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NASA/DOD EARTH ORBIT SHUTTLE TRAFFIC MODELS BASED ON END-TO-END LOADING OF PAYLOADS

Flight Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION

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By R. E. Kincade, M. E. Donahoo, and W. R. Pruett
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NASA/DOD EARTH ORBIT SHUTTLE TRAFFIC MODELS

BASED ON END-TO-END LOADING OF PAYLOADS

By Richard Kincade, Michael Donahoo,
and William Pruett

1.0 SUMMARY

This report is the first of two documents written to present optimized Earth Orbit Shuttle traffic models for the years 1979 through 1990 and will partially fulfill the requirements of reference 1 for NASA/DOD traffic model and fleet sizing analyses. The traffic models contained herein satisfy the requirements that two separate cases be analyzed--first, a DOD or foreign developed resuable tug will be available in 1979; and second, expendable boosters will be used through the year 1984 with a NASA developed resuable tug available in 1985. The tug characteristics are the same for either case. Both traffic model cases consider only end-to-end stacking of the satellites on the tug. A second traffic model will be defined in another internal note with the major difference between the two documents being the change in the mode of cargo loading. For the later analysis all cargo will be loaded side-by-side.

The reason for analyzing the two different methods of loading is that although the groundrules of reference 1 state that the number of payloads on any one Earth Orbit Shuttle mission should not exceed three and that these payloads may be stacked either end-to-end or side-by-side, they do not specify what loading method should be used in defining the traffic models.

Previous analyses have indicated that because the satellites are usually deployed separately with a phasing maneuver between deployments, side-by-side loadings are apt to present more problems than end-to-end stacking. Very little is known about what c.g. limits the tug will have, what the tug's gimbal limits will be for alining the thrust through the c.g., the amount of loading the tug structure can withstand and what affect these factors will have on tug loadings. Another factor which could preclude side-by-side loading is an increase in the diameters of the satellites. These increases may occur in the future and will probably affect the majority of the payloads.

Although the above reasons for end-to-end loading of payloads on the tug appear to be valid, side-by-side stacking should not be completely eliminated from any future planning. Side-by-side loadings could save a number of EOS flights and, therefore, reduce the cost of the program significantly. It is not intended that either of the two documents recommend one loading method over the other. Each of the two loading methods are analyzed using the same groundrules with the reader free to determine which mode of cargo loading should be used in future planning.

2.0 INTRODUCTION

To obtain the most economical usage of the EOS, it is imperative that the maximum number of missions should be accomplished with the minimum number of EOS flights. A number of traffic models and fleet sizing studies are anticipated prior to actual mission planning for the EOS program. The purpose of this report is to present optimized EOS traffic models associated with two possible reusable tug availability dates and end-to-end loading of satellites on the tug or booster using the NASA and DOD payload information obtained from OSSA, Space Station, and DOD mission models generated specifically for this purpose.

At the time this traffic model was being defined the DOD was updating their mission models; therefore, this report does not reflect the official DOD program. However, the DOD missions used in this report and contained in reference 2 are considered to be representative.

3.0 SYMBOLS AND ABBREVIATIONS

ABES	Air Breathing Engine Subsystem
DOD	Department of Defense
EOS	Earth Orbit Shuttle
fps	feet per second
h_a	height of apogee
h_p	height of perigee
NASA	National Aeronautics and Space Administration
n. mi.	nautical miles

OMS	Orbital Maneuvering System
OSSA	Office of Space Science and Applications
ΔV	change in velocity

4.0 GROUND RULES

The missions of the traffic models were combined into EOS payloads according to the groundrules defined in reference 1 and listed below:

a. NASA and DOD missions shall be flown separately.

b. The maximum number of payloads carried on a single mission should not exceed three.

c. The payloads should be integrated into the EOS cargo compartment either end-to-end or side-by-side. Payloads should not be stacked atop each other.

d. Each mission needing an energy stage for payload placement requires a dedicated EOS flight.

e. The EOS capability to be used is presented in figure 1. The preferred mode of operation is with ABES on and OMS propellant equivalent to 1500 fps in the tanks. Those missions on which OMS or ABES must be offloaded to gain necessary capability should be identified.

f. The first 10 EOS flights are not to be analyzed. These flights will be identified in detail by the NASA Headquarters.

g. Starting with NASA flight number 5 and DOD flight number 3 in 1979, the choice of payloads is to be based on the NASA priorities defined in table I. The DOD missions are to be selected from reference 2, with the mission at the bottom of the table having the highest priority and the mission at the top of the page (first part of the alphabet) having the lowest priority.

h. It should be assumed that the EOS has the capability to fly all payloads starting in 1982.

5.0 DISCUSSION

The EOS, as it is presently designed, has the capability (figure 1 defines payload weight as a function of inclination) to accomplish, without the assistance of a boost stage, a little more than half of the NASA flights planned for the period from 1978 through 1990 with these flights encompassing Space Station, sortie, automated spacecraft, man-tended spacecraft and non-NASA (excluding DOD) missions. Based on the DOD information supplied for this study, approximately 40 percent of the DOD flights are assumed to require booster or tug assistance.

In previous traffic models, kick stages such as the Centaur, Agena and FW-4S or a reusable tug have been used for satellite placement when the EOS did not have the capability. These studies have assumed that the tug could take 10 000 pounds to an equatorial geosynchronous orbit from the basic EOS 100 n. mi. circular orbit inclined 28.5° and then return empty to the EOS. The request made in reference 1 specifies that all traffic models shall be designed using a tug with half this capability (the capability curves for this tug are presented in figure 2) and that boosters shall be employed for those years in which the tug is not available.

Another difference between the traffic models for this report and others derived in the past will be found in the methods used in determining the total payload weight. Other traffic models assumed the tug carried a full load of fuel for every mission in order to insure that there would be enough propellant for any required phasing and terminal rendezvous maneuver. Minimum fuel usage computations assume that transfers from one orbit to another are the only maneuvers that are required.

Although neither maximum nor minimum fuel consumption presents a truly accurate account of the number of EOS flights required, minimum fuel loadings would be more nearly correct because it is not envisioned that large amounts of propellant will be needed for phasing and rendezvous maneuvers. Therefore, minimum fuel usage is assumed in this study for all tug flights.

The above tug data plus the groundrules presented in section 4.0 constitute the basis for the two traffic model studies described in this report. For both models, every attempt is made to combine payloads with similar inclination and destination characteristics. Lengths, diameters and weights of the cargo are also prime factors in the combination process (the cargo bay dimensions are 15 X 60 feet while the maximum payload which can be carried to the low earth parking orbit varies according to the inclination of the orbit). Combination of two identical satellites is not done unless specifically called for in the mission models of reference 1 or, if necessary, to keep the EOS flights at a minimum. At no time is a combination of a NASA and DOD payload allowed. Very little is known about either NASA or DOD packaging and mounting factors; and therefore, these items are not considered in the end-to-end stacking combinations. In the years when the tug is available, booster stages are used only when the tug does not have the capability to place the payload in orbit.

The number of EOS flights planned for the years 1978 through 1981 (table II) limits the number of missions which can be performed by the EOS during this period. The first 10 flights, 4 in 1978 and 6 in 1979, are to be defined in detail by NASA Headquarters and are not included in the traffic models but are shown in some of the tables presenting total EOS flights.

Because the number of EOS flights required for the 1978 through 1981 period greatly exceeds the maximum number of flights planned, the OSSA priorities listed in table I are used as the basis for NASA payload selection. The highest priority for DOD missions starts at the bottom of the DOD payload characteristics and frequencies table of reference 2 and works up the table with the mission listed at the top having the lowest priority. If all DOD missions could not be accommodated on the limited number of flights, an attempt is made to include at least one of each type.

After the year 1981, no restrictions are placed on the number of EOS flights, thus an unlimited traffic model exists for the period from 1981 through 1990. The frequencies and payload characteristics of the DOD and NASA mission models are presented in reference 2 and table III, respectively.

The amount of propellant used determines the tug life. In this study, the tug is considered to be expended after 500 000 pounds of propellant have been consumed by the tug engines. As mentioned previously, minimum tug fuel consumption is assumed for each flight of these traffic models. Actual fuel usage considering all station-keeping, phasing, transfer and other rendezvous and docking maneuvers will increase the fuel usage but is impossible to calculate at the present time since the missions are so ill defined. The addition of the tug fuel necessary to perform these maneuvers should not increase the number of tugs expended significantly. The boosters are flown with the fuel tanks full in order to keep computation time to a minimum.

For sun synchronous payload placements by the tug, the EOS is placed in a 90° inclination orbit and the tug makes the plane changes. If the EOS were to take the payload to the sun synchronous orbit inclination then the amount of OMS propellant that has to be offloaded would exceed the amount of tug propellant consumed, thus reducing the efficiency of the EOS. The EOS makes the plane changes for FW-4S payload placement because the FW-4S is so light.

The characteristics of the reusable tug along with those for the various non-reusable booster stages are presented in table IV. The tug data was extracted from reference 1 while booster information was obtained from reference 3. Figure 2 defines the tug payload capability as a function of ΔV.

The actual combination of payloads, both NASA and DOD, for end-to-end loadings are defined in tables V and VI for the tug availability dates of 1979 and 1985, respectively. It should be noted that the EOS flights of these tables would not necessarily be flown in the order presented. Expediency in selecting the payloads and simplicity of the methods used in the analysis dictated the order in which the flights are presented in these tables.

Tables V and VI are further reduced to the number of EOS flights and the total number of payloads associated with these flights (table VII). The number of EOS flights by inclination (table VIII), the total payload taken to orbit (table IX), the energy stages required (table X), and the number of EOS flights per year (table XI) are tabulated for information.

The traffic models indicate that when the tug will be in service starting in 1979, 811 missions are accomplished on 670 EOS flights. Of these 670 flights, 452 carry NASA payloads (564 missions) while 218 carry DOD payloads (247 missions). Combinations of NASA and DOD payloads are not permitted, and therefore, are not attempted. One hundred and ninety-four of the 452 NASA flights and 98 of the 218 DOD flights require tugs.

The traffic model for the second tug availability date of 1985 consists of 642 EOS flights (832 missions), and these flights are relegated to 430 flights for the 578 NASA missions and 212 flights for the 254 DOD missions. Tugs are used on 110 of the NASA flights and 53 of the DOD flights. The first 10 EOS flights are not included in any of the above numbers.

The first traffic model requires the expenditure of 12 tugs for NASA missions (table X). Eleven of these 12 are expended because the tug does not have the ΔV capability to return to the EOS after satellite placement. However, this is not as big a waste of tugs as it might first appear because if the tugs that are expended in the traffic model could return to the EOS, 11 tugs would still have to be retired based on 500 000 pounds of fuel consumption constituting the retirement of a tug. DOD missions result in the expenditure of six tugs, all resulting from 500 000 pounds propellant usage. Totalling the two organizations tug expenditures together, 18 tugs are expended.

When the tug is not used until 1985, 11 tugs are required to be expended with NASA and DOD missions accounting for eight and three tugs, respectively. All eight of the tugs expended for the NASA flights are attributed to the tug not having the capability for a round trip (six tugs would be retired by the fuel usage requirement even if all eight of the tugs could be returned). All DOD tug expenditures result from normal tug retirement.

In the event the weight of the tug plus satellites exceeds the nominal designed payload capabilities of the EOS, either OMS propellant is offloaded or the ABES is removed in order to gain the necessary capabilities. In this study, it is assumed that OMS propellant offloading (maximum offloaded is equivalent to a ΔV of 600 fps at an inclination of 28.5° and 500 fps at an inclination of 90°) will be considered first and the ABES will be removed only if the EOS cannot perform orbit insertion after OMS propellant reduction.

For the first traffic model, 165 flights (132 NASA and 33 DOD) require offloading of OMS and 13 flights (7 NASA and 6 DOD) cannot be performed without the removal of the ABES. If the tug does not become available until 1985, the total number of flights requiring either offloading of OMS or removal of ABES drops to 91 and 22 for NASA and DOD, respectively. No flights required both the removal of the ABES and the offloading of OMS. Table XII further identifies those flights requiring the removal of the ABES or offloading of the OMS propellant.

6.0 COMMENTS

When the tug is available in 1979 approximately 30 percent of the EOS flights carrying NASA cargo require either offloading of OMS propellant or the removal of the ABES to accomplish the flight. The percentage for DOD flights is approximately 18 percent. For the 1985 availability date, the percentages drop to roughly 20 percent and 10 percent for NASA and DOD, respectively. The reason for these offloadings is that large amounts of tug propellant are necessary to place the satellites in orbit. This is especially true for equatorial geosynchronous orbits where 40 000 to 49 000 pounds of propellant are required for a round trip and the maximum weight the EOS can take to the 100 n. mi. circular orbit at a 28.5° inclination without OMS fuel reduction or ABES removal is 50 000 pounds. Although not nearly as much propellant is required for a polar or sun synchronous orbit, the situation is just as bad for these high inclination orbits since the inert weight of the tug is approximately one half of the payload capability of the EOS with the ABES on and full OMS ΔV fuel loading.

