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EDIN0621B SIZING AND PERFORMANCE RESULTS

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ABSTRACT

A launch vehicle has been investigated for the Solar Power Satellite System (SPS). The technology level assumed for sizing was that predicted for 1995. The candidate concept designated EDIN0621B is a two stage, winged, series burn vehicle capable of delivering an one million pound payload to low earth orbit.

The mission profile for launch vehicle sizing was an unmanned due east launch from a latitude of -5.3 degrees and the payload was delivered to a 50 X 270 nautical mile orbit. A propulsion system was sized to provide payload circularization at apogee. Any docking, rendezvous or additional Delta V requirements were assumed to be integral to the payload.

The EDIN0621B concept used LOX/C₃H₈ booster engines and updated Shuttle System main engines in the upper stage. The propulsion system characteristics were updated to a 1995 technology level. Gross liftoff weight of the baseline vehicle was 18,367,853 pounds. The booster stage required thirteen engines; the upper stage required seven. The vehicle was designed to a liftoff thrust to weight ratio of 1.3.

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SUMMARY

The objective of this study designated EDIN0621B was to define a candidate heavy lift launch vehicle for the Solar Power Satellite System. Each solar power satellite has been estimated to weigh nearly 200,000,000 pounds in geosynchronous earth orbit, and thus would require the launch vehicle fleet to deliver close to 500,000,000 pounds to a low earth assemble orbit for each power satellite.

The mission profile for launch vehicle sizing was an unmanned launch from a latitude of -5.3 degrees to an elliptical earth orbit. The launch vehicle injected the payload into a 50 X 270 nautical mile orbit; the orbit injection point was near the 50 nm perigee. After injection, the payload was separated from the upper stage payload bay. The payload was then placed into a circular orbit at 270 nm apogee by a propulsion system in the payload. Payload at 270 nm circular was 1,000,000 pounds. The second stage of the launch vehicle would reenter the earths atmosphere at an altitude of 400,000 feet after one orbit. The mission profile required that each spent stage be returned to launch site for reuse.

The EDIN062B concept was sized based on a predicated technology level expected for the year 1995. In addition, twenty percent of the first dry weight and ten percent of the vehicles second stage dry weight was established for growth allowance. The configuration investigated was a two stage series burn vehicle. Recovery system was a non-powered winged flyback for both stages.

A three degree of freedom launch trajectory program was used to simulate vehicle flight for the configuration. The analysis program optimized the launch vehicle tilt profile and exo-atmospheric portion of the flight. A parametric study of winged configurations was made prior to the study.

A base line launch vehicle is defined in this report. It is a two stage tandem configuration series burn, winged vehicle with a payload capability of 1,000,000 pound to the target orbit. Vehicle gross liftoff weight is 18,367,853 pounds and the thrust to weight at liftoff is 1.3. The booster is a heat sink non-powered flyback stage that required thirteen LOX/C₃H₈ high chamber pressure engines for boost. Landing speed for both the booster and second stage is 250 knots. The second stage is powered by seven uprated shuttle type main engines and its wings were sized to permit unpowered glide back to the launch site after one orbit. Main propulsion systems for both stages were uprated in performance characteristics to that considered feasible for a 1995 time frame. EDIN0621B is the thirty-ninth sizing and performance study.

The following tables provide a summary of weights and sizing data associated with EDIN0621B:

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SIZING DATA SUMMARY:

STAGE 1

STAGE 2

MASS FRACTION	.9166	.8636
IDEAL VELOCITY	10689.9	18135.7
AVERAGE ISP	328.2	466.0
THRUST/WEIGHT	1.30	.97
NUMBER OF ENGINES	13.	7.
% POWER AT LIFTOFF	100.0	100.0
MASS RATIO	2.7517	3.3522
PAYLOAD RATIO	.3055	.1875

WEIGHT SUMMARY:

PAYLOAD	1051919.
STAGE 1 LIFTOFF WEIGHT	12756341.
INERT WEIGHT	1063652.
MAIN PROPELLANT WEIGHT	11692689.
STAGE 2 LIFTOFF WEIGHT	4559594.
INERT WEIGHT	622076.
MAIN PROPELLANT WEIGHT	3937518.
GROUND LIFTOFF WEIGHT	18367853.

INTRODUCTION

The envisioned scope of the Solar Power Satellite System indicates that an operational power generating satellite will weigh about 200,000,000 pounds. The synthesis of such a massive satellite at geosynchronous altitude would require the delivery of close to 500,000,000 pounds to low earth orbit. Since most SPS scenarios call for the assembly of up to four operational satellites per year, the number of earth launches is several hundred per year, and launch vehicle payloads of one million pounds are required.

The transportation system necessary for the implementation of the SPS would require "heavy lift" launch vehicles (HHLV's) to be dedicated, designed and developed specifically for the SPS mission. In addition, the high launch rate required by the SPS program in some measure dictates the desired characteristics of a launch vehicle; for example, vehicle lifetime, the extent of reusability and operational mode would have a direct bearing on total program costs. This report is part of a parametric study to define viable vehicle concepts to support SPS.

MISSION DATA

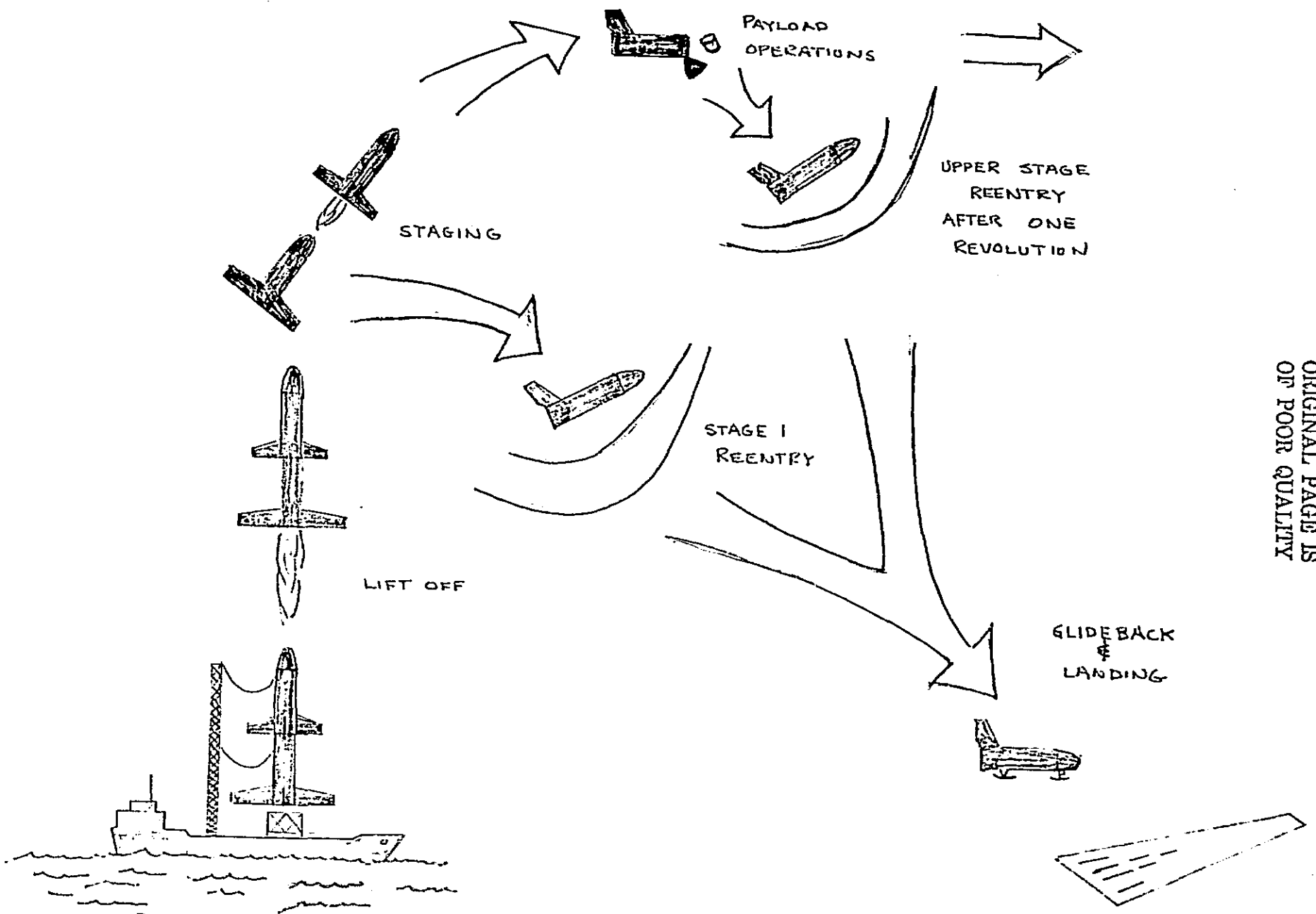
The mission performance requirements and data used for sizing and performance are listed below and illustrated in figure 1.

Launch Site = -5.3 degrees latitude (due east launch).
Payload = One million pounds to 50 x 270 nm orbit.
Orbit Inclination = 5.3 degrees.
Injection Gamma = .149 degrees.
Injection Velocity = 26148.6 ft./sec.
Injection Altitude = 306787 ft.
Stage 1 Reentry Profile = Nonpowered glide to downrange landing site.
Stage 2 Reentry Profile = Nonpowered glide to booster landing site after one orbit.

CONFIGURATION CONSTRAINTS

Most of the vehicle configuration specifications and constraints are a result of previous studies. The more influential constraints are listed below:

1. Reusable non-manned booster and upper stage.



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FIGURE 1 MISSION PROFILE.

2. Payload density is 30 lbs. per cu. ft.
3. Payload bay sized for platform and aerodynamic shroud.
4. Length to diameter ratio for stage 1 is 3.5.
5. Stage 2 has RSI for reentry protection.
6. LOX/LH₂ stage 2 propulsion.
7. Stage 1 is a heat sink booster.
8. LOX/C₃H₈ stage 1 propulsion.
9. Interstage is a stage 1 retractable component.
10. Integral load carrying tanks with common bulkhead.
11. X-15 type skids assumed for stages 1 and 2.
12. Wings sized for a landing speed of 250 knots.
13. Technology level assumed for weight estimates corresponds to shuttle less 25%.

SYSTEM PERFORMANCE GROUND RULES

During the sizing of the vehicle, it was necessary to set ground rules pertaining to system performance, steering logic, flight constraints, contingency, etc. The more influential sizing ground rules are listed below:

1. Series burn tandem launch configuration.
2. Design lift-off thrust to weight ratio is 1.3.
3. Maximum load factor is 4 g's.
4. Patrick Air Force Base atmosphere is used.
5. Load factor is limited by engine throttling to 4 g's.
6. First stage design reserve is 20 percent of dry weight.
7. Second stage design reserve is 10 percent of dry weight.

ANALYSIS

In an effort to formulate a dedicated study to investigate viable candidate launch vehicles for the SPS program, several conceptual designs have been studied. The EDIN project under the direction of Mr. Robert W. Abel, Engineering Analysis Division, have completed the following analysis as part of this effort.

<u>STUDY</u>	<u>DESCRIPTION</u>
EDIN0601+EDIN0614	Mass fraction analysis of two stage ballistics and two stage winged powered flyback.
EDIN0601A+EDIN06014A	Mass fraction analysis of two stage ballistics and two stage winged powered flyback with improved Delta V prediction.
EDIN0607B-1	Sizing and performance study of two stage winged vehicle. First stage heat sink LOX/LH2, airbreathing engines for flyback. Second stage LOX/LH2 glideback reentry.
EDIN0613B-1	Sizing and performance study of two stage winged vehicle. First stage heat sink LOX/RP-1, airbreathing engines for flyback. Second stage LOX/LH2 glideback reentry (Baseline).
EDIN0607B-2	Same as EDIN0607B-1 with improved weight estimating relationships and the addition of design reserve contingency.
EDIN0613B-2	Same as EDIN0613B-1 with improved weight estimating relationships and the addition of design reserve contingency.
EDIN0613B-3	Same as EDIN0613B-2 with improved WER's and propulsion data.
EDIN0613P-1	Sizing and performance study of two stage winged vehicle. First stage heat sink LOX/C ₃ H ₈ , airbreathing engines for flyback. Second stage, LOX/LH2 glideback reentry.
EDIN0613P-2	Same as EDIN0613P-1 with improved WER's.
EDIN0620	Sizing and performance study of two staged winged vehicle. First stage heat sink LOX/C ₃ H ₈ , glideback. Second stage, LOX/LH ₂ , glideback reentry. Nested tanks (belly to belly) configuration.

