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TABLE OF SPACE VEHICLES: 1973-1978. (U)

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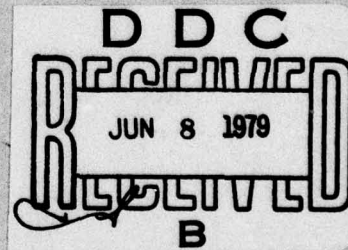
ROYAL AIRCRAFT ESTABLISHMENT

TABLE OF SPACE VEHICLES: 1973-1978

by

J. A. Pilkington

February 1979



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by

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10 J. A. Pilkington*

SUMMARY

RAE Technical Report 73006 lists all space vehicles successfully launched before 31 December 1972. This Memorandum, which supersedes Technical Memorandum Space 271, extends the tabulation to the end of 1978, and gives amendments to Technical Report 73006. 763024 NH

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Table 2 (continued)

(A) Heliocentric orbits (continued)

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks	
T Pioneer 10	1972 Mar 3.075	250 hexagon + dish	2.75 dia 1.45 long	0.991 0.987	5.864 ∞	0.711 1.21	1.317 1.317	2318 -	Passed 130400km behind Jupiter on 1973 Dec 4.10	
Pioneer 10 rocket	1972 Mar 3.075	66 sphere + nozzle	0.94 dia 1.32 long	Orbit probably similar to 1972-12A						Up-rated Surveyor Retro-rocket
D Venus 8 [†] (capsule)	1972 Mar 27.177	495 sphere	1.0 dia	0.727	1.087	0.207	27	3137	Soft-landed on Venus day side 1972 July 22 at 09h 29m	
D Venus 8 (compartment)	1972 Mar 27.177	689 cylinder + 2 Vanes	1.22 dia 2.5 long	0.727	1.087	0.207	27	3137	Decayed in Venus atmosphere, 1972 July 22 at 08h 38m	
Venus 8 rocket	1972 Mar 27.177	440 cylinder	2.0 dia 2.0 long	-	-	-	-	-	Orbit unknown	
Pioneer 11	1973 Apr 6.091	259 hexagon + dish	2.75 dia 1.45 long	1.000 0.987	6.012 ∞	0.715 1.21	1.317 1.317	2398 -	Passed 41850km below Jupiter on 1974 Dec 3.224	
Pioneer 11 rocket	1973 Apr 6.091	66 sphere + nozzle	0.94 dia 1.32 long	Orbit probably similar to 1973-19A						Up-rated Surveyor Retro-rocket

* Expected final path apex near R.A. 04h 33.0m; Declination 16.42°N. Occulted by Jovian satellite Io on 1974 Dec 4.11
 **Expected to pass 24000km above Saturn's cloud tops (just outside rings) on 1979 Sep 5; and then past satellite Titan. Renamed 'Pioneer Saturn'.
 † Parachute descent took 51min; surface transmissions lasted 50min.

Table 2 (continued)

(A) Heliocentric orbits (continued)

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
Mars 4 * orbiter	1973 Jul 21.813	3440? full cylinder + 2 panels	2.3 dia 2.7 long	1.02?	1.63?	0.23?	2.2?	556?	Passed 2200km behind Mars on 1974 Feb 10
Mars 4 rocket	1973 Jul 21.813	1900? cylinder	3.9 dia 3.9 long?			Orbit probably similar to 1973-47A			Proton escape stage
Mars 5 orbiter	1973 Jul 25.789	3440? full cylinder + 2 panels	2.3 dia 2.7 long	1.01?	1.65?	0.24?	2.2?	560?	Entered Areocentric orbit on 1974 Feb 12.66. See page 36
Mars 5 rocket	1973 Jul 25.789	1900? cylinder	3.9 dia 3.9 long?			Orbit probably similar to 1973-49A			Proton escape stage
Mars 6 compartment	1973 Aug 5.740	2060? empty cylinder + 2 panels	2.3 dia 2.7 long	1.01?	1.67?	0.24?	2.2?	567?	Passed 1600km behind Mars on 1974 Mar 12.38
Mars 6 capsule **	1973 Aug 5.740	1200? full 635 empty cone-sphere	2.5 dia 1.1 long	1.01?	1.67?	0.24?	2.2?	567?	Soft landed on Mars 1974 Mar 12 at 24°S, 25°W
Mars 6 rocket	1973 Aug 5.740	1900? cylinder	3.9 dia 3.9 long?			Orbit probably similar to 1973-52A			Proton escape stage
Mars 7 compartment	1973 Aug 9.708	2060? empty cylinder + 2 panels	2.3 dia 2.7 long	1.01?	1.69?	0.25?	2.2?	574?	Passed 1300km behind Mars on 1974 Mar 9
Mars 7 † capsule	1973 Aug 9.708	1200? full 635 empty cone-sphere	2.5 dia 1.1 long	1.01?	1.69?	0.25?	2.2?	574?	Passed 1300km behind Mars on 1974 Mar 9 (Planned landing site 43°S, 42°W)

* Areocentric orbit insertion engine failed.