There is probably no way the tug characteristics can be changed such that less fuel is needed for the equatorial geosynchronous orbits. However, it does seem feasible to use some small solid stages such as the FW-4S for satellite placements in polar and sun synchronous orbits since it was found that the size of the tug was the reason that two EOS flights were often needed to complete these missions. The use of these small solid stages should save approximately 10 flights over the 12-year period and would eliminate the necessity for offloading of OMS propellant or the removal of the ABES for the polar and sun synchronous orbit missions.

Overall, this analysis has attempted to take the groundrules of reference 1 and define the most optimum traffic models for the two tug availability dates and end-to-end stacking of the NASA and DOD payloads. A similar report containing side-by-side loadings is forthcoming shortly. No recommendations are made as to which method of payload integration on the tug should be planned for in the future. The decision on which mode of cargo loading will be used is left to NASA management.

TABLE I.- OSSA PRIORITY ASSIGNMENT

Mission	Priority I			Priority II			Priority III			Total
	79	80	81	79	80	81	79	80	81	
Space station			9							9
Sortie										
Type 1			2							
Type 2			2							16
Pallet	2	6	4							
Automated S/C										
Comm/nav				6	4	5				
Earth obs.				1	3	4				41
Physics/astr.				5	6	7				
Man tended										
LST			1							
HEAO revis.	1	2	2							6
Planetary					1		3		1	5
Non-NASA							15	12	18	45
TOTAL	3	8	20	12	14	16	18	12	19	122

TABLE II.- MAXIMUM NUMBER OF EOS FLIGHTS WHICH CAN BE FLOWN FOR THE PERIOD 1978-81

	[a]1978	[b]1979	1980	1981
NASA	3	10	24	34
DOD	1	4	12	16

[a]The flights for the year 1978 will be defined by NASA headquarters.

[b]Four of the NASA flights and two of the DOD flights will be defined by NASA headquarters for the year 1979.

TABLE III.- NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES

(a) Physics and astronomy

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
1	Astronomy explorer	2	3	720	28.5	270	270	1	2		1	2	2	1		2	1	2	2	
2	Radio explorer	5	4	720	28.5	19 300	19 300	1		2	1			1	2		1			2
3	Low magnetosphere explorer	4	8	1 200	0-90	1 800	180	1 (90)	1 (0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)
4	Middle magnetosphere explorer	6	8	1 000	0-90	20 000	1 000	1 (90)	1 (0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)
5	High magnetosphere explorer	4	6	600	0-90	1.0 A.U.	Any	1 (90)	1 (0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)	1(0)	1(28.5)	1(55)	1(90)
6	Orbiting solar observatory	7	10	1 900	28.5	350	350			1										
7	Gravity/relativity experiment (C, E)	5	7	1 500	90	300	300							1[C]						1[E]
8	Gravity/relativity experiment (B, D)	4	5	500	28.5	1.0 A.U.	1.0 A.U.				1[B]						1[D]			
9	Radio interferometer synchronous	12	15	6 000	28.5	38 300	38 300				1									
10	Solar orbit pair synchronous	10	12	1 900	30	19 300	19 300							1					1	
11	Solar orbit pair 1 A.U.	10	12	1 900	28.5	1.0 A.U.	1.0 A.U.							1					1	
12	Optical interferometer pair	7 ea	10 ea	3 500 ea	30	19 300	19 300											2		
13	High energy stellar astronomy observatory (HESAO)	14	46	21 000	30	230	230		1(up)			1(up)	1(down)		1(up)		1(down)		1(up)	
14	HESAO revisit	14	13	3 500	30	230	230			2	2	2	2	2	2	2	2	2	2	2
15	Large space telescope (LST-RAM)	14	60	30 000	28.5	350	350				1(up)				1(down) 1(up)					
16	LST-RAM revisit	14	13	3 500	30	350	350					2	2	2	1	2	2	2	2	2
17	Large solar observatory (LSO)	14	54	27 000	30	350	350						1(up)					1(d), 1(u)		
18	LSO revisits	14	13	3 500	30	350	350							2	2	2	2	1	2	2
19	Large radio observatory (LRO)	14	30	19 300	30	350	350								1(up)					
20	LRO revisits	14	13	3 500	30	350	350									2	2	2	2	2

(b) Earth observations

(R and D)

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
21	Polar earth observation satellite	6	12	2 500	99.15	500	500		1	1	1	1	1	1	1	1	1	1	1	1
22	Sync. earth observation satellite	4	6	1 000	0	19 300	19 300			1		1		1		1		1		1
23	Earth physics satellite	3.5	6.5	600	90	400	400			1	1	1	1		1		1		1	
Systems demonstrations																				
24	Sync. meteorological satellite	5	8	1 000	0	19 300	19 300					1	1							
25	Tiros	5	10	1 000	101.1	700	700				1				1					1
26	Polar earth resources satellite (take two at a time)	6	12	2 500	99.15	500	500									2	4			
27	Synchronous earth resources satellite	4	6	1 000	0	19 300	19 300				1	2	1				1	2		

TABLE III.- NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES - Continued

(c) Communications and navigation

(R and D)

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
28	Applications technology satellite	15	20	7 950	0	19 300	19 300		1		1		1	1		1		1	1	
29	Small app. technology satellite synchronous	6.5	12	600	0	19 300	19 300	1	1	1	1	1	1	1	1	1	1	1	1	1
30	Small app. technology satellite polar	6.5	12	600	90	3 000	300	1	1	1	1	1	1	1	1	1	1	1	1	1
31	Cooperative application synchronous	6.5	12	820	0	19 300	19 300		1					1						
32	Cooperative application polar	6.5	12	820	90	3 000	300					1							1	
Systems demonstration																				
33	Medical network satellite	12	15	2 000	0	19 300	19 300		2											
34	Education broadcast satellite	10	19	2 145	0	19 300	19 300			2										
35	Follow-on system demonstration	12	15	2 000	0	19 300	19 300				2	2	2	2	2	2	2	2	2	2
Operational																				
36	Tracking and data relay	12	15	2 300	0	19 300	19 300		1	2	1		2	1			2	1		
37	Planetary relay satellite	10	20	1 000	0	19 300	19 300		2	1				1	2				1	2

(d) RAM sortie missions

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
38	General scientific research module sortie	14	54	27 500	55	200	200				2	3	4	4	3					
39	General applications module sortie	14	51	30 000	65	100	100				2	3	2	3	2	3		3	1	
40	Dedicated scientific research module-astronomy sortie	14	54	29 500	55	200	200							1	3	4	5	4	5	5
41	Dedicated applications module-earth observation sortie	14	41	22 500	75	100	100							2	2	2	2	2	3	4
Pallet-type module																				
42	Earth resources sortie	14	37	6 000	90	125	125			1	1	2								
43	Bio research module sortie	14	37	4 300	28.5	200	200		1											
44	Astronomy sortie	14	37	5 700	28.5	200	200			2	2	2	1							
45	Fluid management sortie	14	37	7 100	28.5	200	200			1			1							
46	Teleoperator sortie	14	37	5 000	28.5	200	200			1										
47	Manned work platform sortie	14	37	6 700	28.5	200	200				1									
48	Large telescope mirror test sortie	14	37	13 000	28.5	200	200		1											
49	Astronomical maneuvering unit sortie	14	37	3 800	28.5	200	200			1										

TABLE III.- NASA AND NON-NASA (EXCLUDING DOD) PAYLOAD CHARACTERISTICS AND FREQUENCIES - Concluded

(e) Planetary

Payload designation	Satellite name	Payload characteristics			Final orbital parameters		Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	ΔV required, fps	78	79	80	81	82	83	84	85	86	87	88	89	90
50	Mars Viking	10	12	7 700	30	15 400		1		1									
51	Mars sample return	15	22.5	22 000	30	15 400													2
52	Venus explorer	5	12	1 000	30	13 400			1										
53	Venus radar mapping	10	12	7 900	30	13 400					1								
54	Venus explorer lander	10	15	7 300	30	13 400								1			1		
55	Jupiter pioneer orbiter	10	15	900	30	22 700					2								
56	JUN grand tour	10	12	1 500	30	25 900		2											
57	Jupiter tops orbiter/probe	10	15	3 300	30	22 700								1		1			
58	Uranus tops orbiter/probe	10	15	3 700	30	24 000									1			1	
59	Asteroid survey	10	35	27 000	30	13 400							1						
60	Comet rendezvous	10	35	24 000	30	13 400					1			1					

(f) Space station

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
61	Station module-core (includes refurbishment)	14	40	20 000	55	270	270				1			1	1	3	2			
62	Station module-others	14	30	20 000	55	270	270				5				3					
63	Crew/cargo	14	30	20 000	55	270	270				1	6	6	6	6	8	8	8	8	8
64	Physics laboratory	14	32	22 000	55	100	270						1(up)			1(down)		1(up)		
65	Cosmic ray laboratory Part I	14	52	30 000	55	270	270											1(up)		
	Cosmic ray laboratory Part II	14	7	24 000	55	270	270											1(up)		
66	Life sciences lab	14	58	33 000	55	100	270				1(up)		1(down)		1(up)					1(down)
67	Earth observation laboratory	14	45	25 000	55	100	270				1(up)		1(down)		1(up)					1(down)
68	Communications/navigation laboratory	14	38	19 000	55	100	270						1(up)		1(down)					1(up)
69	Space manufacture laboratory	14	45	25 000	55	100	270													1(up)

(g) Non NASA

Payload designation	Satellite name	Payload characteristics			Final orbital parameters			Year												
		Diam. ft.	Lgth. ft.	Wt. lb.	i	h_a	h_p	78	79	80	81	82	83	84	85	86	87	88	89	90
70	Comsat satellite	6.5	12	1 420	0	19 300	19 300	2	2	1	1		2	1	1			2	1	
71	U. S. domestic communication	10	19	2 145	0	19 300	19 300	2	1	2	1	1	2	2	2	2	2	2	2	2
72	Foreign domestic communication	4	12	1 000	0	19 300	19 300	2		2	6	2	2			4	5	2	1	2
73	Navigation and traffic control	5	8	700	29	30 000	16 000	1	3	1	2		1		1		1		1	
74	Navigation and traffic control	5	8	700	5	19 300	19 300	1		1	1		1		1		1		1	
75	Tos meteorological	5	6	1 000	101.1	700	700	1	1	1	1	1	1	1	1	1	1	1	1	1
76	Synchronous meteorological	5	8	1 000	0	19 300	19 300	1	1	1	1	1	1	1	1	1	1	1	1	1
77	Polar earth resources (take two at a time)	12	15	2 500	99.15	500	500		4		4		4		4				6	
78	Synchronous earth resources	6	6	1 000	0	19 300	19 300								4			4		

TABLE IV.- CHARACTERISTICS OF THE REUSABLE

TUG, CENTAUR, AGENA, AND FW-4S

	Tug	Centaur	Agena	FW-4S
Dry weight, lb	6 818	4 614	1 380	90
Maximum propellant loading, lb	49 550	29 858	13 440	608
I_{sp}, sec	460	442	310	283
Dimensions, ft	14.5 × 40	10 × 30	5 × 20	2 × 5

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979

(a) NASA - 1979

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb [a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Bio research module sortie plus astronomy explorer	14 × 40	5 020	28.5 28.5	200/200 270/270	Same	as EOS orbit		
2	Large telescope mirror test sortie plus astronomy explorer	14 × 40	13 720	28.5 28.5	200/200 270/270	Same	as EOS orbit		
3	High energy stellar astronomy observatory (HESAO) placement	14 × 46	21 000	30.0	230/230	Same	as EOS orbit		
4	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	[b]53 555	28.5	100/100	0 0	1 800/180 20 000/1000	28 755	44 535
5	Small applications technology synchronous plus high magnetosphere explorer	14.5 × 58	[b]52 170	28.5	100/100	0 0	19 300/19 300 1 A.U./19 300	28 865	44 150
6	Medical network	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

(a) DOD - 1979

Shuttle flight no.	Payload description [a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1	None			
2	None			

[a]Payloads are defined in classified addendum (ref. 2).