STUDYDESCRIPTION

EDIN0621

Same as EDIN0620 with updated WER's to reflect a configuration change to a tandem launch.

EDIN0621A

Same as EDIN0621 with updated WER's.

EDIN0621B RESULTS

The following sections provide a summary of results from the sizing and performance study designated EDIN0621B. Detailed specifications and results including computer listings of the procedures and programs used for the sizing and performance analysis are available in reference 1.

Stage 1 Weight Statement

AERODYNAMIC SURFACES		76431.
WING	68397.	
HEAT SINK PENALTY (WING)	0.	
VERTICAL TAIL	4198.	
HORIZONTAL STABILIZER	1909.	
HEAT SINK PENALTY (STAB)	1935.	
BODY STRUCTURE		278562.
INTEGRAL LOX TANK	59393.	
HEAT SINK PENALTY (LOX)	0.	
INTEGRAL FUEL TANK	41178.	
HEAT SINK PENALTY (FL)	0.	
THRUST STRUCTURE	95203.	
INTERSTAGE STRUCTURE	41648.	
AFT SKIRT	22581.	
NOSE STRUCTURE	14439.	
SECONDARY STRUCTURE	4117.	
INDUCED ENVIRONMENTAL PROTECTION		3714.
INSULATION	3714.	
MISCELLANEOUS	0.	
LAUNCH AND RECOVERY SYSTEM		41627.
LAUNCH GEAR	3827.	
LANDING GEAR	37780.	
PROPULSION		320568.
MAIN ENGINES	270158.	
PROPELLANT FEED SYSTEM	19516.	
MAIN ENGINE MOUNTS	2669.	
PRESSURIZATION SYSTEM	18560.	
HEAT SHIELD	9665.	
ORIENTATION, CONTROLS & SEPARATION		61719.
MAIN ENGINE GIMBAL SYSTEM	63369.	
ACS	10417.	
ACS TANKAGE	792.	
AERODYNAMIC CONTROLS	5588.	
SEPARATION SYSTEM	1552.	
AVIONICS		4693.
ELECTRICAL POWER SYSTEM		2855.
HYDRAULIC & PNEUMATIC SYSTEM		4996.

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DRY WEIGHT		815145.
DESIGN RESERVE		163029.
EMPTY WEIGHT		978174.
MAIN PROPELLANTS		11692689.
OXIDIZER	8515328.	
FUEL	3177361.	
RESIDUAL PROPELLANTS		52099.
TRAPPED GASSES	2901.	
TRAPPED OXIDIZER	29973.	
TRAPPED FUEL	19064.	
TRAPPED ENGINE PROPELLANT	161.	
RESERVE PROPELLANTS		0.
OXIDIZER	0.	
FUEL	0.	
INFLIGHT LOSSES		28722.
OXIDIZER	23162.	
FUEL	5560.	
AUXILIARY PROPELLANTS		4657.
ACS PROPELLANT	4657.	
BOOSTER LIFTOFF WEIGHT		12756341.
MASS FRACTION		.917
BOOSTER WEIGHT AT STAGING		1034930.
ENTRY WEIGHT (ATMOSPHERIC INTERFACE)		1030578.
BOOSTER LANDING WEIGHT		997238.

WEIGHT PERCENTAGES - BASED ON BLOW : (%)

AERODYNAMIC SURFACES	.5992	
BODY STRUCTURE	2.1837	
ENVIRONMENTAL PROTECTION	.0291	
LAUNCH AND RECOVERY	.3262	
PROPULSION	2.5130	
ORIENTATION/CONTROLS/SEPERATION	.6406	
AVIONICS	.0368	
ELECTRICAL POWER SYSTEM	.0224	
HYDRAULIC & PNEUMATIC SYSTEM	.0392	
DRY WEIGHT		6.3901
DESIGN RESERVE	1.2760	
EMPTY WEIGHT		7.6681
MAIN PROPELLANTS	91.6618	
TRAPPED PROPELLANTS	.4084	
RESERVE PROPELLANTS	.0000	
INFLIGHT LOSSES	.2252	
AUXILIARY PROPELLANTS	.0365	

WEIGHT PERCENTAGES - BASED ON EMPTY WEIGHT : (%)

AERODYNAMIC SURFACES	7.6137	
BODY STRUCTURE	28.4777	
ENVIRONMENTAL PROTECTION	.3797	
LAUNCH AND RECOVERY	4.2536	
PROPULSION	32.7721	
ORIENTATION/CONTROLS/SEPERATION	8.3542	
AVIONICS	.4798	
ELECTRICAL POWER SYSTEM	.2918	
HYDRAULIC & PNEUMATIC SYSTEM	.5108	
DRY WEIGHT		83.3333
DESIGN RESERVE	16.6667	
EMPTY WEIGHT		100.0000

Stage 2 Weight Statement

AERODYNAMIC SURFACES		43698.
WING	38747.	
VERTICAL TAIL	4274.	
HORIZONTAL STABILIZER	677.	
BODY STRUCTURE		198018.
INTEGRAL LOX TANK	23789.	
INTEGRAL FUEL TANK	62510.	
THRUST STRUCTURE	17405.	
PAYLD BAY STRUCTURE	45309.	
PAYLD DECK	11361.	
INTERSTAGE STRUCTURE	0.	
AFT SKIRT	34718.	
SECONDARY STRUCTURE	2926.	
THERMAL PROTECTION		59500.
TPS UPPER SURFACE	7007.	
TPS LOWER SURFACE	52553.	
MISCELLANEOUS	0.	
LAUNCH AND RECOVERY SYSTEM		19402.
LAUNCH GEAR	1683.	
LANDING GEAR	17719.	
PROPULSION		120421.
MAIN ENGINES	81298.	
PROPELLANT FEED SYSTEM	7826.	
MAIN ENGINE MOUNTS	610.	
PRESSURIZATION SYSTEM	21023.	
HEAT SHIELD	9663.	
ORIENTATION, CONTROLS & SEPARATION		29890.
MAIN ENGINE GIMBAL SYSTEM	11185.	
ACS	11125.	
ACS TANKAGE	127.	
AERODYNAMIC CONTROLS	3813.	
SEPARATION SYSTEM	2495.	
AVIONICS		4907.
ELECTRICAL POWER SYSTEM		2948.
HYDRAULIC & PNEUMATIC SYSTEM		3376.
DRY WEIGHT		482231.
DESIGN RESERVE		48222.
EMPTY WEIGHT		530443.
PAYLOAD		1051923.
MAIN PROPELLANTS		3937514.
OXIDIZER	3375012.	
FUEL	562502.	
RESIDUAL PROPELLANTS		26168.
TRAPPED GASSES	2668.	
TRAPPED OXIDIZER	7348.	
TRAPPED FUEL	5248.	
TRAPPED ENGINE PROPELLANT	10927.	
RESERVE PROPELLANTS		47250.
OXIDIZER	40500.	
FUEL	6750.	
INFLIGHT LOSSES		10710.
OXIDIZER	9180.	
FUEL	1530.	
AUXILIARY PROPELLANTS		7485.
ACS PROPELLANT	7485.	

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STAGE LIFTOFF WEIGHT MINUS PAYLOAD	4559590.
STAGE LIFTOFF WEIGHT WITH PAYLOAD	5611513.
MASS FRACTION (BASED ON INERT WEIGHT)	.864
WEIGHT AT INJECTION (INCL PAYLOAD)	1663289.
ENTRY WEIGHT (ATMOSPHERIC INTERFACE)	593703.
STAGE LANDING WEIGHT	582938.

WEIGHT PERCENTAGES - BASED ON LIFTOFF WEIGHT : (%)

AERODYNAMIC SURFACES	.9584	
BODY STRUCTURE	4.3429	
ENVIRONMENTAL PROTECTION	1.3063	
LAUNCH AND RECOVERY	.4255	
PROPULSION	2.6411	
ORIENTATION/CONTROLS/SEPERATION	.6555	
AVIONICS	.1076	
ELECTRICAL POWER SYSTEM	.0647	
HYDRAULIC & PNEUMATIC SYSTEM	.0740	
DRY WEIGHT		10.5760
DESIGN RESERVE	1.0576	
EMPTY WEIGHT		11.6336
MAIN PROPELLANTS	26.3508	
TRAPPED PROPELLANTS	.5744	
RESERVE PROPELLANTS	1.0363	
INFLIGHT LOSSES	.2349	
AUXILIARY PROPELLANTS	.1642	

WEIGHT PERCENTAGES - BASED ON EMPTY WEIGHT : (%)

AERODYNAMIC SURFACES	8.2381	
BODY STRUCTURE	37.3308	
ENVIRONMENTAL PROTECTION	11.2284	
LAUNCH AND RECOVERY	3.6578	
PROPULSION	22.7020	
ORIENTATION/CONTROLS/SEPERATION	5.6348	
AVIONICS	.9251	
ELECTRICAL POWER SYSTEM	.5558	
HYDRAULIC & PNEUMATIC SYSTEM	.6364	
DRY WEIGHT		90.9091
DESIGN RESERVE	9.0909	
EMPTY WEIGHT		100.0000