** Transmissions ceased on landing, at 09h 11m 05s UT

† Capsule separated from compartment correctly 48000km from Mars, but its small motor failed to put it on a collision course.

Table 2 (continued)

(A) Heliocentric orbits (continued)

Page 14b

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
Mars 7 rocket	1973 Aug 9.708	1900? cylinder	3.9 dia 3.9 long?		Orbit probably similar to 1973-53A				Proton escape stage,
Mariner 10*	1973 Nov 3.24	526 octagonal cylinder	1.27 dia 2.90 long?	0.70 0.387	1.11 0.839	0.23 0.369	2.6 2.6	317 176	Passed 5750km ahead of Venus 1974 Feb 5.71
Mariner 10 rocket	1973 Nov 3.24	1815 cylinder	3.05 dia 8.14 long		Orbit probably similar to 1973-85A				Centaur. Passed 45000km behind Venus
Helios 1	1974 Dec 10.299	370 double-cone	1.75 to 2.77 dia 2.18 long	0.307	0.985	0.525	0	190	At perihelion on 1975 Mar 15.47
Helios 1 rocket	1974 Dec 10.299	66 sphere + nozzle	0.94 dia 1.32 long		Orbit probably similar to 1974-97A				Up-rated Surveyor Retrorocket
Fragment	1974-97D								
Venus 9 orbiter	1975 Jun 8.109	3376 full cylinder + 2 panels	2.3 dia 2.7 long 5.7 span	0.707	1.117	0.237	2.37	3167	Entered orbit round Venus on 1975 Oct 22.17. See Page 36b
Venus 9 lander**	1975 Jun 8.109	1560 sphere-annulus	2.4 dia sphere	0.707	1.117	0.237	2.37	3167	Soft landed on Venus day side on 1975 Oct 22 at 05h 13m 07s.
Venus 9 rocket	1975 Jun 8.109	1900? cylinder	3.9 dia 3.9 long?		Orbit probably similar to 1975-50A				Proton escape stage

* Passed 700km ahead of Mercury (night side) on 1974 Mar 29.87;

passed 48000km below Mercury's South Pole on 1974 Sep 21.874;

**parachute descent took 75min; surface transmissions lasted 53min. Location - at 31° 42'N, 293° 50' long. (Inside region Beta).

Helios is German spacecraft launched by US rocket.

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Table 2 (continued)

(A) Heliocentric orbits (continued)

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
Venus 10 orbiter	1975 Jun 14.13	3473 full cylinder + 2 panels	2.3 dia 2.7 long 5.7 span	0.707	1.117	0.237	2.37	3167	Entered orbit round Venus on 1975 Oct 25.17. See page 36b
D Venus 10 lander*	1975 Jun 14.13	1560 sphere-annulus	2.4 dia	0.707	1.117	0.237	2.37	3167	Soft-landed on Venus day side on 1975 October 25 at 05h 17m 06s Proton escape stage
Venus 10 rocket	1975 Jun 14.13	1900? cylinder	3.9 dia 3.9 long?						Ejected onto impact path 1975 Oct 23
T Viking 1 orbiter	1975 Aug 20.890	2325 full octagonal box + 4 vanes	3.3 high 1.8 wide 1.5 deep	1.003	1.672	0.250	4.48	565	Orbit probably similar to 1975-54A Entered Areocentric orbit on 1976 Jun 19, then ejected lander
D Viking 1 lander	1975 Aug 20.890	1090 full 600 empty pyramid	2.1 high** 3.0 wide 2.5 deep	1.003	1.672	0.250	4.48	565	Soft-landed on Mars 1976 Jul 20 at 12h 12m. Site 22.27°N, 47.94°W
Viking 1 rocket	1975 Aug 20.890	1815 cylinder	3.05 dia 8.14 long						Centaur. Passed 80500km from Mars
Viking 2 orbiter	1975 Sep 9.777	2325 full octagonal box + 4 vanes	3.3 high 1.8 wide 1.5 deep	1.006	1.669	0.248	2.92	565	Entered Areocentric orbit on 1976 Aug 7.47 then ejected lander
D Viking 2 lander	1975 Sep 9.777	1090 full 600 empty pyramid	2.1 high** 3.0 wide 2.5 deep	1.006	1.669	0.248	2.92	565	Soft-landed on Mars 1976 Sep 3 at 22h 58m. Site 47.67°N, 225.71°W.
Viking 2 rocket	1975 Sep 9.777	1815 cylinder	3.05 dia 8.14 long						Centaur. Passed 80500km from Mars.