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(b) NASA - 1980

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Earth resources sortie	14 × 37	6 000	90.0	125/125	Same as EOS orbit			
2,3	Astronomy sortie	14 × 37	5 700	28.5	200/200	Same as EOS orbit			
4	Fluid management sortie	14 × 37	7 100	28.5	200/200	Same as EOS orbit			
5	Tele operator sortie	14 × 37	5 000	28.5	200/200	Same as EOS orbit			
6	Astronomical maneuvering unit sortie	14 × 37	3 800	28.5	200/200	Same as EOS orbit			
7,8	HESAO revisit	14 × 13	3 500	30.0	230/230	Same as EOS orbit			
9	Small applications technical-synchronous plus navigation and traffic control	14.5 × 60	[b]51 470	28.5	100/100	5 0	19 300/19 300 19 300/19 300	28 725	43 350
10	Small applications technology - polar plus earth physics	14.5 × 58	[b]13 080	90.0	100/100	90 90	3 000/300 400/400	7 840	5 060
11,12	Education broadcast	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
13,14	Tracking and data relay	14.5 × 55	[b]53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
15	Planetary relay	14.5 × 60	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
16	Polar earth observation plus TOS meteorological	14.5 × 58	[b]19 320	90.0	100/100	99.15 101.1	500/500 700/700	11 255	9 200
17	Synchronous earth observation plus synchronous meteorological	14.5 × 54	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
18	Orbiting solar observatory plus radio explorer plus high magnetosphere explorer	14.5 × 60	[b]51 390	28.5	100/100	28.5 28.5 28.5	350/350 19 300/19 300 1 A.U./19 300	27 965	41 350

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(b) NASA - 1980 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
19	Low magnetosphere explorer plus radio explorer plus middle magnetosphere explorer	14.5 × 60	46 215	28.5	100/100	28.5 28.5 28.5	1 800/180 19 300/19 300 20 000/1000	25 985	36 475
20	Venus explorer	14.5 × 52	44 340	30.0	100/100	Planetary		26 800	36 520
21	Comsat	14.5 × 52	[b]49 745	28.5	100/100	0	19 300/19 300	28 190	41 505
22-23	U.S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
24	Foreign domestic communication	14.5 × 59	41 885	28.5	100/100	28.5	19 300/19 300	25 835	34 065

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(b) DOD - 1980

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-5	None			
6-7	N-2B	5 × 15	1 400	38 364
8	N-2A	5 × 15	1 400	29 360
9	Three M-1	5 × 3 (each)	700 (each)	[b]7 481
10	S-4	9 × 60	10 000	
11	S-2B	15 × 25	5 000	18 756
12	C-1 C-3A	9 × 8 6 × 7	1 100 700	[b]42 362

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979

(c) NASA - 1981

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb [a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Station module - core	14 × 40	20 000	55	270/270	Same	as EOS orbit		
2-6	Station module - others	14 × 30	20 000	55	270/270	Same	as EOS orbit		
7	Station crew/cargo	14 × 30	20 000	55	270/270	Same	as EOS orbit		
8	Life Sciences Lab (up)	14 × 58	33 000	55	100/270	Same	as EOS orbit		
9	Earth Observation Lab (up)	14 × 45	25 000	55	100/270	Same	as EOS orbit		
10-11	General scientific research module sortie	14 × 54	27 500	55	200/200	Same	as EOS orbit		
12-13	General applications module sortie	14 × 51	30 000	65	100/100	Same	as EOS orbit		
14	Earth resources sortie	14 × 43.5	6 600	90	125/125	Same	as EOS orbit		
15-16	HESAO revisit plus astronomy sortie	14 × 50	9 200	30 28.5	230/230 200/200	Same	as EOS orbit		
17	Manned work platform sortie plus astronomy explorer	14 × 40	7 420	28.5 28.5	200/200 270/270	Same	as EOS orbit		
18	Large space telescope (LST)	14 × 60	30 000	28.5	350/350	Same	as EOS orbit		
19	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[b]23 535
20	Navigation and traffic control plus small applications technical satellite - synchronous	14.5 × 60	[c]51 470	28.5	100/100	5 0	19 300/19 300 19 300/19 300	28 725	43 350
21	Small application technical - polar plus earth physics	14.5 × 58	[c]13 080	90	100/100	90 90	3000/300 400/400	7 840	5 060
22-23	Follow-on systems demonstration	14.5 × 55	[c]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
24	Tracking and data relay	14.5 × 55	[c]52 285	28.5	100/100	0	19 300/19 300	28 190	43 165
25	Polar earth observation plus Tiros	14.5 × 58	[c]19 320	90	100/100	99.15 101.1	500/500 700/700	11 255	9 200

[a]Based on the minimum propellant required to place payloads in orbit.

[b]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

[c]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(c) NASA - 1981 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
26	Tiros	14.5 × 50	15 995	90	100/100	101.1	700/700	11 120	8 175
27	Synchronous earth resources plus foreign domestic communication	14.5 × 58	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
28	Medical network satellite plus navigation and traffic control	14.5 × 52	44 755	28.5	100/100	28.5 29	19 300/19 300 30 000/16 000	26 500	36 495
29	Lower magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	25 490	55	100/100	55 55	1800/180 20 000/1000	17 390	16 470
30	High magnetosphere explorer	14.5 × 46	29 920	55	100/100	55	1 A.U./1000	21 180	22 500
31	Radio interferometer synchronous plus gravity relativity experiment B	14.5 × 60	[b]60 860	28.5	100/100	28.5 28.5	38 300/38 300 1 A.U./38 300	27 640	47 540
32	Mars Viking	14.5 × 52	40 280	30	100/100	Planetary		15 400	26 760
33	Comsat plus synchronous meteorological	14.5 × 60	[b]52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
34	Foreign domestic communication plus navigation and traffic control	14.5 × 60	35 020	28.5	100/100	28.5 29	19 300/19 300 30 000/16 000	26 500	37 055

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(c) DOD - 1981

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	C-3B	6 × 7	700	[b]21 450
12	C-4	9 × 20	2 300	16 450
13-14	S-2A	15 × 25	5 000	[c]47 461
15	S-4	9 × 60	10 000	
16	Three M-1	5 × 3 (each)	700 (each)	[c]7 481

[a]Payloads are defined in classified addendum (ref. 2).

[b]ABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

[c]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(d) NASA - 1982

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1-2	Astronomy explorer plus follow-on systems demonstration	14.5 × 58	[b]52 035	28.5	100/100	28.5 0	270/270 19 300/19 300	28 190	42 495
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	[c]25 490	90.0	100/100	90 90	1800/180 20 000/1000	17 390	16 470
4	Polar earth observation	14.5 × 52	[b]16 080	90.0	100/100	99.15	500/500	9 090	6 760
5	High energy stellar astronomy laboratory (up) plus LST revisit	14 × 59	24 500	28.5	350/350	28.5 30	350/350 230/230		
6-7	HESAO revisit plus astronomy sortie	14 × 50	9 200	30	230/230	30 28.5	230/230 200/200		
8	LST revisit	14 × 13	3 500	28.5	350/350	same as EOS orbit			
9	Synchronous earth observation synchronous meteorological plus synchronous earth resources	14.5 × 60	[b]54 085	28.5	100/100	0	19 300/19 300	28 190	44 265
10	Earth physics plus small applications technical-polar	14.5 × 58.5	[b]13 080	90	100/100	90 90	400/400 3000/300	7 840	5 060
11	Synchronous earth resources plus small applications tech. - synchronous	14.5 × 58	[b]49 970	28.5	100/100	0	19 300/19 300	28 190	41 550
12	Cooperative application polar plus TOS meteorological	14.5 × 58	[c]21 895	90	100/100	90 101.1	3000/300 700/700	14 995	13 255
13-15	General scientific research module sortie	14 × 54	27 500	55	200/200	same as EOS orbit			
16-18	General applications module sortie	14 × 51	30 000	65	100/100	same as EOS orbit			
19-20	Earth resources sortie	14 × 37	6 000	90	125/125	same as EOS orbit			

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(d) NASA - 1982 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
21-26	Crew/cargo	14 × 30	20 000	55	270/270	Same as EOS orbit		--	--
27	Venus radar mapping	14.5 × 52	[b]50 240	30	100/100	Planetary		26 800	46 545
28-29	Jupiter pioneer orbiter	14.5 × 55	36 090	30	100/100	Planetary		22 700	28 370
30	Comet rendezvous payload	10 × 35	24 000	30	100/100	Same as EOS orbit		--	--
31	Tug for comet rendezvous	14.5 × 40	[b]52 310	30	100/100	Planetary		13 400	45 490
32	U.S. domestic communications	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
33	Foreign domestic communication	14.5 × 52	41 885	28.5	100/100	28.5	19 300/19 300	25 835	34 065
34	Foreign domestic communication plus synchronous meteorological	14.5 × 60	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
35	High magnetosphere explorer	14.5 × 46	[c]29 920	90	100/100	90	1 A.U./1000	21 180	22 500

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(d) DOD - 1982

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-1	9 × 8	1 100	41 260
13	C-3B	6 × 7	700	[b]21 450
14-15	S-2B	15 × 25	5 000	18 756
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364
21	S-4	9 × 60	10 000	

[a]Payloads are defined in classified addendum (ref. 2).

[b]ABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(e) NASA - 1983

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Astronomy explorer plus tracking and data relay	14.5 × 58	[b]53 280	28.5	270/270	28.5 0	270/270 19 300/19 300	same as EOS orbit 28 190	43 160
2	Astronomy explorer plus follow-on systems demonstration	14.5 × 58	[b]51 315	28.5	270/270	28.5 0	270/270 19 300/19 300	same as EOS orbit 28 190	42 495
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	[b]53 555	28.5	100/100	0 0	1 800/180 20 000/1000	28 755	44 535
4	Comsat plus high magnetosphere explorer	14.5 × 58	[b]54 290	28.5	100/100	0 0	19 300/19 300 1 A.U./19 300	28 865	45 450
5	Large solar observatory (up) plus high energy stellar astronomy observatory (down)	14 × 54 14 × 46	27 000 21 000	30.0 30.0	350/350 230/230	same as EOS orbit			
6-7	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit			
8	LST revisit plus astronomy sortie	14 × 50	9 200	28.5	350/350	28.5 28.5	350/350 200/200		
9	LST revisit plus fluid management sortie	14 × 50	10 600	28.5	350/350	28.5 28.5	350/350 200/200		
10	Polar earth observation plus TOS meteorological	14.5 × 58	[b]19 320	90	100/100	99.15 101.1	500/500 700/700	11 255	9 200
11	Earth physics plus small applications technical - polar	14.5 × 58.5	[b]13 080	90	100/100	90.0 90.0	400/400 3 000/300	7 840	5 060
12	Synchronous meteorological plus small applications technical - synchronous	14.5 × 60	49 970	28.5	100/100	0	19 300/19 300	28 190	41 550

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(e) NASA - 1983 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
13	Navigation and traffic control plus synchronous earth resources	14.5 × 54	[b]52 055	28.5	100/100	5 0	19 300/19 300 19 300/19 300	28 725	43 535
14	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[c]23 535
15-18	General scientific research module sortie	14 × 54	27 500	55.0	200/200	same as EOS orbit			
19	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
20	Tracking and data relay	14.5 × 55	[b]53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
21-22	General applications module sortie	14 × 51	30 000	65.0	100/100	same as EOS orbit			
23-28	Crew/cargo	14 × 30	20 000	55	270/270	same as EOS orbit			
29	Physics laboratory (up) plus earth observation laboratory (down)	14 × 32 14 × 45	22 000 25 000	55	100/270	same as EOS orbit			
30	Communications/navigation laboratory (up) plus life sciences laboratory (down)	14 × 38 14 × 58	19 000 33 000	55 55	100/270 100/270	same as EOS orbit			
31	Comsat plus synchronous meteorological	14.5 × 60	52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
32-33	U. S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
34	Foreign domestic communication plus navigation and traffic control	14.5 × 60	45 575	28.5	100/100	28.5 29	19 300/19 300 30 000/16 000	26 500	37 055

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1983 - Continued

(e) NASA - 1983 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
35	Navigation and traffic control	14.5 × 52	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
36	Polar earth resources	14.5 × 55	[b]16 980	90	100/100	99.15	500/500	same as EOS orbit	
37	Polar earth resources	12 × 15	2 500	90	100/100	99.15	500/500	9 090	7 660
38	Polar earth resources	14.5 × 55	[b]16 980	90	100/100	99.15	500/500	same as EOS orbit	
39	Polar earth resources	12 × 15	2 500	90	100/100	99.15	500/500	9 090	7 660

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(e) DOD - 1983

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-3A C-2	6 × 7 10 × 12	700 2 100	[b]43 535
13	C-2	10 × 12	2 100	[b]42 518
14	C-4	9 × 20	2 300	16 450
15	S-2B	15 × 25	5 000	18 756
16-17	Two S-3	6 × 5 (each)	1 300 (each)	[b]3 591
18	S-4	9 × 60	10 000	
19	Three M-1	5 × 3 (each)	700 (each)	[b]7 481
20-23	N-2A	5 × 15	1 400	29 360
24	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(f) NASA - 1984

Shuttle flight no.	Payload description	Total payload dimension, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	LST revisit plus astronomy explorer	14 × 16	4 220	28.5 28.5	350/350 270/270	same as EOS orbit			
2	Low magnetosphere explorer plus radio explorer plus high magnetosphere explorer	14.5 × 58	[b]49 850	28.5	100/100	28.5 28.5 28.5	1 800/180 19 300/19 300 1 A.U./19 300	27 775	40 510
3	Middle magnetosphere explorer plus solar orbit pair-synchronous	14.5 × 60	45 235	28.5	100/100	28.5 30.0	20 000/1000 19 300/19 300	25 905	35 515
4	Gravity/relative experiment C plus small applications technical-polar	14.5 × 59	[b]13 775	90.0	100/100	90.0 90.0	300/300 3 000/300	7 555	4 855
5	Solar orbit pair-1 A.U.	14.5 × 52	32 685	28.5	100/100	28.5	1 A.U./1000	21 180	23 965
6	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit			
7	HESAO revisit plus asteroid survey payload	14 × 48	30 500	30.0	230/230	same as EOS orbit			
8	Asteroid survey booster	[c]10 × 30+	34 575+	30.0	230/230	same as EOS orbit			
9	LST revisit	14 × 13	3 500	28.5	350/350	same as EOS orbit			
10-11	LSO revisit	14 × 13	3 500	30.0	350/350	same as EOS orbit			
12	Polar earth observation plus TOS meteorological	14.5 × 58	[b]19 320	90.0	100/100	99.15 101.1	500/500 700/700	11 255	9 200