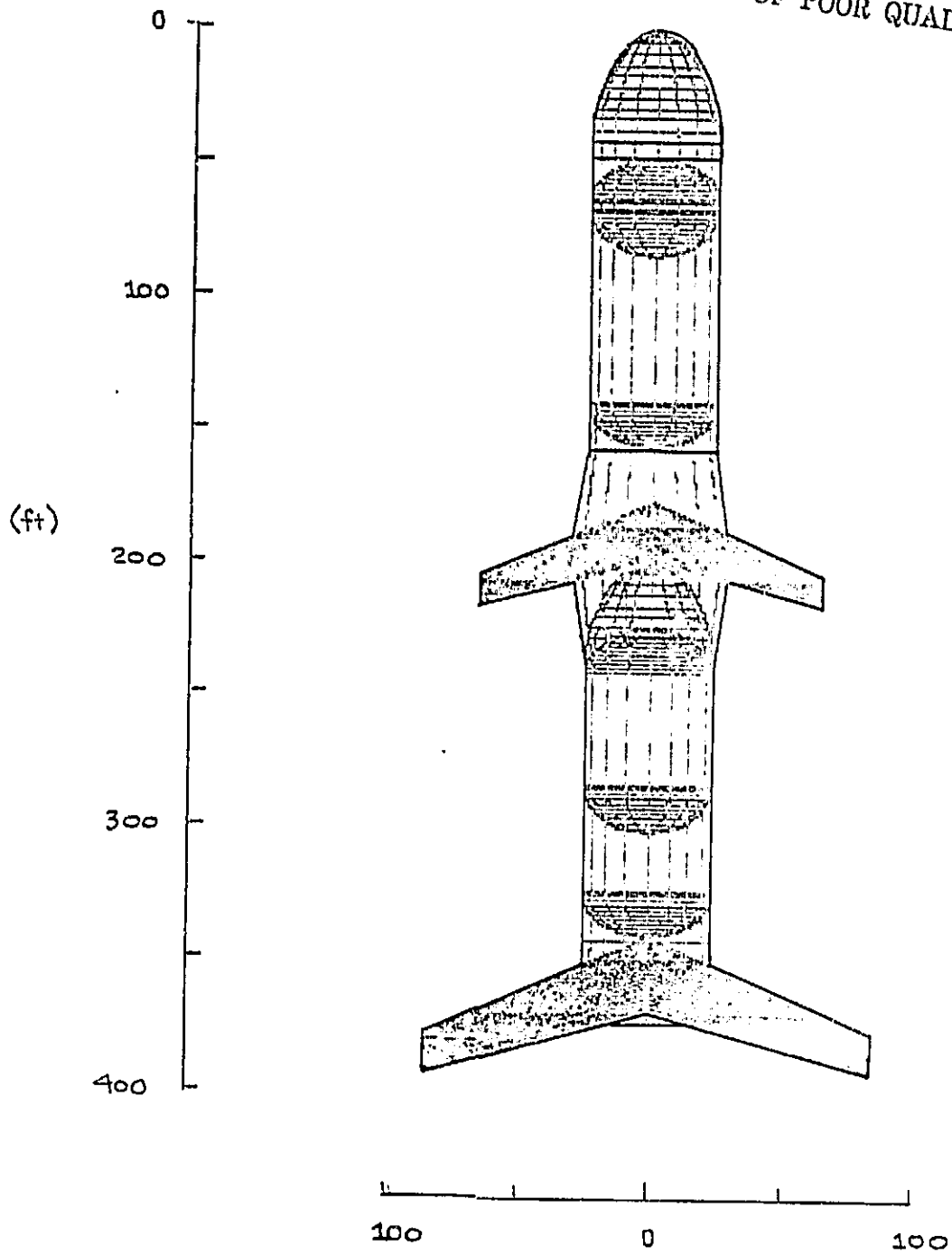
Stage 1 Geometric Characteristics

FUSELAGE:		
TOTAL LENGTH (FT)		171.8
STAGE DIAMETER (FT)		49.2
LENGTH/DIAMETER RATIO		3.50
AFT SKIRT LENGTH (FT)	31.2	
NOSE LENGTH (FT)	41.8	
LOX TANK LENGTH (FT)	76.8	
FUEL TANK LENGTH (FT)	56.8	
TOTAL TANK VOLUME INCL ULLAGE		198605.
LOX TANK VOLUME	123735.	
FUEL TANK VOLUME	74870.	
WING:		
WING AREA (SQ FT)		3555.2
WING LOADING (LBS/SQ FT)		280.5
WING SPAN (FT)		169.6
STRUCTURAL WING SPAN (FT)		169.6
ROOT CHORD (FT)		27.9
THEORETICAL ROOT THICKNESS (FT)		3.4
TIP CHORD (FT)		14.0
TAPER RATIO		.500
ASPECT RATIO		8.1
SWEEP OF FILLET (DEG)		.0
LEADING EDGE SWEEP (DEG)		23.4
TRAILING EDGE SWEEP (DEG)		-15.0
SPANWISE DISTANCE		.0
DY1		.0
DY2		84.8
CF		.0
VERTICAL TAIL:		
VERTICAL TAIL AREA (SQ FT)		867.0
HORIZONTAL STABILIZER:		
HORIZONTAL STABILIZER AREA (SQ FT)		355.5

Stage 2 Geometric Characteristics

FUSELAGE:		
TOTAL LENGTH (FT)		197.3
STAGE DIAMETER (FT)		49.2
LENGTH/DIAMETER RATIO		4.02
AFT SKIRT LENGTH (FT)	41.6	
PAYLOAD BAY (FT)	46.3	
PAYLOAD DENSITY (LB/CU FT)	30.0	
LOX TANK LENGTH (FT)	37.7	
FUEL TANK LENGTH (FT)	89.0	
TOTAL TANK VOLUME		185452.
LOX TANK VOLUME	49561.	
FUEL TANK VOLUME	135891.	
WING:		
WING AREA (SQ FT)		2078.2
WING LOADING (LBS/SQ FT)		280.5
WING SPAN (FT)		129.7
STRUCTURAL WING SPAN		137.4
ROOT CHORD (FT)		21.4
THEORETICAL ROOT THICKNESS		2.6
TIP CHORD (FT)		10.7
TAPER RATIO		.500
ASPECT RATIO		8.1
SWEEP OF FILLET (DEG)		30.0
LEADING EDGE SWEEP (DEG)		23.4
TRAILING EDGE SWEEP (DEG)		-15.0
SPANWISE DISTANCE		.0
DY1		3.2
DY2		61.6
CF		1.9
VERTICAL TAIL:		
VERTICAL TAIL AREA (SQ FT)		382.7
HORIZONTAL STABILIZER:		
HORIZONTAL STABILIZER AREA (SQ FT)		207.8

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Center of Gravity Data

Upper Stage Dry C.G.:

BWING	WT=	38746.6	XCG=	231.86	YCG=	.00	ZCG=	.00
BVERT	WT=	4274.3	XCG=	193.33	YCG=	.00	ZCG=	29.74
BHORZ	WT=	677.4	XCG=	41.78	YCG=	.00	ZCG=	.00
BSKIRT	WT=	34718.4	XCG=	182.70	YCG=	.00	ZCG=	.00
BINEUT	WT=	62509.8	XCG=	111.15	YCG=	.00	ZCG=	.00
BINOXT	WT=	23789.5	XCG=	65.18	YCG=	.00	ZCG=	.00
BTHRST	WT=	17404.7	XCG=	155.64	YCG=	.00	ZCG=	.00
BNOST	WT=	56669.5	XCG=	27.80	YCG=	.00	ZCG=	.00
BSTGST	WT=	.0	XCG=	.00	YCG=	.00	ZCG=	.00
BSECST	WT=	2926.4	XCG=	66.66	YCG=	.00	ZCG=	.00
BTPS	WT=	59560.1	XCG=	66.66	YCG=	.00	ZCG=	.00
BLRD	WT=	19402.5	XCG=	138.09	YCG=	.00	ZCG=	.00
BENG	WT=	81298.4	XCG=	176.46	YCG=	.00	ZCG=	.00
BENGMT	WT=	609.7	XCG=	176.46	YCG=	.00	ZCG=	.00
BFEED	WT=	7826.3	XCG=	69.13	YCG=	.00	ZCG=	.00
BPRSYS	WT=	21023.3	XCG=	66.66	YCG=	.00	ZCG=	.00
BHEAT	WT=	9663.4	XCG=	155.64	YCG=	.00	ZCG=	.00
BSTAB	WT=	11184.7	XCG=	176.46	YCG=	.00	ZCG=	.00
BACS	WT=	11124.9	XCG=	98.64	YCG=	.00	ZCG=	.00
BACSTK	WT=	1272.4	XCG=	46.33	YCG=	.00	ZCG=	.00
BAERO	WT=	3812.6	XCG=	138.09	YCG=	.00	ZCG=	.00
BSEP	WT=	2494.9	XCG=	138.09	YCG=	.00	ZCG=	.00
BAVION	WT=	4907.1	XCG=	46.33	YCG=	.00	ZCG=	.00
BPOWER	WT=	2948.1	XCG=	138.09	YCG=	.00	ZCG=	.00
BHYCAD	WT=	3375.8	XCG=	138.09	YCG=	.00	ZCG=	.00
BCONT	WT=	48222.1	XCG=	121.96	YCG=	.00	ZCG=	.00
PAYLD	WT=	1051923.0	XCG=	23.17	YCG=	.00	ZCG=	.00
DRYORB	WT=	1582365.5	XCG=	56.28	YCG=	.00	ZCG=	.00

Upper Stage Wet C.G.:

BOTK	WT=	3432040.0	XCG=	65.18	YCG=	.00	ZCG=	.00
BFTK	WT=	576027.9	XCG=	111.15	YCG=	.00	ZCG=	.00
BAXACS	WT=	7484.8	XCG=	46.33	YCG=	.00	ZCG=	.00
BEGIRP	WT=	10926.5	XCG=	176.46	YCG=	.00	ZCG=	.00
BGASPR	WT=	2668.1	XCG=	138.09	YCG=	.00	ZCG=	.00
WETORB	WT=	5611512.7	XCG=	67.62	YCG=	.00	ZCG=	.02

Stage 1 Dry C.G.:

AWING	WT=	68397.3	XCG=	358.02	YCG=	.00	ZCG=	.00
ASTGST	WT=	41648.5	XCG=	218.16	YCG=	.00	ZCG=	.00
ASKIRT	WT=	22581.0	XCG=	358.17	YCG=	.00	ZCG=	.00
AVERT	WT=	4189.3	XCG=	365.64	YCG=	.00	ZCG=	59.48
AHORZ	WT=	3844.1	XCG=	221.62	YCG=	.00	ZCG=	.00
AINFUT	WT=	41178.5	XCG=	309.49	YCG=	.00	ZCG=	.00
AINOXT	WT=	59393.0	XCG=	277.45	YCG=	.00	ZCG=	.00
ATHRST	WT=	95205.1	XCG=	337.90	YCG=	.00	ZCG=	.00
ANOST	WT=	14439.2	XCG=	222.34	YCG=	.00	ZCG=	.00
ASECST	WT=	4116.7	XCG=	298.46	YCG=	.00	ZCG=	.00
ATPS	WT=	3713.9	XCG=	298.46	YCG=	.00	ZCG=	.00
ALRD	WT=	41607.2	XCG=	317.54	YCG=	.00	ZCG=	.00
AENG	WT=	279157.8	XCG=	353.49	YCG=	.00	ZCG=	.00
AENGMT	WT=	2668.9	XCG=	353.49	YCG=	.00	ZCG=	.00

AFEED	WT=	19516.1	XCG=	258.90	YCG=	.00	ZCG=	.00
APRSYS	WT=	18560.3	XCG=	281.08	YCG=	.00	ZCG=	.00
AHEAT	WT=	9664.9	XCG=	337.90	YCG=	.00	ZCG=	.00
ASTAB	WT=	63369.2	XCG=	353.49	YCG=	.00	ZCG=	.00
AACS	WT=	10417.3	XCG=	283.18	YCG=	.00	ZCG=	.00
AACSTK	WT=	791.7	XCG=	221.68	YCG=	.00	ZCG=	.00
AAERO	WT=	5588.3	XCG=	317.54	YCG=	.00	ZCG=	.00
ASEP	WT=	1552.4	XCG=	317.54	YCG=	.00	ZCG=	.00
AAVION	WT=	4693.2	XCG=	221.68	YCG=	.00	ZCG=	.00
APOWER	WT=	2854.6	XCG=	317.54	YCG=	.00	ZCG=	.00
AHYCAD	WT=	4996.4	XCG=	317.54	YCG=	.00	ZCG=	.00
ACONT	WT=	163029.1	XCG=	325.71	YCG=	.00	ZCG=	.00
DRYBOS	WT=	978174.4	XCG=	325.71	YCG=	.00	ZCG=	.25

Stage 1 Wet C.G.:

AOTK	WT=	8568462.0	XCG=	277.45	YCG=	.00	ZCG=	.00
AFTK	WT=	3201985.6	XCG=	309.49	YCG=	.00	ZCG=	.00
AAXACS	WT=	4657.2	XCG=	221.68	YCG=	.00	ZCG=	.00
AEGTRP	WT=	160.9	XCG=	353.49	YCG=	.00	ZCG=	.00
AGASPR	WT=	2900.8	XCG=	317.54	YCG=	.00	ZCG=	.00
WETBOS	WT=	12756340.5	XCG=	289.18	YCG=	.00	ZCG=	.02

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C.G. Summary:

	X-CG	Y-CG	Z-CG
ORBITER-DRY/PAYLD	56.28	.00	.08
ORBITER-WET/PAYLD	67.62	.00	.02
BOOSTER-DRY	325.71	.00	.25
BOOSTER-WET	289.18	.00	.02
CG AT LAUNCH	221.49	.00	.02
CG AT STAGING	105.93	.00	.06
THRUST VECTOR ANGLE - LAUNCH (DEG)		.01	
THRUST VECTOR ANGLE - STAGING (DEG)		.03	
THRUST VECTOR ANGLE - WEIGHTED AVG		.02	

