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Space Administration

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PREFACE

The work described in this report was performed by the Control and Energy Conversion Division of the Jet Propulsion Laboratory.

ACKNOWLEDGMENTS

The author acknowledges the indispensable assistance and constructive suggestions provided by the many people who contributed to this reevaluation of the principal chemical species emitted and/or entrained by the Space Shuttle Vehicle during the launch phase of its trajectory. Among those persons who provided direct assistance are: Floyd A. Anderson, Jet Propulsion Laboratory; Robert M. Croft, NASA Marshall Space Flight Center; Hubert P. Davis, NASA Johnson Space Center; Orval E. Etheridge, NASA Marshall Space Flight Center; Toshio Fujita, Jet Propulsion Laboratory; Wayne L. Norton, Rockwell International; and Giulio Varsi, Jet Propulsion Laboratory.

ABSTRACT

This memorandum presents the principal chemical species emitted and/or entrained by the rocket motors of the Space Shuttle Vehicle during the launch phase of its trajectory. Results are presented for two extreme trajectories, both of which were calculated in 1976. Thus, the results presented in this memorandum supersede those presented in JPL Technical Memorandum 33-712, which utilized 1973 design data.

CONTENTS

Figures

SECTION I

INTRODUCTION

This report presents results from a recent recalculation of the principal chemical species generated by the Space Shuttle Vehicle (SSV) rocket motors; results corresponding to the subsequent complete afterburning of this exhaust gas mixture with a stoichiometrically equivalent quantity of air from the atmosphere are also presented.

These results are based on recently redefined assumed trajectories and correspondingly updated data regarding the two solid rocket motors (SRMs) that are employed as a booster for the Space Shuttle Vehicle and the three space shuttle main engines (SSMEs) that constitute the main propulsion system (MPS) of the Vehicle.

The results reported herein differ only quantitatively from those presented in Ref. 1, except for the correction of errors, namely in Table 7a, b, c, and d, of Ref. 1.

SECTION II

BASIC TRAJECTORY AND ROCKET MOTOR DATA

As in Ref. 1, basic data regarding four representative trajectories and the corresponding performances of the booster and main propulsion systems of the Space Shuttle Vehicle were obtained from Rockwell International (Refs. 2, 3, 4, and 5).

Again as in Ref. 1, the two trajectories which have been analyzed in this report correspond to (1) that resulting in the lowest burnout altitude for the SRMs, viz., 43.433 km or 142,496 ft., and (2) that resulting in the highest burnout altitude for the SRMs, viz., 45.419 km or 149,009 ft. The first of these trajectories, designated as Mission 1, pertains to an August launch from Kennedy Space Center; an August mean wind and an SRM bulk temperature of 81°F are assumed. The second of these trajectories, designated as Mission 3A, pertains to a December launch from Vandenburg Air Force Base; a December mean wind and an SRM bulk temperature of 52°F are assumed.

Trajectory and rocket motor data pertaining to Mission 1 are presented in Tables 1A and 1B. The same results are presented in Table 1B in English units as are presented in Table 1A in metric units. Similar data pertaining to Mission 3A are presented in Tables 2A and 2B.

Figures 1 and 2, respectively, present propellant mass flow rate and total propellant mass ejected as functions of time for the two SRM's when fired under Mission 1 conditions. Figures 3 and 4 present similar data for the two SRM's when fired under Mission 3A conditions.

Please note that the data presented in these Figures are in metric units. These data were obtained from Refs. 2 and 4; however, the source therein cited for these data is a Thiokol Chemical Corporation report (Ref. 6).

SECTION III

SPACE SHUTTLE ROCKET MOTOR EMISSIONS

The chemical species present at the exit plane of an operating SRM were obtained from Ref. 7, while those present at the exit plane of an SSME were obtained from Ref. 1. The equilibrium calculation reported in Ref. 7 considered the chemical species listed in Table 3. It is anticipated that only negligible deviations from the propellant formulation and the SRM design operating conditions assumed in Ref. 7 will eventuate in the prototypal SRM.

A design chamber pressure of 4.48 (10^6) N/m^2 or 650 lbf/in.^{2}, and a design nozzle exit pressure of 1.01 (10^5) N/m^2 or 14.70 lbf/in.^{2} are specified for the SRMs. The chamber pressure of a rocket motor whose flow is choked at the nozzle throat is, with negligible error, directly proportional to propellant mass flow rate. Thus, the ordinate of Figures 1 or 3 at any particular time is respectively proportional to the chamber pressure of a Mission 1 or Mission 3A SRM at that time.

The chemical species present at the nozzle exit plane of an SRM are listed in Table 4. Eleven principal species, constituting 99.927% of the exhaust products by mass fraction, are enumerated. Trace species, not enumerated here, constitute the remaining 0.073% mass fraction of the exhaust products at the SRM nozzle exit plane.

The performance data regarding the SSME that were presented in Ref. 1 are, today, unchanged or, at most, only slightly changed. Design chamber pressure is currently specified to be 3000 lbf/in.^{2} or 2.068 (10^7) N/m^2; mixture ratio remains at 6.0; nozzle exit area ratio remains at 77.5; currently, vacuum thrust is specified as 4.70 (10^5) lbf or 2.09 (10^6) N, while vacuum specific impulse is specified as 455.15 sec or 4.464 (10^3) N sec/kg, and this corresponds to a fuel flow rate at rated thrust of 1.033 (10^3) lbm/sec or 4.682 (10^2) kg/sec. Current space shuttle vehicle trajectories require thrust modulation of the MPS (1) to limit maximum dynamic pressure and later (2) to limit maximum acceleration to 3 g's; concomitant modulations of SSME chamber pressure and propellant flow rates also occur.

Essentially the same list of chemical species present at the nozzle exit plane of an SSME as presented in Ref. 1 is reproduced as Table 5 herein. According to Ref. 1, these results were obtained from a one-dimensional chemical kinetic calculation.

For a Space Shuttle Vehicle Mission 1 ascent trajectory, Table 6A presents, in metric units, the quantity of each principal constituent of the rocket motor exhaust products emitted during the time-altitude interval that is defined by the first four columns of the table. As will be obvious from an examination of the table, there are, corresponding to each time-altitude interval, two lines of data regarding the quantities of the emitted species. The first of these lines pertains to aggregate quantities present at the rocket motor nozzle exit planes; the second, to aggregate quantities after complete afterburning of the exhaust gas

mixture with a stoichiometrically equivalent amount of air. Where appropriate, totals are presented at the bottom of each column of the table. As in the body of the table, the first line or row corresponds to nozzle exit conditions, while the second corresponds to stoichiometrically afterburned conditions. Table 6B presents the same information in English units as is presented by Table 6A in metric units. Up to thirty-eight seconds after SRM ignition, uniform time increments of two seconds are employed. Then, because of the initiation at thirty-nine seconds of a program to reduce MPS thrust and, thus, to limit the maximum dynamic pressure sustained by the vehicle, one time increment of one second is presented. The next time increment extends from thirty-seconds to the time corresponding to that at which the next higher even multiple of three kilometers, viz., six kilometers, is achieved. Thereafter, the time increment corresponds to the residence time of the vehicle in any one three-kilometer altitude band. Because the vehicle ascends, and near the end of its launch phase descends slightly and then reascends, exhaust products are ejected into the atmosphere in the 114 to 117 km altitude band during three different time periods, in the 117 to 120 km altitude band during two different time periods, and in the 120 to 123 km altitude band during two different time periods. The amounts ejected into each of these altitude bands were not summed because of the multiple values in time interval which would then have resulted.

One further feature of Table 6A is perhaps worth noting: Because the SRMs are separated from the Space Shuttle Vehicle at 120.5 seconds after ignition and because certain species are emitted only by the SRMs, only zeros appear in the columns corresponding to these species and in those rows whose minimum time is equal to or greater than 120.5 seconds.

Tables 7A and 7B present information corresponding to that presented by Tables 6A and 6B, respectively, but pertinent to a Space Shuttle Vehicle Mission 3A ascent trajectory rather than the Mission 1 ascent trajectory. Minor differences between the time-altitude intervals presented in Tables 7A and 7B as compared with intervals presented in Tables 6A and 6B can be found: In the case of the Mission 3A ascent trajectory, two-second time increments are employed to forty seconds; the transition to three-kilometer increments is made from that time. Also, as can be seen in Table 2A or 2B, the SRMs are jettisoned from the Space Shuttle Vehicle at 125.9 seconds in the case of the Mission 3A ascent trajectory.

The mass flow rate of each of the major species ejected and/or entrained by the two SSV SRMs is presented as a function of time for Mission 1 in Figure 5A and for Mission 3A in Figure 5B. The total mass of each of the major species ejected and/or entrained by the two SSV SRMs as a function of time is presented for Missions 1 and 3A by Figures 6A and 6B, respectively. The reader is again cautioned that the quantity of each species generated by afterburning or entrained in the process of afterburning has been calculated under the assumption of complete afterburning of the rocket motor exhaust products present at the nozzle exit planes with a stoichiometrically equivalent quantity of atmospheric air.

SECTION IV

CONCLUDING REMARKS

In this Memorandum, only two extremes of exhaust gas composition, specifically, that at the rocket exits and that resulting from complete afterburning with a stoichiometrically equivalent amount of air, have been considered. In reality, the afterburning will always be incomplete, and yet, at least at the lower altitudes more than the stoichiometrically equivalent amount of air will be entrained by the rocket exhaust jets. Furthermore, the high temperatures generated in the mixing layer between the exhaust jets and the free stream under some flight conditions, coupled with the initially high stagnation temperature of the exhaust gases and further enhanced by afterburning, may lead to further chemical reactions, for example, to the formation of significant amounts of the oxides of nitrogen.

Another mechanism for increasing the mass fraction of certain constituents finally deposited in the atmosphere by the rocket motors is the pattern of locally strong shock waves which develop in a rocket exhaust jet downstream of the nozzle exit plane when the exhaust gas pressure at the nozzle exit is not equal to the local ambient static pressure. For the usual nozzle or set of nozzles exhausting into a base region, some system of recompression shocks in the exhaust jets is virtually always present. The passage of the exhaust gases through these strong recompressions provides conditions favorable to considerable further alteration of the exhaust gas composition.

Further limitation of the present analysis results from failure of the chemical assays of the propellants to include minor species which may, nonetheless, be important in determining the impact of the combustion products emitted by the rocket motor on the environment. Examples of these species would be sulphur and the alkali metals and compounds containing these elements.

While the remarks presented above are entirely qualitative, persistent attempts to quantify some of these effects have been reported (Refs. 8, 9, 10, 11, and 12). Reference 8 presents overall plume enhancement factors (OPEFs) for the NO_x produced by SSV SRMs at fifteen and thirty kilometers altitude of 4.9 and 1.7, respectively. Thus, as a result of the Mach disk (a type of locally-strong recompression shock) on the axis of the exhaust jet and of afterburning at the boundary between the jet and free stream, the amount of NO_x added to the atmosphere is about five times that present at the SRM nozzle exits when the altitude of the SSV is fifteen kilometers and almost two times that present at the nozzle exits when the altitude is thirty kilometers. In the particular case of the space shuttle, as Hwang and Pergament (Ref. 8) point out, even this enhanced emission of NO_x by the SRMs is completely negligible by comparison with the large amounts of hydrogen chloride emitted by these engines in as much as chlorine (derived photolytically from the hydrogen chloride) is probably at least as effective as NO_x in causing the destruction of ozone in the stratosphere (cf. the first sentence of Section III C in Ref. 8).

Several possible effects that SRM-emitted Al_2O_3 and/or products derived from this Al_2O_3 might have on the environment have been studied. Reference 13 summarizes the results of studies whose purpose was to determine the fractional decrease in terrestrial insolation that would result from five hundred launches of the SSV in a ten year period. (A probable maximum fractional decrease of the order of 10^{-5} was predicted.) Reference 8 outlined some additional features that those authors were incorporating into their Atmospheric Interaction Plume Program (AIPP) at the time that report was written. These features are intended to (1) account for the possible heterogeneous chemical processes whereby the recombination of certain gas phase species might take place on the surfaces of the Al_2O_3 particles, (2) account for the possible action of the Al_2O_3 particles as nuclei for the heterogeneous condensation of other exhaust gas species, and (3) account for the growth and agglomeration of particles, once formed.

REFERENCES

1. Solid Propellant Engineering Staff, Nozzle Exit Exhaust Products from Space Shuttle Boost Vehicle, NASA TM 33-712 Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA (February 1, 1975).

2. B. C. Johnson, "IV BC#2 Mission 1 Ascent Reference Trajectory For August Launch - Includes August Mean Wind and 81°F SRM Bulk Temperature", Rockwell International Space Division - Downey, Internal Letter No. SAS/MR&I-76-075 (July 27, 1976).

3. B. C. Johnson, IV BC#2 Mission 1 Ascent Reference Trajectory For February Launch - Includes February Mean Wind and 60°F SRM Bulk Temperature", Rockwell International Space Division - Downey, Internal Letter SAS/MR&I-76-074 (July 27, 1976).

4. B. C. Johnson, IV BC#2 Mission 3A Ascent Reference Trajectory For December Launch - Includes December Mean Wind and 52°F SRM Bulk Temperature", Rockwell International Space Division - Downey, Internal Letter SAS/MR&I-76-043 (May 6, 1976).

5. B. C. Johnson, "IV BC#2 Mission 3A Ascent Reference Trajectory For August Launch - Includes August Mean Wind and 60°F SRM Bulk Temperature", Rockwell International Space Division - Downey, Internal Letter SAS/MR&I-76-054 (May 6, 1976).

6. Author not known, "TC227A-75 SRM Performance Data for Various Temperatures", Thiokol Chemical Corporation 7010/LB-75-504 (October 24, 1975).

7. Unpublished computer program solution to problem No. 76003 obtained by K. E. Duncan on April 12, 1976 using the JPL modification of the KRUZE program. Problem Parameters: Shuttle baseline propellant (PBAN; 86% solids; 16% Al; 0.4% Fe_2O_3); P_c = 650 psia; ϵ = 7.38.

8. B. C. Hwang and H. S. Pergament, "Environmental Effects of Space Shuttle Solid Motor Exhaust Plumes", NASA CR-145079 (AEROCHEM TP-343) AeroChem Research Laboratories, Inc., Princeton, N.J. (July 1976).

9. H. S. Pergament and R. D. Thorpe, "NO_x Deposited in the Stratosphere by the Space Shuttle", NASA CR-132715 (AEROCHEM TN-161) AeroChem Research Laboratories, Inc., Princeton, N.J. (July 1975).

10. R. B. Stewart and R. I. Gomberg, "The Production of Nitric Oxide in the Troposphere as a Result of Solid-Rocket-Motor Afterburning", NASA TN D-8137, NASA, Washington, D.C. (March 1976).

11. R. A. Rhein, "Some Environmental Considerations Relating to the Interaction of the Solid Rocket Motor Exhaust With the Atmosphere: Predicted Chemical Composition of Exhaust Species and Predicted Conditions for the Formation of HCl Aerosol", NASA TM 33-659, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA (December 1, 1973).

12. G. L. Gregory and R. W. Storey, Jr., "Effluent Sampling of Titan IIIC Vehicle Exhaust", NASA TM X-3228, NASA, Washington, D.C. (August 1975).

13. D. J. Kessler, "Current Assessment of the Effect of Aluminum Compound Emission from the Space Shuttle," Johnson Space Center Internal Note JSC 09913, NASA Lyndon B. Johnson Space Center, Houston, Texas (August 1975).

Table 1A. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units)

* TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
1 .0	2031.	.000	.056	.0	.00	90.9	0.	2510.50	0.	.00	5701.	4462.51	1278.	.00
0 .3	2030.	.000	.056	.0	.00	109.0	17924.	2558.50	7005.	.72	6836.	4464.48	1531.	.42
0 .3	2030	.000	.056	.0	.00	109.0	17924.	2558.50	7005.	.72	6836.	4464.48	1531.	.42
2 2.0	2011.	.008	.062	81.3	.02	109.0	26493.	2564.28	10332.	17.84	6836.	4464.48	1531.	3.02
0 4.0	1987.	.019	.088	81.9	.05	109.0	27099.	2563.99	10569.	38.75	6836.	4464.48	1531.	6.09
0 6.0	1962.	.030	.136	82.4	.09	109.0	27688.	2563.67	10800.	60.13	6836.	4464.48	1531.	9.15
3 6.0	1962.	.030	.136	82.4	.09	109.0	27688.	2563.67	10800.	60.13	6836.	4464.48	1531.	9.15
0 8.0	1937.	.042	.208	82.8	.12	109.0	28001.	2563.15	10924.	81.85	6836.	4464.48	1531.	12.21
0 10.0	1912.	.055	.305	83.3	.16	109.0	28200.	2562.67	11004.	103.78	6836.	4464.48	1531.	15.27
0 12.0	1887.	.069	.429	83.3	.20	109.0	28381.	2562.05	11078.	125.87	6836.	4464.48	1531.	18.33
0 14.0	1862.	.083	.580	82.7	.24	109.0	28563.	2561.16	11152.	148.10	6836.	4464.48	1531.	21.39
4 16.0	1836.	.098	.760	81.4	.29	109.0	28750.	2561.43	11224.	170.48	6836.	4464.48	1531.	24.46
0 16.0	1836.	.098	.760	81.4	.29	109.0	28750.	2561.43	11224.	170.48	6836.	4464.48	1531.	24.46
0 18.0	1811.	.114	.969	79.8	.33	109.0	28910.	2561.03	11289.	192.99	6836.	4464.48	1531.	27.52
0 20.0	1785.	.130	1.209	78.1	.38	109.0	28968.	2560.61	11313.	215.59	6836.	4464.48	1531.	30.58
0 22.0	1760.	.147	1.480	76.5	.43	109.0	28252.	2559.76	11037.	237.95	6836.	4464.48	1531.	33.64
0 24.0	1735.	.163	1.781	74.9	.48	109.0	26838.	2558.49	10490.	259.47	6836.	4464.48	1531.	36.70
0 26.0	1711.	.179	2.110	73.4	.53	109.0	26076.	2557.59	10195.	280.15	6836.	4464.48	1531.	39.77
0 28.0	1688.	.194	2.465	71.9	.57	109.0	25409.	2556.80	9938.	300.28	6836.	4464.48	1531.	42.83
0 30.0	1566.	.209	2.845	70.6	.62	109.0	24803.	2556.03	9704.	319.92	6836.	4464.48	1531.	45.89
0 32.0	1643.	.223	3.252	69.3	.67	109.0	24248.	2555.33	9489.	339.12	6836.	4464.48	1531.	48.95

0	34.0	1621.	.238	3.683	68.2	.71	109.0	23717.	2554.62	9284.	357.89	6836.	4464.48	1531.	52.01
0	36.0	1600.	.253	4.137	67.1	.76	109.0	23210.	2553.95	9088.	376.26	6836.	4464.48	1531.	55.07
0	38.0	1579.	.267	4.614	66.1	.81	109.0	22720.	2553.23	8899.	394.25	6836.	4464.48	1531.	58.14
0	39.0	1568.	.274	4.864	65.6	.83	109.0	22477.	2552.86	8805.	403.13	6836.	4464.48	1531.	59.67
0	40.0	1558.	.282	5.115	65.2	.86	101.4	22236.	2552.52	8711.	411.86	6360.	4463.65	1425.	61.14
0	42.0	1538.	.294	5.636	64.2	.90	86.2	21782.	2551.91	8536.	429.11	5406.	4462.00	1212.	63.78
0	44.0	1519.	.306	6.174	63.2	.94	71.0	21428.	2551.29	8399.	446.05	4453.	4460.34	998.	65.99
0	46.0	1501.	.317	6.728	62.1	.98	71.0	21171.	2550.74	8300.	462.75	4453.	4460.34	998.	67.99
0	48.0	1482.	.328	7.295	61.1	1.03	71.0	20855.	2550.22	8178.	479.23	4453.	4460.34	998.	69.98
0	50.0	1464.	.339	7.876	60.0	1.07	71.0	20904.	2549.96	8198.	495.60	4453.	4460.34	998.	71.98
0	52.0	1445.	.351	8.470	59.0	1.12	71.0	21046.	2549.75	8254.	512.05	4453.	4460.34	998.	73.98
0	54.0	1427.	.363	9.078	58.0	1.17	71.0	20954.	2549.46	8219.	528.53	4453.	4460.34	998.	75.97
0	56.0	1408.	.376	9.702	57.0	1.22	71.0	21092.	2549.38	8273.	545.01	4453.	4460.34	998.	77.97
0	58.0	1390.	.391	10.342	56.1	1.28	71.0	21360.	2549.31	8379.	561.67	4453.	4460.34	998.	79.97
0	60.0	1371.	.406	11.000	55.2	1.35	71.0	21643.	2549.25	8490.	578.53	4453.	4460.34	998.	81.96
5	60.8	1364.	.412	11.251	54.9	1.38	71.0					4453.	4460.34	998.	82.76
0	62.0	1352.	.423	11.677	54.3	1.42	71.0	21925.	2549.22	8601.	595.62	4453.	4460.34	998.	83.96
0	64.0	1332.	.441	12.374	53.4	1.50	71.0	22173.	2549.18	8698.	612.92	4453.	4460.34	998.	85.96
0	66.0	1313.	.461	13.093	52.5	1.58	86.2	22426.	2549.13	8798.	630.42	5406.	4462.00	1212.	88.17
0	68.0	1292.	.484	13.838	51.6	1.67	101.4	22679.	2549.04	8897.	648.12	6360.	4463.65	1425.	90.80
0	69.0	1261.	.496	14.225	51.1	1.73	109.0	22761.	2548.96	8930.	657.04	6836.	4464.48	1531.	92.28
0	70.0	1272.	.510	14.612	50.7	1.78	109.0	22839.	2548.89	8960.	665.98	6836.	4464.48	1531.	93.81
0	72.0	1251.	.537	15.416	49.7	1.88	109.0	22960.	2548.72	9009.	683.95	6836.	4464.48	1531.	96.87
0	74.0	1229.	.566	16.251	48.7	1.99	109.0	23053.	2548.51	9046.	702.00	6836.	4464.48	1531.	99.94
0	76.0	1208.	.596	17.118	47.8	2.10	109.0	23133.	2548.32	9078.	720.13	6836.	4464.48	1531.	103.00
0	78.0	1187.	.628	18.017	46.8	2.21	109.0	23136.	2548.11	9080.	738.28	6836.	4464.48	1531.	106.06
0	80.0	1166.	.661	18.948	45.8	2.31	109.0	22824.	2547.59	8959.	756.32	6836.	4464.48	1531.	109.12
0	82.0	1145.	.695	19.910	44.7	2.42	109.0	22320.	2546.96	8763.	774.04	6836.	4464.48	1531.	112.18
0	84.0	1125.	.729	20.903	43.7	2.53	109.0	21909.	2546.39	8604.	791.41	6836.	4464.48	1531.	115.25

Table 1A. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units) Continuation 1

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
0	86.0	1105.	.764	21.925	42.7	2.63	109.0	21598.	2545.78	8484.	808.50	6836.	4464.48	1531.	118.31
0	88.0	1085.	.800	22.977	41.8	2.75	109.0	21281.	2545.01	8362.	825.34	6836.	4464.48	1531.	121.37
0	90.0	1065.	.837	24.057	40.9	2.86	109.0	20955.	2544.21	8237.	841.94	6836.	4464.48	1531.	124.43
0	92.0	1046.	.874	25.166	40.0	2.97	109.0	20608.	2543.40	8103.	858.28	6836.	4464.48	1531.	127.49
0	94.0	1026.	.913	26.302	39.1	3.09	109.0	20232.	2542.58	7957.	874.34	6836.	4464.48	1531.	130.55
0	96.0	1008.	.951	27.467	38.2	3.21	109.0	19787.	2541.60	7785.	890.08	6836.	4464.48	1531.	133.62
0	98.0	989.	.991	28.658	37.4	3.33	109.0	19293.	2540.66	7594.	905.46	6836.	4464.48	1531.	136.68
0	100.0	971.	1.030	29.874	36.6	3.44	109.0	18819.	2539.71	7410.	920.47	6836.	4464.48	1531.	139.74
0	102.0	953.	1.070	31.116	35.9	3.56	109.0	18370.	2538.76	7236.	935.11	6836.	4464.48	1531.	142.80
0	104.0	936.	1.110	32.383	35.1	3.66	109.0	17898.	2537.85	7052.	949.40	6836.	4464.48	1531.	145.86
0	106.0	919.	1.151	33.673	34.4	3.77	109.0	17407.	2536.85	6862.	963.32	6836.	4464.48	1531.	148.92
0	108.0	902.	1.192	34.985	33.7	3.88	109.0	16902.	2535.82	6665.	976.85	6836.	4464.48	1531.	151.99
0	110.0	887.	1.232	36.319	33.1	3.99	109.0	15275.	2533.64	6029.	989.74	6836.	4464.48	1531.	155.05
0	110.0	887.	1.232	36.319	33.1	3.99	109.0	15275.	2533.64	6029.	989.74	6836.	4464.48	1531.	155.05
0	112.0	873.	1.267	37.671	32.4	4.07	109.0	11394.	2527.73	4508.	1000.41	6836.	4464.48	1531.	158.11
0	114.0	863.	1.292	39.032	31.8	4.13	109.0	7118.	2518.82	2826.	1007.63	6836.	4464.48	1531.	161.17
0	116.0	855.	1.310	40.394	31.3	4.16	109.0	4018.	2509.65	1601.	1012.02	6836.	4464.48	1531.	164.23
0	118.0	850.	1.322	41.750	30.7	4.17	109.0	1824.	2497.09	730.	1014.28	6836.	4464.48	1531.	167.30
0	120.0	846.	1.330	43.095	30.2	4.18	109.0	337.	2470.81	136.	1015.03	6836.	4464.48	1531.	170.36
0	120.5	845.	1.332	43.433	30.1	4.18	109.0	204.	2463.05	83.	1015.09	6836.	4464.48	1531.	171.12
6	120.5	687.	1.332	43.433	30.1	4.18	109.0					6836.	4464.48	1531.	171.12
0	128.0	676.	1.369	48.356	28.1	4.24	109.0					6836.	4464.48	1531.	182.60