*Parachute descent took 75min; surface transmissions lasted 65min. Landed 2200km from Venus 9, at 16° 02'N, 291° 00' Long.

**including legs.

Viking areocentric orbits - see pages 36 and 36a.

Table 2 (continued)

(A) Heliocentric orbits (continued)

Name	Launch Date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
Helios 2	1976 Jan 15.23	376 double-cone	1.75 to 2.77 dia 2.18 long	0.28	0.995	0.561	0	186	At perihelion on 1976 Apr 17
Helios 2 second stage	1976 Jan 15.23	1815 cylinder	3.05 dia 8.14 long			Orbit unknown			Centaur
Helios 2 rocket	1976 Jan 15.23	66 sphere + nozzle	0.94 dia 1.32 long			Orbit probably similar to 1976-03A			Up-rated Surveyor Retrorocket
Voyager 2	1977 Aug 20.603	795 decagon + dish	1.9 and 3.7 dia 1.5 long			To exceed Solar escape velocity			Flyby of four outer planets*
Voyager 2 second stage	1977 Aug 20.603	1815 cylinder	3.05 dia 8.14 long			Unknown heliocentric orbit			Centaur
Voyager 2 rocket	1977 Aug 20.603	66 sphere + nozzle	0.94 dia 1.32 long			Orbit probably similar to 1977-76A			Up-rated Surveyor Retrorocket
Voyager 1	1977 Sep 5.539	795 decagon + dish	1.9 and 3.7 dia 1.5 long			To exceed Solar escape velocity			Jupiter and Saturn flyby**
Voyager 1 second stage	1977 Sep 5.539	1815 cylinder	3.05 dia 8.14 long			Unknown heliocentric orbit			Centaur
Voyager 1 rocket	1977 Sep 5.539	66 sphere + nozzle	0.94 dia 1.32 long			Orbit probably similar to 1977-84A			Up-rated Surveyor Retrorocket

* To pass 642000km from Jupiter on 1979 Jul 10, Saturn on 1981 Aug 27, Uranus on 1986 Jan 31, and Neptune in 1989 Sep.

**Passed 280000km from Jupiter on 1979 Mar 5.5 (19000km from Io, 112000km from Ganymede, 732000km from Europa; and on Mar 6 124000km from Callisto); then to pass 138000km from Saturn on 1980 Nov 13 (4000km from Titan).

Table 2 (continued)

(A) Heliocentric orbits (continued)

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
T Pioneer Venus orbiter	1978 May 20.55	580 full 370 empty cylinder	2.4 dia 1.2 long	0.707	1.307	0.307	2.37	3657	Entered Venus orbit on 1978 Dec 4.665 See page 36b
Orbiter rocket	1978 May 20.55	1815 cylinder	3.0 dia 8.6 long				Orbit similar to 1978-51A		Centaur
D Pioneer Venus Multiprobe Bus	1978 Aug 8.31	309* cylinder	2.4 dia 1.2 long*	0.707	1.117	0.237	2.37	3167	Decayed in Venus atmosphere on 1978 Dec 9 at 20h 25m near 33° S, 70° W.
D Large probe** (Sounder)	1978 Aug 8.31	316 sphere + cone	1.5 dia				Ejected from Bus 1978 Nov 16.11		Venus landing 1978 Dec 9 at 19h 43m, near 0° S, 43° W.
D Small probe 1 (North)	1978 Aug 8.31	93 sphere + cone	0.8 dia				Ejected from Bus 1978 Nov 20.55		Venus landing 1978 Dec 9 at 19h 46m near 75° N, 20° E.
D Small probe 2 (Day)	1978 Aug 8.31	93 sphere + cone	0.8 dia				Ejected from Bus 1978 Nov 20.55		Venus landing 1978 Dec 9 at 19h 51m near 26° S, 45° W.
D Small probe 3 (Night)	1978 Aug 8.31	93 sphere + cone	0.8 dia				Ejected from Bus 1978 Nov 20.55		Venus landing 1978 Dec 9 at 19h 55m near 27° S, 45° E
Pioneer Venus rocket	1978 Aug 8.31	1815 cylinder	3.0 dia 8.6 long				Orbit similar to 1978-78A		Centaur

* Excluding probes (total mass 904 kg)

** Transmitted for about 1 hour after Venus landing. Four probes atmospheric descent took about 57 min; coordinates are with respect to Venus's disc seen from Earth at time of encounter.