Performance Summary

	EVENT 1	EVENT 2
START BURN WEIGHT	18367853.	5611512.
END BURN WEIGHT	6675164.	1673994.
TOTAL THRUST	23878144.	6094942.
BURN TIME	147.86	300.93
PROPELLANT BURNED	11692689.	3937518.
STAGED WEIGHT	1063652.	622076.
PAYLOAD	5611512.	1051919.
ALTITUDE	157466.	307420.
RELATIVE GAMMA, DEG	14.294	.159
RELATIVE VELOCITY	7350.2	24606.8
MASS FRACTION	.9166	.8636
MAXIMUM DYNAMIC PRESSURE	845.2	
TIME OF MAX Q	76.7	
MAXIMUM ACCELERATION	4.00	
EVENT 1 - LIFTOFF TO STAGING		
EVENT 2 - STAGING TO INJECTION		

Stage 1 Ballistic Reentry Data

MAXIMUM HEAT RATE, BTU/SQ FT/SEC		12.43
TIME OF MAX HEAT RATE	297.0	
MAXIMUM DYNAMIC PRESSURE		474.92
TIME MAX Q	307.0	
RANGE, NM		224.6
TOTAL HEAT, BTU/SQ FT		1051.70

Propulsion Data

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STAGE 1 ENGINES

SEA LEVEL THRUST	1836780.
VACUUM THRUST	2052982.
SEA LEVEL ISP	301.9
VACUUM ISP	337.5
ENGINE EXIT AREA, SQ FT	103.1
FLOWRATE, LB/SEC	6082.9
EXIT AREA RATIO	40.0
MIXTURE RATIO	2.7

STAGE 2 ENGINES

SEA LEVEL THRUST	777594.
VACUUM THRUST	971054.
SEA LEVEL ISP	416.0
VACUUM ISP	466.0
ENGINE EXIT AREA, SQ FT	152.7
FLOWRATE, LB/SEC	1869.2
EXIT AREA RATIO	200.0
MIXTURE RATIO	6.0

Cost Statement

HEAVY-LIFT LAUNCH VEHICLE COST STATEMENT (IN MILLIONS OF 1975 DOLLARS)

2 STAGE VEHICLE				
PAYLOAD = 1000000.				
FIRST UNIT COST BREAKDOWN		WEIGHT	F-U	DTCE
		(LS)	\$MILLION	\$MILLION
STAGE 1 - HEAT SINK ROOSTER				
AERODYNAMIC SURFACES		74496.	26.	404.
STRUCTURE		557124.	73.	594.
THERMAL PROTECTION		3714.	2.	36.
LAUNCH AND RECOVERY		41607.	8.	29.
PROPULSION		320568.	69.	702.
ORIENTATION AND CONTROL		81719.	26.	236.
AVIONICS		7943.	37.	688.
POWER SYSTEMS		7851.	12.	55.
DESIGN RESERVE		163029.	38.	408.
INSTAL, ASSEM, & CHECK-OUT			46.	69.
MAJOR GROUND TEST			0.	46.
STAGE 1 HARDWARE		1258051.	337.	3267.
SYSTEM ENGR AND INTEG			0.	163.
PROJECT MANAGEMENT			0.	129.
STAGE 1 FIRST-UNIT COST		1258051.	337.	3559.
STAGE 2 - HIGH L/D REENTRY VEHICLE				
AERODYNAMIC SURFACES		43698.	19.	295.
STRUCTURE		396036.	58.	495.
THERMAL PROTECTION		59560.	27.	579.
LAUNCH AND RECOVERY		19402.	5.	17.
PROPULSION		120421.	33.	703.
ORIENTATION AND CONTROL		29890.	11.	101.
AVIONICS		8157.	38.	694.
POWER SYSTEMS		6324.	9.	46.
DESIGN RESERVE		48222.	14.	207.
INSTAL, ASSEM, & CHECK-OUT			34.	51.
MAJOR GROUND TEST			0.	36.
STAGE 2 HARDWARE		731711.	248.	3224.
SYSTEM ENGR AND INTEG			0.	161.
PROJECT MANAGEMENT			0.	128.
STAGE 2 FIRST-UNIT COST		731711.	248.	3513.
VEHICLE FIRST-UNIT COST		1989762.	585.	7072.

HARDWARE COST SUMMARY		\$MILLION	\$MILLION
TOTAL HARDWARE COST			17267.
STAGE 1 PROGRAM HARDWARE COST		9848.	
NUMBER OF UNITS		45.	
LEARNING FACTOR		.95	
STAGE 2 PROGRAM HARDWARE COST		7419.	
NUMBER OF UNITS		45.	
LEARNING FACTOR		.95	

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DDT&E COST SUMMARY

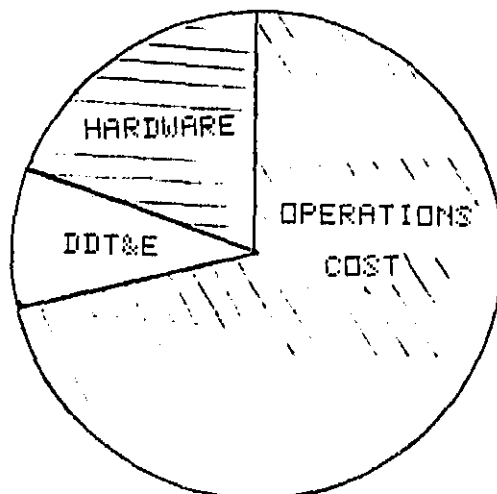
	SMILLION	SMILLION
TOTAL DDT&E COST		8723.
STAGE 1 HARDWARE-RELATED DDT&E	3559.	
STAGE 2 HARDWARE-RELATED DDT&E	3513.	
PROGRAM SYSTEM ENGR & INTEG	354.	
PROGRAM SYSTEM SUPPORT	681.	
PROGRAM FLIGHT TEST SUPPORT	408.	
PROGRAM MANAGEMENT	208.	

OPERATIONS COST SUMMARY FOR

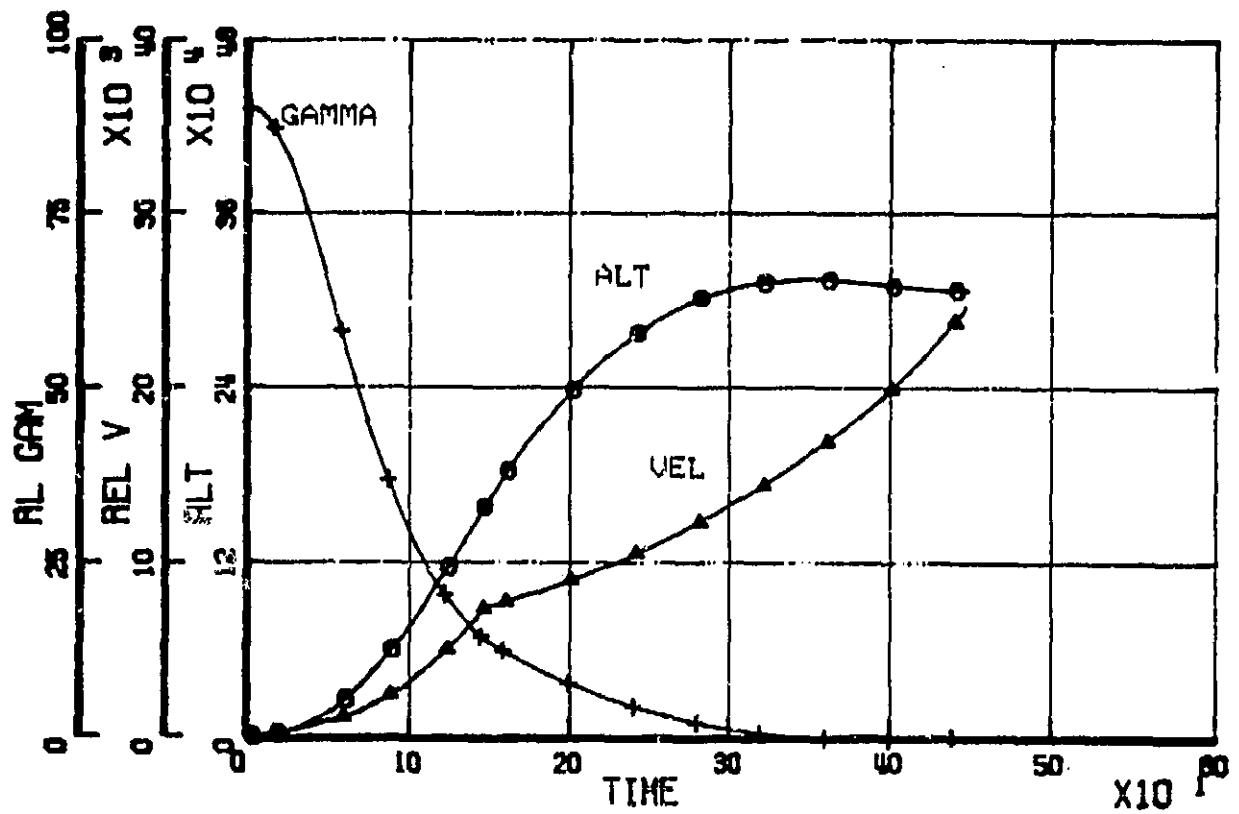
	10800 FLTS	30 YEARS	SMILLION
	\$/FLT	\$M/YEAR	
TOTAL OPERATING COST	6721079.	2420.	72588.
OPERATIONS	6183146.	2226.	66778.
WAGES & SALARIES	388889.	140.	4200.
VEHICLE MAINTENANCE	584543.	210.	6313.
FLIGHT PROPELLANTS	2282518.	822.	24651.
PROPELLANT STORAGE LOSS	1217305.	438.	13147.
MISCELLANEOUS EXPENDABLES	40000.	14.	432.
FACILITIES MAINTENANCE	11111.	4.	120.
GSE MAINTENANCE	41667.	15.	450.
MISC EQUIP MAINTENANCE	306.	0.	3.
CREW TRAINING	0.	0.	0.
TRANSPORTATION	1616808.	582.	17462.
CONTRACTOR FEE	185494.	67.	2003.
PROJECT MANAGEMENT	352439.	127.	3806.

PROGRAM COST SUMMARY

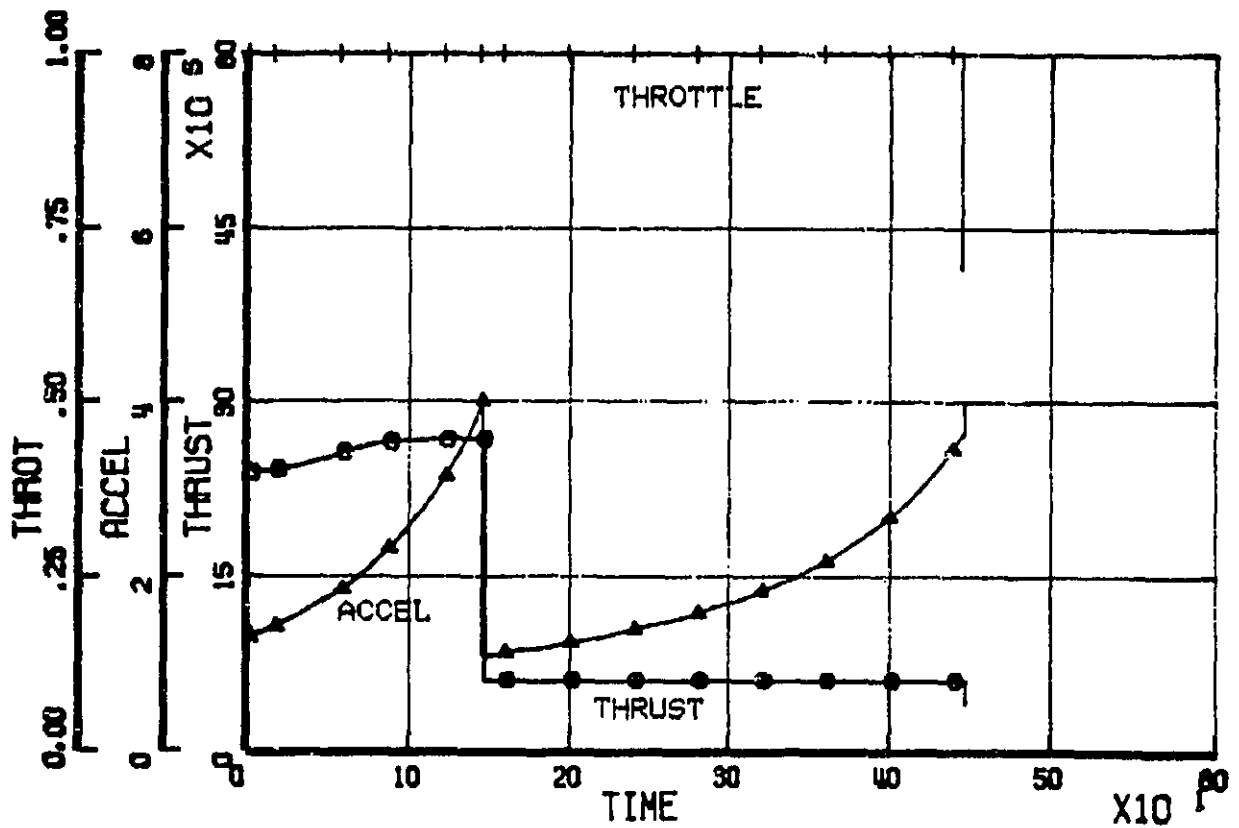
	% COST	\$/LB-PAYL	\$MILLION
TOTAL COST	100.0	9.1	98577.2
HARDWARE COST	17.5	1.6	17266.9
DDT&E COST	8.8	.6	8722.6
OPERATIONS COST	73.6	6.7	72587.7