0	144.0	651.	1.463	58.287	24.1	4.70	109.0	6836.	4464.48	1531.	207.10
0	160.0	627.	1.571	67.452	20.5	5.34	109.0	6836.	4464.48	1531.	231.59
0	176.0	602.	1.693	75.896	17.4	6.08	109.0	6836.	4464.48	1531.	256.09
0	192.0	578.	1.827	83.666	14.8	6.91	109.0	6836.	4464.48	1531.	280.58
0	208.0	553.	1.975	90.814	12.5	7.40	109.0	6836.	4464.48	1531.	305.08
0	224.0	529.	2.135	97.398	10.7	7.60	109.0	6836.	4464.48	1531.	329.57
0	240.0	504.	2.307	103.478	9.1	7.74	109.0	6836.	4464.48	1531.	354.06
7	250.5	488.	2.428	107.235	8.3	7.82	109.0	6836.	4464.48	1531.	370.14
0	250.5	488.	2.428	107.235	8.3	7.71	109.0	6836.	4464.48	1531.	370.14
0	256.0	480.	2.498	109.077	7.5	7.79	109.0	6836.	4464.48	1531.	378.56
0	264.0	467.	2.603	111.524	6.4	7.82	109.0	6836.	4464.48	1531.	390.81
0	272.0	455.	2.712	113.691	5.4	7.84	109.0	6836.	4464.48	1531.	403.05
0	280.0	443.	2.826	115.585	4.5	7.92	109.0	6836.	4464.48	1531.	415.30
0	288.0	431.	2.944	117.215	3.7	8.05	109.0	6836.	4464.48	1531.	427.55
0	296.0	418.	3.066	118.590	2.9	8.22	109.0	6836.	4464.48	1531.	439.79
0	304.0	406.	3.193	119.718	2.3	8.42	109.0	6836.	4464.48	1531.	452.04
0	312.0	394.	3.325	120.612	1.7	8.59	109.0	6836.	4464.48	1531.	464.29
0	320.0	382.	3.461	121.281	1.2	8.78	109.0	6836.	4464.48	1531.	476.54
0	328.0	369.	3.603	121.738	.7	9.04	109.0	6836.	4464.48	1531.	488.78
0	336.0	357.	3.750	121.996	.3	9.35	109.0	6836.	4464.48	1531.	501.03
0	344.0	345.	3.902	122.068	-.0	9.71	109.0	6836.	4464.48	1531.	513.28
0	352.0	333.	4.060	121.971	-.3	10.13	109.0	6836.	4464.48	1531.	525.52
0	360.0	320.	4.225	121.721	-.5	10.60	109.0	6836.	4464.48	1531.	537.77
0	368.0	308.	4.396	121.336	-.7	11.14	109.0	6836.	4464.48	1531.	550.02
0	376.0	296.	4.575	120.835	-.9	11.75	109.0	6836.	4464.48	1531.	562.27
0	384.0	284.	4.761	120.241	-.9	12.42	109.0	6836.	4464.48	1531.	574.51
0	392.0	271.	4.955	119.578	-1.0	13.09	109.0	6836.	4464.48	1531.	586.76
0	400.0	259.	5.159	118.870	-1.0	13.77	109.0	6836.	4464.48	1531	599.01
0	408.0	247.	5.373	118.148	-.9	14.49	109.0	6836.	4464.48	1531.	611.25

Table 1A. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units) Continuation 2

* TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
0 416.0	235.	5.597	117.443	-.9	15.25	109.0					6836.	4464.48	1531.	623.50
12 417.6	232.	5.644	117.305	-.8	15.41	109.0					6836.	4464.48	1531.	625.95
0 417.6	232.	5.644	117.305	-.8	15.41	109.0					6836.	4464.48	1531.	625.95
0 424.0	223.	5.830	116.788	-.7	16.05	104.5					6554.	4463.99	1468.	635.55
0 432.0	211.	6.063	116.212	-.6	16.83	99.1					6216.	4463.40	1393.	646.99
0 440.0	200.	6.296	115.739	-.5	17.61	94.0					5896.	4462.84	1321.	657.84
0 448.0	190.	6.529	115.393	-.3	18.36	89.2					5595.	4462.32	1254.	668.14
0 456.0	180.	6.761	115.202	-.1	19.07	84.6					5306.	4461.82	1189.	677.91
0 464.0	171.	6.994	115.195	.1	19.73	80.3					5036.	4461.35	1129.	687.18
0 472.0	162.	7.227	115.402	.3	20.32	76.1					4773.	4460.89	1070.	695.97
13 478.2	156.	7.408	115.732	.5	20.72	73.0					4579.	4460.55	1026.	702.47

* FLIGHT MILESTONES
1 SOLID ROCKET MOTORS IGNITION COMMAND
2 LIFT-OFF
3 END OF VERTICAL ASCENT AND BEGINNING OF PITCH PROGRAM
4 END OF PITCH PROGRAM
5 MAXIMUM DYNAMIC PRESSURE
6 SOLID ROCKET MOTORS JETTISONNED
7 RETURN TO LANDING SITE OR AROUND-ONCE-ABORT FINAL DECISION POINT
12 NOMINAL MISSION 3-G LIMIT ACHIEVED
13 NOMINAL MISSION MAIN ENGINE CUT-OFF

Table 1B. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (Engish Units)

•	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS/ VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
1	.0	4478.	0.	183.	.0	.00	90.9	0.	256.00	0.	.00	1282.	455.05	2817.	.00
0	.3	4476.	0.	183.	.0	.00	109.0	4029.	260.89	15444.	1.59	1537.	455.25	3376.	.93
0	.3	4476.	0.	183.	.0	.00	109.0	4029.	260.89	15444.	1.59	1537.	455.25	3376.	.93
2	2.0	4432.	26.	204.	81.3	.02	109.0	5956.	261.48	22777.	39.34	1537.	455.25	3376.	6.67
0	4.0	4380.	61.	289.	81.9	.05	109.0	6092.	261.45	23301.	85.43	1537.	455.25	3376.	13.42
3	6.0	4326.	99.	446.	82.4	.09	109.0	6225.	261.42	23810.	132.55	1537.	455.25	3376.	20.17
0	6.0	4326.	99.	446.	82.4	.09	109.0	6225.	261.42	23810.	132.55	1537.	455.25	3376.	20.17
0	8.0	4271.	139.	682.	82.8	.12	109.0	6295.	261.37	24084.	180.45	1537.	455.25	3376.	26.92
0	10.0	4216.	182.	1001.	83.3	.16	109.0	6340.	261.32	24260.	228.80	1537.	455.25	3376.	33.67
0	12.0	4161.	227.	1406.	83.3	.20	109.0	6380.	261.26	24422.	277.49	1537.	455.25	3376.	40.42
0	14.0	4105.	273.	1902.	82.7	.24	109.0	6421.	261.17	24587.	326.50	1537.	455.25	3376.	47.17
4	16.0	4049.	322.	2492.	81.4	.29	109.0	6463.	261.19	24745.	375.83	1537.	455.25	3376.	53.92
0	16.0	4049.	322.	2492.	81.4	.29	109.0	6463.	261.19	24745.	375.83	1537.	455.25	3376.	53.92
0	18.0	3992.	374.	3179.	79.8	.33	109.0	6499.	261.15	24887.	425.47	1537.	455.25	3376.	60.67
0	20.0	3936.	428.	3966.	78.1	.38	109.0	6512.	261.11	24941.	475.30	1537.	455.25	3376.	67.42
0	22.0	3879.	483.	4855.	76.5	.43	109.0	6351.	261.02	24332.	524.59	1537.	455.25	3376.	74.17
0	24.0	3825.	536.	5842.	74.9	.48	109.0	6033.	260.89	23126.	572.02	1537.	455.25	3376.	80.92
0	26.0	3773.	586.	6921.	73.4	.53	109.0	5862.	260.80	22477.	617.62	1537.	455.25	3376.	87.67
0	28.0	3722.	636.	8088.	71.9	.57	109.0	5712.	260.72	21909.	662.00	1537.	455.25	3376.	94.42
0	30.0	3672.	685.	9338.	70.6	.62	109.0	5576.	260.64	21393.	705.30	1537.	455.25	3376.	101.17
0	32.0	3623.	733.	10670.	69.3	.67	109.0	5451.	260.57	20920.	747.62	1537.	455.25	3376.	107.92
0	34.0	3575.	782.	12082.	68.2	.71	109.0	5332.	260.50	20468.	789.01	1537.	455.25	3376.	114.67

0	36.0	3527.	830.	13572.	67.1	.76	109.0	5218.	260.43	20036.	829.51	1537.	455.25	3376.	121.42
0	38.0	3481.	877.	15139.	66.1	.81	109.0	5108.	260.36	19618.	869.17	1537.	455.25	3376.	128.17
0	39.0	3458.	900.	15959.	65.6	.83	109.0	5053.	260.32	19411.	888.73	1537.	455.25	3376.	131.54
0	40.0	3436.	924.	16780.	65.2	.86	101.4	4999.	260.28	19205.	907.99	1430.	455.17	3141.	134.80
0	42.0	3392.	966.	18490.	64.2	.90	86.2	4897.	260.22	18818.	946.02	1215.	455.00	2671.	140.61
0	44.0	3350.	1004.	20257.	63.2	.94	71.0	4817.	260.16	18517.	983.35	1001.	454.83	2201.	145.48
0	46.0	3308.	1040.	22073.	62.1	.98	71.0	4759.	260.10	18298.	1020.17	1001.	454.83	2201.	149.88
0	48.0	3268.	1076.	23934.	61.1	1.03	71.0	4688.	260.05	18028.	1056.50	1001.	454.83	2201.	154.29
0	50.0	3227.	1112.	25838.	60.0	1.07	71.0	4700.	260.02	18073.	1092.60	1001.	454.83	2201.	158.69
0	52.0	3186.	1151.	27787.	59.0	1.12	71.0	4731.	260.00	18197.	1128.87	1001.	454.83	2201.	163.09
0	54.0	3146.	1192.	29784.	58.0	1.17	71.0	4711.	259.97	18119.	1165.19	1001.	454.83	2201.	167.49
0	56.0	3105.	1235.	31830.	57.0	1.22	71.0	4742.	259.96	18239.	1201.54	1001.	454.83	2201.	171.89
0	58.0	3064.	1282.	33930.	56.1	1.28	71.0	4802.	259.96	18472.	1238.25	1001.	454.83	2201.	176.30
0	60.0	3022.	1333.	36088.	55.2	1.35	71.0	4865.	259.95	18717.	1275.43	1001.	454.83	2201.	180.70
5	60.8	3007.	1353.	36913.	54.9	1.38	71.0					1001.	454.83	2201.	182.46
0	62.0	2980.	1388.	38309.	54.3	1.42	71.0	4929.	259.95	18961.	1313.10	1001.	454.83	2201.	185.10
0	64.0	2938.	1448.	40597.	53.4	1.50	71.0	4985.	259.94	19176.	1351.24	1001.	454.83	2201.	189.50
0	66.0	2894.	1514.	42957.	52.5	1.58	86.2	5042.	259.94	19395.	1389.82	1215.	455.00	2671.	194.37
0	68.0	2849.	1589.	45402.	51.6	1.67	101.4	5098.	259.93	19615.	1428.84	1430.	455.17	3141.	200.19
0	69.0	2780.	1627.	46671.	51.1	1.73	109.0	5117.	259.92	19686.	1448.51	1537.	455.25	3376.	203.44
0	70.0	2803.	1673.	47940.	50.7	1.78	109.0	5134.	259.91	19754.	1468.21	1537.	455.25	3376.	206.82
0	72.0	2757.	1763.	50578.	49.7	1.88	109.0	5162.	259.90	19860.	1507.83	1537.	455.25	3376.	213.57
0	74.0	2710.	1857.	53317.	48.7	1.99	109.0	5182.	259.88	19942.	1547.63	1537.	455.25	3376.	220.32
0	76.0	2664.	1956.	56161.	47.8	2.10	109.0	5200.	259.86	20013.	1587.59	1537.	455.25	3376.	227.07
0	78.0	2617.	2060.	59110.	46.8	2.21	109.0	5201.	259.83	20017.	1627.62	1537.	455.25	3376.	233.82
0	80.0	2570.	2169.	62165.	45.8	2.31	109.0	5131.	259.78	19752.	1667.39	1537.	455.25	3376.	240.57
0	82.0	2524.	2279.	65323.	44.7	2.42	109.0	5018.	259.72	19320.	1706.45	1537.	455.25	3376.	247.32
0	84.0	2479.	2391.	68579.	43.7	2.53	109.0	4925.	259.66	18968.	1744.74	1537.	455.25	3376.	254.07
0	86.0	2435.	2506.	71933.	42.7	2.63	109.0	4856.	259.60	18704.	1782.41	1537.	455.25	3376.	260.82

Table 1B. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (English Units) Continuation 1

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MAIN ENGINES/ VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	MASS EXPENDED
	SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
0	88.0	2391.	2624.	75382.	41.8	2.75	109.0	4784.	259.52	18435.	1819.54	1537.	455.25	3376.	267.57
0	90.0	2348.	2745.	78927.	40.9	2.86	109.0	4711.	259.44	18158.	1856.14	1537.	455.25	3376.	274.32
0	92.0	2305.	2868.	82565.	40.0	2.97	109.0	4633.	259.35	17863.	1892.16	1537.	455.25	3376.	281.07
0	94.0	2263.	2994.	86294.	39.1	3.09	109.0	4548.	259.27	17543.	1927.56	1537.	455.25	3376.	287.82
0	96.0	2221.	3121.	90114.	38.2	3.21	109.0	4448.	259.17	17163.	1962.27	1537.	455.25	3376.	294.57
0	98.0	2181.	3250.	94021.	37.4	3.33	109.0	4337.	259.08	16741.	1996.18	1537.	455.25	3376.	301.32
0	100.0	2141.	3379.	98013.	36.6	3.44	109.0	4231.	258.98	16336.	2029.26	1537.	455.25	3376.	308.07
0	102.0	2102.	3511.	102088.	35.9	3.56	109.0	4130.	258.88	15952.	2061.55	1537.	455.25	3376.	314.82
0	104.0	2064.	3643.	106242.	35.1	3.66	109.0	4024.	258.79	15548.	2093.05	1537.	455.25	3376.	321.57
0	106.0	2026.	3776.	110474.	34.4	3.77	109.0	3913.	258.69	15128.	2123.73	1537.	455.25	3376.	328.32
0	108.0	1990.	3910.	114780.	33.7	3.88	109.0	3800.	258.58	14694.	2153.56	1537.	455.25	3376.	335.07
0	110.0	1954.	4041.	119157.	33.1	3.99	109.0	3434.	258.36	13292.	2181.99	1537.	455.25	3376.	341.82
0	110.0	1954.	4041.	119157.	33.1	3.99	109.0	3434.	258.36	13292.	2181.99	1537.	455.25	3376.	341.82
0	112.0	1924.	4156.	123592.	32.4	4.07	109.0	2562.	257.76	9938.	2205.51	1537.	455.25	3376.	348.57
0	114.0	1902.	4240.	128059.	31.8	4.13	109.0	1600.	256.85	6230.	2221.42	1537.	455.25	3376.	355.32
0	116.0	1885.	4299.	132527.	31.3	4.16	109.0	903.	255.91	3530.	2231.10	1537.	455.25	3376.	362.07
0	118.0	1873.	4338.	136975.	30.7	4.17	109.0	410.	254.63	1610.	2236.09	1537.	455.25	3376.	368.82
0	120.0	1865.	4363.	141387.	30.2	4.18	109.0	76.	251.95	300.	2237.74	1537.	455.25	3376.	375.57
0	120.5	1863.	4369.	142496.	30.1	4.18	109.0	46.	251.16	182.	2237.86	1537.	455.25	3376.	377.26
6	120.5	1515.	4369.	142496.	30.1	4.18	109.0					1537.	455.25	3376.	377.26
0	128.0	1490.	4493.	158648.	28.1	4.24	109.0					1537.	455.25	3376.	402.57
0	144.0	1436.	4800.	191230.	24.1	4.70	109.0					1537.	455.25	3376.	456.57

0	160.0	1382.	5155.	221299.	20.5	5.34	109.0	1537.	455.25	3376.	510.57
0	176.0	1328.	5555.	249002.	17.4	6.08	109.0	1537.	455.25	3376.	564.57
0	192.0	1274.	5995.	274494.	14.8	6.91	109.0	1537.	455.25	3376.	618.57
0	208.0	1220.	6480.	297948.	12.5	7.40	109.0	1537.	455.25	3376.	672.57
0	224.0	1166.	7004.	319547.	10.7	7.60	109.0	1537.	455.25	3376.	726.57
0	240.0	1112.	7570.	339496.	9.1	7.74	109.0	1537.	455.25	3376.	780.57
7	250.5	1076.	7966.	351822.	8.3	7.82	109.0	1537.	455.25	3376.	816.01
0	250.5	1076.	7966.	351822.	8.3	7.71	109.0	1537.	455.25	3376.	816.01
0	256.0	1058.	8195.	357864.	7.5	7.79	109.0	1537.	455.25	3376.	834.57
0	264.0	1031.	8540.	365893.	6.4	7.82	109.0	1537.	455.25	3376.	861.57
0	272.0	1004.	8899.	373002.	5.4	7.84	109.0	1537.	455.25	3376.	888.57
0	280.0	977.	9272.	379216.	4.5	7.92	109.0	1537.	455.25	3376.	915.57
0	288.0	950.	9659.	384564.	3.7	8.05	109.0	1537.	455.25	3376.	942.57
0	296.0	923.	10060.	389073.	2.9	8.22	109.0	1537.	455.25	3376.	969.57
0	304.0	896.	10477.	392777.	2.3	8.42	109.0	1537.	455.25	3376.	996.57
0	312.0	869.	10908.	395708.	1.7	8.59	109.0	1537.	455.25	3376.	1023.57
0	320.0	842.	11356.	397903.	1.2	8.78	109.0	1537.	455.25	3376.	1050.57
0	328.0	815.	11820.	399403.	.7	9.04	109.0	1537.	455.25	3376.	1077.57
0	336.0	787.	12302.	400249.	.3	9.35	109.0	1537.	455.25	3376.	1104.57
0	344.0	760.	12802.	400487.	-.0	9.71	109.0	1537.	455.25	3376.	1131.57
0	352.0	733.	13321.	400169.	-.3	10.13	109.0	1537.	455.25	3376.	1158.57
0	360.0	706.	13861.	399348.	-.5	10.60	109.0	1537.	455.25	3376.	1185.57
0	368.0	679.	14423.	398084.	-.7	11.14	109.0	1537.	455.25	3376.	1212.57
0	376.0	652.	15009.	396442.	-.9	11.75	109.0	1537.	455.25	3376.	1239.57
0	384.0	625.	15620.	394493.	-.9	12.42	109.0	1537.	455.25	3376.	1266.57
0	392.0	598.	16258.	392315.	-1.0	13.09	109.0	1537.	455.25	3376.	1293.57
0	400.0	571.	16927.	389994.	-1.0	13.77	109.0	1537.	455.25	3376.	1320.57
0	408.0	544.	17628.	387624.	-.9	14.49	109.0	1537.	455.25	3376.	1347.57
0	416.0	517.	18364.	385310.	-.9	15.25	109.0	1537.	455.25	3376.	1374.57

Table 1B. Mission 1: Selected Trajectory and Rocket Motor Information as a Function of Time (English Units) Continuation 2

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS/ VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
12	417.6	512.	18518.	384858.	-.8	15.41	109.0								
0	417.6	512.	18518.	384858.	-.8	15.41	109.0					1537.	455.25	3376.	1379.97
0	424.0	491.	19127.	383164.	-.7	16.05	104.5					1537.	455.25	3376.	1379.97
0	432.0	466.	19891.	381274.	-.6	16.83	99.1					1473.	455.20	3237.	1401.13
0	440.0	442.	20655.	379720.	-.5	17.61	94.0					1397.	455.14	3070.	1426.35
0	448.0	419.	21419.	378585.	-.3	18.36	89.2					1325.	455.08	2912.	1450.28
0	456.0	397.	22183.	377959.	-.1	19.07	84.6					1258.	455.03	2764.	1472.98
0	464.0	377.	22946.	377937.	.1	19.73	80.3					1193.	454.98	2622.	1494.52
0	472.0	358.	23709.	378617.	.3	20.32	76.1					1132.	454.93	2489.	1514.96
13	478.2	343.	24303.	379697.	.5	20.72	73.0					1073.	454.88	2359.	1534.34
												1029.	454.85	2263.	1548.67

* FLIGHT MILESTONES
1 SOLID ROCKET MOTORS IGNITION COMMAND
2 LIFT-OFF
3 END OF VERTICAL ASCENT AND BEGINNING OF PITCH PROGRAM
4 END OF PITCH PROGRAM
5 MAXIMUM DYNAMIC PRESSURE
6 SOLID ROCKET MOTORS JETTISONNED
7 RETURN TO LANDING SITE OR AROUND-ONCE-ABORT FINAL DECISION POINT
12 NOMINAL MISSION 3-G LIMIT ACHIEVED
13 NOMINAL MISSION MAIN ENGINE CUT-OFF

Table 2A. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units)

* TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
0 .0	2014.	.000	.159	.0	.00	90.9	0.	2510.50	0.	.00	5701.	4462.51	1278.	.00
1 .3	2013.	.000	.159	.0	.00	109.0	16243.	2556.96	6352.	.63	6836.	4464.48	1531.	.42
0 .3	2013.	.000	.159	.0	.00	109.0	16243.	2556.96	6352.	.63	6836.	4464.48	1531.	.42
0 2.0	1994.	.007	.165	79.8	.02	109.0	23600.	2388.58	9881.	16.95	6836.	4464.48	1531.	3.02
0 4.0	1971.	.017	.188	80.5	.05	109.0	25848.	2559.69	10098.	36.93	6836.	4464.48	1531.	6.09
2 6.0	1947.	.027	.232	81.0	.08	109.0	26455.	2563.73	10319.	57.35	6836.	4464.48	1531.	9.15
0 6.0	1947.	.027	.232	81.0	.08	109.0	26455.	2563.73	10319.	57.35	6836.	4464.48	1531.	9.15
0 8.0	1924.	.039	.297	81.7	.11	109.0	26765.	2563.24	10442.	78.11	6836.	4464.48	1531.	12.21
0 10.0	1900.	.051	.385	82.4	.15	109.0	26956.	2562.77	10518.	99.07	6836.	4464.48	1531.	15.27
0 12.0	1875.	.063	.498	82.9	.19	109.0	27124.	2562.31	10586.	120.18	6836.	4464.48	1531.	18.33
0 14.0	1851.	.076	.636	82.8	.22	109.0	27295.	2561.89	10654.	141.42	6836.	4464.48	1531.	21.39
3 16.0	1827.	.090	.800	81.8	.26	109.0	27466.	2561.57	10722.	162.79	6836.	4464.48	1531.	24.46
0 16.0	1827.	.090	.800	81.8	.26	109.0	27466.	2561.57	10722.	162.79	6836.	4464.48	1531.	24.46
0 18.0	1802.	.104	.992	80.2	.31	109.0	27615.	2561.17	10782.	184.30	6836.	4464.48	1531.	27.52
0 20.0	1777.	.119	1.212	78.6	.35	109.0	27762.	2560.82	10841.	205.92	6836.	4464.48	1531.	30.58
0 22.0	1753.	.135	1.461	77.1	.40	109.0	27645.	2560.34	10797.	227.56	6836.	4464.48	1531.	33.64
0 24.0	1729.	.151	1.739	75.6	.44	109.0	26219.	2559.05	10245.	248.60	6836.	4464.48	1531.	36.70
0 26.0	1705.	.166	2.045	74.2	.49	109.0	25345.	2558.05	9908.	268.75	6836.	4464.48	1531.	39.77
0 28.0	1683.	.180	2.376	72.8	.53	109.0	24697.	2557.28	9657.	288.31	6836.	4464.48	1531.	42.83
0 30.0	1661.	.194	2.732	71.5	.58	109.0	24104.	2556.51	9428.	307.40	6836.	4464.48	1531.	45.89
0 32.0	1639.	.208	3.111	70.2	.62	102.6	23570.	2555.81	9222.	326.05	6435.	4463.78	1442.	48.86