Table 2 (continued)

(A) Heliocentric orbits (concluded)

Name	Launch date (UT)	Mass (kg) and basic shape	Basic size (m)	Perihelion (AU)	Aphelion (AU)	Eccentricity	Inclination to ecliptic (deg)	Period (days)	Remarks
T ISEE 3†	1978 Aug 12.63	469 full	-	0.973	1.006	0.017	0.0	359	International Sun-Earth Explorer
T Venus 11 transit module	1978 Sep 9.15	2380? empty cylinder + 2 panels	2.3 dia 2.7 long 5.7 span	0.70?	1.11?	0.23?	2.3?	316?	Passed 35000 km from Venus on 1978 Dec 25
D Venus 11 Lander*	1978 Sep 9.15	1560? sphere-annulus	2.4 dia sphere	0.70?	1.11?	0.23?	2.3?	316?	Soft-landed on Venus on 1978 Dec 25 at 03h 24m
T Venus 11 rocket	1978 Sep 9.15	1900? cylinder	3.9 dia 3.9 long?						Ejected onto impact path 1978 Dec 23
T Venus 12 transit module	1978 Sep 14.11	2380? empty cylinder + 2 panels	2.3 dia 2.7 long 5.7 span	0.70?	1.11?	0.23?	2.3?	316?	Orbit similar to 1978-84A
D Venus 12 Lander**	1978 Sep 14.11	1560? sphere-annulus	2.4 dia sphere	0.70?	1.11?	0.23?	2.3?	316?	Passed 35000 km from Venus on 1978 Dec 21
T Venus 12 rocket	1978 Sep 14.11	1900? cylinder	3.9 dia 3.9 long?						Ejected onto impact path 1978 Dec 19
									Orbit similar to 1978-86A

† Entered heliocentric orbit - a "halo" orbit around the Sun-Earth/Moon libration point, at a distance of 1.6 million km from Earth on Earth-Sun line. (Location maintained by micro-thrusters).

* Surface transmissions lasted 95 min.

** Surface transmissions lasted 110 min. (Two landers are 800 km apart)

Table 2 (continued)

(B) Orbits in the Earth-Moon system (continued)

Name	Launch date (UT) and flight time	Mass (kg) and basic shape	Basic size (m)	Maximum distance from Earth (km)	Moon's age at launch (days)	All-burnt velocity km/s	Remarks
D R 3M Apollo 17 (command module)	1972-96A 1972 Dec 7.23 12.58 days	5826 cone	3.91 dia 3.66 long	400000	1.4	10.907	Orbited Moon 75 times. Landed on Earth 1972 Dec 19 at 19h 24m
D Apollo 17 (service module)	1972-96E 1972 Dec 7.23 12.57 days	24514 full cylinder	3.91 dia 7.49 long	400000	1.4	10.907	Attached to CM until decay in Earth's atmosphere on 1972 Dec 19 at 19h 14m
D Apollo 17 rocket	1972-96B 1972 Dec 7.23 87.0 hours?	13930 cylinder	6.6 dia 18.7 long	400000	1.4	10.907	Saturn I/B. Hit Moon 1972 Dec 10 at 20h 33m? Impact 4.2°S, 12.3°W
D T LEM 12 (AS + DS) (with LRV-3)	1972-96C 1972 Dec 7.23 4.60 days	16440 full box + octagon	4.09 high 3.76 wide 3.13 deep	400000	1.4	10.907	Soft landed on Moon 1972 Dec 11 at 19h 55m. Site 20.16°N, 30.75°E. AS relaunched from Moon*
D Luna 21 (with Lunokhod 2 **)	1973-01A 1973 Jan 8.288 7.65 days	5600? full pyramid + car	2.3 high 3.2 wide 3.3 deep	400000	3.6	10.907	Orbited Moon 40 times. Soft landed 1973 Jan 15 at 22h 35m. Position 26.5°N, 30.6°E
Luna 21 rocket	1973-01D 1973 Jan 8.288	1900? cylinder	3.9 dia 3.9 long?	-	3.6	10.907	Orbit unknown. Proton escape stage
Explorer 49 third stage	1973-39B 1973 Jun 10.592	66 sphere + nozzle	0.94 dia 1.32 long	390250	9.4	10.907	Burner 2. In high eccentricity orbit.
Luna 22 rocket	1974-37E 1974 May 29.373	1900? cylinder	3.9 dia 3.9 long?	-	7.5	10.907	Orbit unknown. Proton escape stage