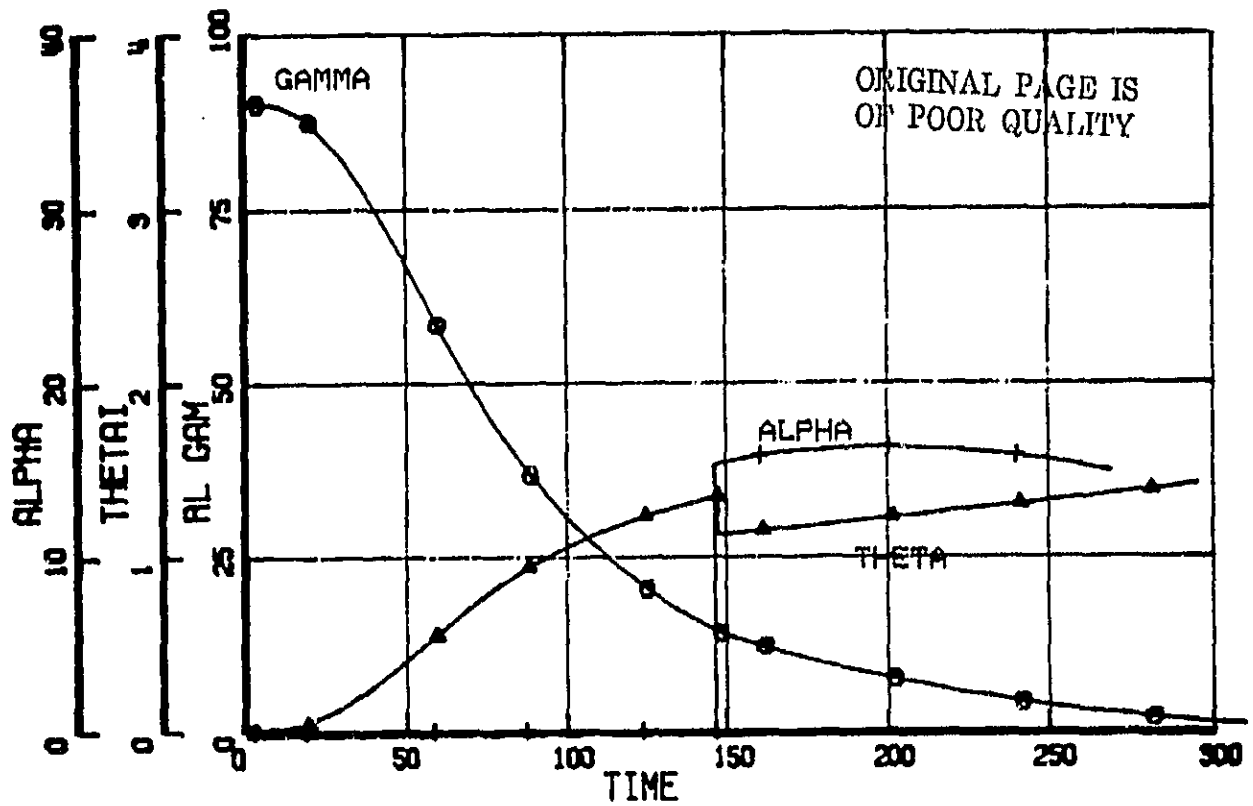
Launch State Time History



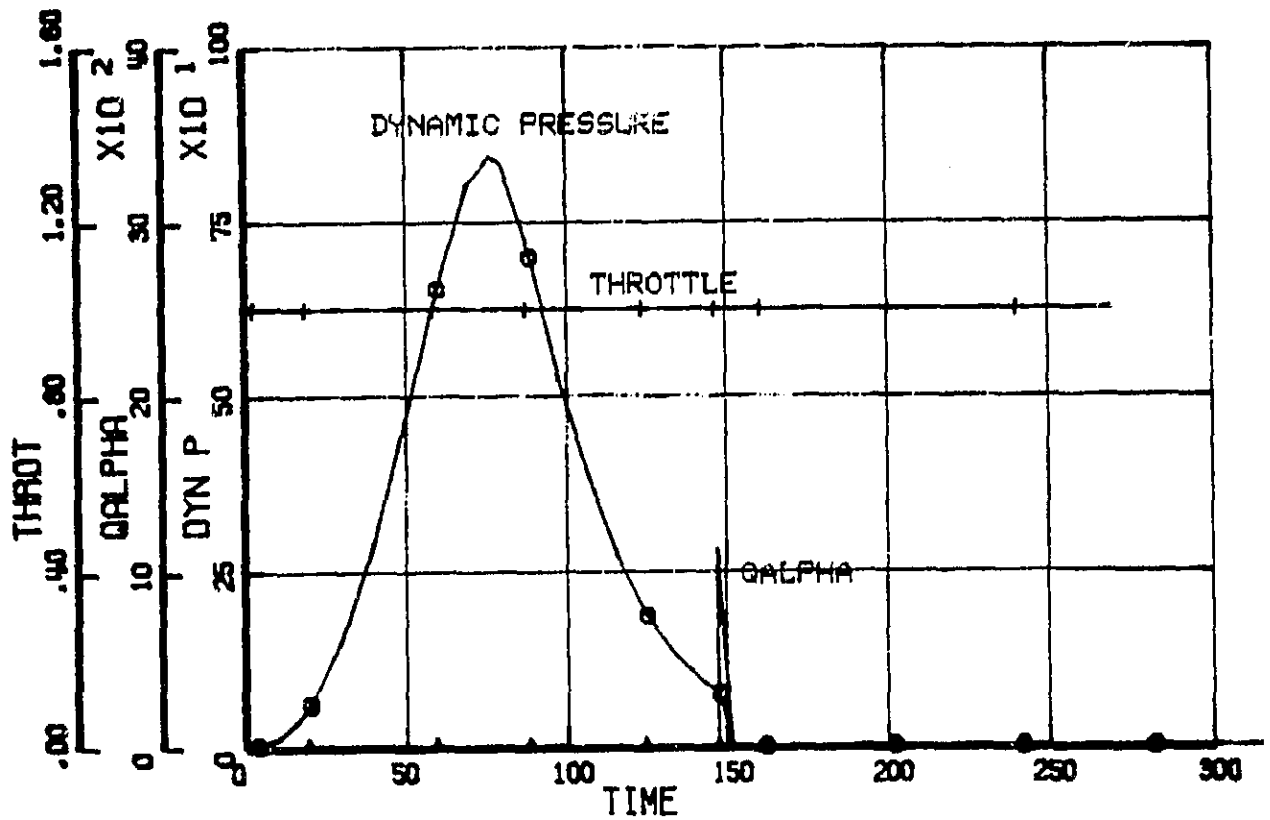
Propulsion Data Time History



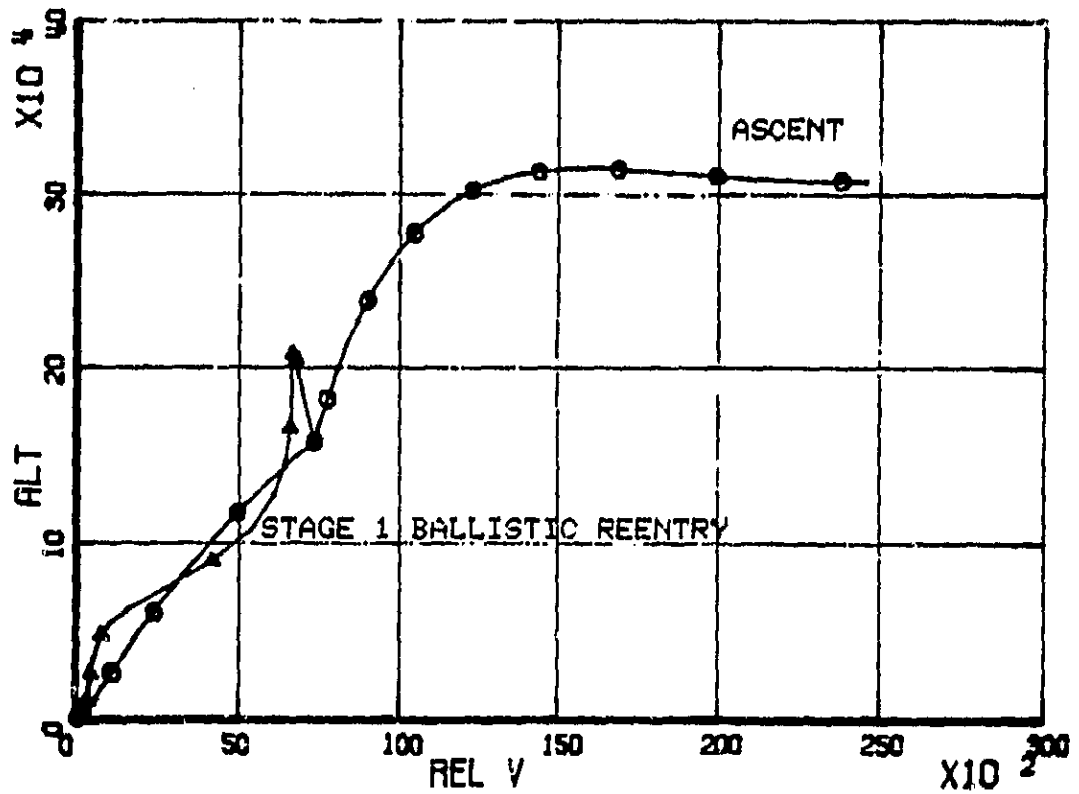
Atmospheric Flight Attitude



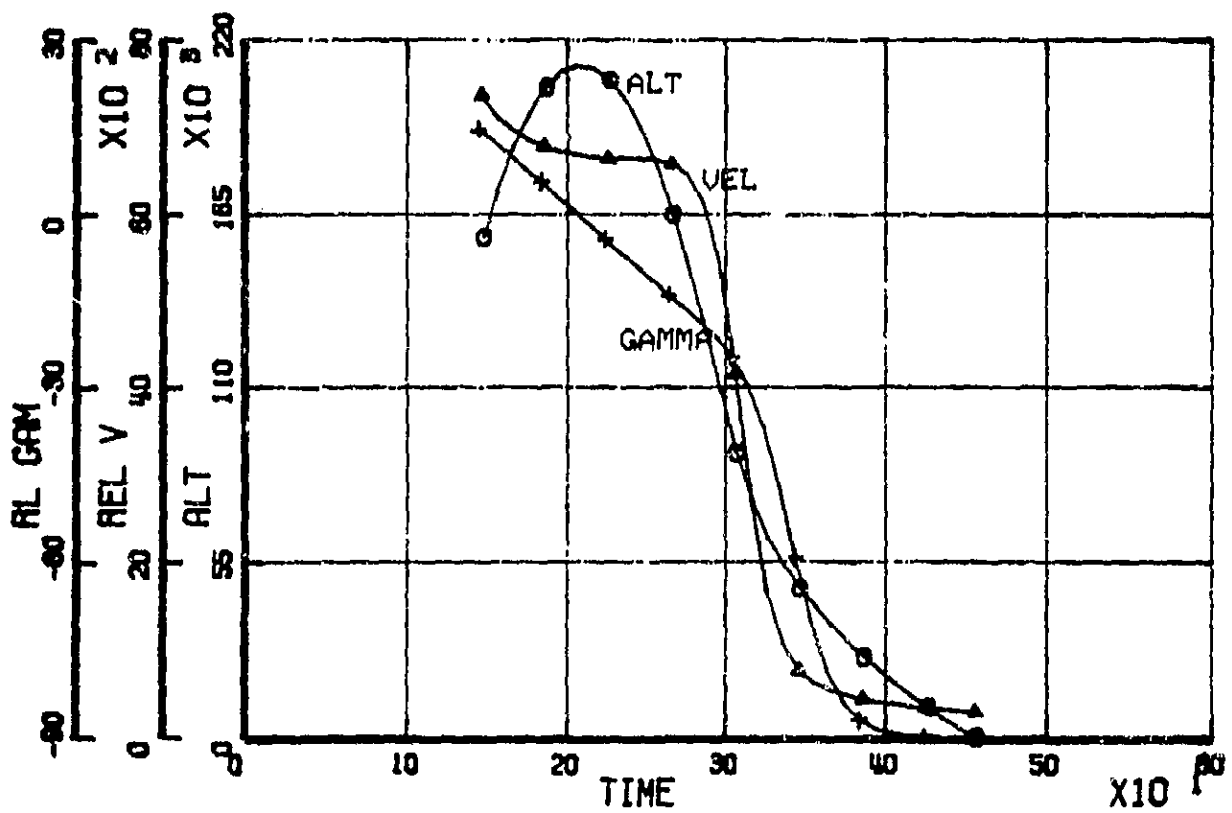
Flight Constraints



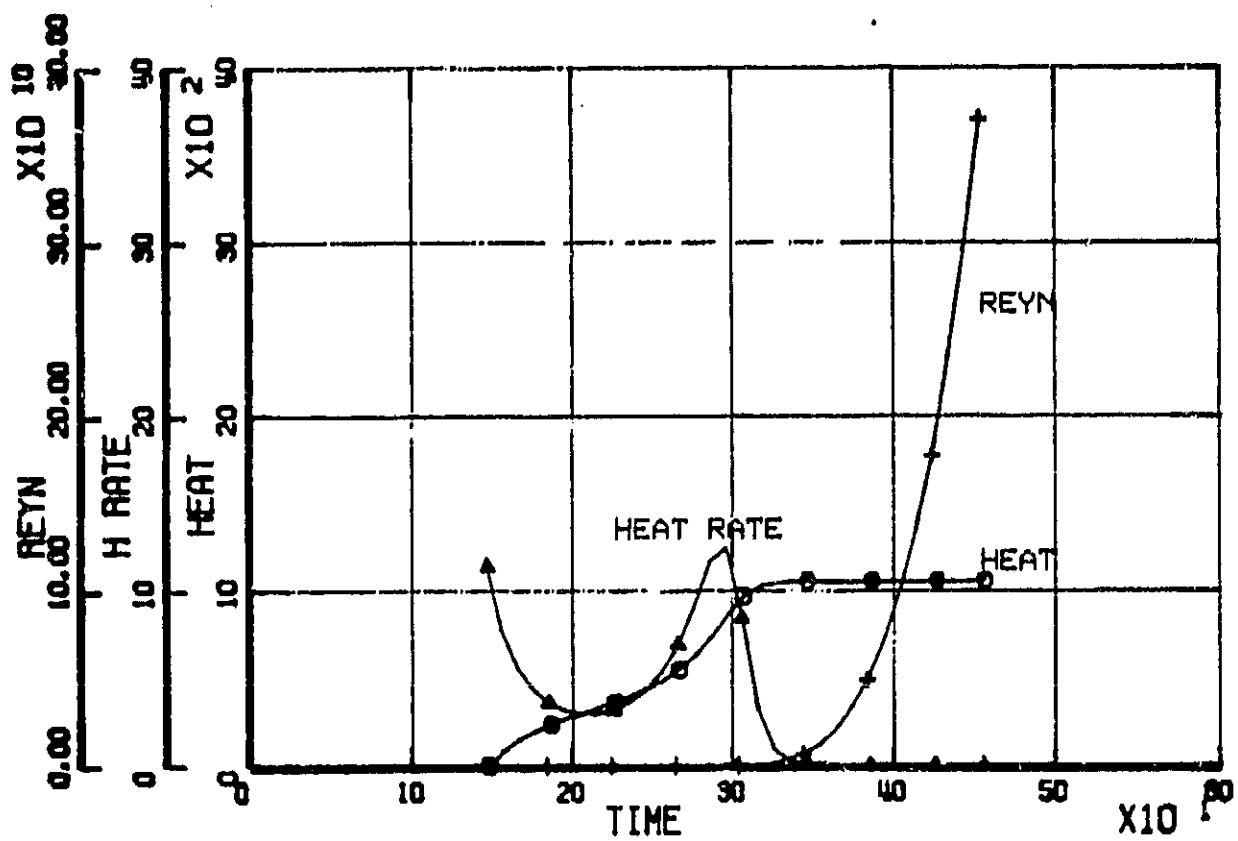
Altitude/Velocity Profile



Reentry State History - Stage 1



Reentry Heating Data - Stage 1



Ascent Performance Data Listings

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TIME	WEIGHT	THRUST	LD FAC	LIFT	DRAG	DYN P	HEAT	HT RT
LIFT-OFF								
4.0	18367853.	23378144.	1.30	0.	0.	1.0	0.	0.
4.0	18051542.	23885971.	1.32	0.	279.	1.9	0.	0.
BEGIN TILT								
6.0	17893386.	23896002.	1.34	31.	643.	4.3	0.	0.
10.0	17577075.	23928957.	1.36	696.	1674.	12.9	0.	0.
END TILT								
16.0	17102508.	24011843.	1.40	1354.	5090.	36.1	0.	0.
20.0	16786297.	24090103.	1.43	8.	8293.	59.7	0.	0.
30.0	15995519.	24365356.	1.52	6.	23527.	150.5	0.	0.
40.0	15204741.	24740169.	1.62	35.	51923.	288.5	0.	0.
50.0	14413762.	25177239.	1.74	161.	112617.	465.8	0.	0.
60.0	13623184.	25623159.	1.84	415.	499932.	653.8	0.	1.
70.0	12832406.	26722734.	1.99	773.	476064.	805.1	0.	1.
0 MAXIMUM								
76.7	12301059.	26243035.	2.10	796.	408049.	845.2	0.	2.
80.0	12041628.	26332543.	2.16	1079.	358210.	834.4	0.	2.
89.0	11329928.	26513962.	2.32	1156.	279502.	697.7	0.	3.
98.0	10616227.	26615331.	2.49	1096.	194457.	522.9	0.	4.
107.0	9906527.	26668909.	2.68	775.	127236.	380.1	0.	5.
116.0	9194827.	26696749.	2.89	924.	82061.	268.4	0.	6.
125.0	8483126.	26710971.	3.14	662.	56654.	185.3	0.	8.
134.0	7771426.	26718210.	3.43	518.	38941.	127.4	0.	9.
143.0	7059726.	26721932.	3.78	403.	27086.	88.6	0.	10.
THROTTLE BND								
147.9	6675168.	26723144.	4.00	353.	22473.	73.5	0.	11.
147.9	6675164.	26723131.	4.00	353.	22473.	73.5	0.	11.
THRUST EVENT								
147.9	5611512.	6094942.	1.08	206.	13137.	73.5	0.	11.
BEGIN MIN-H								
147.9	5611512.	6097330.	1.08	206.	13137.	73.5	0.	11.
152.0	5557365.	6097380.	1.10	0.	0.	0.	0.	12.
162.0	5426540.	6097380.	1.12	0.	0.	0.	0.	12.
172.0	5295695.	6097380.	1.15	0.	0.	0.	0.	10.
182.0	5164350.	6097380.	1.18	0.	0.	0.	0.	8.
192.0	5034005.	6097380.	1.21	0.	0.	0.	0.	7.
202.0	4903160.	6097380.	1.24	0.	0.	0.	0.	6.
212.0	4772314.	6097380.	1.28	0.	0.	0.	0.	5.