0	34.0	1618.	.221	3.513	68.9	.65	96.2	23071.	2555.14	9029.	344.30	6034.	4463.08	1352.	51.65
0	35.0	1607.	.228	3.714	68.3	.68	93.0	22828.	2554.81	8935.	353.27	5833.	4462.73	1307.	52.98
0	36.0	1597.	.234	3.936	67.7	.71	93.0	22587.	2554.46	8842.	362.17	5833.	4462.73	1307.	54.29
0	38.0	1577.	.247	4.378	66.5	.75	93.0	22130.	2553.82	8665.	379.67	5833.	4462.73	1307.	56.90
0	40.0	1558.	.259	4.839	65.4	.80	93.0	21681.	2553.11	8492.	396.83	5833.	4462.73	1307.	59.52
0	42.0	1538.	.272	5.319	64.2	.64	93.0	21238.	2552.46	8321.	413.64	5833.	4462.73	1307.	62.13
0	44.0	1519.	.284	5.817	63.1	.88	93.0	20826.	2551.88	8161.	430.12	5833.	4462.73	1307.	64.75
0	46.0	1500.	.297	6.331	62.0	.93	93.0	20507.	2551.28	8038.	446.32	5833.	4462.73	1307.	67.36
0	48.0	1482.	.309	6.862	60.9	.97	93.0	20272.	2550.75	7947.	462.31	5833.	4462.73	1307.	69.97
0	50.0	1463.	.321	7.409	59.9	1.02	93.0	19986.	2550.26	7837.	478.09	5833.	4462.73	1307.	72.59
0	52.0	1445.	.333	7.971	58.8	1.07	93.0	19993.	2549.98	7841.	493.77	5833.	4462.73	1307.	75.20
0	54.0	1427.	.347	8.548	57.8	1.12	93.0	20126.	2549.79	7893.	509.50	5833.	4462.73	1307.	77.81
0	56.0	1408.	.360	9.142	56.8	1.18	93.0	20083.	2549.52	7877.	525.27	5833.	4462.73	1307.	80.43
0	58.0	1390.	.375	9.752	55.9	1.24	93.0	20149.	2549.40	7904.	541.06	5833.	4462.73	1307.	83.04
0	60.0	1371.	.390	10.381	55.0	1.30	93.0	20372.	2549.33	7991.	556.95	5833.	4462.73	1307.	85.65
0	62.0	1353.	.407	10.725	54.1	1.37	99.4	20629.	2549.27	8092.	573.03	6234.	4463.43	1397.	88.36
0	64.0	1333.	.426	11.699	53.3	1.44	105.8	20888.	2549.23	8194.	589.32	6636.	4464.12	1486.	91.24
4	64.5	1329.	.431	11.871	53.1	1.46	107.4	20953.	2549.23	8219.	593.41	6736.	4464.30	1509.	91.99
0	65.0	1324.	.436	12.042	52.8	1.48	109.0	21014.	2549.22	8243.	597.52	6836.	4464.48	1531.	92.75
0	66.0	1314.	.447	12.390	52.4	1.52	109.0	21127.	2549.20	8288.	605.80	6836.	4464.48	1531.	94.28
0	68.0	1294.	.469	13.113	51.5	1.61	109.0	21357.	2549.15	8378.	622.47	6836.	4464.48	1531.	97.34
0	70.0	1274.	.493	13.858	50.5	1.69	109.0	21594.	2549.09	8471.	639.32	6836.	4464.48	1531.	100.40
0	72.0	1254.	.518	14.630	49.5	1.78	109.0	21782.	2548.97	8545.	656.34	6836.	4464.48	1531.	103.47
0	74.0	1234.	.544	15.430	48.6	1.88	109.0	21913.	2548.82	8597.	673.48	6836.	4464.48	1531.	106.53
0	76.0	1214.	.572	16.258	47.6	1.98	109.0	22013.	2548.64	8637.	690.71	6836.	4464.48	1531.	109.59
0	78.0	1193.	.602	17.115	46.6	2.08	109.0	22093.	2548.43	8669.	708.02	6836.	4464.48	1531.	112.65
0	80.0	1173.	.632	18.002	45.6	2.18	109.0	22166.	2548.28	8698.	725.39	6836.	4464.48	1531.	115.71
0	82.0	1152.	.665	18.919	44.7	2.28	109.0	22092.	2547.99	8671.	742.76	6836.	4464.48	1531.	118.77
0	84.0	1132.	.698	19.866	43.7	2.38	109.0	21746.	2547.46	8537.	759.96	6836.	4464.48	1531.	121.84

Table 2A. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units) Continuation 1

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF RATED MPS FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
0	86.0	1112.	.732	20.843	42.8	2.49	109.0	21294.	2546.87	8361.	776.86	6836.	4464.48	1531.	124.90
0	88.0	1092.	.767	21.849	41.8	2.59	109.0	20937.	2546.34	8223.	793.44	6836.	4464.48	1531.	127.96
0	90.0	1073.	.803	22.883	40.9	2.70	109.0	20652.	2545.72	8113.	809.78	6836.	4464.48	1531.	131.02
0	92.0	1054.	.839	23.945	40.0	2.81	109.0	20361.	2544.98	8001.	825.89	6836.	4464.48	1531.	134.08
0	94.0	1035.	.876	25.034	39.2	2.93	109.0	20062.	2544.22	7886.	841.78	6836.	4464.48	1531.	137.15
0	96.0	1016.	.914	26.151	38.4	3.04	109.0	19745.	2543.44	7763.	857.43	6836.	4464.48	1531.	140.21
0	98.0	998.	.953	27.295	37.6	3.16	109.0	19402.	2542.67	7631.	872.82	6836.	4464.48	1531.	143.27
0	100.0	980.	.992	28.465	36.8	3.29	109.0	19006.	2541.75	7478.	887.93	6836.	4464.48	1531.	146.33
0	102.0	962.	1.032	29.661	36.0	3.41	109.0	18553.	2540.81	7302.	902.71	6836.	4464.48	1531.	149.39
0	104.0	944.	1.072	30.882	35.3	3.52	109.0	18113.	2539.93	7131.	917.14	6836.	4464.48	1531.	152.45
0	106.0	927.	1.112	32.126	34.5	3.64	109.0	17697.	2538.99	6970.	931.24	6836.	4464.48	1531.	155.52
0	108.0	910.	1.153	33.394	33.8	3.75	109.0	17277.	2538.13	6807.	945.02	6836.	4464.48	1531.	158.58
0	110.0	894.	1.195	34.684	33.2	3.87	109.0	16829.	2537.23	6633.	958.46	6836.	4464.48	1531.	161.64
0	110.0	894.	1.195	34.684	33.2	3.87	109.0	16829.	2537.23	6633.	958.46	6836.	4464.48	1531.	161.64
0	112.0	878.	1.236	35.995	32.5	3.99	109.0	16372.	2536.23	6455.	971.55	6836.	4464.48	1531.	164.70
0	114.0	862.	1.277	37.327	31.8	4.10	109.0	15588.	2534.80	6150.	984.27	6836.	4464.48	1531.	167.76
0	116.0	847.	1.316	38.677	31.2	4.20	109.0	12968.	2531.22	5123.	995.65	6836.	4464.48	1531.	170.82
0	118.0	836.	1.348	40.039	30.6	4.28	109.0	8737.	2523.11	0.	1004.28	6836.	4464.48	1531.	173.89
0	120.0	827.	1.370	41.406	30.1	4.32	109.0	5449.	2515.22	2166.	1009.84	6836.	4464.48	1531.	176.95
5	122.0	821.	1.387	42.769	29.5	4.35	109.0	2886.	2505.13	0.	1013.12	6836.	4464.48	1531.	180.01
0	124.0	816.	1.398	44.123	29.0	4.36	109.0	1022.	2488.85	0.	1014.70	6836.	4464.48	1531.	183.07
6	125.9	813.	1.406	45.418	28.5	4.37	109.0	191.	2462.77	0.	1015.08	6836.	4464.48	1531.	185.98

0	125.9	655.	1.406	45.418	28.5	4.37	109.0
0	128.0	652.	1.417	46.793	28.0	4.39	109.0
0	144.0	627.	1.518	56.983	23.9	4.77	109.0
0	160.0	603.	1.633	66.364	20.3	5.46	109.0
0	176.0	578.	1.764	74.978	17.2	6.25	109.0
0	192.0	554.	1.908	82.867	14.5	7.20	109.0
0	208.0	529.	2.065	90.081	12.2	7.78	109.0
0	224.0	505.	2.236	96.671	10.3	7.99	109.0
0	240.0	480.	2.421	102.696	8.7	8.18	109.0
0	255.0	456.	2.620	108.222	7.4	8.34	109.0
7	262.0	446.	2.699	110.184	7.0	8.41	109.0
0	262.0	446.	2.699	110.184	7.0	8.31	100.0
0	264.0	444.	2.724	110.815	6.8	8.29	100.0
0	272.0	432.	2.829	113.179	5.8	8.25	100.0
0	280.0	421.	2.937	115.272	4.9	8.28	100.0
0	288.0	410.	3.050	117.099	4.1	8.35	100.0
0	296.0	399.	3.166	118.669	3.4	8.48	100.0
0	304.0	387.	3.287	119.989	2.8	8.64	100.0
0	312.0	376.	3.413	121.067	2.2	8.71	100.0
0	320.0	365.	3.542	121.913	1.6	8.85	100.0
0	328.0	354.	3.674	122.537	1.2	9.04	100.0
0	336.0	342.	3.816	122.949	.7	9.29	100.0
0	344.0	331.	3.961	123.162	.4	9.60	100.0
0	352.0	320.	4.111	123.186	.0	9.96	100.0
0	360.0	309.	4.267	123.038	-.2	10.37	100.0
0	368.0	298.	4.429	122.730	-.5	10.84	100.0
0	376.0	236.	4.598	122.281	-.7	11.38	100.0
0	384.0	275.	4.774	121.706	-.8	11.99	100.0
0	392.0	264.	4.957	121.028	-.9	12.66	100.0

6836.	4464.48	1531.	185.98
6836.	4464.48	1531.	189.20
6836.	4464.48	1531.	213.69
6836.	4464.48	1531.	238.18
6836.	4464.48	1531.	262.68
6836.	4464.48	1531.	287.17
6836.	4464.48	1531.	311.67
6836.	4464.48	1531.	336.16
6836.	4464.48	1531.	360.65
6836.	4464.48	1531.	383.62
6836.	4464.48	1531.	394.33
6272.	4463.50	1405.	394.33
6272.	4463.50	1405.	397.14
6272.	4463.50	1405.	408.38
6272.	4463.50	1405.	419.62
6272.	4463.50	1405.	430.86
6272.	4463.50	1405.	442.10
6272.	4463.50	1405.	453.34
6272.	4463.50	1405.	464.57
6272.	4463.50	1405.	475.81
6272.	4463.50	1405.	487.05
6272.	4463.50	1405.	498.29
6272.	4463.50	1405.	509.53
6272.	4463.50	1405.	520.77
6272.	4463.50	1405.	532.01
6272.	4463.50	1405.	543.24
6272.	4463.50	1405.	554.48
6272.	4463.50	1405.	565.72
6272.	4463.50	1405.	576.96

Table 2A. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (Metric Units) Continuation 2

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS: VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	KG X10E+3	KM/SEC	KM	DEGREES			N X10E+3	N SEC/KG	KG/SEC	KG X10E+3	N X10E+3	N SEC/KG	KG/SEC	KG X10E+3
0	400.0	253.	5.149	120.266	-1.0	13.42	100.0					6272.	4463.50	1405.	588.20
0	408.0	241.	5.349	119.444	-1.0	14.16	100.0					6272.	4463.50	1405.	599.43
0	416.0	230.	5.559	118.589	-1.0	14.90	100.0					6272.	4463.50	1405.	610.67
0	424.0	219.	5.780	117.731	-.9	15.68	100.0					6272.	4463.50	1405.	621.91
12	428.1	213.	5.898	117.298	-.9	16.11	100.0					6272.	4463.50	1405.	627.67
0	428.1	213.	5.898	117.298	-.9	16.11	100.0					6272.	4463.50	1405.	627.67
0	432.0	208.	6.011	116.900	-.8	16.51	97.5					6115.	4463.22	1370.	633.08
0	440.0	197.	6.243	116.125	-.7	17.36	92.5					5802.	4462.68	1300.	643.76
0	448.0	187.	6.476	115.427	-.6	18.20	87.7					5501.	4462.15	1233.	653.89
0	456.0	177.	6.709	114.827	-.4	19.04	83.2					5218.	4461.66	1170.	663.50
0	464.0	168.	6.941	114.356	-.3	19.85	78.9					4949.	4461.20	1109.	672.61
0	472.0	159.	7.174	114.022	-.1	20.63	74.8					4691.	4460.75	1052.	681.25
0	480.0	151.	7.407	113.868	.1	21.36	71.0					4453.	4460.34	998.	689.45
0	488.0	143.	7.640	113.919	.3	22.01	67.3					4221.	4459.94	946.	697.23
13	495.7	136.	7.864	114.189	.5	22.55	64.0					4014.	4459.57	900.	704.34

* FLIGHT MILESTONES
1 SOLID ROCKET MOTORS IGNITION COMMAND
2 LIFT-OFF
3 END OF VERTICAL ASCENT AND BEGINNING OF PITCH PROGRAM
4 END OF PITCH PROGRAM
5 MAXIMUM DYNAMIC PRESSURE
6 SOLID ROCKET MOTORS JETTISONNED
7 RETURN TO LANDING SITE OR AROUND-ONCE-ABORT FINAL DECISION POINT
12 NOMINAL MISSION 3-G LIMIT ACHIEVED
13 NOMINAL MISSION MAIN ENGINE CUT-OFF

Table 2B. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (English Units)

•	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MAIN ENGINES VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
0	.0	4440.	0.	523.	.0	.00	90.9	0.	256.00	0.	.00	1282.	455.05	2817.	.00
1	.3	4438.	0.	523.	.0	.00	109.0	3652.	260.74	14003.	1.39	1537.	455.25	3376.	.93
0	.3	4438.	0.	523.	.0	.00	109.0	3652.	260.74	14003.	1.39	1537.	455.25	3376.	.93
0	2.0	4396.	23.	541.	79.8	.02	109.0	5306.	243.57	21783.	37.36	1537.	455.25	3376.	6.67
0	4.0	4345.	55.	618.	80.5	.05	109.0	5811.	261.02	22261.	81.41	1537.	455.25	3376.	13.42
2	6.0	4293.	90.	760.	81.0	.08	109.0	5947.	261.43	22749.	126.43	1537.	455.25	3376.	20.17
0	6.0	4293.	90.	760.	81.0	.08	109.0	5947.	261.43	22749.	126.43	1537.	455.25	3376.	20.17
0	8.0	4241.	127.	974.	81.7	.11	109.0	6017.	261.38	23020.	172.20	1537.	455.25	3376.	26.92
0	10.0	4188.	166.	1264.	82.4	.15	109.0	6060.	261.33	23189.	218.41	1537.	455.25	3376.	33.67
0	12.0	4135.	207.	1633.	82.9	.19	109.0	6098.	261.28	23338.	264.94	1537.	455.25	3376.	40.42
0	14.0	4081.	250.	2085.	82.8	.22	109.0	6136.	261.24	23488.	311.77	1537.	455.25	3376.	47.17
3	16.0	4027.	295.	2626.	81.8	.26	109.0	6175.	261.21	23639.	358.90	1537.	455.25	3376.	53.92
0	16.0	4027.	295.	2626.	81.8	.26	109.0	6175.	261.21	23639.	358.90	1537.	455.25	3376.	53.92
0	18.0	3973.	342.	3255.	80.2	.31	109.0	6208.	261.17	23771.	406.31	1537.	455.25	3376.	60.67
0	20.0	3919.	392.	3976.	78.6	.35	109.0	6241.	261.13	23900.	453.98	1537.	455.25	3376.	67.42
0	22.0	3864.	444.	4793.	77.1	.40	109.0	6215.	261.08	23804.	501.68	1537.	455.25	3376.	74.17
0	24.0	3811.	495.	5706.	75.6	.44	109.0	5894.	260.95	22587.	548.06	1537.	455.25	3376.	80.92
0	26.0	3760.	543.	6708.	74.2	.49	109.0	5698.	260.85	21843.	592.48	1537.	455.25	3376.	87.67
0	28.0	3710.	591.	7794.	72.8	.53	109.0	5552.	260.77	21291.	635.61	1537.	455.25	3376.	94.42
0	30.0	3661.	637.	8962.	71.5	.58	109.0	5419.	260.69	20786.	677.69	1537.	455.25	3376.	101.17
0	32.0	3613.	683.	10207.	70.2	.62	102.6	5299.	260.62	20331.	718.80	1447.	455.18	3178.	107.72

0	34.0	3567.	726.	11526.	68.9	.65	96.2	5186.	260.55	19906.	759.04	1356.	455.11	2980.	113.88
0	35.0	3544.	747.	12186.	68.3	.68	93.0	5132.	260.52	19699.	778.82	1311.	455.07	2882.	116.81
0	36.0	3522.	768.	12912.	67.7	.71	93.0	5078.	260.48	19494.	798.43	1311.	455.07	2882.	119.69
0	38.0	3477.	810.	14363.	66.5	.75	93.0	4975.	260.42	19104.	837.03	1311.	455.07	2882.	125.45
0	40.0	3434.	851.	15877.	65.4	.80	93.0	4874.	260.35	18722.	874.85	1311.	455.07	2882.	131.21
0	42.0	3391.	892.	17451.	64.2	.84	93.0	4774.	260.28	18344.	911.91	1311.	455.07	2882.	136.97
0	44.0	3349.	933.	19084.	63.1	.88	93.0	4682.	260.22	17992.	948.25	1311.	455.07	2882.	142.74
0	46.0	3307.	973.	20772.	62.0	.93	93.0	4610.	260.16	17721.	983.96	1311.	455.07	2882.	148.50
0	48.0	3266.	1013.	22514.	60.9	.97	93.0	4557.	260.10	17521.	1019.20	1311.	455.07	2882.	154.26
0	50.0	3226.	1053.	24307.	59.9	1.02	93.0	4493.	260.05	17277.	1054.00	1311.	455.07	2882.	160.02
0	52.0	3186.	1094.	26150.	58.8	1.07	93.0	4495.	260.03	17286.	1088.56	1311.	455.07	2882.	165.78
0	54.0	3145.	1137.	28044.	57.8	1.12	93.0	4524.	260.01	17401.	1123.25	1311.	455.07	2882.	171.55
0	56.0	3104.	1182.	29992.	56.8	1.18	93.0	4515.	259.98	17367.	1158.02	1311.	455.07	2882.	177.31
0	58.0	3064.	1230.	31996.	55.9	1.24	93.0	4530.	259.97	17424.	1192.81	1311.	455.07	2882.	183.07
0	60.0	3023.	1281.	34059.	55.0	1.30	93.0	4580.	259.96	17617.	1227.85	1311.	455.07	2882.	188.83
0	62.0	2982.	1336.	35186.	54.1	1.37	99.4	4638.	259.95	17840.	1263.31	1402.	455.14	3079.	194.79
0	64.0	2940.	1398.	38384.	53.3	1.44	105.8	4696.	259.95	18065.	1299.22	1492.	455.21	3277.	201.15
4	64.5	2929.	1414.	38946.	53.1	1.46	107.4	4710.	259.95	18121.	1308.23	1514.	455.23	3327.	202.80
0	65.0	2918.	1430.	39507.	52.8	1.48	109.0	4724.	259.95	18173.	1317.30	1537.	455.25	3376.	204.47
0	66.0	2896.	1466.	40651.	52.4	1.52	109.0	4750.	259.95	18272.	1335.55	1537.	455.25	3376.	207.85
0	68.0	2853.	1539.	43020.	51.5	1.61	109.0	4801.	259.94	18471.	1372.29	1537.	455.25	3376.	214.60
0	70.0	2809.	1616.	45465.	50.5	1.69	109.0	4854.	259.94	18676.	1409.44	1537.	455.25	3376.	221.35
0	72.0	2765.	1698.	47998.	49.5	1.78	109.0	4897.	259.92	18839.	1446.96	1537.	455.25	3376.	228.10
0	74.0	2720.	1785.	50622.	48.6	1.88	109.0	4926.	259.91	18954.	1484.75	1537.	455.25	3376.	234.85
0	76.0	2675.	1877.	53340.	47.6	1.98	109.0	4949.	259.89	19042.	1522.74	1537.	455.25	3376.	241.60
0	78.0	2631.	1974.	56153.	46.6	2.08	109.0	4967.	259.87	19112.	1560.90	1537.	455.25	3376.	248.35
0	80.0	2586.	2075.	59063.	45.6	2.18	109.0	4983.	259.85	19176.	1599.19	1537.	455.25	3376.	255.10
0	82.0	2540.	2181.	62071.	44.7	2.28	109.0	4967.	259.82	19115.	1637.48	1537.	455.25	3376.	261.85
0	84.0	2496.	2291.	65179.	43.7	2.38	109.0	4889.	259.77	18820.	1675.41	1537.	455.25	3376.	268.60

Table 2B. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (English Units) Continuation 1

*	TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS/ VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
	SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
0	86.0	2452.	2403.	68383.	42.8	2.49	109.0	4787.	259.71	18432.	1712.66	1537.	455.25	3376.	275.35
0	88.0	2408.	2517.	71683.	41.8	2.59	109.0	4707.	259.65	18127.	1749.22	1537.	455.25	3376.	282.10
0	90.0	2366.	2633.	75075.	40.9	2.70	109.0	4643.	259.59	17885.	1785.24	1537.	455.25	3376.	288.85
0	92.0	2323.	2753.	78558.	40.0	2.81	109.0	4577.	259.52	17638.	1820.76	1537.	455.25	3376.	295.60
0	94.0	2282.	2875.	82133.	39.2	2.93	109.0	4510.	259.44	17384.	1855.78	1537.	455.25	3376.	302.35
0	96.0	2240.	2999.	85798.	38.4	3.04	109.0	4439.	259.36	17115.	1890.28	1537.	455.25	3376.	309.10
0	98.0	2200.	3126.	89551.	37.6	3.16	109.0	4362.	259.28	16823.	1924.22	1537.	455.25	3376.	315.85
0	100.0	2160.	3255.	93390.	36.8	3.29	109.0	4273.	259.19	16485.	1957.53	1537.	455.25	3376.	322.60
0	102.0	2120.	3385.	97314.	36.0	3.41	109.0	4171.	259.09	16098.	1990.11	1537.	455.25	3376.	329.35
0	104.0	2082.	3517.	101318.	35.3	3.52	109.0	4072.	259.00	15722.	2021.93	1537.	455.25	3376.	336.10
0	106.0	2044.	3649.	105401.	34.5	3.64	109.0	3979.	258.90	15367.	2053.02	1537.	455.25	3376.	342.85
0	108.0	2007.	3784.	109560.	33.8	3.75	109.0	3884.	258.82	15006.	2083.40	1537.	455.25	3376.	349.60
0	110.0	1970.	3919.	113792.	33.2	3.87	109.0	3783.	258.72	14623.	2113.03	1537.	455.25	3376.	356.35
0	110.0	1970.	3919.	113792.	33.2	3.87	109.0	3783.	258.72	14623.	2113.03	1537.	455.25	3376.	356.35
0	112.0	1935.	4055.	118094.	32.5	3.99	109.0	3681.	258.62	14231.	2141.88	1537.	455.25	3376.	363.10
0	114.0	1900.	4191.	122463.	31.8	4.10	109.0	3504.	258.48	13557.	2169.93	1537.	455.25	3376.	369.85
0	116.0	1868.	4318.	126892.	31.2	4.20	109.0	2915.	258.11	11295.	2195.02	1537.	455.25	3376.	376.60
0	118.0	1842.	4421.	131362.	30.6	4.28	109.0	1964.	257.29	1.	2214.03	1537.	455.25	3376.	383.35
0	120.0	1823.	4496.	135845.	30.1	4.32	109.0	1225.	256.48	4776.	2226.30	1537.	455.25	3376.	390.10
5	122.0	1809.	4549.	140317.	29.5	4.35	109.0	649.	255.45	0.	2233.53	1537.	455.25	3376.	396.85
0	124.0	1799.	4586.	144760.	29.0	4.36	109.0	230.	253.79	1.	2237.00	1537.	455.25	3376.	403.60
6	125.9	1792.	4612.	149009.	28.5	4.37	109.0	43.	251.13	0.	2237.85	1537.	455.25	3376.	410.01