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the ΔV capability; therefore, a kick stage was used.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(f) NASA - 1984 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
13	Synchronous earth observation plus small applications technical-synchronous	14.5 × 58	[b]49 970	28.5	100/100	0	19 300/19 300	14 095	41 550
14	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[c]23 535
15	Cooperative application - synchronous	14.5 × 52	48 620	28.5	100/100	0	19 300/19 300	28 190	40 980
16-17	Follow-on systems demonstration	14.5 × 55	51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
18	Tracking and data relay	14.5 × 55	53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
19	Planetary relay	14.5 × 60	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
20-23	General scientific research module sortie	14 × 54	27 500	55.0	200/200	same as EOS orbit			
24-26	General applications module sortie	14 × 51	30 000	65.0	100/100	same as EOS orbit			
27	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same as EOS orbit			
28-29	Dedicated applications module-earth observation sortie	14 × 41	22 500	75.0	100/100	same as EOS orbit			
30	Station module - core	14 × 40	20 000	55.0	270/270	same as EOS orbit			
31-36	Crew/cargo	14 × 30	20 000	55.0	270/270	same as EOS orbit			
37	Comsat plus synchronous meteorological	14.5 × 60	[b]52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
38-39	U. S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(f) DOD - 1984

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	[b]43 535
13	C-2	10 × 12	2 100	[b]42 518
14-15	S-2A	15 × 25	5 000	[b]47 461
16	S-4	9 × 60	10 000	
17	Three M-1	5 × 3 (each)	700 (each)	[b]7 481
18-21	N-2A	5 × 15	1 400	29 360
22	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(g) NASA - 1985

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Two radio explorers plus navigation and traffic control	14.5 × 56	46 450	28.5	100/100	28.5 29.0	19 300/19 300 30 000/16 000	26 500	37 490
2	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	35 475	55.0	100/100	55.0 55.0	1 800/180 20 000/1 000	28 755	26 455
3	High magnetosphere explorer	14.5 × 46	29 920	55.0	100/100	55.0	1 A.U./1 000	21 180	22 500
4	LSO revisit plus high energy stellar astronomy observatory	14 × 59	24 500	30.0 30.0	350/350 230/230	same as EOS orbit			
5	HESAO revisit plus comet rendezvous payload	14 × 48	27 500	30.0 30.0	230/230 100/100	same as EOS orbit planetary			
6	LSO revisit plus comet rendezvous tug	14.5 × 53	[b]52 310	30.0 30.0	350/350 100/100	same as EOS orbit planetary		13 400	[c]45 490
7	HESAO revisit plus large radio observatory	14 × 43	22 800	30.0 30.0	230/230 350/350	same as EOS orbit			
8	Large space telescope (down)	14 × 60	30 000	28.5	350/350	same as EOS orbit			
9	Large space telescope (up)	14 × 60	30 000	28.5	350/350	same as EOS orbit			
10	LST revisit plus synchronous earth resources	14.5 × 59	[b]52 470	28.5	350/350	same as EOS orbit 0	 19 300/19 300	28 190	41 150
11	Polar earth observation	14.5 × 52	[b]16 080	90.0	100/100	99.15	500/500	9 090	6 760
12	Earth physics plus small applications technology-polar	14.5 × 58.5	[b]13 080	90.0	100/100	90.0 90.0	400/400 3 000/300	7 840	5 060

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND . . .

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(g) NASA - 1985 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
13	Tiros plus TOS meteorological	14.5 × 56	[b]17 370	90.0	100/100	101.1	700/700	11 115	8 550
14	Small application technology - synchronous plus navigation and traffic control	14.5 × 60	[b]51 470	28.5	100/100	0 5	19 300/19 300 19 300/19 300	28 725	43 350
15-16	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
17-18	Planetary relay	14.5 × 60	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
19-21	General scientific research module sortie	14 × 54	27 500	55.0	200/200	same as	EOS orbit		
22-23	General applications module sortie	14 × 51	30 000	65.0	100/100	same as	EOS orbit		
24-26	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same as	EOS orbit		
27-28	Dedicated applications module - earth observation sortie	14 × 41	22 500	75.0	100/100	same as	EOS orbit		
29	Venus explorer lander	14.5 × 55	[b]60 270	30.0	100/100	planetary		26 800	46 150
30	Jupiter tops orbiter/probe	14.5 × 55	47 270	30.0	100/100	planetary		22 700	[c]37 150
31	Station module - core	14 × 40	20 000	55.0	270/270	same as	EOS orbit		
32-34	Station module - others	14 × 30	20 000	55.0	270/270	same as	EOS orbit		
35-40	Crew/cargo	14 × 30	20 000	55.0	270/270	same as	EOS orbit		

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(g) NASA - 1985 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
41	Life sciences laboratory	14 × 58	33 000	55.0	100/270	same as EOS orbit			
42	Earth observation laboratory (up) comm/nav laboratory (down)	14 × 45 14 × 38	25 000 19 000	55.0 55.0	100/270 100/270	same as EOS orbit			
43	Comsat plus synchronous earth resources	14.5 × 58	[b]52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
44-45	U. S. domestic communications	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
46	Synchronous meteorological plus 2 synchronous earth resources	14.5 × 60	[b]54 085	28.5	100/100	0	19 300/19 300	28 190	44 265
47	Polar earth resources	14.5 × 55	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
48	Polar earth resources	12 × 15	2 500	90.0	100/100	99.15	500/500	9 090	7 660
49	Polar earth resources	14.5 × 55	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
50	Polar earth resources	12 × 15	2 500	90.0	100/100	99.15	500/500	9 090	7 660

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(g) DOD - 1985

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-3A	6 × 7	700	40 484
13-14	C-5	9 × 20	3 300	[b]44 505
15-16	S-2B	15 × 25	5 000	18 756
17	Two S-3	6 × 5 (each)	1 300 (each)	[b]3 591
18-21	S-5	10 × 60	12 000	

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(h) NASA - 1986

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1-2	LST revisit plus astronomy explorer	14 × 16	4 220	28.5 28.5	350/350 270/270	same as EOS orbit			
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	25 490	90.0	100/100	90.0 90.0	1 800/180 20 000/1 000	17 390	16 470
4	Small applications technology polar	14.5 × 52	[b]12 170	90.0	100/100	90.0	3 000/300	7 515	4 750
5-6	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit			
7-8	LSO revisit	14 × 13	3 500	30.0	350/350	same as EOS orbit			
9-10	LRO revisit	14 × 13	3 500	30.0	350/350	same as EOS orbit			
11	Polar earth observation plus TOS meteorological	14.5 × 58	[b]19 320	90.0	100/100	99.15 101.1	500/500 700/700	11 255	9 200
12	Synchronous earth observation plus small applications technology - synchronous	14.5 × 58	[b]49 970	28.5	100/100	0	19 300/19 300	28 190	41 550
13	Polar earth resources	14.5 × 52	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
14	Polar earth resources	6 × 12	2 500	90.0	100/100	99.15	500/500	9 090	7 660
15	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[c]23 535
16-17	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
18-20	General applications module sortie	14 × 51	30 000	65.0	100/100	same as EOS orbit			

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(h) NASA - 1986 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
21-24	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same as EOS orbit			
25-26	Dedicated applications module - earth observation sortie	14 × 41	22 500	75.0	100/100	same as EOS orbit			
27	Uranius tops orbiter/probe	14.5 × 55	[b]53 585	30.0	100/100	planetary		24 000	[c]43 065
28-30	Station module-core	14 × 40	20 000	55.0	270/270	same as EOS orbit			
31-38	Crew/cargo	14 × 30	20 000	55.0	270/270	same as EOS orbit			
39	Physics laboratory (down)	14 × 32	22 000	55.0	100/270	same as EOS orbit			
40-41	U. S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
42	Foreign domestic communication plus synchronous meteorological	14.5 × 60	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
43-44	Foreign domestic communication	14.5 × 52	44 280	28.5	100/100	28.5	19 300/19 300	25 835	35 460
45	Foreign domestic communication	14.5 × 52	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
46	High magnetosphere explorer	14.5 × 46	[d]29 920	90.0	100/100	90.0	1 A.U./1 000	21 180	22 500

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

[d]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(h) DOD - 1986

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2	10 × 12	2 100	[b]42 518
13	C-3B Two S-3	6 × 7 6 × 5	700 1 300	[c]20 452
14	S-2B	15 × 25	5 000	18 756
15	Three M-1	5 × 3 (each)	700 (each)	[b]7 481
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

[c]ABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) NASA - 1987

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	LST revisit plus astronomy explorer	14 × 16	4 020	28.5 28.5	350/350 270/270	same	as EOS orbit		
2	Radio explorer plus gravity/relativity experiment D	14.5 × 49	[b]48 100	28.5	100/100	28.5 28.5	19 300/19 300 1 A.U./19 300	27 690	40 060
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	[b]53 555	28.5	100/100	0 0	1 800/180 20 000/1000	28 755	44 535
4	Foreign domestic communication plus high magnetosphere explorer	14.5 × 58	[b]51 320	28.5	100/100	0 0	19 300/19 300 1 A.U./19 300	28 865	44 500
5	Jupiter tops orbiter/probe (up) plus high energy stellar astronomy laboratory (down)	14.5 × 55 14 × 46	47 270 21 000	30.0 30.0	100/100 230/230	planetary same	 as EOS orbit	22 700	[c]37 150
6-7	HESAO revisit	14 × 13	3 500	30.0	230/230	same	as EOS orbit		
8	LST revisit	14 × 13	3 500	28.5	350/350	same	as EOS orbit		
9-10	LSO revisit	14 × 13	3 500	30.0	350/350	same	as EOS orbit		
11-12	LRO revisit	14 × 13	3 500	30.0	350/350	same	as EOS orbit		
13	Polar Earth observation plus TOS meteorological	14.5 × 58	[b]19 320	90.0	100/100	99.15 101.1	500/500 700/700	11 255	9 200
14	Earth physics plus small applications technical-polar	14.5 × 58.5	[b]13 080	90.0	100/100	90.0 90.0	400/400 3 000/300	7 840	5 060
15	Polar earth resources	14.5 × 52	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) NASA - 1987 - Continued

Shuttle flight no.	Payload diescription	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
16	Polar earth resources	16 × 12	2 500	90.0	100/100	99.15	500/500	9 090	7 660
17	Polar earth resources	14.5 × 52	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
18	Polar earth resources	6 × 12	2 500	90.0	100/100	99.15	500/500	9 090	7 660
19	Synchronous earth resources plus small applications technical synchronous	14.5 × 58	[b]49 970	28.5	100/100	0	19 300/19 300	28 190	41 550
20-21	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
22-23	Tracking and Data Relay	14.5 × 55	[b]53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
24-28	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same as EOS orbit			
29-30	Dedicated applications module-earth observation sortie	14 × 41	22 500	75.0	100/100	same as EOS orbit			
31-32	Station module-core	14 × 40	20 000	55.0	270/270	same as EOS orbit			
33-40	Crew/cargo	14 × 30	20 000	55.0	270/270	same as EOS orbit			
41-42	U.S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) NASA - 1987 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
43	Foreign domestic communication	14.5 × 52	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
44	Foreign domestic communication plus synchronous meteorological	14.5 × 60	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
45	Foreign domestic communication plus navigation and traffic control	14.5 × 60	35 020	28.5	100/100	28.5 29.0	19 300/19 300 30 000/16 000	26 500	37 055
46	Navigation and traffic control plus foreign domestic communication	14.5 × 60	[b]52 055	28.5	100/100	5 0	19 300/19 300 19 300/19 300	28 725	43 535

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(i) DOD - 1987

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-3B	6 × 7	700	[b]21 450
13	C-5	9 × 20	3 300	[c]44 505
14-15	S-2A	15 × 25	5 000	[c]47 461
16-17	S-5	10 × 60	12 000	
18	Three M-1	5 × 3 (each	700 (each)	[c]7 481
19-22	N-2A	5 × 15	1 400	29 360
23	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]ABES will have to be removed to place this payload in a 100-n. mi. circular orbit.