222.0	4641469.	6097380.	1.31	0.	0.	0.	0.	4.
232.0	4510624.	6097380.	1.35	0.	0.	0.	0.	4.
242.0	4379779.	6097380.	1.39	0.	0.	0.	0.	3.
252.0	4248934.	6097380.	1.44	0.	0.	0.	0.	3.
262.0	4118089.	6097380.	1.48	0.	0.	0.	0.	3.
272.0	3987244.	6097380.	1.53	0.	0.	0.	0.	3.
282.0	3856399.	6097380.	1.58	0.	0.	0.	0.	3.
292.0	3725554.	6097380.	1.64	0.	0.	0.	0.	3.
302.0	3594709.	6097380.	1.70	0.	0.	0.	0.	3.
312.0	3463864.	6097380.	1.76	0.	0.	0.	0.	3.
322.0	3333019.	6097380.	1.83	0.	0.	0.	0.	3.
332.0	3202174.	6097380.	1.90	0.	0.	0.	0.	3.
342.0	3071329.	6097380.	1.99	0.	0.	0.	0.	3.

352.0	2946484.	6097380.	2.07	0.	0.	0.	0.	4.
362.0	2609639.	6097380.	2.17	0.	0.	0.	0.	4.
372.0	2678793.	6097380.	2.28	0.	0.	0.	0.	5.
382.0	2547948.	6097380.	2.32	0.	0.	0.	0.	6.
392.0	2417103.	6097380.	2.52	0.	0.	0.	0.	7.
402.0	2286258.	6097380.	2.67	0.	0.	0.	0.	8.
412.0	2155413.	6097380.	2.83	0.	0.	0.	0.	10.
422.0	2024568.	6097380.	3.01	0.	0.	0.	0.	11.
432.0	1893723.	6097380.	3.22	0.	0.	0.	0.	13.
442.0	1762878.	6097380.	3.46	0.	0.	0.	0.	13.

INJECTION

448.8	1673994.	6097380.	3.64	0.	0.	0.	0.	13.
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TIME	REL VEL	RL FPA	ALT RANGE	REL AZ	GC LAT	LONG	TRANGE
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LIFT-OFF

0.0	40.0	89.99	-1.	2.5078.65	-5.26	-80.56	2.
4.0	40.3	89.96	79.	2.-155.49	-5.26	-80.56	2.

BEGIN TILT

6.0	61.6	89.96	180.	2.-145.86	-5.26	-80.56	2.
10.0	106.7	89.72	516.	2. 97.28	-5.26	-80.56	2.

END TILT

16.0	180.8	88.54	1374.	2. 91.39	-5.26	-80.56	2.
20.0	235.1	87.32	2204.	2. 90.75	-5.26	-80.56	2.
30.0	390.5	82.44	5293.	2. 90.25	-5.26	-80.56	2.
40.0	581.2	75.34	10023.	2. 90.11	-5.26	-80.56	3.
50.0	818.5	66.95	16592.	2. 90.05	-5.26	-80.56	4.
60.0	1110.2	58.24	25086.	3. 90.02	-5.26	-80.54	9.
70.0	1467.9	49.93	35434.	3. 90.00	-5.26	-80.52	17.

Q MAXIMUM

76.7	1751.9	44.81	43361.	4. 39.99	-5.26	-80.50	25.
80.0	1904.2	42.47	47496.	5. 89.98	-5.26	-80.49	30.
89.0	2368.6	36.60	59651.	7. 39.97	-5.26	-80.45	45.
93.0	2933.2	31.53	72854.	10. 89.96	-5.26	-80.40	64.
107.0	3510.5	27.19	86919.	14. 89.94	-5.26	-80.33	67.
116.0	4194.5	23.48	101670.	19. 89.93	-5.26	-80.24	116.
125.0	4961.1	20.33	116955.	26. 89.91	-5.26	-80.14	149.
134.0	5819.1	17.64	132653.	33. 89.89	-5.26	-80.01	169.
143.0	6781.1	15.37	148682.	42. 89.87	-5.26	-79.86	237.