0	125.9	1444.	4612.	149009.	28.5	4.37	109.0
0	128.0	1437.	4649.	153521.	28.0	4.39	109.0
0	144.0	1383.	4979.	186951.	23.9	4.77	109.0
0	160.0	1329.	5359.	217731.	20.3	5.46	109.0
0	176.0	1275.	5787.	245991.	17.2	6.25	109.0
0	192.0	1221.	6260.	271875.	14.5	7.20	109.0
0	208.0	1167.	6776.	295540.	12.2	7.78	109.0
0	224.0	1113.	7337.	317161.	10.3	7.99	109.0
0	240.0	1059.	7943.	336928.	8.7	8.18	109.0
0	255.0	1005.	8595.	355058.	7.4	8.34	109.0
7	262.0	984.	8854.	361497.	7.0	8.41	109.0
0	262.0	984.	8854.	361497.	7.0	8.31	100.0
0	264.0	978.	8937.	363565.	6.8	8.29	100.0
0	272.0	953.	9280.	371323.	5.8	8.25	100.0
0	280.0	929.	9636.	378188.	4.9	8.28	100.0
0	288.0	904.	10005.	384183.	4.1	8.35	100.0
0	296.0	879.	10388.	389333.	3.4	8.48	100.0
0	304.0	854.	10785.	393663.	2.8	8.64	100.0
0	312.0	829.	11196.	397201.	2.2	8.71	100.0
0	320.0	805.	11622.	399977.	1.6	8.85	100.0
0	328.0	780.	12053.	402024.	1.2	9.04	100.0
0	336.0	755.	12521.	403377.	.7	9.29	100.0
0	344.0	730.	12996.	404073.	.4	9.60	100.0
0	352.0	705.	13488.	404155.	.0	9.96	100.0
0	360.0	681.	14000.	403667.	-.2	10.37	100.0
0	368.0	656.	14532.	402658.	-.5	10.84	100.0
0	376.0	631.	15086.	401183.	-.7	11.38	100.0
0	384.0	606.	15662.	399299.	-.8	11.99	100.0
0	392.0	582.	16264.	397072.	-.9	12.66	100.0

1537.	455.25	3376.	410.01
1537.	455.25	3376.	417.10
1537.	455.25	3376.	471.10
1537.	455.25	3376.	525.10
1537.	455.25	3376.	579.10
1537.	455.25	3376.	633.10
1537.	455.25	3376.	687.10
1537.	455.25	3376.	741.10
1537.	455.25	3376.	795.10
1537.	455.25	3376.	845.72
1537.	455.25	3376.	869.35
1410.	455.15	3098.	869.35
1410.	455.15	3098.	875.54
1410.	455.15	3098.	900.32
1410.	455.15	3098.	925.10
1410.	455.15	3098.	949.87
1410.	455.15	3098.	974.65
1410.	455.15	3098.	999.42
1410.	455.15	3098.	1024.20
1410.	455.15	3098.	1048.98
1410.	455.15	3098.	1073.75
1410.	455.15	3098.	1098.53
1410.	455.15	3098.	1123.30
1410.	455.15	3098.	1148.08
1410.	455.15	3098.	1172.86
1410.	455.15	3098.	1197.63
1410.	455.15	3098.	1222.41
1410.	455.15	3098.	1247.18
1410.	455.15	3098.	1271.96

Table 2B. Mission 3A: Selected Trajectory and Rocket Motor Information as a Function of Time (English Units) Continuation 2

* TIME	GROSS MASS	RELATIVE SPEED	ALTITUDE	RELATIVE FLIGHT PATH ANGLE	MACH NUMBER	PERCENT OF MPS RATED FUEL FLOW	FOR THE TWO SOLID ROCKET MOTORS VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED	FOR THE THREE SPACE SHUTTLE MOTORS/ VACUUM THRUST	VACUUM SPECIFIC IMPULSE	PROPELLANT MASS FLOW RATE	PROPELLANT MASS EXPENDED
SECONDS	LBM X10E+3	FT/SEC	FT	DEGREES			LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3	LBF X10E+3	SECONDS	LBM/SEC	LBM X10E+3
0 400.0	557.	16892.	394572.	-1.0	13.42	100.0					1410.	455.15	3098.	1296.74
0 408.0	532.	17549.	391877.	-1.0	14.16	100.0					1410.	455.15	3098.	1321.51
0 416.0	507.	18238.	389073.	-1.0	14.90	100.0					1410.	455.15	3098.	1346.29
0 424.0	482.	18962.	386256.	-.9	15.68	100.0					1410.	455.15	3098.	1371.06
12 428.1	470.	19349.	384835.	-.9	16.11	100.0					1410.	455.15	3098.	1383.76
0 428.1	470.	19349.	384835.	-.9	16.11	100.0					1410.	455.15	3098.	1383.76
0 432.0	458.	19720.	383531.	-.8	16.51	97.5					1375.	455.12	3021.	1395.69
0 440.0	434.	20483.	380988.	-.7	17.36	92.5					1304.	455.07	2866.	1419.24
0 448.0	412.	21246.	378697.	-.6	18.20	87.7					1237.	455.01	2718.	1441.56
0 456.0	391.	22010.	376729.	-.4	19.04	83.2					1173.	454.96	2578.	1462.75
0 464.0	371.	22773.	375184.	-.3	19.85	78.9					1112.	454.92	2445.	1482.84
0 472.0	352.	23537.	374086.	-.1	20.63	74.8					1055.	454.87	2319.	1501.89
0 480.0	333.	24300.	373584.	.1	21.36	71.0					1001.	454.83	2201.	1519.96
0 488.0	316.	25064.	373751.	.3	22.01	67.3					949.	454.79	2087.	1537.11
13 495.7	301.	25801.	374635.	.5	22.55	64.0					902.	454.75	1984.	1552.78

* FLIGHT MILESTONES
1 SOLID ROCKET MOTORS IGNITION COMMAND
2 LIFT-OFF
3 END OF VERTICAL ASCENT AND BEGINNING OF PITCH PROGRAM
4 END OF PITCH PROGRAM
5 MAXIMUM DYNAMIC PRESSURE
6 SOLID ROCKET MOTORS JETTISONNED
7 RETURN TO LANDING SITE OR AROUND-ONCE-ABORT FINAL DECISION POINT
12 NOMINAL MISSION 3-G LIMIT ACHIEVED
13 NOMINAL MISSION MAIN ENGINE CUT-OFF

Table 3. Chemical species considered in the equilibrium calculations of Ref. 7

Al	C	C_2H_2	Fe(c)	H_2O_2
Al(ℓ)[a]	C(s)	C_2O	FeO	H_3N
Al(c)	CClO	Cl	FeO(ℓ)	H_4N_2
AlCl	CHN	ClFe	FeO(c)	N
AlClO	CHO	ClH	FeOH	NO
$AlCl_2$	CH_2	ClHO	Fe_2O_2	NO_2
$AlCl_3$	CH_2O	ClH_4N(c)	Fe_2O_3	NO_3
$AlCl_3$(ℓ)	CH_3	ClO	Fe_2O_3(c)	N_2
$AlCl_3$(c)	CH_3Cl	ClO_2	Fe_3O_4(c)	N_2O
AlHO	CH_3OH	Cl_2	H	N_2O_3
$AlHO_2$	CH_4	Cl_2Fe	HN	N_2O_4
AlN	CN	Cl_2Fe(ℓ)	HNO	N_2O_5
AlN(c)	CN_2	Cl_2Fe(c)	HO	O
AlO	CO	Cl_3Fe	HO_2	O_2
Al_2O	CO_2	Cl_3Fe(ℓ)	H_2	O_3
Al_2O_2	C_2	Cl_3Fe(c)	H_2N	
Al_2O_3(ℓ)	C_2Cl_4	Fe	H_2O	
Al_2O_3(c)	C_2Cl_6	Fe(ℓ)	H_2O(ℓ)	

[a]All species are in the gaseous phase except as noted:

(ℓ) = liquid phase

(c) = crystalline solid

(s) = solid (unspecified form)

Table 4. Mass fractions of the various chemical species constituting the exhaust gas mixture at the nozzle exit plane of an SRM

Exhaust component	Mass fraction
Al_2O_3 (l and s)[a]	0.30210
CO	0.23293
HCl	0.20918
H_2O	0.10151
N_2	0.08586
CO_2	0.03949
H_2	0.01884
$FeCl_2$ (g, l, and s)	0.00598
Cl	0.00303
H	0.00020
Fe (g and c)	0.00015
Traces	0.00073

[a]Unless otherwise noted or as noted by g, where other phases are present, the species are in the gaseous phase

Table 5. Mass fractions of the various chemical species constituting the exhaust gas mixture at the nozzle exit plane of an SSME

Exhaust component	Mass fraction
H_2O	0.95939
H_2	0.03547
Ar[a]	0.00471
N_2[a]	0.000307
H	0.000085
Traces	0.000038

[a]Ar and N_2 occur as dissolved impurities in the liquid O_2 that is employed as the oxidizer in an SSME.

Table 6A. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units)

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000036
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
5.58-02 TO 6.21-02	6.31-03	TO 2.0	2.0	1.043+04	2.087+04	NOZZLE EXIT	5390.	3732.	4156.	705.	443.	4.	4712.	1533.	107.	54.	3.	14.	13.1
						AFTERBURNED	5390.	3732.		7235.			8708.	20839.	107.	54.	3.	344.	13.1
6.21-02 TO 8.81-02	2.60-02	2.0 TO 4.0	2.0	1.198+04	2.397+04	NOZZLE EXIT	6316.	4373.	4870.	826.	502.	4.	5060.	1796.	125.	63.	3.	14.	15.4
						AFTERBURNED	6316.	4373.		8477.			9588.	23975.	125.	63.	3.	393.	15.4
8.81-02 TO 1.36-01	4.80-02	4.0 TO 6.0	2.0	1.222+04	2.444+04	NOZZLE EXIT	6458.	4471.	4979.	844.	511.	5.	5107.	1836.	128.	65.	3.	14.	15.7
						AFTERBURNED	6458.	4471.		8667.			9715.	24449.	128.	65.	3.	400.	15.7
1.36-01 TO 1.36-01	0.00	6.0 TO 6.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
1.36-01 TO 2.08-01	7.18-02	6.0 TO 8.0	2.0	1.239+04	2.479+04	NOZZLE EXIT	6564.	4545.	5061.	858.	518.	5.	5143.	1866.	130.	66.	3.	14.	16.0
						AFTERBURNED	6564.	4545.		8810.			9810.	24805.	130.	66.	3.	406.	16.0
2.08-01 TO 3.05-01	9.71-02	8.0 TO 10.0	2.0	1.250+04	2.499+04	NOZZLE EXIT	6625.	4587.	5108.	866.	522.	5.	5164.	1884.	131.	66.	3.	14.	16.1
						AFTERBURNED	6625.	4587.		8892.			9865.	25011.	131.	66.	3.	409.	16.1
3.05-01 TO 4.29-01	1.24-01	10.0 TO 12.0	2.0	1.257+04	2.515+04	NOZZLE EXIT	6672.	4619.	5144.	872.	525.	5.	5179.	1897.	132.	67.	3.	14.	16.2
						AFTERBURNED	6672.	4619.		8954.			9907.	25166.	132.	67.	3.	411.	16.2
4.29-01 TO 5.80-01	1.51-01	12.0 TO 14.0	2.0	1.265+04	2.529+04	NOZZLE EXIT	6716.	4650.	5178.	878.	527.	5.	5194.	1910.	133.	67.	3.	14.	16.3
						AFTERBURNED	6716.	4650.		9014.			9947.	25315.	133.	67.	3.	414.	16.3
5.80-01 TO 7.60-01	1.80-01	14.0 TO 16.0	2.0	1.272+04	2.544+04	NOZZLE EXIT	6760.	4681.	5212.	884.	530.	5.	5209.	1922.	134.	68.	3.	14.	16.5
						AFTERBURNED	6760.	4681.		9073.			9987.	25463.	134.	68.	3.	416.	16.5
7.60-01 TO 7.60-01	0.00	16.0 TO 16.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
7.60-01 TO 9.69-01	2.09-01	16.0 TO 18.0	2.0	1.279+04	2.558+04	NOZZLE EXIT	6801.	4709.	5244.	889.	533.	5.	5223.	1934.	135.	68.	3.	14.	16.6
						AFTERBURNED	6801.	4709.		9128.			10023.	25601.	135.	68.	3.	418.	16.6
9.69-01 TO 1.21+00	2.40-01	18.0 TO 20.0	2.0	1.283+04	2.567+04	NOZZLE EXIT	6829.	4728.	5265.	893.	534.	5.	5232.	1942.	135.	68.	3.	14.	16.6
						AFTERBURNED	6829.	4728.		9165.			10048.	25692.	135.	68.	3.	420.	16.6

1.21+00 TO 1.48+00	2.71-01	20.0 TO 22.0	2.0	1.271+04	2.542+04	NOZZLE EXIT	6754.	4676.	5207.	883.	530.	5.	5207.	1920.	134.	68.	3.	14.	16.4
						AFTERBURNED	6754.	4676.		9064.			9981.	25441.	134.	68.	3.	416.	16.4
1.48+00 TO 1.78+00	3.01-01	22.0 TO 24.0	2.0	1.229+04	2.458+04	NOZZLE EXIT	6500.	4501.	5012.	850.	514.	5.	5122.	1848.	129.	65.	3.	14.	15.8
						AFTERBURNED	6500.	4501.		8724.			9753.	24592.	129.	65.	3.	402.	15.8
1.78+00 TO 2.11+00	3.29-01	24.0 TO 26.0	2.0	1.187+04	2.374+04	NOZZLE EXIT	6248.	4326.	4818.	817.	498.	4.	5037.	1777.	124.	63.	3.	14.	15.2
						AFTERBURNED	6248.	4326.		8386.			9527.	23748.	124.	63.	3.	389.	15.2
2.11+00 TO 2.47+00	3.55-01	26.0 TO 28.0	2.0	1.160+04	2.319+04	NOZZLE EXIT	6082.	4211.	4689.	795.	488.	4.	4981.	1729.	120.	61.	3.	14.	14.8
						AFTERBURNED	6082.	4211.		8163.			9377.	23190.	120.	61.	3.	381.	14.8
2.47+00 TO 2.85+00	3.81-01	28.0 TO 30.0	2.0	1.135+04	2.270+04	NOZZLE EXIT	5933.	4108.	4575.	776.	479.	4.	4931.	1687.	117.	60.	3.	14.	14.5
						AFTERBURNED	5933.	4108.		7964.			9244.	22693.	117.	60.	3.	373.	14.5
2.85+00 TO 3.25+00	4.06-01	30.0 TO 32.0	2.0	1.113+04	2.225+04	NOZZLE EXIT	5798.	4015.	4471.	758.	470.	4.	4886.	1649.	115.	58.	3.	14.	14.1
						AFTERBURNED	5798.	4015.		7782.			9122.	22240.	115.	58.	3.	366.	14.1
3.25+00 TO 3.68+00	4.30-01	32.0 TO 34.0	2.0	1.092+04	2.184+04	NOZZLE EXIT	5672.	3927.	4373.	741.	462.	4.	4843.	1613.	112.	57.	3.	14.	13.8
						AFTERBURNED	5672.	3927.		7612.			9009.	21816.	112.	57.	3.	359.	13.8
3.68+00 TO 4.14+00	4.54-01	34.0 TO 36.0	2.0	1.072+04	2.143+04	NOZZLE EXIT	5550.	3843.	4280.	726.	455.	4.	4802.	1578.	110.	56.	3.	14.	13.5
						AFTERBURNED	5550.	3843.		7449.			8900.	21410.	110.	56.	3.	353.	13.5
4.14+00 TO 4.61+00	4.77-01	36.0 TO 38.0	2.0	1.052+04	2.105+04	NOZZLE EXIT	5434.	3763.	4190.	710.	447.	4.	4763.	1545.	108.	55.	3.	14.	13.2
						AFTERBURNED	5434.	3763.		7293.			8795.	21020.	108.	55.	3.	347.	13.2
4.61+00 TO 4.86+00	2.50-01	38.0 TO 39.0	1.0	1.041+04	1.041+04	NOZZLE EXIT	2681.	1856.	2067.	350.	221.	2.	2370.	762.	53.	27.	1.	7.	6.5
						AFTERBURNED	2681.	1856.		3598.			4365.	10389.	53.	27.	1.	171.	6.5
4.86+00 TO 6.00+00	1.14+00	39.0 TO 43.5	4.5	9.883+03	4.400+04	NOZZLE EXIT	11566.	8009.	8918.	1512.	924.	8.	9373.	3289.	229.	116.	6.	27.	28.2
						AFTERBURNED	11566.	8009.		15523.			17701.	44007.	229.	116.	6.	722.	28.2
6.00+00 TO 9.00+00	3.00+00	43.5 TO 53.8	10.4	9.264+03	9.626+04	NOZZLE EXIT	25928.	17953.	19991.	3389.	1987.	18.	18721.	7372.	513.	260.	13.	49.	63.0
						AFTERBURNED	25928.	17953.		34799.			36626.	96455.	513.	260.	13.	1569.	63.0
9.00+00 TO 1.20+01	3.00+00	53.8 TO 63.0	9.2	9.412+03	8.644+04	NOZZLE EXIT	23342.	16163.	17998.	3051.	1781.	16.	16640.	6637.	462.	234.	12.	43.	56.8
						AFTERBURNED	23342.	16163.		31329.			32688.	86631.	462.	234.	12.	1408.	56.8
1.20+01 TO 1.50+01	3.00+00	63.0 TO 71.1	8.0	1.014+04	8.150+04	NOZZLE EXIT	21461.	14860.	16547.	2805.	1709.	15.	17243.	6103.	425.	215.	11.	49.	52.3
						AFTERBURNED	21461.	14860.		28804.			32645.	81512.	425.	215.	11.	1336.	52.3
1.50+01 TO 1.80+01	3.00+00	71.1 TO 78.1	7.0	1.058+04	7.402+04	NOZZLE EXIT	19124.	13242.	14745.	2500.	1573.	14.	16703.	5438.	379.	192.	9.	50.	46.6
						AFTERBURNED	19124.	13242.		25667.			30873.	73917.	379.	192.	9.	1219.	46.6

Table 6A. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units) Continuation 1

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE												
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000036
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
1.80+01		78.1				NOZZLE EXIT	16627.	11513.	12820.	2173.	1375.	12.	14733.	4729.	329.	167.	8.	45.	40.5
TO	3.00+00	TO	6.2	1.037+04	6.457+04														
2.10+01		84.3				AFTERBURNED	16627.	11513.		22316.			27123.	64469.	329.	167.	8.	1064.	40.5
2.10+01		84.3				NOZZLE EXIT	14503.	10042.	11183.	1896.	1214.	10.	13252.	4125.	287.	145.	7.	41.	35.4
TO	3.00+00	TO	5.7	9.947+03	5.674+04														
2.40+01		90.0				AFTERBURNED	14503.	10042.		19465.			24192.	56618.	287.	145.	7.	937.	35.4
2.40+01		90.0				NOZZLE EXIT	12888.	8924.	9937.	1685.	1092.	9.	12120.	3665.	255.	129.	6.	38.	31.5
TO	3.00+00	TO	5.3	9.575+03	5.078+04														
2.70+01		95.3				AFTERBURNED	12888.	8924.		17298.			21957.	50642.	255.	129.	6.	840.	31.5
2.70+01		95.3				NOZZLE EXIT	11517.	7975.	8880.	1506.	990.	8.	11219.	3276.	228.	116.	6.	36.	28.1
TO	3.00+00	TO	5.0	9.150+03	4.578+04														
3.00+01		100.3				AFTERBURNED	11517.	7975.		15458.			20139.	45628.	228.	116.	6.	759.	28.1
3.00+01		100.3				NOZZLE EXIT	10295.	7128.	7938.	1346.	900.	7.	10443.	2928.	204.	103.	5.	34.	25.2
TO	3.00+00	TO	4.8	8.698+03	4.136+04														
3.30+01		105.1				AFTERBURNED	10295.	7128.		13817.			18553.	41182.	204.	103.	5.	687.	25.2
3.30+01		105.1				NOZZLE EXIT	9228.	6390.	7115.	1206.	823.	7.	9805.	2625.	183.	93.	5.	33.	22.6
TO	3.00+00	TO	4.6	8.223+03	3.754+04														
3.60+01		109.6				AFTERBURNED	9228.	6390.		12386.			17223.	37341.	183.	93.	5.	625.	22.6
3.60+01		109.6				NOZZLE EXIT	6175.	4276.	4761.	807.	626.	5.	8583.	1757.	122.	62.	3.	32.	15.2
TO	3.00+00	TO	4.4	8.144+03	2.722+04														
3.90+01		114.1				AFTERBURNED	6175.	4276.		8288.			14219.	26923.	122.	62.	3.	461.	15.2
3.90+01		114.				NOZZLE EXIT	2029.	1405.	1564.	265.	366.	2.	7173.	579.	40.	20.	1.	32.	5.2
TO	3.00+00	TO	4.4	3.050+03	1.348+04														
4.20+01		118.5				AFTERBURNED	2029.	1405.		2723.			10473.	13017.	40.	20.	1.	244.	5.2
4.20+01		118.5				NOZZLE EXIT	189.	131.	148.	25.	257.	1.	6696.	56.	4.	2.	0.	33.	.7
TO	3.00+00	TO	4.5	1.670+03	7.539+03														
4.50+01		123.0				AFTERBURNED	189.	131.		254.			9009.	6989.	4.	2.	0.	151.	.7
4.50+01		123.0				NOZZLE EXIT	0.	0.	0.	0.	248.	1.	6713.	2.	0.	0.	0.	33.	.3
TO	3.00+00	TO	4.6	1.531+03	6.997+03														
4.80+01		127.6				AFTERBURNED	0.	0.		0.			8946.	6432.	0.	0.	0.	143.	.3
4.80+01		127.6				NOZZLE EXIT	0.	0.	0.	0.	261.	1.	7053.	2.	0.	0.	0.	35.	.3
TO	3.00+00	TO	4.8	1.531+03	7.352+03														
5.10+01		132.4				AFTERBURNED	0.	0.		0.			9400.	6759.	0.	0.	0.	150.	.3
5.10+01		132.4				NOZZLE EXIT	0.	0.	0.	0.	262.	1.	7099.	2.	0.	0.	0.	35.	.3
TO	3.00+00	TO	4.8	1.531+03	7.399+03														
5.40+01		137.2				AFTERBURNED	0.	0.		0.			9461.	6802.	0.	0.	0.	151.	.3

