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ORBITAL IMAGERY FOR PLANETARY EXPLORATION

VOLUME III

ORBIT SELECTION AND DEFINITION

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VOLUME III

ORBIT SELECTION AND DEFINITION

by

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ORBIT SELECTION AND DEFINITION

1. INTRODUCTION

This volume contains the quantitative orbit selection results in the form of orbit selection data sheets. The orbit selection procedure and a discussion of these results are presented in Sections 2.5 and 5, respectively, of Volume I. Orbit selections and reference data presented here are organized by planet in the order Mars, Venus, Mercury and Jupiter.

Individual observable measurement specifications are summarized in Table 1 (this is identical to Table 4-1 of Volume I). The observables (and related sensor types) are grouped into measurement families on the basis of specification similarities. Using candidate orbit sizes and typical interplanetary transfers, orbit selections are made for each measurement family as shown in Figure 1.

The specifications which are used to group individual observables into measurement families are:

(a) minimum image size
(b) minimum image overlap
(c) amount of planet coverage
(d) solar elevation angle
(e) coverage time
(f) image interval
(g) coverage interval.

The family measurement specifications are generated from the individual specifications of observables in the family and corresponding worth curves. Where small differences in specifications occur the most stringent specification is used. Larger differences in specifications,of course, eliminate the observable from the family. Family specifications for Mars, Venus, Mercury and Jupiter are presented in Tables 3, 7, 11 and 15, respectively.

