	
100.0	82.	2.26	2.26	1.61	1.43	0.96	1.01	1.32	
105.0	91.	1.65	1.65	1.17	1.04	0.70	0.74	0.97	
110.0	99.	1.01	1.01	0.72	0.63	0.43	0.46	0.60	
120.0	118.	0.46	0.31	0.27	0.16	0.09	0.17	0.17	
130.0	138.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
140.0	158.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
150.0	179.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
160.0	201.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
170.0	223.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	
173.8	232.	0.40	0.24	0.23	0.11	0.06	0.14	0.12	<-SEP
Heat Load **		316.88	308.55	228.26	205.41	132.22	141.39	173.93	

* Approximate time from launch
** Heat load includes 0.00 to 173.77 seconds.
BECO at 173.77 seconds.

Table 30: (Concluded)

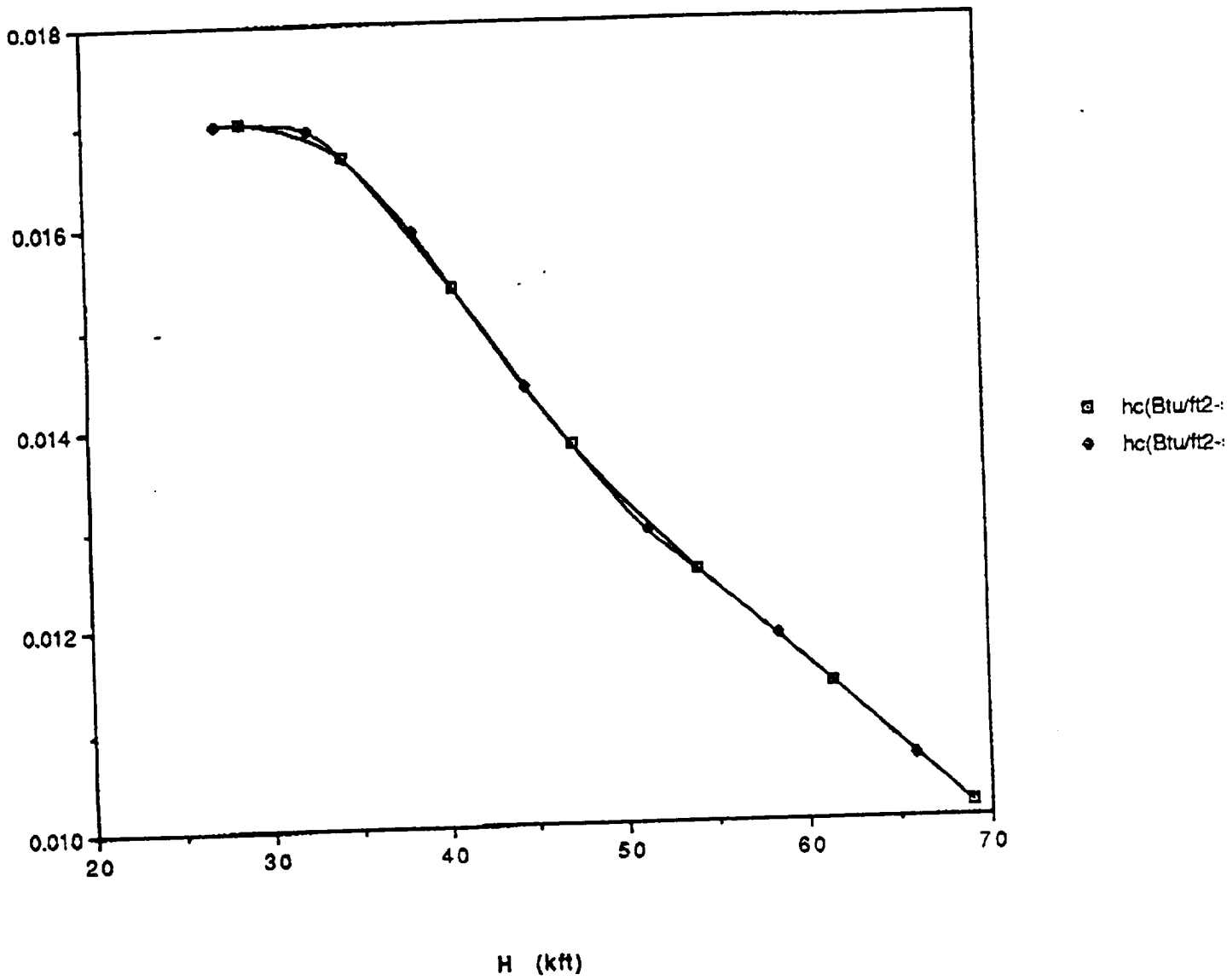
BASE GAS RADIATION FOR:
1.5-Stage Main Stage Surfaces - July 1992
1.5-Stage Base-Gas Eng-Out Mission 1 Alt Adj Functions - July 1992
1.5 Stage 650k STME Mission 1 Engine Out - July 1992