5.40+01 TO 5.70+01	3.00+00	137.2 TO 142.0	4.8	1.531+03	7.399+03	NOZZLE EXIT	0.	0.	0.	0.	262.	1.	7099.	2.	0.	0.	0.	35.	.3
						AFTERBURNED	0.	0.		0.			9461.	6802.	0.	0.	0.	151.	.3
5.70+01 TO 6.00+01	3.00+00	142.0 TO 147.1	5.1	1.531+03	7.752+03	NOZZLE EXIT	0.	0.	0.	0.	275.	1.	7438.	2.	0.	0.	0.	37.	.3
						AFTERBURNED	0.	0.		0.			9912.	7127.	0.	0.	0.	158.	.3
6.00+01 TO 6.30+01	3.00+00	147.1 TO 152.3	5.2	1.531+03	8.018+03	NOZZLE EXIT	0.	0.	0.	0.	284.	1.	7692.	2.	0.	0.	0.	38.	.3
						AFTERBURNED	0.	0.		0.			10251.	7371.	0.	0.	0.	163.	.3
6.30+01 TO 6.60+01	3.00+00	152.3 TO 157.6	5.2	1.531+03	8.018+03	NOZZLE EXIT	0.	0.	0.	0.	284.	1.	7692.	2.	0.	0.	0.	38.	.3
						AFTERBURNED	0.	0.		0.			10251.	7371.	0.	0.	0.	163.	.3
6.60+01 TO 6.90+01	3.00+00	157.6 TO 163.0	5.5	1.531+03	8.371+03	NOZZLE EXIT	0.	0.	0.	0.	297.	1.	8031.	3.	0.	0.	0.	39.	.3
						AFTERBURNED	0.	0.		0.			10703.	7696.	0.	0.	0.	171.	.3
6.90+01 TO 7.20+01	3.00+00	163.0 TO 168.7	5.7	1.531+03	8.703+03	NOZZLE EXIT	0.	0.	0.	0.	309.	1.	8349.	3.	0.	0.	0.	41.	.3
						AFTERBURNED	0.	0.		0.			11127.	8001.	0.	0.	0.	177.	.3
7.20+01 TO 7.50+01	3.00+00	168.7 TO 174.4	5.7	1.531+03	8.703+03	NOZZLE EXIT	0.	0.	0.	0.	309.	1.	8349.	3.	0.	0.	0.	41.	.3
						AFTERBURNED	0.	0.		0.			11127.	8001.	0.	0.	0.	177.	.3
7.50+01 TO 7.80+01	3.00+00	174.4 TO 180.4	6.0	1.531+03	9.232+03	NOZZLE EXIT	0.	0.	0.	0.	327.	1.	8857.	3.	0.	0.	0.	43.	.4
						AFTERBURNED	0.	0.		0.			11804.	8487.	0.	0.	0.	188.	.4
7.80+01 TO 8.10+01	3.00+00	180.4 TO 186.6	6.2	1.531+03	9.457+03	NOZZLE EXIT	0.	0.	0.	0.	335.	1.	9073.	3.	0.	0.	0.	45.	.4
						AFTERBURNED	0.	0.		0.			12092.	8694.	0.	0.	0.	193.	.4
8.10+01 TO 8.40+01	3.00+00	186.6 TO 192.8	6.2	1.531+03	9.549+03	NOZZLE EXIT	0.	0.	0.	0.	339.	1.	9161.	3.	0.	0.	0.	45.	.4
						AFTERBURNED	0.	0.		0.			12209.	8778.	0.	0.	0.	195.	.4
8.40+01 TO 8.70+01	3.00+00	192.8 TO 199.6	6.7	1.531+03	1.028+04	NOZZLE EXIT	0.	0.	0.	0.	365.	1.	9862.	3.	0.	0.	0.	48.	.4
						AFTERBURNED	0.	0.		0.			13143.	9450.	0.	0.	0.	210.	.4
8.70+01 TO 9.00+01	3.00+00	199.6 TO 206.3	6.7	1.531+03	1.028+04	NOZZLE EXIT	0.	0.	0.	0.	365.	1.	9862.	3.	0.	0.	0.	48.	.4
						AFTERBURNED	0.	0.		0.			13143.	9450.	0.	0.	0.	210.	.4
9.00+01 TO 9.30+01	3.00+00	206.3 TO 213.4	7.1	1.531+03	1.092+04	NOZZLE EXIT	0.	0.	0.	0.	387.	1.	10479.	3.	0.	0.	0.	51.	.4
						AFTERBURNED	0.	0.		0.			13965.	10041.	0.	0.	0.	223.	.4
9.30+01 TO 9.60+01	3.00+00	213.4 TO 220.7	7.3	1.531+03	1.116+04	NOZZLE EXIT	0.	0.	0.	0.	396.	1.	10708.	3.	0.	0.	0.	53.	.4
						AFTERBURNED	0.	0.		0.			14271.	10261.	0.	0.	0.	228.	.4
9.60+01 TO 9.90+01	3.00+00	220.7 TO 228.3	7.6	1.531+03	1.165+04	NOZZLE EXIT	0.	0.	0.	0.	413.	1.	11181.	4.	0.	0.	0.	55.	.4
						AFTERBURNED	0.	0.		0.			14902.	10715.	0.	0.	0.	238.	.4

Table 6A. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units) Continuation 2

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000038
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
9.90+01 TO 1.02+02	3.00+00	228.3 TO 236.2	7.9	1.531+03	1.209+04	NOZZLE EXIT	0.	0.	0.	0.	429.	1.	11594.	4.	0.	0.	0.	57.	.5
						AFTERBURNED	0.	0.		0.			15452.	11110.	0.	0.	0.	246.	.5
1.02+02 TO 1.05+02	3.00+00	236.2 TO 244.4	8.1	1.531+03	1.247+04	NOZZLE EXIT	0.	0.	0.	0.	442.	1.	11960.	4.	0.	0.	0.	59.	.5
						AFTERBURNED	0.	0.		0.			15939.	11460.	0.	0.	0.	254.	.5
1.05+02 TO 1.08+02	3.00+00	244.4 TO 252.9	8.5	1.531+03	1.306+04	NOZZLE EXIT	0.	0.	0.	0.	463.	1.	12530.	4.	0.	0.	0.	62.	.5
						AFTERBURNED	0.	0.		0.			16699.	12007.	0.	0.	0.	266.	.5
1.08+02 TO 1.11+02	3.00+00	252.9 TO 262.4	9.5	1.531+03	1.455+04	NOZZLE EXIT	0.	0.	0.	0.	516.	1.	13957.	4.	0.	0.	0.	69.	.6
						AFTERBURNED	0.	0.		0.			18600.	13374.	0.	0.	0.	297.	.6
1.11+02 TO 1.14+02	3.00+00	262.4 TO 273.4	11.0	1.531+03	1.687+04	NOZZLE EXIT	0.	0.	0.	0.	598.	1.	16183.	5.	0.	0.	0.	79.	.6
						AFTERBURNED	0.	0.		0.			21568.	15508.	0.	0.	0.	344.	.6
1.14+02 TO 1.17+02	3.00+00	273.4 TO 287.0	13.6	1.531+03	2.088+04	NOZZLE EXIT	0.	0.	0.	0.	741.	2.	20033.	6.	0.	0.	0.	98.	.8
						AFTERBURNED	0.	0.		0.			26698.	19196.	0.	0.	0.	426.	.8
1.17+02 TO 1.20+02	3.00+00	287.0 TO 306.6	19.6	1.531+03	2.997+04	NOZZLE EXIT	0.	0.	0.	0.	1063.	3.	28754.	9.	0.	0.	0.	141.	1.1
						AFTERBURNED	0.	0.		0.			38321.	27553.	0.	0.	0.	611.	1.1
1.20+02 TO 1.23+02	3.00+00	306.6 TO 344.0	37.4	1.531+03	5.722+04	NOZZLE EXIT	0.	0.	0.	0.	2030.	5.	54898.	18.	0.	0.	0.	270.	2.2
						AFTERBURNED	0.	0.		0.			73164.	52606.	0.	0.	0.	1167.	2.2
1.23+02 TO 1.20+02	3.00+00	344.0 TO 387.0	43.0	1.531+03	6.584+04	NOZZLE EXIT	0.	0.	0.	0.	2335.	6.	63167.	20.	0.	0.	0.	310.	2.5
						AFTERBURNED	0.	0.		0.			84185.	60530.	0.	0.	0.	1343.	2.5

1.20+02 TO 1.17+02	3.00+00	387.0 TO 421.5	34.5	1.527+03	5.265+04	NOZZLE EXIT	0.	0.	0.	0.	1867.	4.	50508.	16.	0.	0.	0.	248.	2.0
						AFTERBURNED	0.	0.		0.			67314.	48400.	0.	0.	0.	1073.	2.8
1.17+02 TO 1.14+02	3.00+00	421.5 TO 464.0	42.5	1.303+03	5.542+04	NOZZLE EXIT	0.	0.	0.	0.	1966.	5.	53167.	17.	0.	0.	0.	261.	2.1
						AFTERBURNED	0.	0.		0.			70856.	50947.	0.	0.	0.	1130.	2.1
1.14+02 TO 1.17+02	3.00+00	464.0 TO 478.2	14.2	1.077+03	1.529+04	NOZZLE EXIT	0.	0.	0.	0.	542.	1.	14670.	5.	0.	0.	0.	72.	.6
						AFTERBURNED	0.	0.		0.			19551.	14057.	0.	0.	0.	312.	.6
				TOTALS:	1.7176+06	NOZZLE EXIT	306658.	212336.	236444.	40086.	44041.	263.	776986.	87371.	6070.	3076.	152.	3309.	767.7
						AFTERBURNED	306658.	212336.		411577.			1173604.	1673180.	6070.	3076.	152.	30362.	767.7

Table 6B. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units)

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000038
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
1.83+02		.0				NOZZLE EXIT	11884.	8228.	9163.	1553.	978.	8.	10389.	3379.	235.	119.	6.	31.	29.0
TO	2.07+01	TO	2.0	2.300+04	4.600+04														
2.04+02		2.0				AFTERBURNED	11884.	8228.		15949.			19197.	45941.	235.	119.	6.	757.	29.0
2.04+02		2.0				NOZZLE EXIT	13924.	9642.	10736.	1820.	1108.	10.	11155.	3960.	276.	140.	7.	32.	33.9
TO	8.53+01	TO	2.0	2.642+04	5.284+04														
2.89+02		4.0				AFTERBURNED	13924.	9642.		18688.			21137.	52855.	276.	140.	7.	866.	33.9
2.89+02		4.0				NOZZLE EXIT	14237.	9858.	10977.	1861.	1127.	10.	11260.	4048.	282.	143.	7.	32.	34.7
TO	1.57+02	TO	2.0	2.694+04	5.388+04														
4.46+02		6.0				AFTERBURNED	14237.	9858.		19108.			21417.	53901.	282.	143.	7.	882.	34.7
4.46+02		6.0				NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
TO	0.00	TO	.0	0.000	0.000														
4.46+02		6.0				AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
4.46+02		6.0				NOZZLE EXIT	14471.	10020.	11158.	1892.	1142.	10.	11338.	4115.	286.	145.	7.	32.	35.2
TO	2.36+02	TO	2.0	2.733+04	5.465+04														
6.82+02		8.0				AFTERBURNED	14471.	10020.		19422.			21628.	54686.	286.	145.	7.	894.	35.2
6.82+02		8.0				NOZZLE EXIT	14606.	10113.	11262.	1909.	1150.	10.	11384.	4153.	289.	146.	7.	32.	35.6
TO	3.19+02	TO	2.0	2.755+04	5.510+04														
1.00+03		10.0				AFTERBURNED	14606.	10113.		19603.			21749.	55139.	289.	146.	7.	902.	35.6
1.00+03		10.0				NOZZLE EXIT	14708.	10184.	11340.	1923.	1157.	10.	11418.	4182.	291.	148.	7.	32.	35.8
TO	4.06+02	TO	2.0	2.772+04	5.544+04														
1.41+03		12.0				AFTERBURNED	14708.	10184.		19740.			21841.	55481.	291.	148.	7.	907.	35.8
1.41+03		12.0				NOZZLE EXIT	14806.	10252.	11416.	1935.	1163.	10.	11451.	4210.	293.	149.	7.	32.	36.0
TO	4.96+02	TO	2.0	2.788+04	5.576+04														
1.90+03		14.0				AFTERBURNED	14806.	10252.		19872.			21929.	55810.	293.	149.	7.	912.	36.0
1.90+03		14.0				NOZZLE EXIT	14904.	10320.	11491.	1948.	1169.	10.	11484.	4238.	295.	149.	7.	32.	36.3
TO	5.90+02	TO	2.0	2.804+04	5.608+04														
2.49+03		16.0				AFTERBURNED	14904.	10320.		20003.			22016.	56136.	295.	149.	7.	917.	36.3
2.49+03		16.0				NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
TO	0.00	TO	.0	0.000	0.000														
2.49+03		16.0				AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
2.49+03		16.0				NOZZLE EXIT	14994.	10382.	11561.	1960.	1175.	11.	11514.	4264.	297.	150.	7.	32.	36.5
TO	6.87+02	TO	2.0	2.819+04	5.638+04														
3.18+03		18.0				AFTERBURNED	14994.	10382.		20125.			22098.	56440.	297.	150.	7.	922.	36.5
3.18+03		18.0				NOZZLE EXIT	15054.	10424.	11607.	1968.	1178.	11.	11534.	4281.	298.	151.	7.	32.	36.6
TO	7.87+02	TO	2.0	2.829+04	5.658+04														
3.97+03		20.0				AFTERBURNED	15054.	10424.		20205.			22151.	56641.	298.	151.	7.	925.	36.6

3.97+03 TO 4.85+03	8.89+02	20.0 TO 22.0	2.0	2.802+04	5.604+04	NOZZLE EXIT	14889.	10310.	11480.	1946.	1168.	10.	11479.	4234.	295.	149.	7.	32.	36.2
						AFTERBURNED	14889.	10310.		19984.			22003.	56088.	295.	149.	7.	916.	36.2
4.85+03 TO 5.84+03	9.88+02	22.0 TO 24.0	2.0	2.709+04	5.419+04	NOZZLE EXIT	14331.	9923.	11050.	1873.	1133.	10.	11291.	4075.	284.	144.	7.	32.	34.9
						AFTERBURNED	14331.	9923.		19234.			21502.	54217.	284.	144.	7.	887.	34.9
5.84+03 TO 6 92+03	1.08+03	24.0 TO 26.0	2.0	2.617+04	5.235+04	NOZZLE EXIT	13775.	9538.	10621.	1801.	1098.	10.	11105.	3917.	273.	138.	7.	32.	33.5
						AFTERBURNED	13775.	9538.		18488.			21003.	52355.	273.	138.	7.	858.	33.5
6.92+03 TO 8.09+03	1.17+03	26.0 TO 28.0	2.0	2.557+04	5.113+04	NOZZLE EXIT	13408.	9284.	10338.	1753.	1076.	9.	10981.	3813.	265.	134.	7.	32.	32.7
						AFTERBURNED	13408.	9284.		17996.			20673.	51126.	265.	134.	7.	839.	32.7
8.09+03 TO 9.34+03	1.25+03	28.0 TO 30.0	2.0	2.502+04	5.005+04	NOZZLE EXIT	13081.	9057.	10086.	1710.	1055.	9.	10871.	3720.	259.	131.	6.	32.	31.9
						AFTERBURNED	13081.	9057.		17556.			20379.	50029.	259.	131.	6.	822.	31.9
9.34+03 TO 1.07+04	1.33+03	30.0 TO 32.0	2.0	2.453+04	4.906+04	NOZZLE EXIT	12783.	8851.	9856.	1671.	1037.	9.	10771.	3635.	253.	128.	6.	32.	31.1
						AFTERBURNED	12783.	8851.		17156.			20111.	49031.	253.	128.	6.	806.	31.1
1.07+04 TO 1.21+04	1.41+03	32.0 TO 34.0	2.0	2.407+04	4.814+04	NOZZLE EXIT	12504.	8658.	9641.	1634.	1019.	9.	10677.	3556.	248.	125.	6.	32.	30.5
						AFTERBURNED	12504.	8658.		16782.			19861.	48095.	248.	125.	6.	792.	30.5
1.21+04 TO 1.36+04	1.49+03	34.0 TO 36.0	2.0	2.363+04	4.725+04	NOZZLE EXIT	12236.	8473.	9435.	1600.	1003.	9.	10587.	3480.	242.	123.	6.	32.	29.8
						AFTERBURNED	12236.	8473.		16423.			19621.	47200.	242.	123.	6.	778.	29.8
1.36+04 TO 1.51+04	1.57+03	36.0 TO 38.0	2.0	2.320+04	4.641+04	NOZZLE EXIT	11980.	8295.	9237.	1566.	987.	9.	10501.	3407.	237.	120.	6.	32.	29.2
						AFTERBURNED	11980.	8295.		16079.			19390.	46341.	237.	120.	6.	764.	29.2
1.51+04 TO 1.60+04	8.21+02	38.0 TO 39.0	1.0	2.294+04	2.294+04	NOZZLE EXIT	5911.	4093.	4557.	773.	488.	4.	5224.	1681.	117.	59.	3.	16.	14.4
						AFTERBURNED	5911.	4093.		7933.			9624.	22905.	117.	59.	3.	378.	14.4
1.60+04 TO 1.97+04	3.73+03	39.0 TO 43.5	4.5	2.179+04	9.701+04	NOZZLE EXIT	25499.	17656.	19660.	3333.	2037.	18.	20654.	7251.	505.	256.	13.	59.	62.1
						AFTERBURNED	25499.	17656.		34223.			39023.	97017.	505.	256.	13.	1591.	62.1
1.97+04 TO 2.95+04	9.84+03	43.5 TO 53.8	10.4	2.042+04	2.122+05	NOZZLE EXIT	57161.	39579.	44073.	7472.	4381.	40.	41272.	16253.	1131.	573.	28.	108.	139.0
						AFTERBURNED	57161.	39579.		76718.			80745.	212645.	1131.	573.	28.	3458.	139.0
2.95+04 TO 3.94+04	9.84+03	53.8 TO 63.0	9.2	2.075+04	1.906+05	NOZZLE EXIT	51461.	35632.	39678.	6727.	3926.	36.	36684.	14632.	1019.	516.	26.	95.	125.1
						AFTERBURNED	51461.	35632.		69067.			72064.	190988.	1019.	516.	26.	3104.	125.1
3.94+04 TO 4.92+04	9.84+03	63.0 TO 71.1	8.0	2.235+04	1.797+05	NOZZLE EXIT	47313.	32761.	36480.	6185.	3768.	33.	38014.	13454.	937.	475.	23.	109.	115.2
						AFTERBURNED	47313.	32761.		63501.			71968.	179702.	937.	475.	23.	2945.	115.2
4.92+04 TO 5.91+04	9.84+03	71.1 TO 78.1	7.0	2.332+04	1.632+05	NOZZLE EXIT	42160.	29193.	32507.	5511.	3467.	30.	36824.	11990.	835.	423.	21.	111.	102.8
						AFTERBURNED	42160.	29193.		56585.			68063.	162958.	835.	423.	21.	2687.	102.8

Table 6B. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units) Continuation 1

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS												
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE												.000730
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
													.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.959390	.000307				.004710	.000038
						AFTERBURNED					.035470	.000085	1.278600	.919340				.020390	.000038
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
5.91+04 TO 6.89+04	9.84+03	78.1 TO 84.3	6.2	2.286+04	1.424+05	NOZZLE EXIT	36656.	25381.	28263.	4792.	3031.	26.	32481.	10424.	726.	368.	18.	99.	89.4
						AFTERBURNED	36656.	25381.		49198.			59795.	142128.	726.	368.	18.	2346.	89.4
6.89+04 TO 7.87+04	9.84+03	84.3 TO 90.0	5.7	2.193+04	1.251+05	NOZZLE EXIT	31974.	22139.	24653.	4180.	2677.	23.	29215.	9093.	633.	321.	16.	91.	78.0
						AFTERBURNED	31974.	22139.		42914.			53334.	124820.	633.	321.	16.	2065.	78.0
7.87+04 TO 8.86+04	9.84+03	90.0 TO 95.3	5.3	2.111+04	1.120+05	NOZZLE EXIT	28413.	19674.	21908.	3714.	2407.	20.	26720.	8081.	562.	285.	14.	84.	69.3
						AFTERBURNED	28413.	19674.		38134.			48406.	111646.	562.	285.	14.	1851.	69.3
8.86+04 TO 9.84+04	9.84+03	95.3 TO 100.3	5.0	2.017+04	1.009+05	NOZZLE EXIT	25391.	17581.	19577.	3319.	2183.	18.	24734.	7222.	503.	255.	13.	80.	62.0
						AFTERBURNED	25391.	17581.		34078.			44398.	100592.	503.	255.	13.	1672.	62.0
9.84+04 TO 1.08+05	9.84+03	100.3 TO 105.1	4.8	1.917+04	9.117+04	NOZZLE EXIT	22696.	15715.	17499.	2967.	1985.	16.	23022.	6455.	449.	228.	11.	76.	55.5
						AFTERBURNED	22696.	15715.		30461.			40903.	90789.	449.	228.	11.	1514.	55.5
1.08+05 TO 1.18+05	9.84+03	105.1 TO 109.6	4.6	1.813+04	8.275+04	NOZZLE EXIT	20345.	14087.	15687.	2659.	1815.	15.	21616.	5787.	403.	204.	10.	73.	49.7
						AFTERBURNED	20345.	14087.		27306.			37970.	82323.	403.	204.	10.	1378.	49.7
1.18+05 TO 1.28+05	9.84+03	109.6 TO 114.1	4.4	1.355+04	6.002+04	NOZZLE EXIT	13613.	9426.	10496.	1779.	1379.	10.	18921.	3874.	269.	137.	7.	70.	33.5
						AFTERBURNED	13613.	9426.		18271.			31347.	59355.	269.	137.	7.	1017.	33.5
1.28+05 TO 1.38+05	9.84+03	114.1 TO 118.5	4.4	6.725+03	2.972+04	NOZZLE EXIT	4473.	3097.	3449.	585.	808.	4.	15813.	1276.	89.	45.	2.	70.	11.4
						AFTERBURNED	4473.	3097.		6003.			23088.	28697.	89.	45.	2.	538.	11.4
1.38+05 TO 1.48+05	9.84+03	118.5 TO 123.0	4.5	3.681+03	1.662+04	NOZZLE EXIT	417.	289.	322.	55.	567.	2.	14762.	123.	8.	4.	0.	72.	1.6
						AFTERBURNED	417.	289.		560.			19861.	15409.	8.	4.	0.	393.	1.6
1.48+05 TO 1.57+05	9.84+03	123.0 TO 127.6	4.6	3.375+03	1.542+04	NOZZLE EXIT	0.	0.	0.	0.	547.	1.	14798.	5.	0.	0.	0.	73.	.6
						AFTERBURNED	0.	0.		0.			19722.	14181.	0.	0.	0.	315.	.6
1.57+05 TO 1.67+05	9.84+03	127.6 TO 132.4	4.8	3.375+03	1.621+04	NOZZLE EXIT	0.	0.	0.	0.	575.	1.	15549.	5.	0.	0.	0.	76.	.6
						AFTERBURNED	0.	0.		0.			20723.	14900.	0.	0.	0.	330.	.6
1.67+05 TO 1.77+05	9.84+03	132.4 TO 137.2	4.8	3.375+03	1.631+04	NOZZLE EXIT	0.	0.	0.	0.	579.	1.	15650.	5.	0.	0.	0.	77.	.6
						AFTERBURNED	0.	0.		0.			20857.	14997.	0.	0.	0.	333.	.6