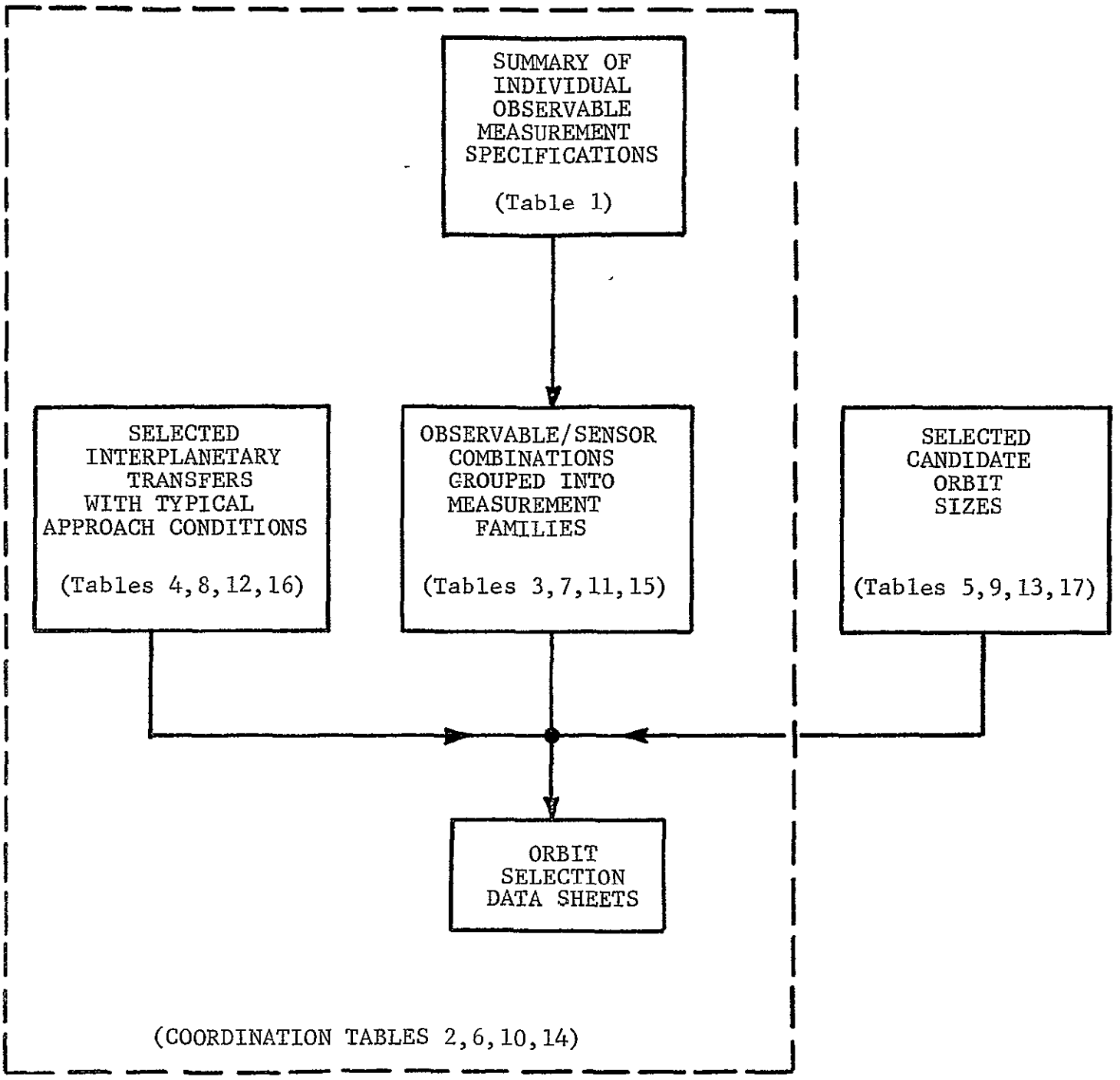


Figure 1. ORBIT SELECTION PROCEDURE REFERENCES

TABLE I SUMMARY OF MEASUREMENT SPECIFICATIONS

OBSERVABLE	PLANET	GROUND RESOLUTION	IMAGE SIZE	POSITIONAL ACCURACY	PLANETARY COVERAGE	PLANETARY DISTRIBUTION	ACQUISITION TIME: IMAGE	ACQUISITION TIME: COVERAGE	REPETITION RATE: IMAGE	REPETITION RATE: COVERAGE	SENSOR REFERENCES	SENSOR TYPE	SPECTRAL REGION	BANDWIDTH	OVERLAP	SUN ELEVATION	SUPPORT MEASUREMENTS	COMMENTS
1)* Surface Elevations	Moon	5 km A7	500 km B5	10 km C7	100% D1	-	-	-	-	-	a,d,f,i	a Visible	5750Å F3	1000Å G3	20% H1	20° I1	S/C Altitude, Local Time	Vertical resolution for all bodies is 1 km (J1) except Jupiter which is 4 km (J2)
	Mercury	5 km A7	800 km B6	10 km C7	100% D1	-	-	-	-	-	b,d,g,i	b	5750Å F3	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Mars	5 km A7	1000 km B6	10 km C7	100% D1	-	-	-	-	-	c,e,g,i	c	6250Å F4	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Venus	5 km A7	2000 km B8	10 km C7	100% D1	-	-	-	-	-	g,i	d Visible Stereo	5750Å F3	1000Å G3	60% H3	80° I4	S/C Altitude	
	Jupiter	50 km A8	20000 km B11	50 km C9	100% D1	-	-	-	-	-	h,j	e	6250Å F4	1000Å G3	60% H3	80° I4	S/C Altitude	
												f Radar	50 cm F18	-	20% H1	-	S/C Altitude	
												g	50 cm F18	-	20% H2	-	S/C Altitude	
												h	1 m F21	-	20% H2	-	S/C Altitude	
												i Radar Stereo	50 cm F18	-	60% H3	-	S/C Altitude	
												j	1 m F21	-	60% H3	-	S/C Altitude	
2) Layering	Moon	10 cm A1	1 km B2	10 m C2	<1%	Determined by prior mapping	-	-	-	-	a,d,f	a Visible	5750Å F3	1000Å G2	20% H1	45° I2	-	
	Mercury	10 cm A1	1 km B2	10 m C2	<1%	Determined by prior mapping	-	-	-	-	b,e,g	b	5750Å F3	1000Å G2	20% H2	45° I2	-	
	Mars	10 cm A1	1 km B2	10 m C2	<1%	Determined by prior mapping	-	-	-	-	c,e,g	c	6250Å F4	1000Å G2	20% H2	45° I2	-	
	Venus	10 cm A1	1 km B2	10 m C2	<1%	Determined by prior mapping	-	-	-	-	g,i	d Radar	10 cm F17	-	20% H1	-	-	
	Jupiter	1 m A3	1 km B2	10 m C2	<1%	Determined by prior mapping	-	-	-	-	h	e	10 cm F17	-	20% H2	-	-	
												f Multifreq Radar	50 cm F18	3 bands G16	20% H1	-	-	
												g	50 cm F18	3 bands G16	20% H2	-	-	
												h	50 cm F18	3 bands G16	20% H2	-	-	
Contacts 3) (Regional)	Mercury	1 km A6	800 km B6	10 km C6	100% D1	-	-	-	-	-	b,d,g,j,l,o	a Ultraviolet	2250Å F1	500Å G1	20% H1	90° I5	-	
	Mars	1 km A6	1000 km B6	10 km C6	100% D1	-	-	-	-	-	c,h,j,l,p	b	2250Å F1	500Å G1	20% H2	90° I5	-	
	Venus	1 km A6	2000 km B8	10 km C6	100% D1	-	-	-	-	-	l	c Visible	5750Å F3	1000Å G2	20% H1	20° I1	-	
	Jupiter	5 km A7	10000 km B10	50 km C9	5% D3	Global	-	-	-	-	m	d	5750Å F3	1000Å G2	20% H2	20° I1	-	
												e	6250Å F4	1000Å G2	20% H2	20° I1	-	
4) (Local)	Moon	100 m A5	100 km B4	1 km C4	100% D1	-	-	-	-	-	a,c,f,i,k,n	f Infrared	1.75μ F7	0.1μ G2	20% H3	20° I1	-	
	Mercury	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	b,d,g,j,l,o	g	1.5μ F6	0.1μ G2	20% H2	20° I1	-	
	Mars	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	e,h,j,l,p	h	1.75μ F7	0.1μ G2	20% H2	20° I1	-	
	Venus	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	l	i Infrared	120μ F12	20μ G9	20% H1	90° I5	-	
												j	120μ F12	20μ G9	20% H2	90° I5	-	
5) (Detailed)	Moon	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	a,c,f,i,k,n	k Radar	10 cm F17	-	20% H1	-	-	