[c]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(j) NASA - 1988

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1-2	HESAO revisit plus astronomy explorer	14 × 16	4 220	28.5 28.5	230/230 270/270	same	as EOS orbit		
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	25 490	28.5	100/100	28.5 28.5	1 800/180 20 000/1 000	17 390	16 470
4	Foreign domestic communication plus high magnetosphere explorer	14.5 × 58	48 910	28.5	100/100	28.5 28.5	19 300/19 300 1 A.U./19 300	27 690	40 490
5	Optical interferometer pair	14.5 × 60	[b]56 280	28.5	100/100	30.0	19 300/19 300	25 840	42 460
6-7	LST revisit plus synchronous earth resources	14.5 × 59	48 970	28.5	350/350	same 0	as EOS orbit 19 300/19 300	28 190	41 150
8	Large solar observatory (down)	14 × 54	27 000	30.0	350/350	same	as EOS orbit		
9	Large solar observatory (up)	14 × 54	27 000	30.0	350/350	same	as EOS orbit		
10	LSO revisit plus synchronous earth observation	14.5 × 59	[b]52 835	30.0	350/350	same 0	as EOS orbit 19 300/19 300	28 410	41 515
11	LRO revisit	14 × 13	3 500	30.0	350/350	same	as EOS orbit		
12	LRO revisit plus synchronous earth resources	14.5 × 59	[b]52 835	30.0	350/350	0	19 300/19 300	28 410	41 515
13	Polar earth observation	14.5 × 52	[b]16 080	90.0	100/100	99.15	500/500	9 090	6 760
14	Synchronous earth resources plus small applications technical	14.5 × 58	[b]49 970	28.5	100/100	0	19 300/19 300	28 410	41 550
15	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[c]23 535

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(j) NASA - 1988 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
16	Small applications technical plus TOS meteorological	14.5 × 58	[b]21 590	90	100/100	90 101.1	3 000/300 700/700	14 995	13 170
17-18	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
19	Tracking and Data Relay	14.5 × 55	[b]53 280	28.5	100/100	0	19 300/19 300	28 190	43 160
20-22	General applications module sortie	14 × 51	30 000	65	100/100	same	as EOS orbit		
23-26	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55	200/200	same	as EOS orbit		
27-28	Dedicated applications module earth observation sortie	14 × 41	22 500	75	100/100	same	as EOS orbit		
29	Venus explorer lander	14.5 × 55	[b]60 270	30	100/100	planetary		26 800	46 150
30-37	Crew/cargo	14 × 30	20 000	55	270/270	same	as EOS orbit		
38	Physics laboratory (up)	14 × 32	22 000	55	100/270	same	as EOS orbit		
39	Cosmic ray laboratory part I (up) plus cosmic ray laboratory - part II (up)	14 × 59	[c]54 000	55	270/270	same	as EOS orbit		

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(j) NASA - 1988 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
40	Comsat plus synchronous earth resources	14.5 × 58	[b]52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
41	Comsat plus synchronous meteorological	14.5 × 60	[b]52 600	28.5	100/100	0	19 300/19 300	28 190	43 360
42-43	U.S. Domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
44	Foreign domestic communication plus synchronous earth resources	14.5 × 58	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(j) DOD - 1988

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	[b]43 535
13-14	S-2B	15 × 25	5 000	18 756
15	Two S-3	6 × 5 (each)	1 300 (each)	[b]3 591
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(k) NASA - 1989

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1-2	LST revisit plus astronomy explorer	14 × 16	4 220	28.5 28.5	350/350 270/270	same as EOS orbit			
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	25 490	55.0	100/100	55 55	1 800/180 20 000/1000	17 390	16 470
4	High magnetosphere explorer	14.5 × 46	29 920	55.0	100/100	55	1 A.U./1000	21 180	22 500
5	Solar orbit pair synchronous plus navigation and traffic control	14.5 × 60	47 780	30.0	100/100	30 29	19 300/19 300 30 000/16 000	26 520	38 360
6	Solar orbit pair - 1 A.U.	14.5 × 52	32 685	28.5	100/100	28.5	1 A.U./1000	21 180	23 965
7	High energy stellar astronomy observatory (up)	14 × 46	21 000	30.0	230/230	same as EOS orbit			
8-9	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit			
10-11	LSO revisit	14 × 13	3 500	30.0	350/350	same as EOS orbit			
12-13	LRO revisit	14 × 13	3 500	30.0	350/350	same as EOS orbit			
14	Polar earth resources	14.5 × 55	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
15	Polar earth resources plus polar earth observation	12 × 27	5 000	90.0	100/100	99.15	500/500	9 090	7 660
16	Earth physics plus cooperative applications-polar	14.5 × 58.5	[b]13 080	90.0	100/100	90 90	400/400 3 000/300	7 840	5 060
17	Applications technology	15 × 60	38 305	28.5	100/100	0	19 300/19 300	14 095	[c]23 535

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(k) NASA - 1989 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
18	Navigation and traffic control plus small applications technical synchronous	14.5 × 60	[b]51 470	28.5	100/100	5 0	19 300/19 300 19 300/19 300	28 725	43 350
19	Small applications technical polar plus TOS meteorological	14.5 × 58	[b]21 590	90.0	100/100	90 101.1	3 000/300 700/700	14 995	13 170
20-21	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
22	Synchronous earth observation	14.5 × 60	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
23	General applications module sortie	14 × 51	30 000	65.0	100/100	same as EOS orbit			
24-28	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55.0	200/200	same as EOS orbit			
29-31	Dedicated applications module earth observation sortie	14 × 41	22 500	75.0	100/100	same as EOS orbit			
32	Uranius tops orbiter/probe	14.5 × 55	[b]53 575	30.0	100/100	planetary		24 000	[c]43 065
33-40	Crew/cargo	14 × 30	20 000	55.0	270/270	same as EOS orbit			
41	Comsat	14.5 × 52	[b]49 745	28.5	100/100	0	19 300/19 300	28 190	41 505
42-43	U.S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]The tug does not have the capability for a round trip and was therefore expended after the payload is placed in orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(k) NASA - 1989 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
44	Foreign domestic communication plus synchronous meteorological	14.5 × 60	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
45-46	Polar earth resources	14.5 × 55	[b]16 980	90.0	100/100	99.15	500/500	same as EOS orbit	
47-48	Polar earth resources	12 × 15	2 500	90.0	100/100	99.15	500/500	9 090	7 660

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

(k) DOD - 1989

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	[b]43 535
13	S-2B	15 × 25	5 000	18 756
14	Two S-3	6 × 5 (each)	1 300 (each)	[b]3 591
15-16	S-5	10 × 60	12 000	
17	Three M-1	5 × 3 (each)	700 (each)	7 481

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(1) NASA - 1990

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
1	Radio explorer plus foreign domestic communication	14.5 × 56	43 605	28.5	100/100	28.5	19 300/19 300	25 835	35 065
2	LST revisit plus radio explorer	14.5 × 57	41 635	28.5	350/350	same as EOS orbit 28.5	 19 300/19 300	25 835	34 815
3	Low magnetosphere explorer plus middle magnetosphere explorer	14.5 × 56	[b]25 490	90.0	100/100	90 90	1 800/180 20 000/1000	17 390	16 470
4	Small applications technical - polar	14.5 × 52	[c]12 170	90.0	100/100	90	3 000/300	7 515	4 750
5	Gravity/relativity experiment E plus polar earth observation	14.5 × 59	[c]18 410	90.0	100/100	90 99.15	300/300 500/500	8 875	7 590
6	LRO revisit plus Mars sample return payload	15 × 35.5	25 500	30.0	230/230	same as EOS orbit			
7-8	LSO revisit plus Mars sample return booster	[d]14 × 43+	41 500+	30.0	350/350	same as EOS orbit planetary		15 400	
9-10	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit			
11	LST revisit	14 × 13	3 500	28.5	350/350	same as EOS orbit			
12	LRO revisit plus Mars sample return payload	15 × 35.5	25 500	30.0	350/350	same as EOS orbit			
13	Synchronous earth observation plus small application technical - synchronous	14.5 × 58	[c]49 970	28.5	100/100	0	19 300/19 300	28 190	41 550

[a]Based on the minimum propellant required to place payloads in orbit.
[b]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.
[c]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.
[d]The tug does not have the ΔV capability; therefore, a kick stage was used.

TABLE V.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Continued

(1) NASA - 1990 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft (D × L)	Total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Total tug ΔV required	Round trip minimum tug propellant required, lb
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.		
14	Tiros plus TOS meteorological	14.5 × 56	[b]17 370	90.0	100/100	101.1	700/700	11 120	8 550
15-16	Follow-on systems demonstration	14.5 × 55	[b]51 315	28.5	100/100	0	19 300/19 300	28 190	42 495
17-18	Planetary relay	14.5 × 60	48 970	28.5	100/100	0	19 300/19 300	28 190	41 150
19-23	Dedicated scientific research module-astronomy sortie	14 × 54	29 500	55.0	200/200	same	as EOS orbit		
24-27	Dedicated applications module earth observation sortie	14 × 41	22 500	75.0	100/100	same	as EOS orbit		
28-35	Crew/cargo	14 × 30	20 000	55.0	270/270	same	as EOS orbit		
36	Communications/navigations lab (up) life sciences laboratory (down)	14 × 38 14 × 58	19 000 33 000	55.0 55.0	100/270 100/270	same	as EOS orbit		
37	Space manufacture laboratory (up) earth observation lab (down)	14 × 45 14 × 45	25 000 25 000	55.0 55.0	100/270 100/270	same	as EOS orbit		
38-39	U.S. domestic communication	14.5 × 59	[b]51 495	28.5	100/100	0	19 300/19 300	28 190	42 530
40	*Foreign domestic communication plus synchronous meteorological*	*14.5 × 60*	[b]*51 315*	*28.5*	*100/100*	*0*	*19 300/19 300*	*28 190*	*42 495*
41	High magnetosphere explorer	14.5 × 46	[c]29 920	90.0	100/100	90	1 A.U/1000	21 180	22 500

[a]Based on the minimum propellant required to place payloads in orbit.

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]ABES will have to be removed to place this payload in a 100 n. mi. circular orbit.

TABLE V. - EARTH ORBIT SHUTTLE TRAFFIC MODELS - TUG USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1979 - Concluded

(l) DOD - 1990

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None			
11	D-1	10 × 20	6 000	
12	C-2 C-3A	10 × 12 6 × 7	2 100 700	[b]43 535
13-14	S-2A	15 × 25	5 000	[b]47 461
15	Three M-1	5 × 3 (each	700 (each)	[b]7 481
16-19	N-2A	5 × 15	1 400	29 360
20	N-2B	5 × 15	1 400	38 364

[a]Payloads are defined in classified addendum (ref. 2).

[b]OMS must be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
(a) NASA - 1979								
1	Bio research module sortie plus astronomy explorer	14 × 40	5 020	28.5 28.5	200/200 270/270	same as EOS orbit		EOS
2	Large telescope mirror test plus astronomy explorer	14 × 40	13 720	28.5 28.5	200/200 270/270	same as EOS orbit		EOS
3	Low magnetosphere explorer plus small applications tech. sync. plus middle magnetosphere explorer	10 × 58	37 275	28.5	100/100	0 0 0	1 800/180 19 300/19 300 20 000/1000	Centaur
4	Medical network plus high magnetosphere explorer	12 × 51	37 075	28.5	100/100	0 0	19 300/19 300 1 A.U./19 300	Centaur
5	High energy stellar astronomy observatory (UP)	14 × 46	21 000	30.0	230/230	same as EOS orbit		EOS
6	Cooperative application sync. plus medical network	12 × 57	37 295	28.5	100/100	0	19 300/19 300	Centaur

[a] In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(a) DOD - 1979

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1	None	--	--	EOS
2	None	--	--	EOS

[a]Payloads are defined in classified addendum (ref. 2)

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(b) NASA - 1980

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maxium total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
1	Earth resources sortie	14 × 37	6 000	90.0	125/125	same as EOS orbit		EOS
2-3	Astronomy sortie	14 × 37	5 700	28.5	200/200	same as EOS orbit		EOS
4	Fluid management sortie	14 × 37	7 100	28.5	200/200	same as EOS orbit		EOS
5	Teleoperator sortie	14 × 37	5 000	28.5	200/200	same as EOS orbit		EOS
6	Astronomical maneuvering unit sortie plus orbiting solar observatory	14 × 47	5 700	28.5 28.5	200/200 350/350	same as EOS orbit		EOS
7-8	HESAO revisit	14 × 13	3 500	30.0	230/230	same as EOS orbit		EOS
9	Small applications tech. synch. plus foreign domestic communication	6.5 × 44	16 420	28.5	100/100	0	19 300/19 300	Agena
10	Polar earth observation plus TOS meteorological	6 × 28	[b]4 900	99.15	100/100	99.15 101.1	500/500 700/700	2 FW-4S
11	Education broadcast	10 × 39	16 965	28.5	100/100	0	19 300/19 300	Agena
12	Education broadcast plus navigation and traffic control	10 × 57	37 315	28.5	100/100	0	19 300/19 300	Centaur
13	Radio explorer plus middle magnetosphere explorer plus tracking and data relay	12 × 57	37 490	28.5	100/100	28.5 28.5 0	1800/180 20 000/1000 19 300/19 300	Centaur
14	Tracking and data relay plus comsat	12 × 57	38 190	28.5	100/100	0	19 300/19 300	Centaur
15	Planetary relay	10 × 40	15 820	28.5	100/100	0	19 300/19 300	Agena

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(b) NASA - 1980 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi	
16	Synchronous earth observation plus U. S. domestic communication	10 × 55	37 615	28.5	100/100	0	19 300/19 300	Centaur
17	Low magnetosphere explorer plus foreign domestic communication plus navigation and traffic control	10 × 58	37 370	28.5	100/100	28.5 28.5 29.0	1800/180 19 300/19 300 30 000/16 000	Centaur
18	Radio explorer plus high magnetosphere explorer	10 × 40	35 790	28.5	100/100	28.5 28.5	19 300/19 300 1 A.U./19 300	Centaur
19	U. S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur
20	Venus explorer	10 × 42	35 470	30.0	100/100	planetary		Centaur
21	Earth physics plus small applications tech. - polar	6.5 × 28.5	2 600	90.0	100/100	90.0 90.0	400/400 3000/300	2 FW-4S