1.77+05 TO 1.87+05	9.84+03	137.2 TO 142.0	4.8	3.375+03	1.631+04	NOZZLE EXIT	0.	0.	0.	0.	579.	1.	15650.	5.	0.	0.	0.	77.	.8
						AFTERBURNED	0.	0.		0.			20857.	14997.	0.	0.	0.	333.	.8
1.87+05 TO 1.97+05	9.84+03	142.0 TO 147.1	5.1	3.375+03	1.709+04	NOZZLE EXIT	0.	0.	0.	0.	606.	1.	16397.	5.	0.	0.	0.	80.	.8
						AFTERBURNED	0.	0.		0.			21853.	15712.	0.	0.	0.	348.	.8
1.97+05 TO 2.07+05	9.84+03	147.1 TO 152.3	5.2	3.375+03	1.768+04	NOZZLE EXIT	0.	0.	0.	0.	627.	2.	16958.	5.	0.	0.	0.	83.	.7
						AFTERBURNED	0.	0.		0.			22600.	16250.	0.	0.	0.	360.	.7
2.07+05 TO 2.17+05	9.84+03	152.3 TO 157.6	5.2	3.375+03	1.768+04	NOZZLE EXIT	0.	0.	0.	0.	627.	2.	16958.	5.	0.	0.	0.	83.	.7
						AFTERBURNED	0.	0.		0.			22600.	16250.	0.	0.	0.	360.	.7
2.17+05 TO 2.26+05	9.84+03	157.6 TO 163.0	5.5	3.375+03	1.845+04	NOZZLE EXIT	0.	0.	0.	0.	655.	2.	17705.	6.	0.	0.	0.	87.	.7
						AFTERBURNED	0.	0.		0.			23596.	16966.	0.	0.	0.	376.	.7
2.26+05 TO 2.36+05	9.84+03	163.0 TO 168.7	5.7	3.375+03	1.919+04	NOZZLE EXIT	0.	0.	0.	0.	681.	2.	18407.	6.	0.	0.	0.	90.	.7
						AFTERBURNED	0.	0.		0.			24531.	17638.	0.	0.	0.	391.	.7
2.36+05 TO 2.46+05	9.84+03	168.7 TO 174.4	5.7	3.375+03	1.919+04	NOZZLE EXIT	0.	0.	0.	0.	681.	2.	18407.	6.	0.	0.	0.	90.	.7
						AFTERBURNED	0.	0.		0.			24531.	17638.	0.	0.	0.	391.	.7
2.46+05 TO 2.56+05	9.84+03	174.4 TO 180.4	6.0	3.375+03	2.035+04	NOZZLE EXIT	0.	0.	0.	0.	722.	2.	19526.	6.	0.	0.	0.	96.	.8
						AFTERBURNED	0.	0.		0.			26023.	18711.	0.	0.	0.	415.	.8
2.56+05 TO 2.66+05	9.84+03	180.4 TO 186.6	6.2	3.375+03	2.085+04	NOZZLE EXIT	0.	0.	0.	0.	740.	2.	20002.	6.	0.	0.	0.	98.	.8
						AFTERBURNED	0.	0.		0.			26657.	19167.	0.	0.	0.	425.	.8
2.66+05 TO 2.76+05	9.84+03	186.6 TO 192.8	6.2	3.375+03	2.105+04	NOZZLE EXIT	0.	0.	0.	0.	747.	2.	20196.	6.	0.	0.	0.	99.	.8
						AFTERBURNED	0.	0.		0.			26916.	19353.	0.	0.	0.	429.	.8
2.76+05 TO 2.85+05	9.84+03	192.8 TO 199.6	6.7	3.375+03	2.266+04	NOZZLE EXIT	0.	0.	0.	0.	804.	2.	21742.	7.	0.	0.	0.	107.	.9
						AFTERBURNED	0.	0.		0.			28976.	20834.	0.	0.	0.	462.	.9
2.85+05 TO 2.95+05	9.84+03	199.6 TO 206.3	6.7	3.375+03	2.266+04	NOZZLE EXIT	0.	0.	0.	0.	804.	2.	21742.	7.	0.	0.	0.	107.	.9
						AFTERBURNED	0.	0.		0.			28976.	20834.	0.	0.	0.	462.	.9
2.95+05 TO 3.05+05	9.84+03	206.3 TO 213.4	7.1	3.375+03	2.408+04	NOZZLE EXIT	0.	0.	0.	0.	854.	2.	23101.	7.	0.	0.	0.	113.	.9
						AFTERBURNED	0.	0.		0.			30787.	22137.	0.	0.	0.	491.	.9
3.05+05 TO 3.15+05	9.84+03	213.4 TO 220.7	7.3	3.375+03	2.461+04	NOZZLE EXIT	0.	0.	0.	0.	873.	2.	23607.	8.	0.	0.	0.	116.	.9
						AFTERBURNED	0.	0.		0.			31462.	22622.	0.	0.	0.	502.	.9
3.15+05 TO 3.25+05	9.84+03	220.7 TO 228.3	7.6	3.375+03	2.569+04	NOZZLE EXIT	0.	0.	0.	0.	911.	2.	24651.	8.	0.	0.	0.	121.	1.0
						AFTERBURNED	0.	0.		0.			32852.	23622.	0.	0.	0.	524.	1.0

Table 6B. Mission 1: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units) Continuation 2

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.065860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000036
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
3.25+05 TO 3.35+05	9.84+03	228.3 TO 236.2	7.9	3.375+03	2.664+04	NOZZLE EXIT	0.	0.	0.	0.	945.	2.	25561.	8.	0.	0.	0.	125.	1.0
						AFTERBURNED	0.	0.		0.			34066.	24494.	0.	0.	0.	543.	1.0
3.35+05 TO 3.44+05	9.84+03	236.2 TO 244.4	8.1	3.375+03	2.748+04	NOZZLE EXIT	0.	0.	0.	0.	975.	2.	26366.	8.	0.	0.	0.	129.	1.0
						AFTERBURNED	0.	0.		0.			35139.	25266.	0.	0.	0.	560.	1.0
3.44+05 TO 3.54+05	9.84+03	244.4 TO 252.9	8.5	3.375+03	2.879+04	NOZZLE EXIT	0.	0.	0.	0.	1021.	2.	27623.	9.	0.	0.	0.	136.	1.1
						AFTERBURNED	0.	0.		0.			36814.	26470.	0.	0.	0.	587.	1.1
3.54+05 TO 3.64+05	9.84+03	252.9 TO 262.4	9.5	3.375+03	3.207+04	NOZZLE EXIT	0.	0.	0.	0.	1138.	3.	30769.	10.	0.	0.	0.	151.	1.2
						AFTERBURNED	0.	0.		0.			41007.	29485.	0.	0.	0.	654.	1.2
3.64+05 TO 3.74+05	9.84+03	262.4 TO 273.4	11.0	3.375+03	3.719+04	NOZZLE EXIT	0.	0.	0.	0.	1319.	3.	35677.	11.	0.	0.	0.	175.	1.4
						AFTERBURNED	0.	0.		0.			47548.	34188.	0.	0.	0.	758.	1.4
3.74+05 TO 3.84+05	9.84+03	273.4 TO 287.0	13.6	3.375+03	4.603+04	NOZZLE EXIT	0.	0.	0.	0.	1633.	4.	44164.	14.	0.	0.	0.	217.	1.7
						AFTERBURNED	0.	0.		0.			58858	42320.	0.	0.	0.	939.	1.7
3.84+05 TO 3.94+05	9.84+03	287.0 TO 306.6	19.6	3.375+03	6.607+04	NOZZLE EXIT	0.	0.	0.	0.	2344.	6.	63391.	20.	0.	0.	0.	311.	2.5
						AFTERBURNED	0.	0.		0.			84482.	60744.	0.	0.	0.	1347.	2.5
3.94+05 TO 4.04+05	9.84+03	306.6 TO 344.0	37.4	3.375+03	1.262+05	NOZZLE EXIT	0.	0.	0.	0.	4475.	11.	121028.	39.	0.	0.	0.	594.	4.8
						AFTERBURNED	0.	0.		0.			161297.	115976.	0.	0.	0.	2572.	4.8

4.04+05 TO 3.94+05	9.84+03	344.0 TO 387.0	43.0	3.375+03	1.452+05	NOZZLE EXIT	0.	0.	0.	0.	5149.	12.	139259.	45.	0.	0.	0.	684.	5.5
						AFTERBURNED	0.	0.		0.			185593.	133446.	0.	0.	0.	2960.	5.5
3.94+05 TO 3.84+05	9.84+03	387.0 TO 421.5	34.5	3.367+03	1.161+05	NOZZLE EXIT	0.	0.	0.	0.	4117.	10.	111351.	36.	0.	0.	0.	547.	4.4
						AFTERBURNED	0.	0.		0.			148399.	106702.	0.	0.	0.	2367.	4.4
3.84+05 TO 3.74+05	9.84+03	421.5 TO 464.0	42.5	2.873+03	1.222+05	NOZZLE EXIT	0.	0.	0.	0.	4333.	10.	117211.	38.	0.	0.	0.	575.	4.6
						AFTERBURNED	0.	0.		0.			156210.	112318.	0.	0.	0.	2491.	4.6
3.74+05 TO 3.84+05	9.84+03	464.0 TO 478.2	14.2	2.374+03	3.371+04	NOZZLE EXIT	0.	0.	0.	0.	1196.	3.	32341.	10.	0.	0.	0.	159.	1.3
						AFTERBURNED	0.	0.		0.			43102.	30991.	0.	0.	0.	687.	1.3
				TOTALS:	3.7865+06	NOZZLE EXIT	676057.	468116.	521265.	88373.	97093.	579.	1712943.	192618.	13382.	6781.	336.	7294.	1692.5
						AFTERBURNED	676057.	468116.		907363.			2587328.	3688692.	13382.	6781.	336.	66936.	1692.5

Table 7A. Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units)

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS: AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE												
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000038
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
1.59-01 TO 1.65-01	5.58-03	.0 TO 2.0	2.0	9.985+03	1.997+04	NOZZLE EXIT	5120.	3545.	3947.	669.	427.	4.	4621.	1456.	101.	51.	3.	14.	12.5
						AFTERBURNED	5120.	3545.		6871.			8464.	19932.	101.	51.	3.	329.	12.5
1.65-01 TO 1.88-01	2.34-02	2.0 TO 4.0	2.0	1.152+04	2.304+04	NOZZLE EXIT	6037.	4180.	4654.	789.	485.	4.	4966.	1717.	119.	61.	3.	14.	14.7
						AFTERBURNED	6037.	4180.		8102.			9337.	23039.	119.	61.	3.	378.	14.7
1.88-01 TO 2.32-01	4.33-02	4.0 TO 6.0	2.0	1.174+04	2.348+04	NOZZLE EXIT	6169.	4271.	4756.	806.	493.	4.	5010.	1754.	122.	62.	3.	14.	15.0
						AFTERBURNED	6169.	4271.		8279.			9455.	23481.	122.	62.	3.	385.	15.0
2.32-01 TO 2.32-01	0.00	6.0 TO 6.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
2.32-01 TO 2.97-01	6.51-02	6.0 TO 8.0	2.0	1.191+04	2.382+04	NOZZLE EXIT	6272.	4343.	4836.	820.	500.	4.	5045.	1784.	124.	63.	3.	14.	15.3
						AFTERBURNED	6272.	4343.		8418.			9548.	23828.	124.	63.	3.	390.	15.3
2.97-01 TO 3.65-01	8.83-02	8.0 TO 10.0	2.0	1.201+04	2.402+04	NOZZLE EXIT	6332.	4385.	4882.	828.	504.	4.	5065.	1801.	125.	64.	3.	14.	15.4
						AFTERBURNED	6332.	4385.		8499.			9602.	24030.	125.	64.	3.	394.	15.4
3.65-01 TO 4.98-01	1.13-01	10.0 TO 12.0	2.0	1.208+04	2.417+04	NOZZLE EXIT	6376.	4415.	4916.	833.	506.	4.	5080.	1813.	126.	64.	3.	14.	15.5
						AFTERBURNED	6376.	4415.		8557.			9641.	24175.	126.	64.	3.	396.	15.5
4.98-01 TO 6.36-01	1.38-01	12.0 TO 14.0	2.0	1.215+04	2.430+04	NOZZLE EXIT	6417.	4443.	4948.	839.	509.	5.	5094.	1825.	127.	64.	3.	14.	15.6
						AFTERBURNED	6417.	4443.		8612.			9678.	24313.	127.	64.	3.	398.	15.6
6.36-01 TO 8.00-01	1.65-01	14.0 TO 16.0	2.0	1.222+04	2.444+04	NOZZLE EXIT	6458.	4472.	4979.	844.	511.	5.	5107.	1836.	128.	65.	3.	14.	15.7
						AFTERBURNED	6458.	4472.		8668.			9715.	24451.	128.	65.	3.	400.	15.7
8.00-01 TO 8.00-01	0.00	16.0 TO 16.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
8.00-01 TO 9.92-01	1.92-01	16.0 TO 18.0	2.0	1.228+04	2.457+04	NOZZLE EXIT	6497.	4499.	5009.	849.	514.	5.	5120.	1847.	129.	65.	3.	14.	15.8
						AFTERBURNED	6497.	4499.		8720.			9750.	24581.	129.	65.	3.	402.	15.8
9.92-01 TO 1.21+00	2.20-01	18.0 TO 20.0	2.0	1.234+04	2.469+04	NOZZLE EXIT	6533.	4523.	5037.	854.	516.	5.	5132.	1858.	129.	66.	3.	14.	15.9
						AFTERBURNED	6533.	4523.		8768.			9782.	24700.	129.	66.	3.	404.	15.9

1.21+00 TO 1.46+00	2.49-01	20.0 TO 22.0	2.0	1.235+04	2.470+04	NOZZLE EXIT	6537.	4526.	5040.	854.	516.	5.	5134.	1859.	129.	66.	3.	14.	15.9
						AFTERBURNED	6537.	4526.		8773.			9786.	24715.	129.	66.	3.	404.	15.9
1.46+00 TO 1.74+00	2.78-01	22.0 TO 24.0	2.0	1.205+04	2.410+04	NOZZLE EXIT	6355.	4400.	4900.	831.	505.	4.	5073.	1807.	126.	64.	3.	14.	15.5
						AFTERBURNED	6355.	4400.		8529.			9622.	24105.	126.	64.	3.	395.	15.5
1.74+00 TO 2.04+00	3.05-01	24.0 TO 26.0	2.0	1.161+04	2.321+04	NOZZLE EXIT	6088.	4215.	4694.	796.	488.	4.	4983.	1731.	121.	61.	3.	14.	14.8
						AFTERBURNED	6088.	4215.		8171.			9382.	23210.	121.	61.	3.	381.	14.8
2.04+00 TO 2.38+00	3.31-01	26.0 TO 28.0	2.0	1.131+04	2.263+04	NOZZLE EXIT	5910.	4092.	4557.	773.	477.	4.	4923.	1681.	117.	59.	3.	14.	14.4
						AFTERBURNED	5910.	4092.		7932.			9223.	22615.	117.	59.	3.	372.	14.4
2.38+00 TO 2.73+00	3.56-01	28.0 TO 30.0	2.0	1.107+04	2.215+04	NOZZLE EXIT	5765.	3992.	4445.	754.	468.	4.	4875.	1640.	114.	58.	3.	14.	14.0
						AFTERBURNED	5765.	3992.		7738.			9093.	22130.	114.	58.	3.	364.	14.0
2.73+00 TO 3.11+00	3.80-01	30.0 TO 32.0	2.0	1.081+04	2.162+04	NOZZLE EXIT	5634.	3901.	4344.	736.	457.	4.	4745.	1602.	112.	57.	3.	14.	13.7
						AFTERBURNED	5634.	3901.		7561.			8861.	21608.	112.	57.	3.	355.	13.7
3.11+00 TO 3.51+00	4.02-01	32.0 TO 34.0	2.0	1.052+04	2.104+04	NOZZLE EXIT	5513.	3818.	4251.	721.	443.	4.	4532.	1568.	109.	55.	3.	13.	13.4
						AFTERBURNED	5513.	3818.		7400.			8523.	21039.	109.	55.	3.	345.	13.4
3.51+00 TO 3.94+00	4.23-01	34.0 TO 36.0	2.0	1.025+04	2.051+04	NOZZLE EXIT	5399.	3738.	4163.	706.	430.	4.	4343.	1535.	107.	54.	3.	12.	13.1
						AFTERBURNED	5399.	3738.		7246.			8219.	20510.	107.	54.	3.	336.	13.1
3.94+00 TO 4.38+00	4.42-01	36.0 TO 38.0	2.0	1.006+04	2.012+04	NOZZLE EXIT	5289.	3662.	4078	691.	423.	4.	4285.	1504.	105.	53.	3.	12.	12.9
						AFTERBURNED	5289.	3662.		7098.			8092.	20121.	105.	53.	3.	330.	12.9
4.38+00 TO 4.84+00	4.61-01	38.0 TO 40.0	2.0	9.885+03	1.977+04	NOZZLE EXIT	5183.	3589.	3996	678.	416.	4.	4249.	1474.	103.	52.	3.	12.	12.6
						AFTERBURNED	5183.	3589.		6956.			7997.	19767.	103.	52.	3.	324.	12.6
4.84+00 TO 6.00+00	1.16+00	40.0 TO 44.8	4.8	9.592+03	4.616+04	NOZZLE EXIT	12045.	8340.	9287	1575.	974.	9.	10081.	3425.	238.	121.	6.	30.	29.3
						AFTERBURNED	12045.	8340.		16166.			18859.	46136.	238.	121.	6.	758.	29.3
6.00+00 TO 9.00+00	3.00+00	44.8 TO 55.6	10.8	9.225+03	9.973+04	NOZZLE EXIT	25860.	17906.	19939	3380.	2114.	18.	22243.	7354.	512.	259.	13.	67.	63.0
						AFTERBURNED	25860.	17906.		34708.			41290.	99625.	512.	259.	13.	1641.	63.0
9.00+00 TO 1.20+01	3.00+00	55.6 TO 65.0	9.4	9.388+03	8.782+04	NOZZLE EXIT	22669.	15697.	17479	2963.	1667.	16.	19880.	6447.	449.	227.	11.	60.	55.3
						AFTERBURNED	22669.	15697.		30426.			36703.	87698.	449	227.	11.	1446.	55.3
1.20+01 TO 1.50+01	3.00+00	65.0 TO 73.0	8.0	9.954+03	8.011+04	NOZZLE EXIT	20478.	14179.	15789.	2677.	1714.	15.	18701.	5824.	405.	205.	10.	58.	50.0
						AFTERBURNED	20478.	14179.		27485.			34145.	79933.	405	205.	10.	1322.	50.0
1.50+01 TO 1.80+01	3.00+00	73.0 TO 80.1	7.1	1.017+04	7.190+04	NOZZLE EXIT	18453.	12777.	14228.	2412.	1535.	13.	16583.	5248.	365.	185.	9.	51.	45.0
						AFTERBURNED	18453.	12777.		24766.			30410.	71770.	365.	185.	9.	1186.	45.0

Table 7A. Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units) Continuation 1

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
													.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460								.004710	.000038
						AFTERBURNED					.035470	.000085	.959390	.000307				.020390	.000038
													1.278600	.919340					
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
1.80+01 TO 2.10+01	3.00+00	80.1 TO 86.4	6.3	1.009+04	6.373+04	NOZZLE EXIT	16332.	11308.	12592.	2135.	1362.	12.	14766.	4645.	323.	164.	8.	46.	39.8
						AFTERBURNED	16332.	11308.		21920.			27033.	63606.	323.	164.	8.	1051.	39.8
2.10+01 TO 2.40+01	3.00+00	86.4 TO 92.2	5.8	9.687+03	5.609+04	NOZZLE EXIT	14266.	9878.	10999.	1865.	1204.	10.	13297.	4057.	282.	143.	7.	42.	34.8
						AFTERBURNED	14266.	9878.		19147.			24146.	55942.	282.	143.	7.	927.	34.8
2.40+01 TO 2.70+01	3.00+00	92.2 TO 97.6	5.4	9.357+03	5.036+04	NOZZLE EXIT	12726.	8812.	9812.	1664.	1086.	9.	12181.	3619.	252.	128.	6.	39.	31.1
						AFTERBURNED	12726.	8812.		17080.			21965.	50210.	252.	128.	6.	834.	31.1
2.70+01 TO 3.00+01	3.00+00	97.6 TO 102.7	5.1	8.988+03	4.558+04	NOZZLE EXIT	11425.	7911.	8809.	1493.	988.	8.	11287.	3249.	226.	115.	6.	37.	27.9
						AFTERBURNED	11425.	7911.		15334.			20187.	45412.	226.	115.	6.	756.	27.9
3.00+01 TO 3.30+01	3.00+00	102.7 TO 107.5	4.8	8.579+03	4.138+04	NOZZLE EXIT	10270.	7111.	7919.	1343.	902.	7.	10535.	2921.	203.	103.	5.	35.	25.1
						AFTERBURNED	10270.	7111.		13784.			18666.	41196.	203.	103.	5.	688.	25.1
3.30+01 TO 3.60+01	3.00+00	107.5 TO 112.1	4.6	8.185+03	3.789+04	NOZZLE EXIT	9305.	6443.	7175.	1216.	832.	7.	9925.	2647.	184.	93.	5.	33.	22.8
						AFTERBURNED	9305.	6443.		12489.			17418.	37689.	184.	93.	5.	631.	22.8
3.60+01 TO 3.90+01	3.00+00	112.1 TO 116.6	4.5	7.328+03	3.274+04	NOZZLE EXIT	7824.	5417.	6032.	1023.	730.	6.	9190.	2226.	155.	78.	4.	32.	19.2
						AFTERBURNED	7824.	5417.		10500.			15770.	32498.	155.	78.	4.	549.	19.2
3.90+01 TO 4.20+01	3.00+00	116.6 TO 121.0	4.4	4.557+03	2.004+04	NOZZLE EXIT	4020.	2783.	3099.	525.	489.	3.	7810.	1145.	80.	40.	2.	32.	10.0
						AFTERBURNED	4020.	2783.		5395.			12219.	19657.	80.	40.	2.	348.	10.0
4.20+01 TO 4.50+01	3.00+00	121.0 TO 125.4	4.4	2.333+03	1.030+04	NOZZLE EXIT	1070.	741.	825.	140.	306.	1.	6843.	306.	21.	11.	1.	32.	2.8
						AFTERBURNED	1070.	741.		1436.			9602.	9797.	21.	11.	1.	194.	2.8
4.50+01 TO 4.80+01	3.00+00	125.4 TO 130.0	4.6	1.553+03	7.158+03	NOZZLE EXIT	31.	22.	24.	4.	252.	1.	6778.	11.	1.	0.	0.	33.	.3
						AFTERBURNED	31.	22.		42.			9048.	6591.	1.	0.	0.	145.	.3
4.80+01 TO 5.10+01	3.00+00	130.0 TO 134.7	4.7	1.531+03	7.212+03	NOZZLE EXIT	0.	0.	0.	0.	256.	1.	6919.	2.	0.	0.	0.	34.	.3
						AFTERBURNED	0.	0.		0.			9221.	6630.	0.	0.	0.	147.	.3
5.10+01 TO 5.40+01	3.00+00	134.7 TO 139.4	4.7	1.531+03	7.212+03	NOZZLE EXIT	0.	0.	0.	0.	256.	1.	6919.	2.	0.	0.	0.	34.	.3
						AFTERBURNED	0.	0.		0.			9221.	6630.	0.	0.	0.	147.	.3

5.40+01 TO 5.70+01	3.00+00	139.4 TO 144.1	4.7	1.531+03	7.215+03	NOZZLE EXIT	0.	0.	0.	0.	256.	1.	6922.	2.	0.	0.	0.	34.	.3
						AFTERBURNED	0.	0.		0.			9225.	6633.	0.	0.	0.	147.	.3
5.70+01 TO 6.00+01	3.00+00	144.1 TO 149.2	5.1	1.531+03	7.833+03	NOZZLE EXIT	0.	0.	0.	0.	278.	1.	7515.	2.	0.	0.	0.	37.	.3
						AFTERBURNED	0.	0.		0.			10015.	7201.	0.	0.	0.	160.	.3
6.00+01 TO 6.30+01	3.00+00	149.2 TO 154.4	5.1	1.531+03	7.833+03	NOZZLE EXIT	0.	0.	0.	0.	278.	1.	7515.	2.	0.	0.	0.	37.	.3
						AFTERBURNED	0.	0.		0.			10015.	7201.	0.	0.	0.	160.	.3
6.30+01 TO 6.60+01	3.00+00	154.4 TO 159.5	5.1	1.531+03	7.833+03	NOZZLE EXIT	0.	0.	0.	0.	278.	1.	7515.	2.	0.	0.	0.	37.	.3
						AFTERBURNED	0.	0.		0.			10015.	7201.	0.	0.	0.	160.	.3
6.60+01 TO 6.90+01	3.00+00	159.5 TO 165.0	5.5	1.531+03	8.446+03	NOZZLE EXIT	0.	0.	0.	0.	300.	1.	8103.	3.	0.	0.	0.	40.	.3
						AFTERBURNED	0.	0.		0.			10799.	7765.	0.	0.	0.	172.	.3
6.90+01 TO 7.20+01	3.00+00	165.0 TO 170.6	5.6	1.531+03	8.531+03	NOZZLE EXIT	0.	0.	0.	0.	303.	1.	8184.	3.	0.	0.	0.	40.	.3
						AFTERBURNED	0.	0.		0.			10908.	7843.	0.	0.	0.	174.	.3
7.20+01 TO 7.50+01	3.00+00	170.6 TO 176.1	5.6	1.531+03	8.537+03	NOZZLE EXIT	0.	0.	0.	0.	303.	1.	8190.	3.	0.	0.	0.	40.	.3
						AFTERBURNED	0.	0.		0.			10915.	7848.	0.	0.	0.	174.	.3
7.50+01 TO 7.80+01	3.00+00	176.1 TO 182.2	6.1	1.531+03	9.314+03	NOZZLE EXIT	0.	0.	0.	0.	330.	1.	8936.	3.	0.	0.	0.	44.	.4
						AFTERBURNED	0.	0.		0.			11909.	8563.	0.	0.	0.	190.	.4
7.80+01 TO 8.10+01	3.00+00	182.2 TO 188.3	6.1	1.531+03	9.314+03	NOZZLE EXIT	0.	0.	0.	0.	330.	1.	8936.	3.	0.	0.	0.	44.	.4
						AFTERBURNED	0.	0.		0.			11909.	8563.	0.	0.	0.	190.	.4
8.10+01 TO 8.40+01	3.00+00	188.3 TO 194.6	6.3	1.531+03	9.644+03	NOZZLE EXIT	0.	0.	0.	0.	342.	1.	9252.	3.	0.	0.	0.	45.	.4
						AFTERBURNED	0.	0.		0.			12330.	8866.	0.	0.	0.	197.	.4
8.40+01 TO 8.70+01	3.00+00	194.6 TO 201.3	6.7	1.531+03	1.019+04	NOZZLE EXIT	0.	0.	0.	0.	361.	1.	9774.	3.	0.	0.	0.	48.	.4
						AFTERBURNED	0.	0.		0.			13025.	9366.	0.	0.	0.	208.	.4
8.70+01 TO 9.00+01	3.00+00	201.3 TO 207.9	6.7	1.531+03	1.019+04	NOZZLE EXIT	0.	0.	0.	0.	361.	1.	9774.	3.	0.	0.	0.	48.	.4
						AFTERBURNED	0.	0.		0.			13025.	9366.	0.	0.	0.	208.	.4
9.00+01 TO 9.30+01	3.00+00	207.9 TO 215.2	7.3	1.531+03	1.112+04	NOZZLE EXIT	0.	0.	0.	0.	395.	1.	10673.	3.	0.	0.	0.	52.	.4
						AFTERBURNED	0.	0.		0.			14224.	10228.	0.	0.	0.	227.	.4
9.30+01 TO 9.60+01	3.00+00	215.2 TO 222.5	7.3	1.531+03	1.115+04	NOZZLE EXIT	0.	0.	0.	0.	396.	1.	10698.	3.	0.	0.	0.	53.	.4
						AFTERBURNED	0.	0.		0.			14258.	10251.	0.	0.	0.	227.	.4
9.60+01 TO 9.90+01	3.00+00	222.5 TO 230.3	7.8	1.531+03	1.196+04	NOZZLE EXIT	0.	0.	0.	0.	424.	1.	11477.	4.	0.	0.	0.	56.	.5
						AFTERBURNED	0.	0.		0.			15295.	10957.	0.	0.	0.	244.	.5