THROTTLE END

147.9	7350.2	14.29	157466.	47. 89.86	-5.26	-79.77	266.
147.9	7350.2	14.29	157466.	47. 89.86	-5.26	-79.77	266.

THRUST EVENT

147.9	7350.2	14.29	157466.	47. 89.86	-5.26	-79.77	266.
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BEGIN MIN-H

147.9	7350.2	14.29	157466.	47. 89.86	-5.26	-79.77	266.
152.0	7450.2	13.68	164869.	52. 89.85	-5.26	-79.69	275.
162.0	7738.7	12.27	181909.	64. 89.82	-5.26	-79.49	297.
172.0	8026.2	10.96	197762.	77. 89.79	-5.26	-79.26	319.
182.0	8334.8	9.75	212452.	90. 89.77	-5.26	-79.06	342.
192.0	8656.5	8.63	226006.	104. 89.74	-5.26	-78.83	365.
202.0	8993.4	7.60	239449.	118. 89.71	-5.26	-78.59	390.

TIME	REL	VEL	RL	FPA	ALT	RANGE	REL	AZ	GC	LAT	LONG	TRANGE
212.0	9345.7	6.55	249809.	132.	89.68	-5.26	-78.35	415.				
222.0	9713.6	5.78	260116.	148.	89.65	-5.26	-78.09	442.				
232.0	10097.6	4.99	269398.	164.	89.62	-5.25	-77.82	469.				
242.0	10498.1	4.26	277687.	181.	89.58	-5.25	-77.54	497.				
252.0	10915.5	3.60	285016.	193.	89.55	-5.25	-77.25	527.				
262.0	11350.5	3.01	291419.	216.	89.52	-5.25	-76.95	558.				
272.0	11803.7	2.47	296933.	235.	89.48	-5.25	-76.64	590.				
282.0	12270.1	1.99	301596.	254.	89.45	-5.24	-76.31	624.				
292.0	12768.5	1.55	305451.	274.	89.41	-5.24	-75.97	659.				
302.0	13281.9	1.17	308539.	295.	89.37	-5.24	-75.62	697.				
312.0	13817.7	.84	310911.	317.	89.33	-5.23	-75.25	737.				
322.0	14377.1	.55	312615.	340.	89.29	-5.23	-74.87	780.				
332.0	14961.8	.31	313708.	364.	89.25	-5.22	-74.47	826.				
342.0	15573.5	.11	314247.	389.	89.20	-5.22	-74.06	875.				
352.0	16214.2	-.06	314299.	414.	89.16	-5.21	-73.63	930.				
362.0	16886.3	-.19	313932.	441.	89.11	-5.20	-73.18	991.				
372.0	17592.5	-.28	313226.	469.	89.07	-5.20	-72.72	1060.				
382.0	18335.7	-.33	312264.	498.	89.02	-5.19	-72.23	1140.				
392.0	19120.1	-.35	311139.	528.	88.97	-5.18	-71.72	1235.				
402.0	19949.3	-.34	309955.	560.	88.91	-5.17	-71.19	1355.				
412.0	20828.6	-.29	308826.	593.	88.86	-5.16	-70.64	1514.				
422.0	21763.9	-.21	307881.	627.	88.80	-5.15	-70.06	1755.				
432.0	22762.5	-.10	307263.	664.	88.74	-5.13	-69.46	2008.				
442.0	23833.1	.04	307135.	701.	88.68	-5.12	-68.83	2209.				
INJECTION												
448.8	24606.8	.16	307420.	728.	88.64	-5.11	-68.38	2208.				

ORIGINAL PAGE IS
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TIME	MACH	ALPHA	BANK	VELI	FPAI	AZI
LIFT-OFF						
.0	.000	.00-90.00		1519.4	.00	90.00
4.0	.035	.00-90.00		1520.0	1.52	90.00
BEGIN TILT						
6.0	.054	.03	1.66	1520.7	2.32	90.00
10.0	.094	.20	.19	1523.7	4.01	90.00
END TILT						
16.0	.160	.14	.24	1534.8	6.76	90.00
20.0	.208	.00	90.00	1548.5	8.72	90.01
30.0	.349	.00	90.00	1618.2	13.34	90.01
40.0	.528	.00	90.00	1759.5	18.64	90.01
50.0	.759	.00	90.00	1989.3	22.25	90.01
60.0	1.066	.00	90.00	2307.6	24.15	90.01
70.0	1.461	.00	90.00	2710.6	24.46	90.00

Q MAXIMUM					
76.7	1.830	.00-90.00	3028.5	24.06	39.99
80.0	2.015	.00-90.00	3197.4	23.71	39.99
89.0	2.511	.00-90.00	3705.0	22.41	39.98
98.0	3.004	.01-90.00	4277.0	20.79	39.97
107.0	3.564	.01-90.00	4917.3	19.04	39.96
116.0	4.178	.01-90.00	5627.9	17.26	39.95
125.0	4.827	.01-90.00	6415.9	15.58	39.93
134.0	5.525	.01-90.00	7291.0	14.00	39.91
143.0	6.305	.01-90.00	8266.6	12.56	39.90

THROTTLE END					
147.9	6.786	.01-90.00	8841.7	11.84	39.83
147.9	6.786	.01-90.00	8841.7	11.84	39.88

THRUST EVENT					
147.9	6.786	.01-90.00	8841.7	11.84	39.83

BEGIN MIN-H					
147.9	6.786	15.28-90.00	8841.7	11.84	39.88
152.0	.000	15.45-90.00	8955.5	11.35	39.87
162.0	.000	15.81-90.00	9240.1	10.25	39.85
172.0	.000	16.04-90.00	9538.5	9.21	39.83
182.0	.000	16.20-90.00	9850.9	8.24	39.80
192.0	.000	16.30-90.00	10177.5	7.34	39.78
202.0	.000	16.32-90.00	10518.6	6.49	39.75
212.0	.000	16.29-90.00	10874.3	5.72	39.72
222.0	.000	16.19-90.00	11245.2	4.99	39.70
232.0	.000	16.03-90.00	11631.6	4.33	39.67
242.0	.000	15.82-90.00	12034.0	3.72	39.64
252.0	.000	15.56-90.00	12453.0	3.16	39.61
262.0	.000	15.25-90.00	12889.2	2.65	39.57
272.0	.000	14.89-90.00	13343.5	2.16	39.54
282.0	.000	14.49-90.00	13816.6	1.76	39.51
292.0	.000	14.05-90.00	14309.6	1.39	39.47
302.0	.000	13.56-90.00	14823.5	1.05	39.44
312.0	.000	13.04-90.00	15359.6	.76	39.40
322.0	.000	12.49-90.00	15919.2	.50	39.36
332.0	.000	11.90-90.00	16504.0	.28	39.32
342.0	.000	11.28-90.00	17115.7	.10	39.28
352.0	.000	10.64-90.00	17756.5	-.05	39.23
362.0	.000	9.97-90.00	18428.5	-.17	39.19
372.0	.000	9.27-90.00	19134.7	-.25	39.14
382.0	.000	8.55-90.00	19878.0	-.30	39.09
392.0	.000	7.82-90.00	20662.1	-.32	39.04
402.0	.000	7.06-90.00	21491.2	-.31	38.99
412.0	.000	6.30-90.00	22370.4	-.27	38.94
422.0	.000	5.51-90.00	23305.7	-.20	38.88
432.0	.000	4.72-90.00	24304.2	-.09	38.82
442.0	.000	3.92-90.00	25374.8	.04	38.76

INJECTION					
448.8	.000	3.38-90.00	26148.5	.15	38.72

Lifting Reentry Performance Data Listings

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TIME	WEIGHT	THRUST	LO FAC	LIFT	DRAG	DYN P	HEAT	HT RT
147.9	1063652.	0.	1.47	0.	1564836.	73.6	0.	11.
157.0	1063652.	0.	.76	0.	811337.	38.2	83.	7.
Q TRIGGER								
162.4	1063652.	0.	.56	0.	593217.	27.9	116.	6.
167.0	1063652.	0.	.23	61245.	231787.	22.2	144.	5.
176.0	1063652.	0.	.15	41878.	158491.	15.2	185.	4.
185.0	1063652.	0.	.11	31175.	117984.	11.2	220.	4.
194.0	1063652.	0.	.09	25329.	95662.	9.2	249.	3.
203.0	1063652.	0.	.08	22529.	85265.	8.2	276.	3.
212.0	1063652.	0.	.08	21976.	83171.	8.0	302.	3.
221.0	1063652.	0.	.09	23499.	88934.	8.5	323.	3.
230.0	1063652.	0.	.10	27466.	103948.	9.9	355.	3.
239.0	1063652.	0.	.17	34910.	132122.	12.6	385.	4.
248.0	1063652.	0.	.18	47919.	181356.	17.3	419.	4.
257.0	1063652.	0.	.26	70484.	266756.	25.5	461.	5.
266.0	1063652.	0.	.41	110244.	417233.	39.9	511.	6.
275.0	1063652.	0.	.68	185970.	703825.	67.3	574.	8.
284.0	1063652.	0.	1.24	336917.	1275101.	121.9	654.	10.
293.0	1063652.	0.	2.24	607323.	2298483.	219.8	752.	12.
302.0	1063652.	0.	3.51	954421.	3612116.	345.4	857.	11.
311.0	1063652.	0.	4.18	1136564.	4301459.	411.3	941.	7.
320.0	1063652.	0.	3.71	1007360.	3812471.	364.6	990.	4.
329.0	1063652.	0.	2.79	758869.	2872029.	274.6	1013.	3.
338.0	1063652.	0.	2.03	552128.	2089593.	199.8	1022.	1.
347.0	1063652.	0.	1.55	420573.	1591706.	152.2	1027.	0.
356.0	1063652.	0.	1.28	349100.	1321211.	126.3	1029.	0.
365.0	1063652.	0.	1.16	316015.	1195996.	114.4	1031.	0.
374.0	1063652.	0.	1.12	302978.	1146653.	109.7	1032.	0.
383.0	1063652.	0.	1.10	300209.	1136174.	108.6	1032.	0.
392.0	1063652.	0.	1.10	299922.	1135089.	108.5	1033.	0.
401.0	1063652.	0.	1.10	298852.	1131040.	108.2	1034.	0.
410.0	1063652.	0.	1.09	297268.	1125045.	107.6	1034.	0.
419.0	1063652.	0.	1.09	295120.	1116914.	106.8	1034.	0.
428.0	1063652.	0.	1.08	292874.	1108415.	106.0	1035.	0.
437.0	1063652.	0.	1.07	290766.	1100436.	105.5	1035.	0.
446.0	1063652.	0.	1.06	288859.	1093219.	104.5	1035.	0.
455.0	1063652.	0.	1.06	287135.	1086696.	103.9	1035.	0.
MIN. ALT.								
461.9	1063652.	0.	1.05	205923.	1082107.	103.5	1035.	0.

TIME	REL VEL	RL FPA	ALT	RANGE	REL A2	GC LAT	LONG	TRANGE
147.9	7350.2	14.29	157423.	5400.	89.86	-5.26	280.16	4767.
157.0	6974.1	12.29	172431.	5400.	89.84	-5.26	280.34	4757.
Q TRIGGER								
162.4	6825.5	11.06	179924.	5400.	89.82	-5.26	280.44	4751.
167.0	6759.1	10.04	185700.	5400.	89.81	-5.26	280.52	4746.
176.0	6662.5	8.00	195177.	5400.	89.79	-5.26	280.68	4736.
185.0	6591.1	5.89	202396.	5400.	89.76	-5.26	280.84	4727.
194.0	6538.6	3.73	207353.	5400.	89.74	-5.26	281.00	4717.
203.0	6501.1	1.53	210049.	5400.	89.72	-5.26	281.16	4708.
212.0	6476.2	-1.68	210485.	5400.	89.70	-5.26	281.32	4698.
221.0	6461.8	-2.90	208668.	5400.	89.68	-5.26	281.48	4689.
230.0	6455.6	-3.11	204608.	5400.	89.65	-5.26	281.64	4679.
239.0	6454.5	-7.30	193324.	5400.	89.63	-5.26	281.80	4670.