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(b) DOD - 1980

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None	--	--	EOS
11	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
12	N-2A C-3A C-1	5 × 15 6 × 7 9 × 8	1 400 700 1 100	Centaur
13	Three M-1	5 × 3 (each)	700 (each)	Agena
14	S-4	9 × 60	10 000	EOS
15	S-2B	15 × 25	5 000	Agena

[a]Payloads are defined in classified addendum (ref. 2)

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(c) NASA - 1981

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb [a]	Original EOS orbit		Satellite final orbit		Booster Required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
1	Station module-core	14 × 40	20 000	55	270/270	same as EOS orbit		EOS
2-6	Station module-others	14 × 30	20 000	55	270/270	same as EOS orbit		EOS
7	Station crew/cargo	14 × 30	20 000	55	270/270	same as EOS orbit		EOS
8	Life sciences lab (up)	14 × 58	33 000	55	100/270	same as EOS orbit		EOS
9	Earth observation lab (up)	14 × 45	25 000	55	100/270	same as EOS orbit		EOS
10-11	General scientific research module sortie	14 × 54	27 500	55	200/200	same as EOS orbit		EOS
12-13	General applications module sortie	14 × 51	30 000	65	100/100	same as EOS orbit		EOS
14	Earth resources sortie	14 × 43.5	6 600	90	125/125	same as EOS orbit		EOS
15	Astronomy sortie plus astronomy explorer	14 × 40	6 420	28.5 28.5	200/200 270/270	same as EOS orbit		EOS
16-17	HESAO revisit plus astronomy sortie	14 × 50	9 200	28.5 30	200/200 230/230	same as EOS orbit		EOS
18	Manned work platform sortie	14 × 37	6 700	28.5	200/200	same as EOS orbit		EOS
19	Large space telescope	14 × 60	30 000	28.5	350/350	same as EOS orbit		EOS
20	Applications technology plus synchronous earth resources	15 × 56	43 420	28.5	100/100	0	19 300/19 300	Centaur
21	Small applications technology synchonous plus foreign domestic communication	6.5 × 44	16 420	28.5	100/100	0	19 300/19 300	Agena
22	Earth physics plus small applications technical-polar plus polar earth observation	6.5 × 50.5	[b,c]18 520	90	100/100	90 90 99.15	400/400 3000/300 500/500	Agena

[a] In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

[b] OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c] If minimum propellant usage is assumed, then no OMS offloading would be required.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(c) NASA - 1981 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
23	Follow-on systems demonstration plus foreign domestic communication	12 × 57	37 470	28.5	100/100	0	19 300/19 300	Centaur
24	Follow-on systems demonstration plus tracking and data relay	12 × 60	38 770	28.5	100/100	0	19 300/19 300	Centaur
25	Two Polar earth resources plus Tiros	12 × 40	[b]8 095	99.15	100/100	99.15 101.1	500/500 700/700	3 FW-4S
26	Radio explorer plus foreign domestic communication plus navigation and traffic control	5 × 44	17 240	28.5	100/100	28.5 28.5 29.0	19 300/19 300 19 300/19 300 30 000/16 000	Agena
27	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	10 × 52	17 620	55	100/100	55 55 55	1800/180 20 000/1000 1 A.U./1000	Agena
28	Radio interferometer synchronous plus gravity/relativity experiment B	12 × 50	40 970	28.5	100/100	28.5 28.5	38 300/38 300 1 A.U./38 300	Centaur
29	Mars Viking	10 × 42	42 170	30	100/100	Planetary		Centaur
30	Comsat plus foreign domestic communications	6.5 × 44	17 240	28.5	100/100	0	19 300/19 300	Agena
31	U.S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur
32	Foreign domestic communication plus navigation and traffic control	5 × 40	16 520	28.5	100/100	28.5 5	19 300/19 300 19 300/19 300	Agena

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.
[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
(c) NASA - 1981 - Concluded								
33	Two polar earth resources plus TOS meteorological	12 × 56	[b]8 095	99.15	100/100	99.15 101.1	500/500 700/700	3 FW-4S
34	Foreign domestic communication plus navigation and traffic control	5 × 40	16 520	28.5	100/100	28.5 29	19 300/19 300 30 000/16 000	Agena

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(c) DOD - 1981

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None	--	--	EOS
11	Three M-1	5 × 3 (each)	700 (each)	Agena
12	S-4	9 × 60	10 000	EOS
13-14	S-2A	15 × 25	5 000	Centaur
15	C-4 C-3B	9 × 20 6 × 7	2 300 700	Agena
16	C-1	9 × 8	1 100	Agena

[a]Payloads are defined in classified addendum (ref. 2)

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(d) NASA - 1982

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
1	Astronomy explorer plus foreign domestic communication plus synchronous earth resources	10 × 51	17 540	28.5	100/100	28.5 28.5 0	270/270 19 300/19 300 19 300/19 300	EOS Agena
2	LST revisit plus astronomy explorer	14 × 16	4 220	28.5 28.5	350/350 270/270	same as EOS orbit		EOS
3	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	10 × 52	[b,c]17 620	90	100/100	90 90 90	1800/180 20 000/1000 1 A.U./1000	Agena
4	High energy stellar astronomy observatory (up)	14 × 46	21 000	30	230/230	same as EOS orbit		EOS
5-6	HESAO revisit plus astronomy sortie	14 × 50	9 200	30 28.5	230/230 200/200	same as EOS orbit		EOS
7	LST revisit plus comet rendezvous booster	14 × 43+	38 000+	28.5 30	350/350 350/350	same as EOS orbit Planetary		EOS Centaur plus some other kick stage
8	Polar earth observation plus TOS meteorological	6 × 28	[b]4 900	99.15		99.15 101.1	500/500 700/700	2 FW-4S
9	Synchronous earth resources plus follow-on demonstration	12 × 51	37 470	28.5	100/100	0	19 300/19 300	Centaur
10	Earth resources sortie plus earth physics	14 × 48.5	7 300	90	125/125	same as EOS orbit 90	 400/400	EOS FW-4S
11	Synchronous meterological plus synchronous earth resources plus follow-on systems demonstration	12 × 59	38 470	28.5	100/100	0	19 300/19 300	Centaur

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100 n. mi. circular orbit.

[c]If minimum propellant usage is assumed, then no OMS offloading would be required.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(d) NASA - 1982 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
12	Small applications technical synchronous plus foreign domestic communications	6.5 × 44	16 420	28.5	100/100	0	19 300/19 300	Agena
13	Small applications technical polar plus cooperative applications polar	6.5 × 44	2 820	90	100/100	90	3000/300	2 FW-4S
14-16	General scientific research module sortie	14 × 54	27 500	55	200/200	same as EOS orbit		EOS
17-19	General applications module sortie	14 × 51	30 000	65	100/100	same as EOS orbit		EOS
20	Earth resources sortie	14 × 37	6 000	90	125/125	same as EOS orbit		EOS
21	Venus radar mapping	10 × 42	42 370	30	100/100	planetary		Centaur
22-23	Jupiter Pioneer orbiter	10 × 45	34 370	30	100/100	planetary		Centaur
24	Comet rendezvous payload	10 × 35	24 000	30	350/350	planetary		EOS
25-30	Crew/cargo	14 × 30	20 000	55	270/270	same as EOS orbit		EOS
31	U.S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(d) DOD - 1982

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None	--	--	EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
13	N-2A C-1	5 × 15 9 × 8	1 400 1 100	Centaur
14-15	N-2A	5 × 15	1 400	Agena
16	S-4	9 × 60	10 000	EOS
17-18	S-2B	15 × 25	5 000	Agena
19	C-3B	6 × 7	700	Agena

[a]Payloads are defined in classified addendum (ref. 2)

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(e) NASA - 1983

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maxium total payload weight, lb[a]	Original EOS orbit i, deg	Original EOS orbit h_a/h_p, n. mi.	Satellite final orbit i, deg	Satellite final orbit h_a/h_p, n. mi.	Booster required
1	HESAO revisit plus astronomy sortie plus astronomy explorer	14 × 53	9 920	30 28.5 28.5	230/230 200/200 270/270	same as EOS orbit		EOS
2	LST revisit plus fluid management sortie plus astronomy explorer	14 × 53	11 320	28.5 28.5 28.5	350/350 200/200 270/270	same as EOS orbit		EOS
3	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	10 × 52	37 275	28.5	100/100	0 0 0	1 800/180 20 000/1000 1 A.U./1000	Centaur
4	Large solar observatory (up) high energy stellar astronomy observatory (down)	14 × 54 14 × 46	27 000 21 000	30 30	350/350 230/230	same as EOS orbit		EOS
5	HESAO revisit plus foreign domestic communication	14 × 45	15 820	30	230/230	same as EOS orbit 28.5	 19 300/19 300	Agena
6	LST revisit plus navigation and traffic control plus navigation and traffic control	14 × 49	19 720	28.5	350/350	same as EOS orbit 29 5	 30 000/16 000 19 300/19 300	Agena
7	2 Polar earth resources plus TOS meteorological	12 × 40	[b]8 095	99.15	100/100	99.15 101.1	500/500 700/700	3 FW-4S
8	Polar earth observation plus two polar earth resources	12 × 57	[b]9 595	99.15	100/100	99.15	500/500	3 FW-4S
9	Synchronous meteorological plus applications technology	15 × 58	43 420	28.5	100/100	0	19 300/19 300	Centaur
10	Synchronous earth resources plus U. S. domestic communication	10 × 55	37 615	28.5	100/100	0	19 300/19 300	Centaur

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.
[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(e) NASA - 1983 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
11	Small applications technical synchronous plus comsat	6.5 × 44	16 840	28.5	100/100	0	19 300/19 300	Agena
12	Earth physics plus small applications technical-polar	6.5 × 28.5	2 600	90	100/100	90 90	400/400 3000/300	2 FW-4S
13-14	Follow-on systems demonstration plus tracking and data relay	12 × 60	38 770	28.5	100/100	0	19 300/19 300	Centaur
15-18	General scientific research module sortie	14 × 54	27 500	55	200/200	same as EOS orbit		EOS
19-20	General applications module sortie	14 × 51	30 000	65	100/100	same as EOS orbit		EOS
21-26	Crew/cargo	14 × 30	20 000	55	270/270	same as EOS orbit		EOS
27	Physics laboratory (up) earth observation lab (down)	14 × 32 14 × 45	22 000 25 000	55 55	100/270 100/270	same as EOS orbit		EOS
28	Communications/navigation lab (up) life sciences laboratory (down)	14 × 38 14 × 58	19 000 33 000	55 55	100/270 100/270	same as EOS orbit		EOS
29	Comsat plus foreign domestic communication	6.5 × 44	17 240	28.5	100/100	0	19 300/19 300	Agena
30	U. S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(e) DOD - 1983

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None	--	--	EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
13	N-2A C-2 C-3A	5 × 15 10 × 12 6 × 7	1 400 2 100 700	Centaur
14-15	N-2A C-2	5 × 15 10 × 12	1 400 2 100	Centaur
16	Three M-1	5 × 3 (each)	700 (each)	Agena
17	S-4	9 × 60	10 000	EOS
18	Two S-3 C-4	6 × 5 (each) 9 × 20	1 300 2 300	Agena
19	Two S-3	6 × 5 (each)	1 300	Agena
20	S-2B	15 × 25	5 000	Agena

[a]Payloads are defined in classified addendum (ref. 2)

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(f) NASA - 1984

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
1	LST revisit plus astronomy explorer plus comsat	14 × 48	20 460	28.5 28.5	350/350 270/270	same as same as 0	EOS orbit EOS orbit 19 300/19 300	EOS EOS Agena
2	Radio explorer plus solar orbit pair - 1 A.U.	10 × 45	37 090	28.5	100/100	28.5 28.5	19 300/19 300 1 A.U./19 300	Centaur
3	Low magnetosphere explorer plus middle magnetosphere explorer plus high magnetosphere explorer	10 × 52	37 270	28.5	100/100	28.5 28.5 28.5	1800/180 20 000/1000 1 A.U./1000	Centaur
4	Gravity/relativity experiment C plus small applications technical polar	6.5 × 29	3 500	90	100/100	90 90	300/300 3000/300	2 FW-4S
5	Solar orbit pair synchronous plus small applications technical synchronous	10 × 54	36 970	28.5	100/100	30 0	19 300/19 300 19 300/19 300	Centaur
6	HESAO revisit	14 × 13	3 500	30	230/230	same as	EOS orbit	EOS
7	HESAO revisit plus asteroid survey payload	14 × 48	30 500	30 30	230/230 350/350	same as planetary	EOS orbit	EOS EOS
8	LSO revisit plus asteroid survey booster	14 × 43+	37 970+	30	350/350	same as planetary	EOS orbit	EOS Centaur + some other kick stage
9	LST revisit plus U. S. domestic communications	14 × 45	20 445	28.5	350/350	same as 0	EOS orbit 19 300/19 300	Agena
10	LSO revisit	14 × 13	3 500	30	350/350	same as	EOS orbit	EOS
11	Polar earth observation plus TOS meteorological	6 × 28	[b]4 900	99.15	100/100	99.15 101.1	500/500 700/700	2 FW-4S