* See page 35

** Lunokhod 2 mass 840kg

(B) Orbits in the Earth-Moon system (concluded)

Name	Launch date (UT) and flight time	Mass (kg) and basic shape	Basic size (m)	Maximum distance from Earth (km)	Moon's age at launch (days)	All-burnt velocity km/s	Remarks
D Luna 23* (AS + DS)	1974 Oct 28.60 8.63 days	5600? full pyramid + cylinder	3.1 high 3.2 wide 3.3 deep	400000	13.1	10.90?	Orbited Moon 53 times? Hard landed 1974 Nov 6 at 05h 37m. Position 13.5°N?; 56.5°E?
Luna 23 rocket	1974 Oct 28.60	1900? cylinder	3.9 dia 3.9 long?	-	13.1	10.90?	Orbit unknown. Proton escape stage
D Luna 24 (AS + DS)	1976 Aug 9.628 8.65 days	5600? full pyramid + cylinder	3.1 high 3.2 wide 3.3 deep	400000	13.6	10.90?	Orbited Moon 53 times? Soft-landed 1976 Aug 18 at 06h 36m. Position 12.75°N, 62.2°E. AS relaunched from Moon**
Luna 24 rocket	1976 Aug 9.628	1900? cylinder	3.9 dia 3.9 long?	-	13.6	10.90?	Orbit unknown. Proton escape stage

* Damage on landing prevented re-launch of ascent stage.

**See page 35.

Table 2 (continued)

Table 2 (continued)

(C) Selenocentric orbits - Earth launch (continued)

Name	Launch date injection date and ejection date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Moon's equator (deg)	Period (min)	Semi major axis (km)	Periselene height (km)	Aposelene height (km)	Orbital eccen- tricity
D Apollo 17 (CM + SM)	1972 Dec 7.23	30340 full cone-cylinder	3.91 dia	1972 Dec 10.83	159.9	128	1944	94	317	0.057
	1972 Dec 10.83		11.15 long	1972 Dec 11.01	159.9	115	1807	28	109	0.023
	1972 Dec 16.98			1972 Dec 11.78	159.9	118.8	1849	96	126	0.008
D LEM 12 (with LRV-3)	1972 Dec 7.23	4937 empty box + octagon	4.09 high 3.76 wide 3.13 deep	1972 Dec 11.72	159.9	115	1807	28	109	0.023
	1972 Dec 10.83			1972 Dec 11.79	159.9	114	1800	13	111	0.027
	1972 Dec 11.83									
D Luna 21 (with Lunokhod 2)	1973 Jan 8.288	4000? full	2.3 high	1973 Jan 12.60	60	118	1838	90	110	0.005
	1973 Jan 12.60	pyramid + car	3.2 wide	1973 Jan 15.93	60	114	1801	16	110	0.026
	1973 Jan 15.94		3.3 deep							
Explorer 49 (RAE 2)	1973 Jun 10.592	200	0.92 dia	1973 Jun 15.31	38.26	241	2964	1120	1331	0.036
	1973 Jun 15.26	cylinder + booms	0.79 long	1973 Jun 20.16	38.71	221.2	2797	1053	1065	0.002
				1974 Aug 14	55.34	221.9	2802	1051	1077	0.005
Explorer 49 retrorocket	1973 Jun 10.592	134 full cone-cylinder	0.5 dia? 1.0 long?	1975 Sep 1.0	76.2	222.0	2803	1020	1109	0.016
	1973 Jun 15.26									
Fragment Luna 22	1974 May 29.373	4000? pyramid	2.3 high 3.2 wide 3.3 deep	1974 Jun 2.7	19.58	130	1958	219	221	0.0
	1974 Jun 2.687			1974 Jun 9	19.58	121	1873	25	244	0.058
				1974 Jun 13	19.58	131	1978	181	299	0.030
D Luna 23 (AS + DS)	1974 Oct 28.60	4000? full	3.1 high	1974 Nov 11.63	19.55	192	2542	171	1437	0.248
	1974 Nov 1.917	pyramid + cylinder	3.2 wide 3.3 deep	1975 Apr 2.33	21	192	2543	200	1409	0.238
	1974 Nov 6.23			1975 Aug 24	21	192	2542	30	1578	0.304
				1975 Sep 3.4*	21	179	2431	100	1286	0.244
				1974 Nov 2	138	117	1837	94	104	0.003
			1974 Nov 6.22	138	114	1799	17	105	0.024	

Orbit similar to 1973-39A

See pages 28 and 28a for further details of the above decayed satellites.