248.0	6453.8	-9.46	189850.	5400.	89.61	-5.26	261.95	4661.
257.0	6445.7	-11.57	179247.	5400.	89.59	-5.25	262.11	4651.
266.0	6416.5	-13.60	166624.	5400.	89.57	-5.25	262.26	4642.
275.0	6340.1	-15.49	152183.	5400.	89.54	-5.25	262.41	4633.
284.0	6159.4	-17.14	136329.	5400.	89.52	-5.25	262.56	4624.
293.0	5771.2	-18.32	119878.	5400.	89.50	-5.25	262.70	4616.
302.0	5056.7	-18.72	104259.	5400.	89.48	-5.25	262.83	4608.
311.0	4043.9	-18.27	91181.	5400.	89.47	-5.25	262.94	4602.
320.0	3007.1	-17.72	81426.	5400.	89.45	-5.25	263.02	4597.
329.0	2184.4	-18.35	74318.	5400.	89.44	-5.25	263.06	4593.
338.0	1611.3	-21.14	68683.	5400.	89.42	-5.25	263.12	4591.
347.0	1231.1	-26.47	63637.	5400.	89.41	-5.25	263.15	4589.
356.0	982.6	-33.95	58711.	5400.	89.39	-5.25	263.18	4588.
365.0	818.9	-42.53	53749.	5400.	89.38	-5.24	263.20	4587.
374.0	710.7	-50.91	48768.	5400.	89.36	-5.24	263.21	4586.
383.0	634.6	-58.03	43854.	5400.	89.34	-5.24	263.22	4585.
392.0	576.7	-63.45	39105.	5400.	89.32	-5.24	263.23	4585.
401.0	529.9	-67.28	34582.	5400.	89.29	-5.24	263.23	4584.
410.0	490.9	-69.85	30309.	5400.	89.26	-5.24	263.24	4584.
419.0	457.6	-71.50	26284.	5400.	89.22	-5.24	263.24	4584.
428.0	428.8	-72.55	22493.	5400.	89.18	-5.24	263.24	4584.
437.0	403.6	-73.20	18915.	5400.	89.13	-5.24	263.25	4584.
446.0	381.4	-73.61	15532.	5400.	89.08	-5.24	263.25	4583.
455.0	361.6	-73.89	12323.	5400.	89.03	-5.24	263.25	4583.

MIN. ALT.
461.8 348.0 -74.03 10000. 5400. 88.98 -5.24 283.25 4583.

TIME	MACH	ALPHA	BANK	VELI	GAMI	AZI
147.9	6.707	50.00	.00	8841.7	11.94	89.88
157.0	6.497	53.00	.00	8475.3	10.28	89.87

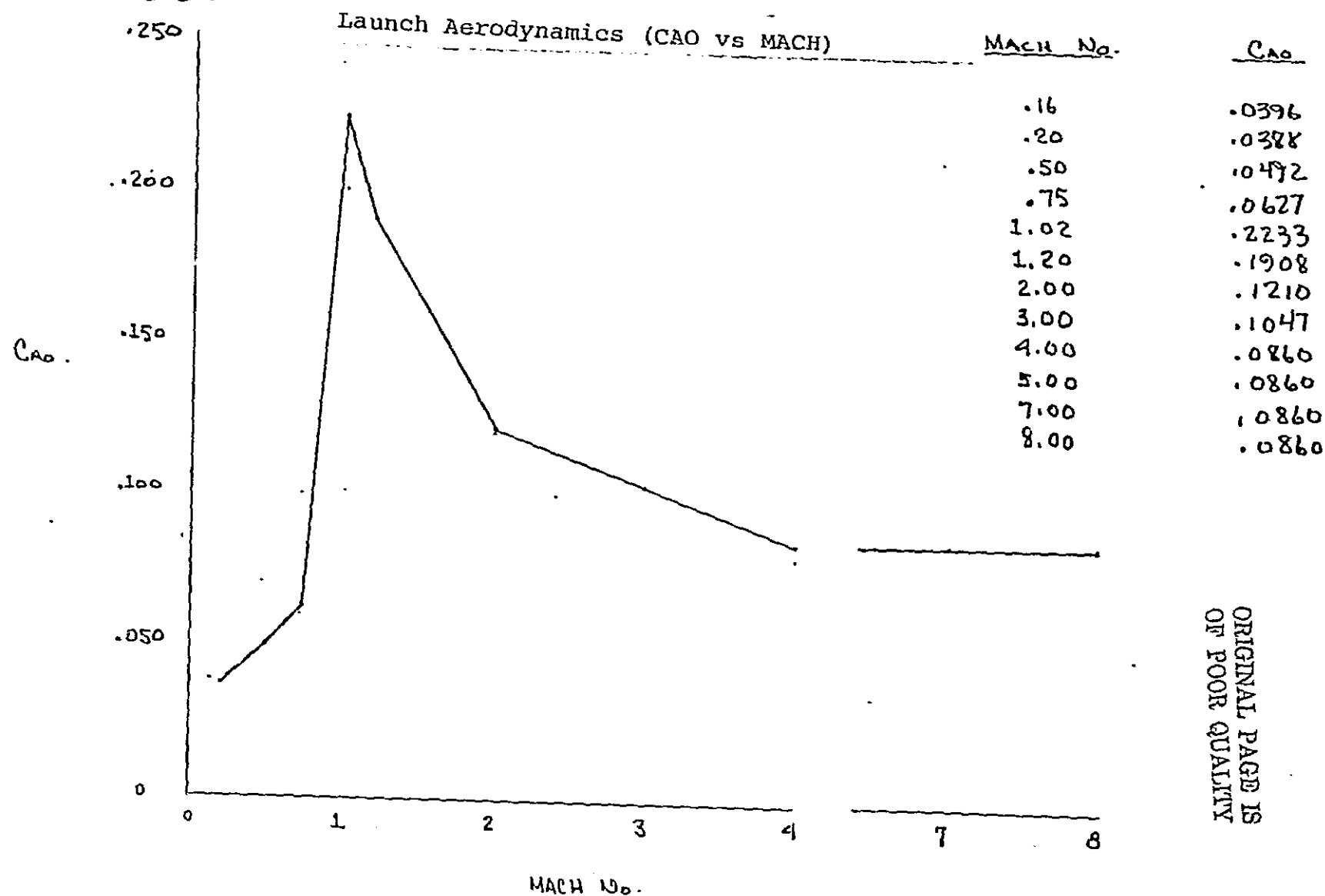
O TRIGGER						
162.4	6.422	50.00	.00	8334.8	9.04	89.85
167.0	6.414	.00	.00	8272.9	8.19	89.85
176.0	6.425	.00	.00	8134.0	6.51	89.83
185.0	6.441	.00	.00	8118.7	4.76	89.81
194.0	6.452	.00	.00	8070.4	3.02	89.79
203.0	6.449	.00	.00	8035.4	1.34	89.77
212.0	6.430	.00	.00	8010.9	-.55	89.76
221.0	6.392	.00	.00	7994.9	-2.34	89.74
230.0	6.336	.00	.00	7985.0	-4.13	89.72
239.0	6.260	.00	.00	7978.3	-5.92	89.70
248.0	6.166	.00	.00	7970.1	-7.65	89.69
257.0	6.059	.00	.00	7952.9	-9.36	89.67
266.0	5.944	.00	.00	7913.3	-10.99	89.65
275.0	5.875	.00	.00	7825.6	-12.50	89.64
284.0	5.817	.00	.00	7634.1	-13.73	89.62
293.0	5.590	.00	.00	7237.9	-14.51	89.61
302.0	5.017	.00	.00	6521.4	-14.41	89.61
311.0	4.089	.00	.00	5513.8	-13.29	89.62
320.0	3.073	.00	.00	4484.2	-11.78	89.64
329.0	2.255	.00	.00	3663.3	-10.82	89.67
338.0	1.680	.00	.00	3082.6	-10.87	89.71
347.0	1.295	.00	.00	2682.9	-11.80	89.75
356.0	1.043	.00	.00	2402.3	-13.20	89.79
365.0	.874	.00	.00	2197.7	-14.59	89.82
374.0	.754	.00	.00	2046.8	-15.63	89.85
383.0	.664	.00	.00	1935.1	-16.15	89.88
392.0	.592	.00	.00	1853.3	-16.16	89.90
401.0	.532	.00	.00	1794.5	-15.81	89.92
410.0	.483	.00	.00	1752.4	-15.25	89.93
419.0	.442	.00	.00	1722.1	-14.59	89.93
428.0	.407	.00	.00	1699.7	-13.93	89.94
437.0	.377	.00	.00	1682.5	-13.26	89.94
446.0	.352	.00	.00	1668.8	-12.66	89.94
455.0	.332	.00	.00	1657.5	-12.12	89.94

MIN. ALT.
461.8 .316 .00 .00 1650.2 -11.70 89.94

REF: AERODYNAMIC DESIGN DATA BOOK, VOL I

SD 72-SH-0060-II, DEC, 1975

FIGURE 3.2-1



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Simulation Convergence Data

	ACTUAL	PREDICTED	DELTA
GLOW	18367853.0	18367853.5	-.7
PAYLOAD	1051918.8	1051923.0	-4.2
STAGE 1			
STAGE WEIGHT	12756341.	12756341.	-0.
PROPELLANT	11692689.	11692689.	-0.
INERT WEIGHT	1063652.	1063652.	0.
JETTISON WEIGHT	1063652.	1063652.	-0.
BURN TIME	148.	148.	0.
IDEAL VELOCITY	10690.	10691.	-1.
MASS FRACTION	.91662	.91662	.00000
STAGE 2			
STAGE WEIGHT	4559594.	4559590.	4.
PROPELLANT	3937518.	3937514.	4.
INERT WEIGHT	622076.	622076.	-0.
JETTISON WEIGHT	622076.	622076.	-0.
BURN TIME	301.	301.	0.
IDEAL VELOCITY	18136.	18135.	0.
MASS FRACTION	.86357	.86357	.00000
STAGE 1 SIZING DATA			
AVERAGE SP. IMP.		328.25	
LIFT-OFF T/W		1.323	
MAXIMUM Q		845.2	
TIME AT MAX Q		76.7	
MAX ACCEL		4.00	
STAGING CONDITIONS:			
WEIGHT		6675164.	
REL VELOCITY (FPS)		7350.2	
REL F.P. ANGLE (DEG)		14.29	
ALTITUDE (FT)		157470.	
TIME (SEC)		147.86	
ATT AFTER STG (DEG)		1.12	
BALISTIC REENTRY DATA			
MAXIMUM HEAT RATE			12.43
TIME		297.0	
MAXIMUM DYNAMIC PRESSURE			474.92
TIME		307.0	
TIME AFTER REENTRY			457.2
RANGE		224.6	
TOTAL HEAT		1051.7	

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REFERENCES

1. EDIN Center, EDIN0620 - Detailed Listings and Specifications, April 1976.
2. EDIN Center, EDIN0601 through EDIN0614 - Simulation Results, January 1976.
3. EDIN Center, EDIN0601A through EDIN0614A - Simulation Results, February 1976.
4. EDIN Center, EDIN0613B-1 through EDIN0613B-3 - Simulation Results, April 1976.
5. EDIN Center, EDIN0607B-1 through EDIN0607B-2 - Simulation Results, April 1976.
6. EDIN Center, EDIN0613P-1 through EDIN0613P-2 - Simulation Results, May 1976.
7. EDIN Center, EDIN0620 - Detailed Listings and Specifications, June 1976.
8. Lockheed Electronics Company, "Unpublished Notes." July, 1976.
9. EDIN Center, EDIN0621 - Detailed Listings and Specifications, July 1976.