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

[b]OMS will have to be offloaded in order for the EOS to have the capability to place this payload in a 100-n. mi. circular orbit.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND

EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Continued

(f) NASA - 1984 - Concluded

Shuttle flight no.	Payload description	Total payload dimensions, ft	Maximum total payload weight, lb[a]	Original EOS orbit		Satellite final orbit		Booster required
				i, deg	h_a/h_p, n. mi.	i, deg	h_a/h_p, n. mi.	
12	Synchronous earth observation plus planetary relay	10 × 46	16 820	28.5	100/100	0	19 300/19 300	Agena
13	Applications technology	15 × 50	42 420	28.5	100/100	0	19 300/19 300	Centaur
14	Cooperative applications synchronous plus follow-on systems demonstration	12 × 57	37 290	28.5	100/100	0	19 300/19 300	Centaur
15	Follow-on systems demonstration plus tracking and data relay	12 × 60	38 770	28.5	100/100	0	19 300/19 300	Centaur
16-19	General scientific research module sortie	14 × 54	27 500	55	200/200	same as EOS orbit		EOS
20-22	General applications module sortie	14 × 51	30 000	65	100/100	same as EOS orbit		EOS
23	Dedicated scientific research module - astronomy sortie	14 × 54	29 500	55	200/200	same as EOS orbit		EOS
24-25	Dedicated applications module earth observation sortie	14 × 41	22 500	75	100/100	same as EOS orbit		EOS
26	Station module-core	14 × 40	20 000	55	270/270	same as EOS orbit		EOS
27-32	Crew/cargo	14 × 30	20 000	55	270/270	same as EOS orbit		EOS
33	U. S. domestic communication plus synchronous meteorological	10 × 57	37 615	28.5	100/100	0	19 300/19 300	Centaur

[a]In order to reduce the number of computer calculations, the total payload weight is based on maximum fuel loading of the booster.

Since the tug becomes available in 1985, EOS flights for years 1985 through 1990 are the same as those defined in table V.

TABLE VI.- EARTH ORBIT SHUTTLE TRAFFIC MODELS - KICK STAGES USED FOR ΔV BEYOND EARTH ORBIT SHUTTLE CAPABILITY WITH PAYLOADS LOADED END-TO-END AND TUG AVAILABLE IN 1985 - Concluded

(f) DOD - 1984

Shuttle flight no.	Payload description[a]	Payload dimensions, ft (D × L)	Payload weight, lb	Tug propellant required, lb
1-10	None	--	--	EOS
11	D-1	10 × 20	30 000	Centaur
12	N-2B N-2A	5 × 15 5 × 15	1 400 1 400	Centaur
13-14	N-2A C-2	5 × 15 10 × 12	1 400 2 100	Centaur
15	N-2A C-3A	5 × 15 6 × 7	1 400 700	Agena
16	Three M-1	5 × 3 (each)	700 (each)	Agena
17	S-4	9 × 60	10 000	EOS
18-19	S-2A	15 × 25	5 000	Centaur

[a]Payloads are defined in classified addendum (ref. 2).

Since the tug becomes available in 1985, EOS flights for years 1985 through 1990 are the same as those defined in table V.

TABLE VII.- EOS FLIGHTS ASSOCIATED WITH TWO TUG AVAILABILITY TIMES, 1979 AND 1985

Description	Mode	[a]1978	[b]1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug available in 1979 - payloads placed end-to-end	NASA flights		6	24	34	35	39	39	50	46	46	44	48	41	452
	NASA payloads		10	32	46	45	52	46	62	52	55	58	54	52	564
Tug available in 1985 - payloads placed end-to-end	NASA flights		6	21	34	31	30	33	50	46	46	44	48	41	430
	NASA payloads		12	34	54	46	52	47	62	52	55	58	54	52	578
Tug available in 1979 - payloads placed end-to-end	DOD flights		2	12	16	21	24	22	21	20	23	20	17	20	218
	DOD payloads		2	15	18	21	29	25	22	24	25	22	21	23	247
Tug available in 1985 - payloads placed end-to-end	DOD flights		2	15	16	19	20	19	21	20	23	20	17	20	212
	DOD payloads		2	20	19	21	30	25	22	24	25	22	21	23	254

[a]Three dedicated NASA and one dedicated DOD flights for the year 1978 will be defined by NASA Headquarters and are not included in this table.

[b]Four dedicated NASA and two dedicated DOD flights for the year 1979 will be defined by NASA Headquarters and are not included in this table.

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS BY INCLINATION

(a) NASA - tug available in 1979 and payloads stacked end-to-end

Year	Inclination						Total
	28.5	30	55	65	75	[a]90-101	
1979	5	1					6
1980	18	3				3	24
1981	12	[b]3	13	2		4	34
1982	9	7	9	3		7	35
1983	16	3	12	2		6	39
1984	15	5	12	3	2	2	39
1985	13	6	20	2	2	7	50
1986	12	7	16	3	2	6	46
1987	16	7	15		2	6	46
1988	17	6	14	3	2	2	44
1989	12	9	15	1	3	8	48
1990	11	6	15		4	5	41
Total	156	63	141	19	17	56	452
Percent	34.5	13.9	31.2	4.2	3.8	12.4	100.0

[a]For sun synchronous orbits, the EOS carries the tug plus payload to a 100-n. mi. circular orbit at an inclination of 90° and the tug is used to make the plane change.

[b]Two flights contain a 30° payload combined with a 28.5° payload.

Many DOD flights do not have an inclination defined; thus the total number of flights for this table does not correspond to values found in other sections of the report.

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE

FLIGHTS BY INCLINATION - Continued

(a) DOD - tug available in 1979 and payloads stacked end-to-end

Year	Inclination				Total
	28.5	30	63.4	90-101	
1979					
1980	3	1	1	2	7
1981	2		1	3	6
1982	2	4	2	2	10
1983	3	4	2	4	13
1984	5	4		2	11
1985	3		2	5	10
1986	2	4	1	2	9
1987	4	4		4	12
1988	2	4	2	1	9
1989	1		1	4	6
1990	4	4		1	9
Total	31	29	12	30	102
Percent	30.4	28.4	11.8	29.4	100

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS

BY INCLINATION - Continued

(b) NASA - tug available in 1985 and payloads stacked end-to-end

Year	Inclination							Total
	28.5	30	55	65	75	90	Sun synchronous	
1979	5	1						6
1980	15	3				2	1	21
1981	13	[a]3	12	2		[b]2	2	34
1982	6	[c]8	9	3		4	1	31
1983	11	[d]2	12	2		1	2	30
1984	10	4	12	3	2	1	1	33
1985	13	6	20	2	2	7		50
1986	12	7	16	3	2	6		46
1987	16	7	15		2	6		46
1988	17	6	14	3	2	2		44
1989	12	9	15	1	3	8		48
1990	11	6	15		4	5		41
Total	141	62	140	19	17	44	7	430
Percent	32.8	14.5	32.6	4.2	3.8	10.3	1.7	100.0

[a]Two flights contain a 30° payload combined with a 28.5° payload.

[b]One flight contains a sun synchronous payload.

[c]Three flights contain a 30° payload combined with a 28.5° payload.

[d]One flight contains a 30° payload combined with two 28.5° payloads.

Many DOD flights do not have an inclination defined; thus the total number of flights for this table does not correspond to values found in other sections of the report.

TABLE VIII.- NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS

BY INCLINATION - Continued

(b) DOD - tug available in 1985 and payloads stacked end-to-end

Year	Inclination				Total
	28.5	30	63.4	90-101	
1979					
1980		2	1	2	5
1981	3		1	2	6
1982		4	2	2	8
1983		4	1	4	9
1984	2	4		2	8
1985	3		2	5	10
1986	2	4	1	2	9
1987	4	4		4	12
1988	2	4	2	1	9
1989	1		1	4	6
1990	4	4		1	9
Total	21	30	11	29	91
Percent	23.1	33.0	12.1	31.8	100

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB)

(a) NASA - tug available in 1979 and payloads stacked end-to-end

Year	Inclination						Total
	28.5	30	55	65	75	[a]90	
1979	175 780	21 000					196 780
1980	625 170	51 340				38 400	714 910
1981	481 045	47 280	280 910	60 000		54 995	924 230
1982	380 820	217 130	202 500	90 000		118 465	1 008 915
1983	727 290	55 000	329 000	60 000		71 360	1 242 650
1984	581 355	75 575	279 500	90 000	45 000	33 095	1 104 525
1985	566 550	234 650	513 395	60 000	45 000	85 490	1 505 085
1986	491 180	74 585	360 000	90 000	45 000	106 380	1 167 145
1987	710 005	95 270	347 500		45 000	71 360	1 269 135
1988	691 780	223 440	354 000	90 000	45 000	37 670	1 441 890
1989	486 550	143 355	362 910	30 000	67 500	95 610	1 185 925
1990	493 585	141 000	341 500		90 000	103 360	1 169 445
Total	6 411 110	1 379 625	3 371 215	570 000	382 500	816 185	12 930 635

[a]Sun synchronous payloads plus tugs were offloaded at an inclination of 90° and the tug performed the plane change.

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB) - Continued

(a) DOD - tug available in 1979 and payloads stacked end-to-end

Year	Inclination				Total
	28.5	30	63.4	90-99	
1979					
1980	144 144	75 156	30 574		276 273
1981	118 558		25 568	55 367	199 453
1982	95 760	150 312	61 148	38 968	346 188
1983	151 171	150 312	56 142	52 417	410 042
1984	269 729	150 312		26 399	446 440
1985	157 248		61 148	61 009	279 405
1986	98 018	150 312	30 574	45 669	324 573
1987	219 763	150 312		69 367	439 442
1988	99 735	150 312	61 148	13 009	324 204
1989	53 153		30 574	53 408	137 117
Total	1 625 572	1 127 340	356 876	458 411	3 568 199

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB) - Continued

(b) NASA - tug available in 1985 and payloads stacked end-to-end

Year	Inclination							Total
	28.5	30	55	65	75	90[a]	Sun synchronous	
1979	130 385	21 000						151 385
1980	339 790	42 470				8 600	4 900	395 760
1981	336 705	49 170	270 620	60 000		25 120	16 190	757 805
1982	166 635	197 610	202 500	90 000		33 740	4 900	695 385
1983	320 825	55 000	329 000	60 000		2 600	17 690	785 115
1984	325 150	75 470	279 500	90 000	45 000	3 500	4 900	823 520
1985	566 550	234 650	513 395	60 000	45 000	85 490		1 505 085
1986	491 180	74 585	360 000	90 000	45 000	106 380		1 167 145
1987	710 005	89 270	347 500		45 000	71 360		1 263 135
1988	691 780	223 440	354 000	90 000	45 000	37 670		1 441 890
1989	486 550	143 355	362 910	30 000	67 500	95 610		1 185 925
1990	493 585	141 000	341 500		90 000	103 360		1 169 445
Total	5 059 140	1 347 020	3 360 925	570 000	382 500	573 430	48 580	11 341 595

[a]From 1985 on sun synchronous payloads plus tugs were offloaded at an inclination of 90° and the tug performed the plane change.

TABLE IX.- TOTAL PAYLOAD TO ORBIT (LB) - Concluded

(b) DOD - tug available in 1985 and payloads stacked end-to-end

Year	Inclination				Total
	28.5	30	63.4	90-99	
1979					
1980		45 957	14 879	14 797	75 633
1981	62 308		11 675	14 797	88 780
1982		61 836	29 758	15 765	107 359
1983		99 090	14 879	35 552	149 521
1984	52 146	87 370		14 797	154 313
1985	157 248		61 148	61 009	7 279 405
1986	98 018	150 312	30 574	45 669	324 573
1987	219 763	150 312		69 367	439 442
1988	99 735	150 312	61 148	13 009	324 205
1989	53 153		30 574	53 408	137 135
1990	218 293	150 312			385 004
Total	960 664	895 501	254 635	354 569	2 465 369

TABLE X.- ENERGY STAGES REQUIRED

(a) NASA - tug available in 1979 and payloads loaded end-to-end

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug flights	3	16	16	16	18	15	21	16	19	20	19	15	194
Tugs expended	0	1	1	0	1	1	[a]2	[a]2	1	1	[a]2	0	12
Centaurs expended	0	0	0	0	0	[b]1	0	0	0	0	0	[b]1	2
Agenas expended	0	0	0	0	0	0	0	0	0	0	0	0	0
FW-4S expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of orbital assemblies	0	0	0	1	2	1	3	1	2	1	2	2	15

[a]Full usage is not made of tugs because they are required to be expended before nominal end of lifetime.
[b]Centaur plus another kick stage.