* Manoeuvring fuel exhausted on 1975 Sep 2

Table 2 (continued)

(C) Selenocentric orbits - Earth launch (concluded)

Name	Launch date injection date and ejection date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Moon's equator (deg)	Period (min)	Semi major axis (km)	Periselenic height (km)	Aposelenic height (km)	Orbital eccen- tricity
D Luna 24. (AS + DS) 1976-81A	1976 Aug 9.628 1976 Aug 13.966 1976 Aug 18.275	4000? full pyramid + cylinder	3.1 high 3.2 wide 3.3 deep	1976 Aug 14.0 1976 Aug 17	120 120	119 114	1853 1804	115 12	115 120	0 0.030

See page 28a for further details of the above decayed satellite.

Table 2 (continued)

(D) Selenocentric orbits - Moon Launch (concluded)

Name	Moon launch date and descent date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Moon's equator (deg)	Period (min)	Semi major axis (km)	Periselene height (km)	Aposelene height (km)	Orbital eccentricity
D R Luna 20 ascent stage	1972 Feb 22.96 1972 Feb 25.80	8007 full cylinder + 3 spheres	2.3 high 1.6 wide 0.5 deep	1972 Apr 24.07 1972 Apr 24.14	169.3 169.3	114 120	1784 1850	17 98	75 126	0.017 0.008
2H LEM 11* ascent stage	1972 Apr 24.06	2134 empty box + 2 tanks	2.52 high 3.76 wide 3.13 deep	1972 Dec 14.97 1972 Dec 15.04	159.9 159.9	114 118.8	1784 1849	17 96	75 126	0.017 0.008
D 2H Luna 24 ascent stage	1976 Aug 19.226 1976 Aug 22.747	8007 full cylinder + 3 spheres	2.3 high 1.6 wide 0.5 deep	Exceeded Moon escape velocity Landed on Earth 1976 Aug 22.75 with Moon material						

* Briefly docked with Apollo 16 for crew transfer on 1972 Apr 24.14. Still in orbit.

** Briefly docked with Apollo 17 for crew transfer on 1972 Dec 15.04. Sent crashing into Moon: 19.95°N, 30.73°E

(E) Areocentric orbits - Earth launch

Table 2 (continued)

Name	Launch date injection date and ejection date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Mars equator (deg)	Period (min)	Semi major axis (km)	Periapis height (km)	Apoapsis height (km)	Orbital eccentricity
Mars 2 orbiter	1971-45A 1971 May 19.68 1971 Nov 27.85	34407 full 20607 empty cylinder + 2 panels	2.3 dia 2.7 long	1971 Nov 27.85	48.9	1078	16585	1380	25000	0.712
Mars 2 lander	1971-45E 1971 May 19.68 1971 Nov 27.85	12007 full 635 empty cone-sphere	2.5 dia 1.1 long	Ejected onto impact path 1971 Nov 27.66 Hard-landed at 44°S, 47°E						
Mars 3 orbiter	1971-49A 1971 May 28.64 1971 Dec 2.57	34407 full 20607 empty cylinder + 2 panels	2.3 dia 2.7 long	1971 Dec 2.57	48.97	15840	99495	1500	190700	0.951
Mars 3 lander	1971-49F 1971 May 28.64 1971 Dec 2.57	12007 full 635 empty cone-sphere	2.5 dia 1.1 long	Ejected onto impact path 1971 Dec 2.38 Soft-landed at 45°S, 158°W						
Mariner 9	1971-51A 1971 May 30.93 1971 Nov 14.02	520 empty octagon + 2 tanks	1.38 dia 2.29 long	1971 Nov 14.02 1971 Nov 16.12 1971 Dec 30	64.28 64.36 64.36	754 718 719	13051 12666 12679	1397 1397 1653	17916 17145 16915	0.633 0.622 0.602
Mars 5 orbiter	1973-49A 1973 Jul 25.79 1974 Feb 12.66	34407 full 20607 empty box + 2 vanes	2.3 dia 2.7 long	1974 Feb 12.66	35.0	1493	20525	1760	32500	0.749
Viking 1 orbiter	1975-75A 1975 Aug 20.89 1976 Jun 19	2325 full 9507 empty box + 4 vanes	3.3 high 1.8 wide 1.5 deep	1976 Jun 19 1976 Jun 21	37.87 37.8	2544 1476	29445 20444	1500 1514	50600 32583	0.834 0.760*
Viking 1 lander	1975-75C 1975 Aug 20.89 1976 Jun 19 1976 Jul 20.51	1090 full 600 empty pyramid	2.1 high 3.0 wide 2.5 deep	1976 Jun 21	37.8	1476	20444	1514	32583	0.760

*88km flyby of Phobos on 20 Feb 1977; periapsis was lowered to 300km on 11 Mar 1977.