Table 7A. Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (Metric Units) Continuation 2

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000038
KM	KM	SEC	SEC	KG/SEC	KG		KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG	KG
9.90+01 TO 1.02+02	3.00+00	230.3 TO 238.3	8.0	1.531+03	1.220+04	NOZZLE EXIT	0.	0.	0.	0.	433.	1.	11701.	4.	0.	0.	0.	57.	.5
						AFTERBURNED	0.	0.		0.			15594.	11212.	0.	0.	0.	249.	.5
1.02+02 TO 1.05+02	3.00+00	238.3 TO 246.4	8.1	1.531+03	1.240+04	NOZZLE EXIT	0.	0.	0.	0.	440.	1.	11900.	4.	0.	0.	0.	58.	.5
						AFTERBURNEL	0.	0.		0.			15859.	11403.	0.	0.	0.	253.	.5
1.05+02 TO 1.08+02	3.00+00	246.4 TO 254.5	8.1	1.531+03	1.247+04	NOZZLE EXIT	0.	0.	0.	0.	442.	1.	11960.	4.	0.	0.	0.	59.	.5
						AFTERBURNED	0.	0.		0.			15940.	11461.	0.	0.	0.	254.	.5
1.08+02 TO 1.11+02	3.00+00	254.5 TO 264.7	10.2	1.497+03	1.532+04	NOZZLE EXIT	0.	0.	0.	0.	543.	1.	14694.	5.	0.	0.	0.	72.	.6
						AFTERBURNED	0.	0.		0.			19583.	14080.	0.	0.	0.	312.	.6
1.11+02 TO 1.14+02	3.00+00	264.7 TO 275.2	10.5	1.405+03	1.477+04	NOZZLE EXIT	0.	0.	0.	0.	524.	1.	14166.	5.	0.	0.	0.	70.	.6
						AFTERBURNED	0.	0.		0.			18880.	13575.	0.	0.	0.	301.	.6
1.14+02 TO 1.17+02	3.00+00	275.2 TO 287.7	12.4	1.405+03	1.746+04	NOZZLE EXIT	0.	0.	0.	0.	619.	1.	16750.	5.	0.	0.	0.	82.	.7
						AFTERBURNED	0.	0.		0.			22323.	16051.	0.	0.	0.	356.	.7
1.17+02 TO 1.20+02	3.00+00	287.7 TO 304.2	16.5	1.405+03	2.321+04	NOZZLE EXIT	0.	0.	0.	0.	823.	2.	22263.	7.	0.	0.	0.	109.	.9
						AFTERBURNED	0.	0.		0.			29670.	21334.	0.	0.	0.	473.	.9
1.20+02 TO 1.23+02	3.00+00	304.2 TO 338.0	33.8	1.405+03	4.752+04	NOZZLE EXIT	0.	0.	0.	0.	1686.	4.	45592.	15.	0.	0.	0.	224.	1.8
						AFTERBURNED	0.	0.		0.			60762.	43669.	0.	0.	0.	969.	1.8
1.23+02 TO 1.26+02	3.00+00	338.0 TO 352.0	14.0	1.405+03	1.965+04	NOZZLE EXIT	0.	0.	0.	0.	697.	2.	18849.	6.	0.	0.	0.	93.	.7
						AFTERBURNED	0.	0.		0.			25121.	18063.	0.	0.	0.	401.	.7
1.26+02 TO 1.23+02	3.00+00	352.0 TO 361.1	9.1	1.405+03	1.276+04	NOZZLE EXIT	0.	0.	0.	0.	453.	1.	12239.	4.	0.	0.	0.	60.	.5
						AFTERBURNED	0.	0.		0.			16311	11728.	0.	0.	0.	260.	.5
1.23+02 TO 1.20+02	3.00+00	361.1 TO 402.7	41.6	1.405+03	5.845+04	NOZZLE EXIT	0.	0.	0.	0.	2073.	5.	56073.	18.	0.	0.	0.	275.	2.2
						AFTERBURNED	0.	0.		0.			74729.	53732.	0.	0.	0.	1192.	2.2

1.20+02 TO 1.17+02	3.00+00	402.7 TO 431.1	28.4	1.403+03	3.989+04	NOZZLE EXIT	0.	0.	0.	0.	1415.	3.	38274.	12.	0.	0.	0.	188.	1.5
						AFTERBURNED	0.	0.		0.			51008.	36676.	0.	0.	0.	813.	1.5
1.17+02 TO 1.14+02	3.00+00	431.1 TO 473.2	42.1	1.203+03	5.064+04	NOZZLE EXIT	0.	0.	0.	0.	1796.	4.	48588.	16.	0.	0.	0.	239.	1.9
						AFTERBURNED	0.	0.		0.			64754.	46560.	0.	0.	0.	1033.	1.9
1.14+02 TO 1.11+02	3.00+00	473.2 TO 480.0	6.8	1.025+03	6.942+03	NOZZLE EXIT	0.	0.	0.	0.	246.	1.	6660.	2.	0.	0.	0.	33.	.3
						AFTERBURNED	0.	0.		0.			8876.	6382.	0.	0.	0.	142.	.3
1.11+02 TO 1.14+02	3.00+00	480.0 TO 490.4	10.4	9.610+02	1.000+04	NOZZLE EXIT	0.	0.	0.	0.	355.	1.	9596.	3.	0.	0.	0.	47.	.4
						AFTERBURNED	0.	0.		0.			12788.	9195.	0.	0.	0.	204.	.4
1.14+02 TO 1.17+02	3.00+00	490.4 TO 495.7	5.3	9.231+02	4.885+03	NOZZLE EXIT	0.	0.	0.	0.	173.	0.	4687.	1.	0.	0.	0.	23.	.2
						AFTERBURNED	0.	0.		0.			6246.	4491.	0.	0.	0.	100.	.2
				TOTALS:	1.7194+06	NOZZLE EXIT	306656.	212335.	236443.	40086.	44107.	263.	778774.	67371.	6070.	3076.	152.	3317.	767.8
						AFTERBURNED	306656.	212335.		411575.			1175987.	1674889.	6070.	3076.	152.	30400.	767.8

Table 7B. Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units)

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS: AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
							EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE												
						BOOSTER: NOZZLE EXIT	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						AFTERBURNED	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						SUSTAINER: NOZZLE EXIT					.035470	.000085	.959390	.000307				.004710	.000038
						AFTERBURNED							1.278600	.919340				.020390	.000038
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
5.23+02 TO 5.41+02	1.83+01	.C TO 2.0	2.0	2.201+04	4.403+04	NOZZLE EXIT	11287.	7815.	8702.	1475.	940.	8.	10188.	3210.	223.	113.	6.	31.	27.5
						AFTERBURNED	11287.	7815.		15148.			18661.	43941.	223.	113.	6.	726.	27.5
5.41+02 TO 6.18+02	7.67+01	2.0 TO 4.0	2.0	2.540+04	5.080+04	NOZZLE EXIT	13308.	9215.	10261.	1740.	1069.	9.	10948.	3784.	263.	133.	7.	32.	32.4
						AFTERBURNED	13308.	9215.		17861.			20583.	50791.	263.	133.	7.	834.	32.4
6.18+02 TO 7.60+02	1.42+02	4.0 TO 6.0	2.0	2.586+04	5.177+04	NOZZLE EXIT	13599.	9416.	10486.	1778.	1088.	10.	11045.	3867.	269.	136.	7.	32.	33.1
						AFTERBURNED	13599.	9416.		18252.			20845.	51766.	269.	136.	7.	849.	33.1
7.60+02 TO 7.60+02	0.00	6.0 TO 6.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
7.60+02 TO 9.74+02	2.14+02	6.0 TO 8.0	2.0	2.626+04	5.252+04	NOZZLE EXIT	13828.	9575.	10662.	1808.	1102.	10.	11122.	3932.	274.	139.	7.	32.	33.7
						AFTERBURNED	13828.	9575.		18559.			21050.	52531.	274.	139.	7.	961.	33.7
9.74+02 TO 1.26+03	2.90+02	8.0 TO 10.0	2.0	2.648+04	5.296+04	NOZZLE EXIT	13960.	9666.	10764.	1825.	1110.	10.	11167.	3970.	276.	140.	7.	32.	34.0
						AFTERBURNED	13960.	9666.		18737.			21169.	52976.	276.	140.	7.	868.	34.0
1.26+03 TO 1.63+03	3.70+02	10.0 TO 12.0	2.0	2.664+04	5.328+04	NOZZLE EXIT	14056.	9733.	10838.	1837.	1116.	10.	11199.	3997.	278.	141.	7.	32.	34.2
						AFTERBURNED	14056.	9733.		18865.			21255.	53297.	278.	141.	7.	873.	34.2
1.63+03 TO 2.09+03	4.52+02	12.0 TO 14.0	2.0	2.679+04	5.358+04	NOZZLE EXIT	14147.	9795.	10908.	1849.	1122.	10.	11229.	4023.	280.	142.	7.	32.	34.4
						AFTERBURNED	14147.	9795.		16987.			21336.	53600.	280.	142.	7.	878.	34.4
2.09+03 TO 2.63+03	5.41+02	14.0 TO 16.0	2.0	2.694+04	5.388+04	NOZZLE EXIT	14238.	9858.	10978.	1861.	1127.	10.	11260.	4049.	282.	143.	7.	32.	34.7
						AFTERBURNED	14238.	9858.		19109.			21418.	53905.	282.	143.	7.	882.	34.7
2.63+03 TO 2.63+03	0.00	16.0 TO 16.0	.0	0.000	0.000	NOZZLE EXIT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0
						AFTERBURNED	0.	0.		0.			0.	0.	0.	0.	0.	0.	.0
2.63+03 TO 3.26+03	6.29+02	16.0 TO 18.0	2.0	2.708+04	5.416+04	NOZZLE EXIT	14323.	9917.	11043.	1872.	1133.	10.	11289.	4073.	284.	144.	7.	32.	34.9
						AFTERBURNED	14323.	9917.		19223.			21495.	54190.	284.	144.	7.	887.	34.9
3.26+03 TO 3.98+03	7.21+02	18.0 TO 20.0	2.0	2.721+04	5.442+04	NOZZLE EXIT	14402.	9972.	11104.	1883.	1138.	10.	11315.	4095.	285.	144.	7.	32.	35.1
						AFTERBURNED	14402.	9972.		19329.			21565.	54454.	285.	144.	7.	891.	35.1

3.98+03 TO 4.79+03	8.17+02	20.0 TO 22.0	2.0	2.723+04	5.445+04	NOZZLE EXIT	14411.	9979.	11111.	1884.	1138.	10.	11318.	4098.	285.	145.	7.	32.	35.1
						AFTERBURNED	14411.	9979.		19342.			21574.	54486.	285.	145.	7.	891.	35.1
4.79+03 TO 5.71+03	9.13+02	22.0 TO 24.0	2.0	2.656+04	5.313+04	NOZZLE EXIT	14010.	9701.	10802.	1831.	1113.	10.	11184.	3984.	277.	141.	7.	32.	34.1
						AFTERBURNED	14010.	9701.		18804.			21214.	53143.	277.	141.	7.	870.	34.1
5.71+03 TO 6.71+03	1.00+03	24.0 TO 26.0	2.0	2.559+04	5.118+04	NOZZLE EXIT	13421.	9293.	10348.	1754.	1076.	9.	10986.	3816.	266.	135.	7.	32.	32.7
						AFTERBURNED	13421.	9293.		18013.			20685.	51169.	266.	135.	7.	840.	32.7
6.71+03 TO 7.79+03	1.09+03	26.0 TO 28.0	2.0	2.494+04	4.988+04	NOZZLE EXIT	13030.	9022.	10046.	1703.	1052.	9.	10854.	3705.	258.	131.	6.	32.	31.7
						AFTERBURNED	13030.	9022.		17487.			20333.	49857.	258.	131.	6.	819.	31.7
7.79+03 TO 8.96+03	1.17+03	28.0 TO 30.0	2.0	2.441+04	4.882+04	NOZZLE EXIT	12710.	8801.	9800.	1661.	1032.	9.	10746.	3614.	252.	127.	6.	32.	31.0
						AFTERBURNED	12710.	8801.		17059.			20046.	48787.	252.	127.	6.	802.	31.0
8.96+03 TO 1.02+04	1.25+03	30.0 TO 32.0	2.0	2.383+04	4.767+04	NOZZLE EXIT	12421.	8600.	9577	1624.	1007.	9.	10461.	3532.	246.	125.	6.	31.	30.3
						AFTERBURNED	12421.	8600.		16670.			19535.	47637.	246.	125.	6.	783.	30.3
1.02+04 TO 1.15+04	1.32+03	32.0 TO 34.0	2.0	2.320+04	4.639+04	NOZZLE EXIT	12155.	8416.	9372	1589.	976.	9.	9992.	3456.	241.	122.	6.	29.	29.6
						AFTERBURNED	12155.	8416.		16313.			18790.	46382.	241.	122.	6.	761.	29.6
1.15+04 TO 1.29+04	1.39+03	34.0 TO 36.0	2.0	2.260+04	4.521+04	NOZZLE EXIT	11902.	8241.	9177	1556.	948.	8.	9574.	3384.	236.	119.	6.	27.	29.0
						AFTERBURNED	11902.	8241.		15974.			18120.	45216.	236.	119.	6.	741.	29.0
1.29+04 TO 1.44+04	1.45+03	36.0 TO 38.0	2.0	2.218+04	4.436+04	NOZZLE EXIT	11660.	8073.	8990	1524.	932.	8.	9446.	3316.	231.	117.	6.	27.	28.4
						AFTERBURNED	11660.	8073.		15649.			17839.	44359.	231.	117.	6.	727.	28.4
1.44+04 TO 1.59+04	1.51+03	38.0 TO 40.0	2.0	2.179+04	4.358+04	NOZZLE EXIT	11426.	7912.	8810	1494.	917.	8.	9367.	3249.	226.	115.	6.	27.	27.8
						AFTERBURNED	11426.	7912.		15336.			17630.	43578.	226.	115.	6.	715.	27.8
1.59+04 TO 1.97+04	3.81+03	40.0 TO 44.8	4.8	2.115+04	1.018+05	NOZZLE EXIT	26555.	18387.	20475	3471.	2148.	19.	22224.	7551.	526.	266.	13.	65.	64.7
						AFTERBURNED	26555.	18387.		35640.			41577.	101711.	526.	266.	13.	1672.	64.7
1.97+04 TO 2.95+04	9.84+03	44.8 TO 55.6	10.8	2.034+04	2.199+05	NOZZLE EXIT	57011.	39476.	43958	7452.	4660.	40.	49038.	16213.	1129.	572.	28.	147.	138.9
						AFTERBURNED	57011.	39476.		76517.			91028.	219633.	1129.	572.	28.	3617.	138.9
2.95+04 TO 3.94+04	9.84+03	55.6 TO 65.0	9.4	2.070+04	1.936+05	NOZZLE EXIT	49977.	34605.	38534	6533.	4116.	35.	43827.	14213.	989.	501.	25.	133.	121.5
						AFTERBURNED	49977.	34605.		67076.			80915.	193339.	989.	501.	25.	3188.	121.8
3.94+04 TO 4.92+04	9.84+03	65.0 TO 73.0	8.0	2.194+04	1.766+05	NOZZLE EXIT	45146.	31260.	34809	5901.	3779.	32.	41227.	12839.	894.	453.	22.	128.	110.1
						AFTERBURNED	45146.	31260.		60592.			75276.	176219.	894.	453.	22.	2915.	110.1
4.92+04 TO 5.91+04	9.84+03	73.0 TO 80.1	7.1	2.242+04	1.585+05	NOZZLE EXIT	40681.	28169.	31367	5318.	3383.	29.	36558.	11569.	805.	408.	20.	112.	99.2
						AFTERBURNED	40681.	28169.		54600.			67042.	158224.	805.	408.	20.	2614.	99.2

Table 7B. Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units) Continuation 1

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS												
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE												
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.278600	.919340				.020390	.000038
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
5.91+04 TO 6.89+04	9.84+03	80.1 TO 86.4	6.3	2.224+04	1.405+05	NOZZLE EXIT	36005.	24931.	27761.	4707.	3002.	26.	32552.	10240.	713.	361.	18.	100.	87.8
						AFTERBURNED	36005.	24931.		48324.			59598.	140225.	713.	361.	18.	2318.	87.8
6.89+04 TO 7.87+04	9.84+03	86.4 TO 92.2	5.8	2.136+04	1.236+05	NOZZLE EXIT	31450.	21777.	24249.	4111.	2654.	22.	29315.	8944.	623.	315.	16.	92.	76.7
						AFTERBURNED	31450.	21777.		42210.			53232.	123330.	623.	315.	16.	2043.	76.7
7.87+04 TO 8.86+04	9.84+03	92.2 TO 97.6	5.4	2.063+04	1.110+05	NOZZLE EXIT	28056.	19426.	21632.	3667.	2394.	20.	26855.	7979.	555.	281.	14.	86.	68.5
						AFTERBURNED	28056.	19426.		37655.			48424.	110693.	555.	281.	14.	1838.	68.5
8.86+04 TO 9.84+04	9.84+03	97.6 TO 102.7	5.1	1.982+04	1.005+05	NOZZLE EXIT	25187.	17440.	19420.	3292.	2178.	18.	24883.	7164.	499.	253.	13.	81.	61.5
						AFTERBURNED	25187.	17440.		33804.			44505.	100116.	499.	253.	13.	1666.	61.5
9.84+04 TO 1.08+05	9.84+03	102.7 TO 107.5	4.8	1.891+04	9.123+04	NOZZLE EXIT	22642.	15678.	17458.	2960.	1989.	16.	23226.	6440.	448.	227.	11.	77.	55.3
						AFTERBURNED	22642.	15678.		30388.			41150.	90821.	448.	227.	11.	1516.	55.3
1.08+05 TO 1.18+05	9.84+03	107.5 TO 112.1	4.6	1.805+04	8.353+04	NOZZLE EXIT	20514.	14204.	15817.	2682.	1833.	15.	21081.	5835.	406.	206.	10.	74.	50.2
						AFTERBURNED	20514.	14204.		27533.			38399.	83089.	406.	206.	10.	1391.	50.2
1.18+05 TO 1.28+05	9.84+03	112.1 TO 116.6	4.5	1.616+04	7.217+04	NOZZLE EXIT	17248.	11943.	13299.	2255.	1610.	13.	20259.	4907.	341.	173.	9.	71.	42.3
						AFTERBURNED	17248.	11943.		23149.			34768.	71644.	341.	173.	9.	1209.	42.3
1.28+05 TO 1.38+05	9.84+03	116.6 TO 121.0	4.4	1.005+04	4.418+04	NOZZLE EXIT	8862.	6136.	6833.	1158.	1079.	7.	17218.	2523.	175.	89.	4.	70.	22.0
						AFTERBURNED	8862.	6136.		11894.			26937.	43335.	175.	89.	4.	766.	22.0
1.38+05 TO 1.46+05	9.84+03	121.0 TO 125.4	4.4	5.143+03	2.271+04	NOZZLE EXIT	2358.	1633.	1818.	308.	676.	3.	15087.	675.	47.	24.	1.	70.	6.3
						AFTERBURNED	2358.	1633.		3165.			21169.	21598.	47.	24.	1.	427.	6.3
1.48+05 TO 1.57+05	9.84+03	125.4 TO 130.0	4.6	3.425+03	1.578+04	NOZZLE EXIT	69.	48.	53.	9.	556.	1.	14943.	24.	1.	1.	0.	73.	.8
						AFTERBURNED	69.	48.		93.			19546.	14530.	1.	1.	0.	321.	.8
1.57+05 TO 1.67+05	9.84+03	130.0 TO 134.7	4.7	3.375+03	1.590+04	NOZZLE EXIT	0.	0.	0.	0.	564.	1.	15253.	5.	0.	0.	0.	75	.6
						AFTERBURNED	0.	0.		0.			20328.	14617.	0.	0.	0.	324.	.6
1.67+05 TO 1.77+05	9.84+03	134.7 TO 139.4	4.7	3.375+03	1.590+04	NOZZLE EXIT	0.	0.	0.	0.	564.	1.	15253.	5.	0.	0.	0.	75.	.6
						AFTERBURNED	0.	0.		0.			20328.	14617.	0.	0.	0.	324.	.6

1.77+05 TO 1.87+05	9.84+03	139.4 TO 144.1	4.7	3.375+03	1.591+04	NOZZLE EXIT	0.	0.	0.	0.	554.	1.	15261.	5.	0.	0.	0.	75.	.6
						AFTERBURNED	0.	0.		0.			20338.	14624.	0.	0.	0.	324.	.6
1.87+05 TO 1.97+05	9.84+03	144.1 TO 149.2	5.1	3.375+03	1.727+04	NOZZLE EXIT	0.	0.	0.	0.	612.	1.	16567.	5.	0.	0.	0.	81.	.7
						AFTERBURNED	0.	0.		0.			22079.	15875.	0.	0.	0.	352.	.7
1.97+05 TO 2.07+05	9.84+03	149.2 TO 154.4	5.1	3.375+03	1.727+04	NOZZLE EXIT	0.	0.	0.	0.	612.	1.	16567.	5.	0.	0.	0.	81.	.7
						AFTERBURNED	0.	0.		0.			22079.	15875.	0.	0.	0.	352.	.7
2.07+05 TO 2.17+05	9.84+03	154.4 TO 159.5	5.1	3.375+03	1.727+04	NOZZLE EXIT	0.	0.	0.	0.	612.	1.	16567.	5.	0.	0.	0.	81.	.7
						AFTERBURNED	0.	0.		0.			22079.	15875.	0.	0.	0.	352.	.7
2.17+05 TO 2.26+05	9.84+03	159.5 TO 165.0	5.5	3.375+03	1.862+04	NOZZLE EXIT	0.	0.	0.	0.	660.	2.	17864.	6.	0.	0.	0.	88.	.7
						AFTERBURNED	0.	0.		0.			23808.	17118.	0.	0.	0.	380.	.7
2.26+05 TO 2.36+05	9.84+03	165.0 TO 170.6	5.6	3.375+03	1.881+04	NOZZLE EXIT	0.	0.	0.	0.	667.	2.	18043.	6.	0.	0.	0.	89.	.7
						AFTERBURNED	0.	0.		0.			24047.	17290.	0.	0.	0.	383.	.7
2.36+05 TO 2.46+05	9.84+03	170.6 TO 176.1	5.6	3.375+03	1.892+04	NOZZLE EXIT	0.	0.	0.	0.	668.	2.	18056.	6.	0.	0.	0.	89.	.7
						AFTERBURNED	0.	0.		0.			24063.	17302.	0.	0.	0.	384.	.7
2.46+05 TO 2.56+05	9.84+03	176.1 TO 182.2	6.1	3.375+03	2.053+04	NOZZLE EXIT	0.	0.	0.	0.	728.	2.	19700.	6.	0.	0.	0.	97.	.8
						AFTERBURNED	0.	0.		0.			26254.	18877.	0.	0.	0.	419.	.8
2.56+05 TO 2.66+05	9.84+03	182.2 TO 188.3	6.1	3.375+03	2.053+04	NOZZLE EXIT	0.	0.	0.	0.	728.	2.	19700.	6.	0.	0.	0.	97.	.8
						AFTERBURNED	0.	0.		0.			26254.	18877.	0.	0.	0.	419.	.8
2.66+05 TO 2.76+05	9.84+03	188.3 TO 194.6	6.3	3.375+03	2.126+04	NOZZLE EXIT	0.	0.	0.	0.	754.	2.	20397	7.	0.	0.	0.	100.	.8
						AFTERBURNED	0.	0.		0.			27183.	19545.	0.	0.	0.	433.	.8
2.76+05 TO 2.85+05	9.84+03	194.6 TO 201.3	6.7	3.375+03	2.246+04	NOZZLE EXIT	0.	0.	0.	0.	797.	2.	21547.	7.	0.	0.	0.	106.	.9
						AFTERBURNED	0.	0.		0.			28716.	20647.	0.	0.	0.	458.	.9
2.85+05 TO 2.95-05	9.84+03	201.3 TO 207.9	6.7	3.375+03	2.246+04	NOZZLE EXIT	0.	0.	0.	0.	797.	2.	21547.	7.	0.	0.	0.	106.	.9
						AFTERBURNED	0.	0.		0.			28716.	20647.	0.	0.	0.	458.	.9
2.95-05 TO 3.05+05	9.84+03	207.9 TO 215.2	7.3	3.375+03	2.453+04	NOZZLE EXIT	0.	0.	0.	0.	870.	2.	23530.	8.	0.	0.	0.	116.	.9
						AFTERBURNED	0.	0.		0.			31359.	22548.	0.	0.	0.	500.	.9
3.05+05 TO 3.15+05	9.84+03	215.2 TO 222.5	7.3	3.375+03	2.458+04	NOZZLE EXIT	0.	0.	0.	0.	872.	2.	23585.	8.	0.	0.	0.	116.	.9
						AFTERBURNED	0.	0.		0.			31432.	22600.	0.	0.	0.	501.	.9
3.15+05 TO 3.25+05	9.84+03	222.5 TO 230.3	7.8	3.375+03	2.637+04	NOZZLE EXIT	0.	0.	0.	0.	935.	2.	25301.	8.	0.	0.	0.	124.	1.0
						AFTERBURNED	0.	0.		0.			33719.	24245.	0.	0.	0.	538.	1.0