(a) DOD - tug available in 1979 and payloads loaded end-to-end

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug flights	0	6	5	10	13	11	10	10	11	10	5	10	98
Tugs expended	0	0	0	1	0	1	1	0	1	1	0	1	6
Centaurs expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Agenas expended	0	0	0	0	0	0	0	0	0	0	0	0	0
FW-4S expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of orbital assemblies	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE X.- ENERGY STAGES EXPENDED - Concluded

(b) NASA - tug available in 1985 and payloads loaded end-to-end

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug flights	0	0	0	0	0	0	21	16	19	20	19	15	110
Tugs expended	0	0	0	0	0	0	[a]2	[a]2	1	1	[a]2	0	8
Centaurs expended	3	8	6	[c]7	6	[c]8	0	0	0	0	0	[b]1	39
Agenas expended	0	3	7	3	4	3	0	0	0	0	0	0	20
FW-4S expended	0	4	6	5	8	4	0	0	0	0	0	0	27
Number of orbital assemblies	0	0	0	1	0	1	3	1	2	1	2	2	13

[a]Full usage is not made of tugs because they are required to be expended before nominal end of lifetime.

[b]Centaur plus another kick stage.

[c]One flight requires Centaur plus another kick stage.

(b) DOD - tug available in 1985 and payloads loaded end-to-end

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Tug flights	0	0	0	0	0	0	7	10	11	10	5	10	53
Tugs expended	0	0	0	0	0	0	0	1	0	1	0	1	3
Centaurs expended	2	9	12	13	15	16	0	0	0	0	0	0	67
Agenas expended	0	1	3	5	4	2	0	0	0	0	0	0	15
FW-4S expended	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of orbital assemblies	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE XI.- NUMBER OF EARTH ORBIT SHUTTLE FLIGHTS PER YEAR

Earth orbit shuttle flight description	[a]1978	[b]1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
NASA satellite placement														
Tug available in 1979 - end-to-end stacking	3	8	18	17	19	23	22	28	25	29	25	31	22	270
Tug available in 1985 - end-to-end stacking	3	8	15	17	15	14	16	28	25	29	25	31	22	248
NASA space station				9	6	8	7	12	12	10	9	8	10	91
NASA sorties		2	6	8	10	8	10	10	9	7	10	9	9	98
Total NASA														
Tug available in 1979 - end-to-end stacking	3	10	24	34	35	39	39	50	46	46	44	48	41	459
Tug available in 1985 - end-to-end stacking	3	10	21	34	31	30	33	50	46	46	44	48	41	437
Total DOD missions														
Tug available in 1979 - end-to-end stacking	1	4	12	16	21	24	22	21	20	23	20	17	20	221
Tug available in 1985 - end-to-end stacking	1	4	15	16	19	20	19	21	20	23	20	17	20	215
Total of NASA and DOD														
Tug available in 1979 - end-to-end stacking	4	14	36	50	56	63	61	71	66	69	64	65	61	680
Tug available in 1985 - end-to-end stacking	4	14	36	50	50	50	52	71	66	69	64	65	61	652

[a]Includes the first 10 flights to be defined by NASA Headquarters.

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFLOADING OF OMS OR REMOVAL OF ABES

(a) NASA - tug available in 1979 and payloads loaded end-to-end

Year	Inclination																				
	28.5			30			55			65			75			[a]90			Total		
	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both
1979	3																		3		
1980	10															2			12		
1981	7															2			9		
1982	6			2												2	3		10	3	
1983	9															4			13		
1984	5															2			7		
1985	8			2												5			15		
1986	6			1												3	1		10	1	
1987	12															4			16		
1988	10			3				1								2			15	1	
1989	7			1												5			13		
1990	6															3	2		9	2	
Total	89			9				1								34	6		132	7	

[a]Sun sychronous payloads plus tugs were offloaded at an inclination of 90° and the tug performed the plane change.

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFLOADING OF OMS OR REMOVAL OF ABES - Continued

(a) DOD - tug available in 1979 and payloads loaded end-to-end

Year	Inclination																							
	0°			5°			30°			63.4°			90°			97°			99°			Total		
	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0
1981	2													1					1			3	1	0
1982														1								0	1	0
1983	2												2						1			5	0	0
1984	4																		1			5	0	0
1985	2												1									3	0	0
1986	1													1					1			2	1	0
1987	3													1					1			4	1	0
1988	1												1									2	0	0
1989	1												1						1			3	0	0
1990	3																		1			4	0	0
Total	20	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	8	0	0	33	6	0

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFLOADING OF OMS OR REMOVAL OF ABES - Continued

(b) NASA - tug available in 1985 and payloads loaded end-to-end

Year	Inclination																							
	28.5			30			55			65			75			90			Sun synchronous			Total		
	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both
1979																								
1980																			1			1		
1981																[a]1			2			3		
1982																[a]1			1			2		
1983																			2			2		
1984																			1			1		
1985	8			2												5						15		
1986	6			1												3	1					10	1	
1987	12															4						16		
1988	10			3				1								2						15	1	
1989	7			1												5						13		
1990	6															3	2					9	2	
Total	49			7				1								24	3		7			87	4	

[a]If minimum booster fuel usage were assumed, no OMS offloading would be required.

TABLE XII.- NUMBER OF FLIGHTS REQUIRING OFFLOADING OF OMS OR REMOVAL OF ABES - Concluded

(b) DOD - tug available in 1985 and payloads loaded end-to-end

Year	Inclination																							
	0			5			30			63.4			90			97			99			Total		
	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both	OMS	ABES	Both
1979																								
1980																								
1981																								
1982																								
1983																								
1984																								
1985	2												1									3		
1986	1													1					1			2	1	
1987	3													1					1			4	1	
1988	1												1									2		
1989	1																		1			2		
1990	3												1						1			5		
Total	11												3	4					4			18	4	

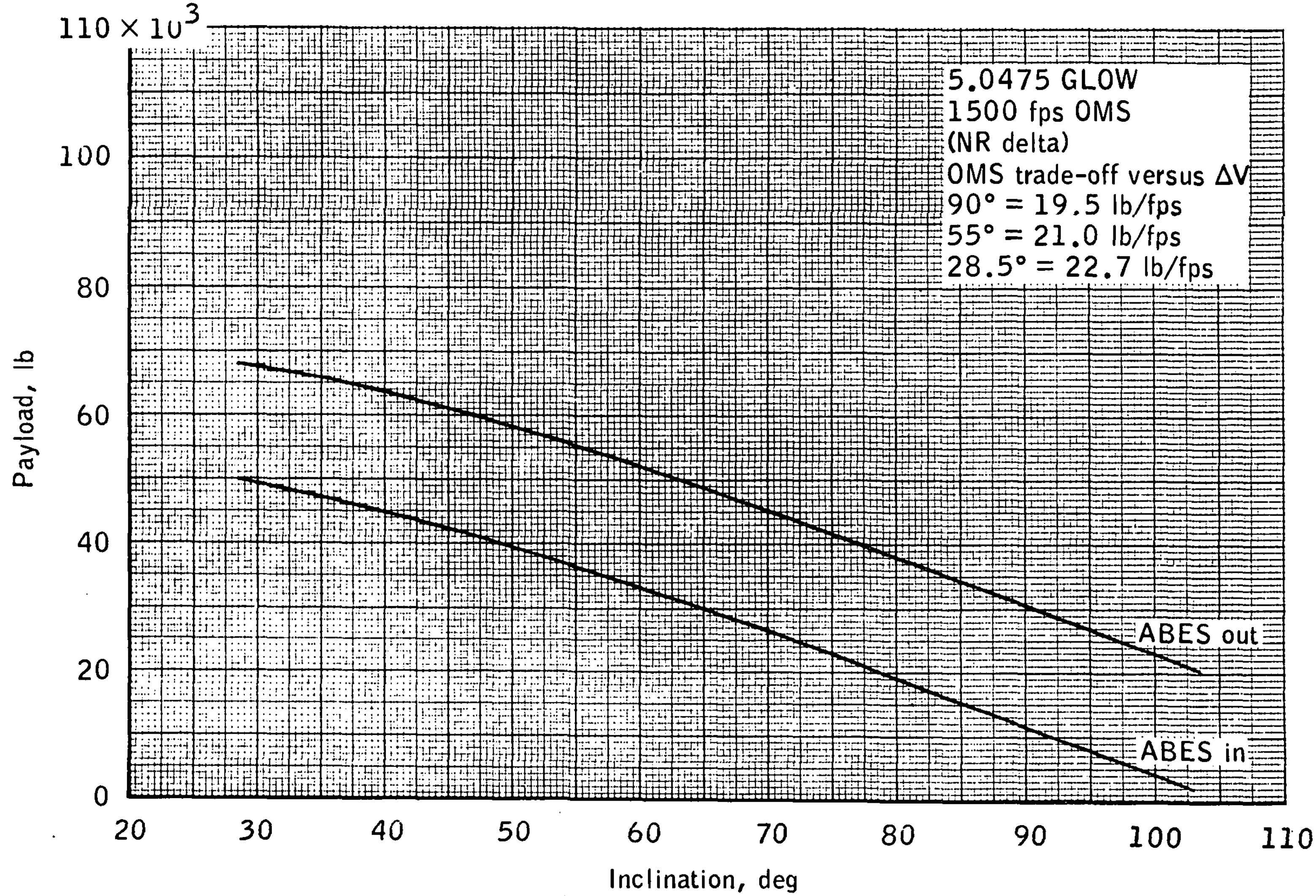

Figure 1.- Earth orbit shuttle payload capability versus inclination.

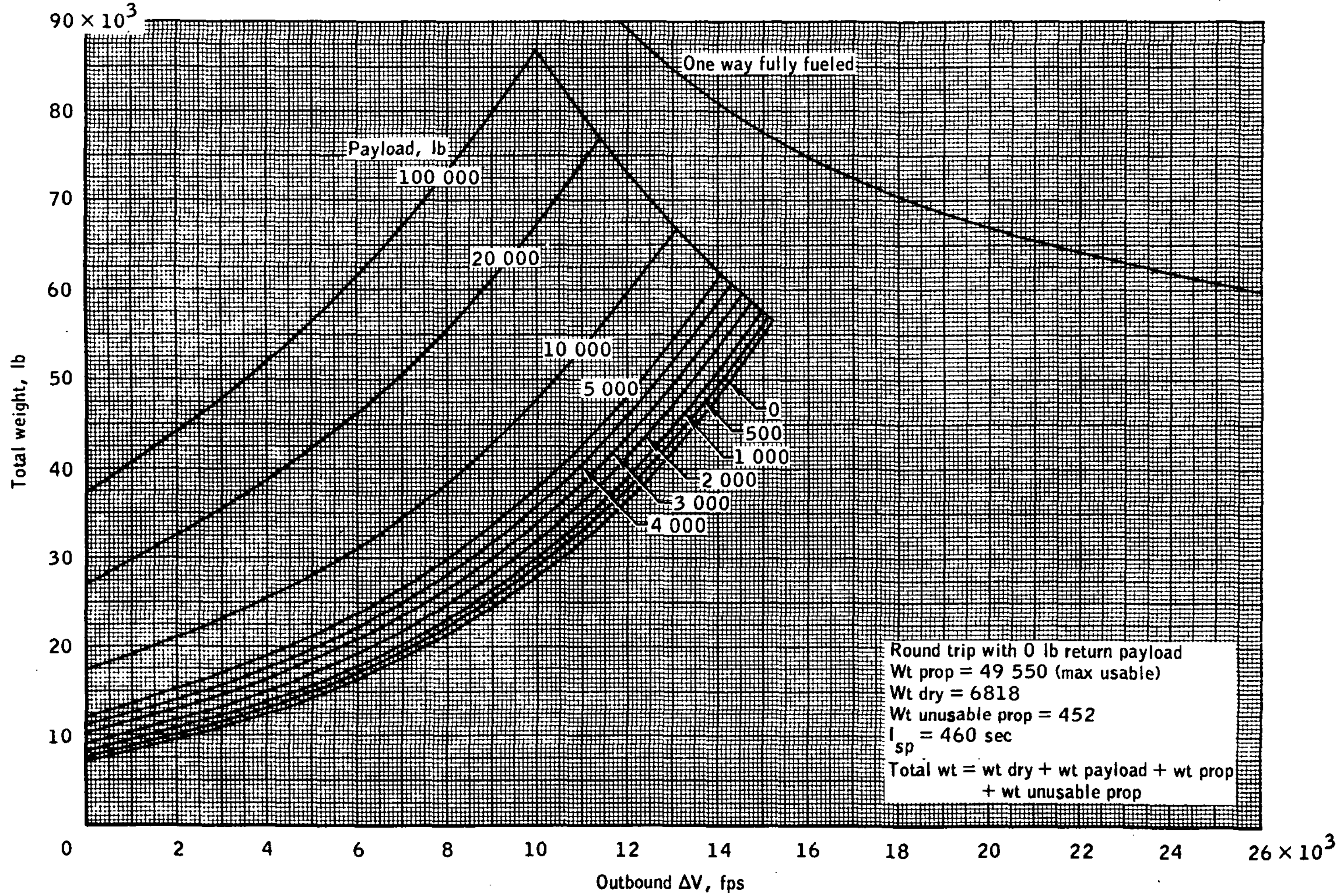

Figure 2.- Tug capability curves.

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