Time* (sec)	Alt (kft)	Heating Rate (Btu/ft2-sec) for Points Listed 201	205	206	208	209	213	
0.0	0.	0.01	0.01	0.01	0.01	0.01	0.00	
10.0	1.	0.05	0.05	0.05	0.03	0.03	0.00	
15.0	1.	0.10	0.10	0.10	0.06	0.05	0.00	
20.0	3.	0.17	0.17	0.17	0.10	0.09	0.00	
25.0	4.	0.27	0.27	0.27	0.16	0.15	0.00	
30.0	6.	0.40	0.40	0.39	0.23	0.21	0.00	
35.0	8.	0.55	0.55	0.54	0.32	0.29	0.00	
40.0	11.	0.74	0.74	0.71	0.43	0.39	0.00	
45.0	15.	0.95	0.95	0.92	0.55	0.50	0.00	
50.0	18.	1.20	1.20	1.16	0.69	0.63	0.00	
55.0	23.	1.93	1.91	1.85	1.12	1.01	0.00	
60.0	27.	3.06	3.01	2.89	1.78	1.59	0.00	
65.0	33.	4.29	4.20	4.03	2.50	2.23	0.00	
70.0	38.	5.64	5.51	5.28	3.29	2.92	0.00	
75.0	45.	5.54	5.39	5.15	3.23	2.86	0.00	
80.0	51.	4.89	4.72	4.50	2.85	2.50	0.00	
85.0	58.	4.19	4.01	3.81	2.45	2.12	0.00	
90.0	66.	3.37	3.20	3.03	1.97	1.69	0.00	
95.0	74.	2.48	2.33	2.20	1.45	1.23	0.00	
100.0	82.	1.67	1.55	1.46	0.97	0.82	0.00	
105.0	91.	1.22	1.13	1.06	0.71	0.59	0.00	
110.0	99.	0.76	0.69	0.64	0.44	0.36	0.00	
120.0	118.	0.35	0.34	0.28	0.21	0.13	0.00	
130.0	138.	0.31	0.31	0.24	0.18	0.10	0.00	
140.0	158.	0.31	0.31	0.24	0.18	0.10	0.00	
150.0	179.	0.31	0.31	0.24	0.18	0.10	0.00	
160.0	201.	0.31	0.31	0.24	0.18	0.10	0.00	
170.0	223.	0.31	0.31	0.24	0.18	0.10	0.00	
173.8	232.	0.31	0.31	0.24	0.18	0.10	0.00	<-SEP
203.0	292.	0.00	0.00	0.00	0.00	0.00	0.00	
306.0	422.	0.00	0.00	0.00	0.00	0.00	0.00	
450.2	470.	0.00	0.00	0.00	0.00	0.00	0.00	
Heat Load **		242.81	235.38	220.99	141.53	120.14	0.00	

* Approximate time from launch
** Heat load includes 0.00 to 450.25 seconds.
BECO at 173.77 and MECO at 450.20 seconds.

"STME"

h_c vs alt for EOξ NOM



PEAK CONVECTIVE HEATING

	STME (Btu/ft²-sec)	BHS (Btu/ft²-sec)
NOM	52.11 h = 40.7 kft	45.21 h = 47.2 kft
E.O.	51.11 h = 44.7 kft	45.80 h = 51.3 kft