Table 2 (continued)

(E) Areocentric orbits - Earth launch (concluded)

Name	Launch date injection date and ejection date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Mars equator (deg)	Period (min)	Semi major axis (km)	Periapsis Height (km)	Apoapsis height (km)	Orbital eccen- tricity
Viking 2* orbiter	1975 Sep 9.78 1976 Aug 7.47	2325 full 9507 empty box + 4 vanes	3.3 high 1.8 wide 1.5 deep	1976 Aug 7.47 1976 Aug 25.76 1976 Aug 27 1976 Dec 20	55.6 55.6 55.4 80	1644.6 1438.8 1477.8 1590	22011 20132 20492 21520	1502 1432 1502 787	35728 32042 32692 35463	0.778 0.760 0.761** 0.806
Viking 2 lander	1975 Sep 9.78 1976 Aug 7.47 1976 Sep 3.96	1090 full 600 empty pyramid	2.1 high 3.0 wide 2.5 deep	1976 Aug 27	55.4	1477.8	20492	1502	32692	0.761

*Passed 23km from Deimos on 1977 Oct 15. Transmissions ceased on 1978 Jul 24 when attitude control gas exhausted.

**Orbital inclination changed to 75 deg on 1976 Sep 30, after manoeuvre.

Separated from Orbiter 1976 Sep 3.82
Soft-landed at 47.67°N, 225.71°W

Table 2 (concluded)

(F) Orbits round Venus - Earth launch

Page 36b

Name	Launch date injection date and ejection date	Mass (kg) and basic shape	Basic size (m)	Date of orbital determination (UT)	Inclination to Venus equator (deg)	Period (min)	Semi major axis (km)	Periapsis height (km)	Apoapsis height (km)	Orbital eccen- tricity
Venus 9 orbiter	1975 Jun 8.11 1975 Oct 22.17	3376 full cylinder ♦ 2 panels	2.3 dia 2.7 long 5.7 span	1975 Oct 22.17	34.17	2898	62910	1510	112200	0.879
Venus 10 orbiter	1975 Jun 14.13 1975 Oct 25.17	3473 full cylinder ♦ 2 panels	2.3 dia 2.7 long 5.7 span	1975 Oct 25.17	29.50	2963	63810	1620	113900	0.880
Pioneer Venus orbiter	1978 May 20.55 1978 Dec 4.665	580 full 370 empty cylinder	2.4 dia 1.2 long	1978 Dec 4.67 1978 Dec 6.83	105 105	1391.4 1454	38564 39160	378 233	64645 65983	0.833 0.839*

* Periapsis height, reduced by manoeuvres to 149km by 1 Jan 1979, will vary due to solar perturbations.

The radius of Venus is taken as 6052km.

AMENDMENTS TO RAE TECHNICAL REPORT 7300B

Page 3 Add to Census of Space Vehicles table:-

Destination	Launches							Still in orbit on 1 Jan 1979*
	1973	1974	1975	1976	1977	1978	1958-78	
Moon	2	2	0	1	0	0	64	19
Venus/Mercury	1	0	0	0	0	0	1	1
Venus	0	0	2	0	0	4	17	10
Mars	4	0	2	0	0	0	15	15
Jupiter	0	0	0	0	0	0	1	1
Jupiter/Saturn	1	0	0	0	2	0	3	3
Solar orbit	0	1	0	1	0	1	8	8
Total launches	8	3	4	2	2	5	109	-
Still in orbit on 1 Jan 1979*	7	2	4	1	2	4	-	57

*Those launches for which an instrumented payload was in orbit on 1 Jan 1979. (Rocket debris from 100 out of the 109 launches, 9 moon probes being excluded, remained in orbit on 1 Jan 1979.)

Country of origin for the 109 launches: USA 56; USSR 51; USA/FRG 2.

Page 7 Luna 1 rocket weight should be 1110kg.

Page 9 Venus 3 orbit should be 0.70 to 1.11 AU? 0.23? 4.3 deg? 316 days?

Page 10 Pioneer 7 probably no longer transmits.

Page 10 Venus 4 orbit should be 0.70 to 1.11 AU? 0.23? 4.3 deg? 316 days?

Page 10 Mariner 5 probably no longer transmits; add footnote - "Heliocentric orbit after Venus flyby."

Page 11 Pioneer 8: perihelion should be 0.990 AU, and inclination 0.06°. It probably no longer transmits.