Table 7B.—Mission 3A: Exhaust Products Released Into the Atmosphere by the Space Shuttle (English Units) Continuation 2

ALTITUDE BAND	ALTITUDE INCREMENT	TIME	TIME INCREMENT	AVERAGE PROPELLANT FLOW RATE	PROPELLANT DECREMENT	LOCATION OF ANALYSIS	EXHAUST GAS COMPONENTS											
							AL2O3	HCL	CO	CO2	H2	H	H2O	N2	FECL2	CL	FE	AR	TRACES
						BOOSTER: NOZZLE EXIT	EXHAUST GAS COMPOSITION EXPRESSED AS MASS FRACTIONS OF THE EXHAUST GAS MIXTURE AT THE NOZZLE EXIT PLANE											
						AFTERBURNED	.302100	.209180	.232930	.039490	.018840	.000200	.101510	.085860	.005980	.003030	.000150		.000730
						SUSTAINER: NOZZLE EXIT	.302100	.209180		.405460			.271330	1.012100	.005980	.003030	.000150	.015800	.000730
						AFTERBURNED					.035470	.000085	.959390	.000307				.004710	.000038
													1.276600	.919340				.020390	.000036
FT	FT	SEC	SEC	LBM/SEC	LBM		LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM	LBM
3.25+05 TO 3.35+05	9.84+03	230.3 TO 238.3	8.0	3.375+03	2.689+04	NOZZLE EXIT	0.	0.	0.	0.	954.	2.	25795.	8.	0.	0.	0.	127.	1.0
						AFTERBURNED	0.	0.		0.			34378.	24718.	0.	0.	0.	548.	1.0
3.35+05 TO 3.44+05	9.84+03	238.3 TO 246.4	8.1	3.375+03	2.735+04	NOZZLE EXIT	0.	0.	0.	0.	970.	2.	26235.	8.	0.	0.	0.	129.	1.0
						AFTERBURNED	0.	0.		0.			34953.	25139.	0.	0.	0.	558.	1.0
3.44+05 TO 3.54+05	9.84+03	246.4 TO 254.5	8.1	3.375+03	2.748+04	NOZZLE EXIT	0.	0.	0.	0.	975.	2.	26367.	2	0.	0.	0.	129.	1.0
						AFTERBURNED	0.	0.		0.			35140.	25267.	0.	0.	0.	560.	1.0
3.54+05 TO 3.64+05	9.84+03	254.5 TO 264.7	10.2	3.301+03	3.377+04	NOZZLE EXIT	0.	0.	0.	0.	1198.	3.	32394.	10.	0.	0.	0.	159.	1.3
						AFTERBURNED	0.	0.		0.			43172.	31042.	0.	0.	0.	688.	1.3
3.64+05 TO 3.74+05	9.84+03	264.7 TO 275.2	10.5	3.097+03	3.255+04	NOZZLE EXIT	0.	0.	0.	0.	1155.	3.	31231.	10.	0.	0.	0.	153.	1.2
						AFTERBURNED	0.	0.		0.			41623.	29928.	0.	0.	0.	664.	1.2
3.74+05 TO 3.84+05	9.84+03	275.2 TO 287.7	12.4	3.097+03	3.849+04	NOZZLE EXIT	0.	0.	0.	0.	1365.	3.	36927.	12.	0.	0.	0.	181.	1.5
						AFTERBURNED	0.	0.		0.			49213.	35385.	0.	0.	0.	785.	1.5
3.84+05 TO 3.94+05	9.84+03	287.7 TO 304.2	16.5	3.097+03	5.116+04	NOZZLE EXIT	0.	0.	0.	0.	1815.	4.	49081.	16.	0.	0.	0.	241.	1.9
						AFTERBURNED	0.	0.		0.			65412.	47032.	0.	0.	0.	1043.	1.9
3.94+05 TO 4.04+05	9.84+03	304.2 TO 338.0	33.8	3.097+03	1.048+05	NOZZLE EXIT	0.	0.	0.	0.	3716.	9.	100513.	32.	0.	0.	0.	493.	4.0
						AFTERBURNED	0.	0.		0.			133956.	96317.	0.	0.	0.	2136.	4.0
4.04+05 TO 4.13+05	9.84+03	338.0 TO 352.0	14.0	3.097+03	4.331+04	NOZZLE EXIT	0.	0.	0.	0.	1536.	4.	41556.	13.	0.	0.	0.	204.	1.6
						AFTERBURNED	0.	0.		0.			55382.	39821.	0.	0.	0.	883.	1.6
4.13+05 TO 4.24+05	9.84+03	352.0 TO 361.1	9.1	3.097+03	2.812+04	NOZZLE EXIT	0.	0.	0.	0.	998.	2.	26983.	9.	0.	0.	0.	132.	1.1
						AFTERBURNED	0.	0.		0.			35960.	25856.	0.	0.	0.	573.	1.1
4.04+05 TO 3.94+05	9.84+03	361.1 TO 402.7	41.6	3.097+03	1.289+05	NOZZLE EXIT	0.	0.	0.	0.	4570.	11.	123618.	40.	0.	0.	0.	607.	4.9
						AFTERBURNED	0.	0.		0.			164748.	118457.	0.	0.	0.	2627.	4.9

3.94+05 TO 3.84+05	9.84+03	402.7 TO 431.1	28.4	3.093+03	8.795+04	NOZZLE EXIT	0.	0.	0.	0.	3120.	7.	84379.	27.	0.	0.	0.	414.	3.3
						AFTERBURNED	0.	0.		0.			112453.	80856.	0.	0.	0.	1793.	3.3
3.84+05 TO 3.74+05	9.84+03	431.1 TO 473.2	42.1	2.652+03	1.117+05	NOZZLE EXIT	0.	0.	0.	0.	3960.	9.	107117.	34.	0.	0.	0.	526.	4.2
						AFTERBURNED	0.	0.		0.			142757.	102645.	0.	0.	0.	2277.	4.2
3.74+05 TO 3.64+05	9.84+03	473.2 TO 480.0	6.8	2.259+03	1.530+04	NOZZLE EXIT	0.	0.	0.	0.	543.	1.	14682.	5.	0.	0.	0.	72.	.6
						AFTERBURNED	0.	0.		0.			19567.	14069.	0.	0.	0.	312.	.6
3.64+05 TO 3.74+05	9.84+03	480.0 TO 490.4	10.4	2.119+03	2.205+04	NOZZLE EXIT	0.	0.	0.	0.	782.	2.	21155.	7.	0.	0.	0.	104.	.8
						AFTERBURNED	0.	0.		0.			28193.	20272.	0.	0.	0.	450.	.8
3.74+05 TO 3.84+05	9.84+03	490.4 TO 495.7	5.3	2.035+03	1.077+04	NOZZLE EXIT	0.	0.	0.	0.	382.	1.	10332.	3.	0.	0.	0.	51.	.4
						AFTERBURNED	0.	0.		0.			13770.	9901.	0.	0.	0.	220.	.4
				TOTALS:	3.7906+06	NOZZLE EXIT	676054.	468113.	521262.	88373.	97238.	580.	1716885.	192618.	13382.	6781.	336.	7314.	1692.6
						AFTERBURNED	676054.	468113.		907359.			2592580.	3692460.	13382.	6781.	336.	67019.	1692.6

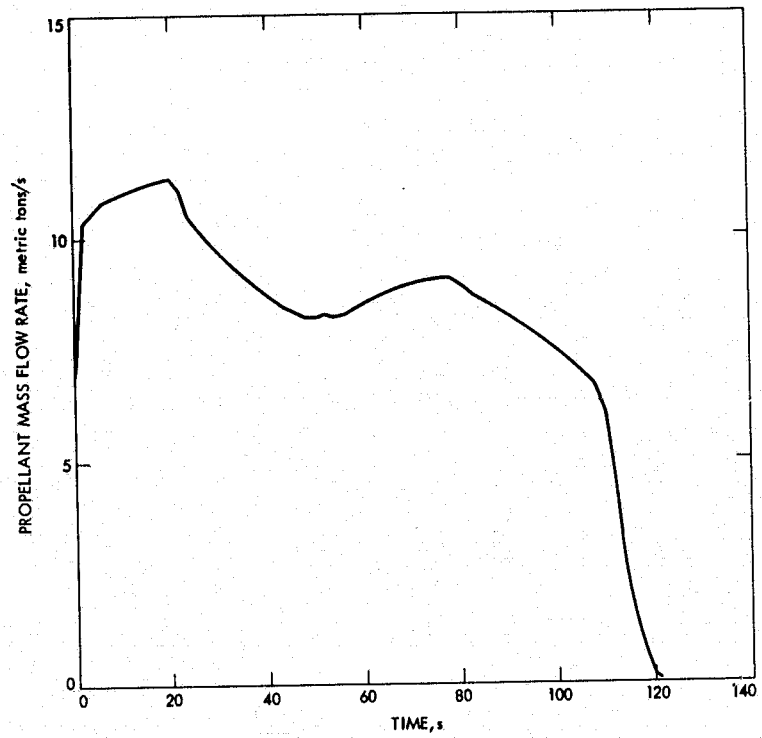

Fig. 1. Mission 1: Propellant Mass Flow Rate of the Two Space Shuttle SRMs Versus Time

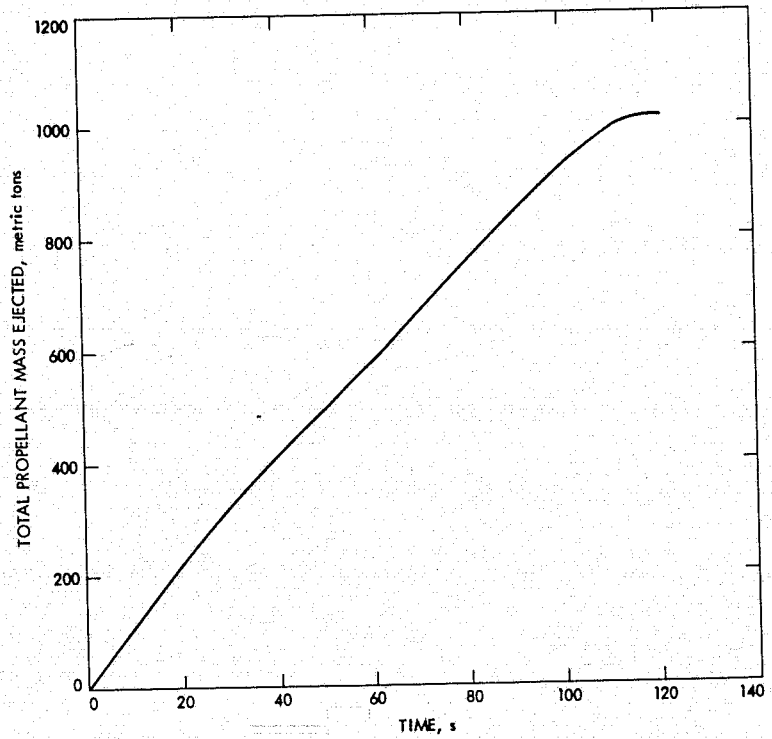

Fig. 2. Mission 1: Total Propellant Mass Ejected by the Two Space Shuttle SRMs Versus Time

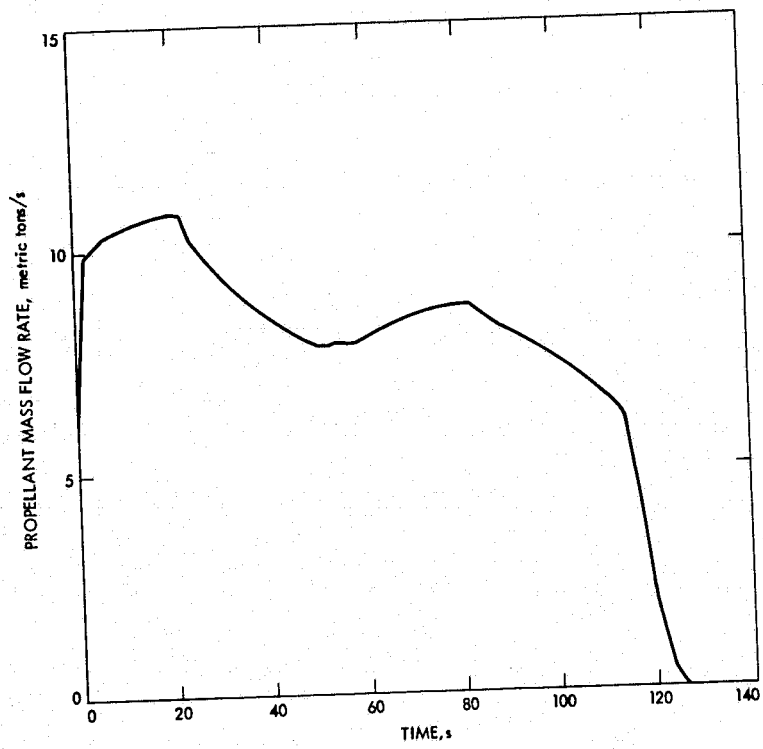

Fig. 3 Mission 3A: Propellant Mass Flow Rate of the Two Space Shuttle SRMs Versus Time

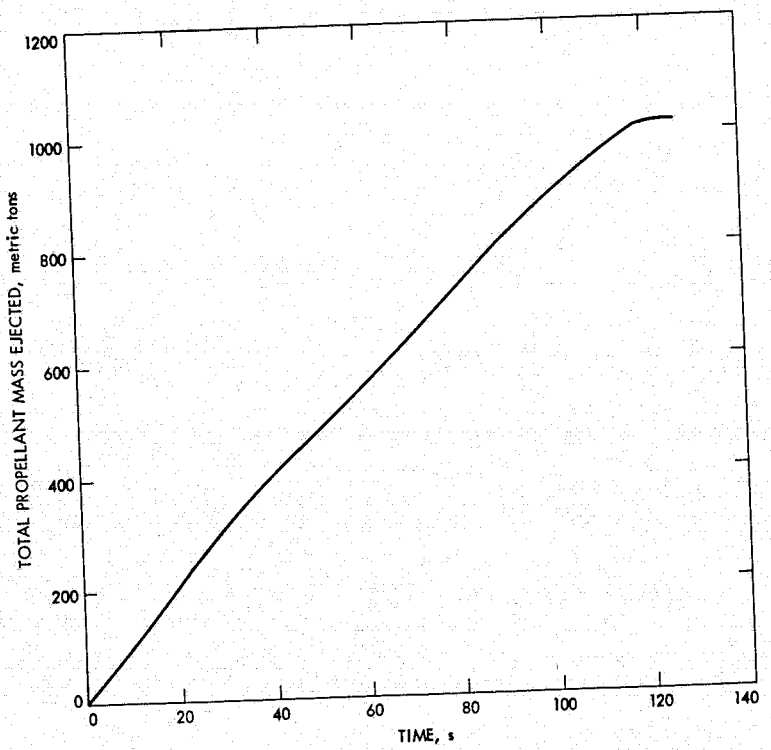

Fig. 4. Mission 3A: Total Propellant Mass Ejected by the Two Space Shuttle SRMs Versus Time

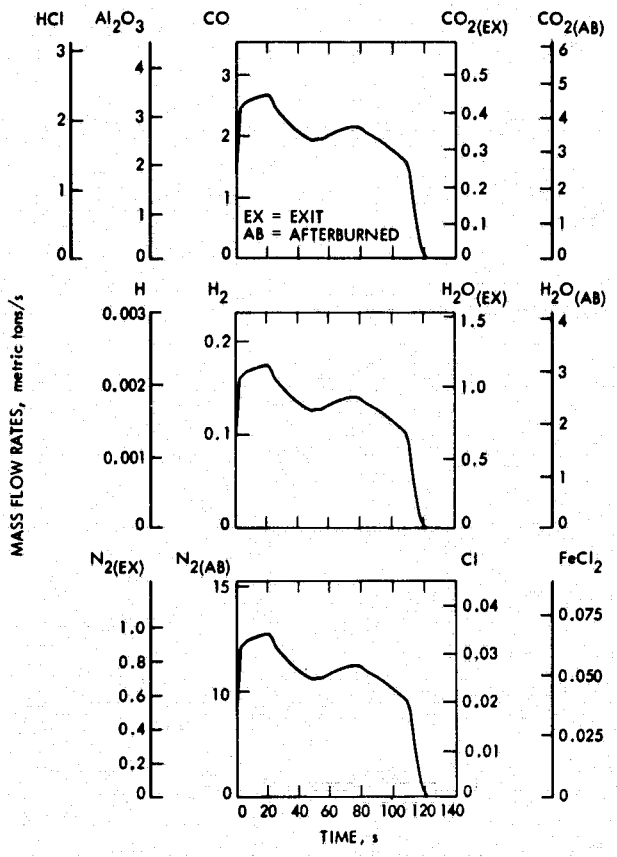

Fig. 5A. Mission 1: Mass Flow Rate of Indicated Species for Two SSV SRMs

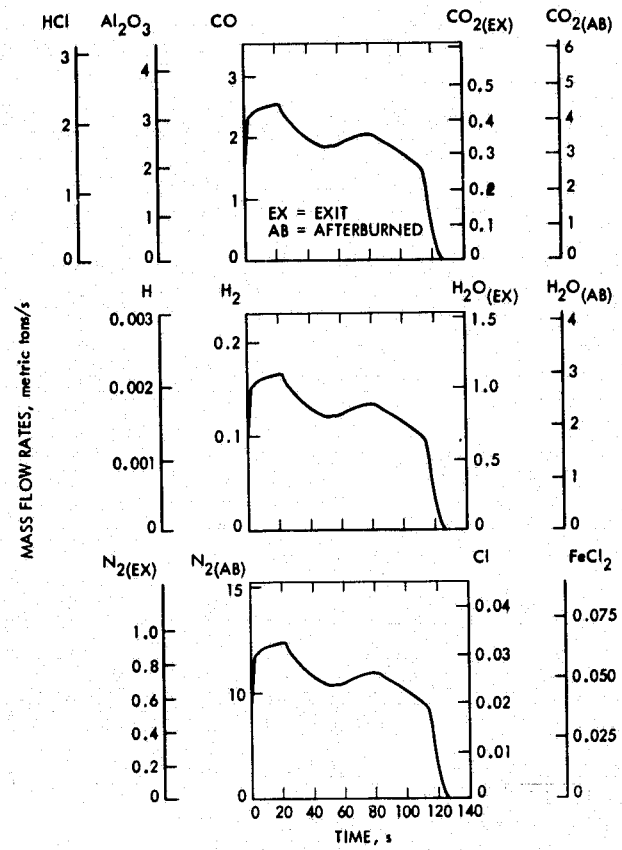

Fig. 5B. Mission 3A: Mass Flow Rate of Indicated Species for Two SSV SRMs

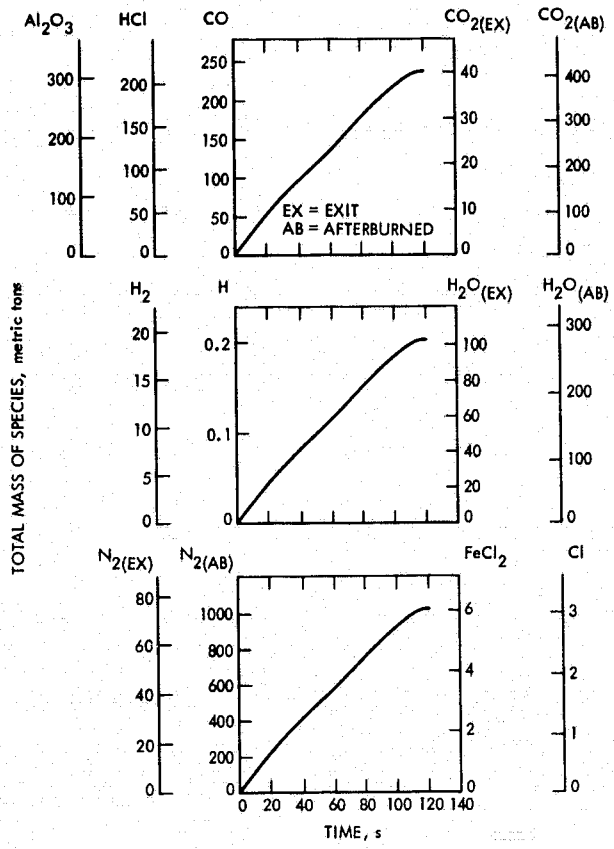

Fig. 6A. Mission 1: Total Mass of Indicated Species Ejected and/or Entrained by Two SSV SRMs as a Function of Time

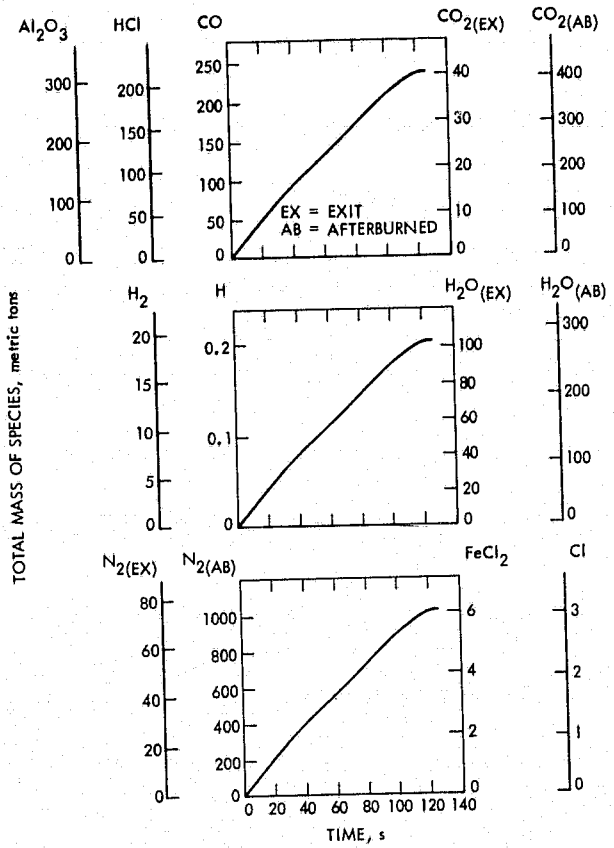

Fig. 6B. Mission 3A: Total Mass of Species Ejected and/or Entrained by Two SSV SRMs as a Function of Time

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