Page 11 Pioneer 9 probably no longer transmits.

Page 12 Mariner 6 probably no longer transmits.

Page 12 Mariner 7 probably no longer transmits.

Page 13 Add Venus 7 capsule footnote - "Surface transmissions lasted 23 min."

Page 13 Add to Mars 3 footnote - "Surface transmissions lasted 20 sec."

Page 15 Small booster, 1959 Theta 3, weighs 157kg?

Page 21 Zond 4 weighs 5375kg?

Page 21 Zond 5 capsule weighs 2760kg?

Page 21 Zond 5 compartment weighs 2615kg?

Page 22 Zond 6 capsule weighs 2760kg?

Page 22 Zond 6 compartment weighs 2615kg?

AMENDMENTS (continued).

- Page 23 LEM 5 (surface experiments) probably no longer transmits.
- Page 23 Zond 7 capsule weighs 2760kg?
- Page 23 Zond 7 compartment weighs 2615kg?
- Page 23 LEM 6 (surface experiments) probably no longer transmits.
- Page 24 Zond 8 capsule weighs 2760kg?
- Page 24 Zond 8 compartment weighs 2615kg?
- Page 25 LEM 8: amend to "T?".
- Page 26 LEM 10: amend to "T?".
- Page 26 Luna 18: add footnote - Damage on landing prevented re-launch of ascent stage.
- Page 27 Luna 20 rocket should be designated 1972-07B.
- Page 27 Apollo 16 command module weighs 5840kg.
- Page 27 Apollo 16 service module weighs 24518kg full.
- Page 27 Apollo 16 rocket weighs 13970kg.
- Page 27 LEM 11 landed on Moon at 8.99°S, 15.51°E.
- Page 27 Particles Subsatellite 2 impacted near 10.16°N, 111.94°E.
- Page 29 Luna 10 retrorocket launch date should be 1966 Mar 31.449
- Page 29 Explorer 35 probably no longer transmits.
- Page 30 Luna 14 basic shape confirmed.
- Page 31 Luna 17 empty weight is 1836kg.
- Page 32 Particles Subsatellite 1 probably no longer transmits. Delete 1973 ejection date.
- Page 32 Luna 19 probably no longer transmits. Basic shape, width and depth confirmed. Height should be 2.3m. Third orbital inclination should be 40.68 deg.
- Page 32 Luna 20 empty weight is 1880kg. (On Moon, including ascent stage).
- Page 32 Delete Luna 20 fragment, 1972-07B.
- Page 34 Luna 16 ascent stage weight should be 800kg? full.
- Page 37 Add to Index:-

		Page/Section		
		A	B	C and D
Explorer 49	1973-39	-	28	33
Helios 1	1974-97	14b	-	-
Helios 2	1976-03	14d	-	-
ISEE 3	1978-79A	14f	-	-
Luna 21	1973-01	-	28	33
Luna 22	1974-37	-	28	33
Luna 23	1974-84	-	28a	33
Luna 24	1976-81	-	28a	33a and 35
Lunokhod 2	- see Luna 21			

AMENDMENTS (concluded)

Page 38 Add to Index:-

		Page/Section	
		A	E and F
Mariner 10	1973-85	14b	-
Mars 4	1973-47	14a	-
Mars 5	1973-49	14a	36
Mars 6	1973-52	14a	-
Mars 7	1973-53	14a	-
Pioneer 11	1973-19	14	-
Pioneer Orbiter	1978-51	14e	36b
Pioneer Multiprobe	1978-78	14e	-
RAE 2 - see Explorer 49			
Venus 9	1975-50	14b	36b
Venus 10	1975-54	14c	36b
Venus 11	1978-84	14f	-
Venus 12	1978-86	14f	-
Viking 1	1975-75	14c	36
Viking 2	1975-83	14c	36a
Voyager 1	1977-84	14d	-
Voyager 2	1977-76	14d	-

REPORT DOCUMENTATION PAGE

Overall security classification of this page

UNCLASSIFIED

As far as possible this page should contain only unclassified information. If it is necessary to enter classified information, the box above must be marked to indicate the classification, e.g. Restricted, Confidential or Secret.

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16. Descriptors (Keywords) (Descriptors marked * are selected from TEST) Space vehicles. Space vehicle orbits.			
17. Abstract <div style="margin-left: 20px;"> <p>RAE Technical Report 73006 lists all space vehicles successfully launched before 31 December 1972. This Memorandum, which supersedes Technical Memorandum Space 256, extends the tabulation to the end of 1978, and gives amendments to Technical Report 73006.</p> </div>			

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