	Mercury	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	b,d,g,j,l,o	l	10 cm F17	-	20% H2	-	-	
	Mars	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	e,h,j,l,p	m	60 cm F18	-	20% H2	-	-	
	Venus	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	l	n Multiband	15-2μ F1,3,7	6 bands G19	20% H1	45° I2	-	
												o	15-2μ F1,3,6	6 bands G19	20% H2	45° I2	-	
												p	5-2 5μ F4,7	6 bands G19	20% H2	45° I2	-	
Structure of Features 6) (Regional)	Mercury	1 km A6	800 km B6	10 km C6	100% D1	-	-	-	-	-	b,d,g,j,l	a Visible	5750Å F3	1000Å G2	20% H1	20° I1	S/C Altitude, Local Time	Vertical resolution same as horizontal
	Mars	1 km A6	1000 km B6	10 km C6	100% D1	-	-	-	-	-	c,e,h,j,l	b	5750Å F3	1000Å G2	20% H2	20° I1	S/C Altitude, Local Time	
	Venus	1 km A6	2000 km B8	10 km C6	100% D1	-	-	-	-	-	j,l	c	6250Å F4	1000Å G2	20% H2	20° I1	S/C Altitude, Local Time	
	Jupiter	10 km A7	20000 km B11	200 km C10	5% D3	Global	-	-	-	-	k,n	d Visible Stereo	5750Å F3	1000Å G2	60% H3	80° I4	S/C Altitude	
7) (Local)	Moon	100 m A5	100 km B4	1 km C4	100% D1	-	-	-	-	-	a,d,f,i,l	e	6250Å F4	1000Å G2	60% H3	80° I4	S/C Altitude	
	Mercury	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	b,d,g,j,l	f Visible Color	5750Å F3	3 bands G4,17	20% H1	60° I3	S/C Altitude	
	Mars	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	c,e,h,j,l	g	5750Å F3	3 bands G4,17	20% H2	60° I3	S/C Altitude	
	Venus	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	j,l	h	6250Å F4	3 bands G4,17	60% H3	60° I3	S/C Altitude	
												i Radar	50 cm F18	-	20% H1	-	S/C Altitude	
8) (Detailed)	Moon	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	a,d,f,i,l	j	50 cm F18	-	20% H2	-	S/C Altitude	
	Mercury	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	b,d,g,j,l	k	1 m F21	-	20% H2	-	S/C Altitude	
	Mars	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	c,e,h,j,l	l Radar Stereo	50 cm F18	-	60% H3	-	S/C Altitude	
	Venus	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	j,l	m	1 m F21	-	60% H3	-	S/C Altitude	
Surface Topography 9)* (Regional)	Mercury	1 km A6	800 km B6	1 km C12	100% D1	-	-	-	-	-	b,d,g,i	a Visible	5750Å F3	1000Å G3	20% H1	20° I1	S/C Altitude, Local Time	Vertical resolution (Regional) - 1 km (J1) for all except Jupiter at 4 km (J2) (Local) - 50 m (J3) (Detailed) - 10 m (J4)
	Mars	1 km A6	1000 km B6	1 km C12	100% D1	-	-	-	-	-	c,e,g,i	b	5750Å F3	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Venus	1 km A6	2000 km B8	1 km C12	100% D1	-	-	-	-	-	g,i	c	6250Å F4	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Jupiter	10 km A7	20000 km B11	200 km C10	5% D3	Global	-	-	-	-	h	d Visible Stereo	5750Å F3	1000Å G3	60% H3	80° I4	S/C Altitude	
10)* (Local)	Moon	100 m A5	100 km B4	100 m C3	100% D1	-	-	-	-	-	a,d,f,i	e	6250Å F4	1000Å G3	60% H3	80° I4	S/C Altitude	
	Mercury	100 m A5	100 km B4	100 m C3	10% D2	See regional maps	-	-	-	-	b,d,g,i	f Radar	50 cm F18	-	20% H1	-	S/C Altitude	
	Mars	100 m A5	100 km B4	100 m C3	10% D2	See regional maps	-	-	-	-	c,e,g,i	g	50 cm F18	-	20% H2	-	S/C Altitude	
	Venus	100 m A5	100 km B4	100 m C3	10% D2	See regional maps	-	-	-	-	g,i	h	1 m F21	-	20% H2	-	S/C Altitude	
												i Radar Stereo	50 cm F18	-	60% H3	-	S/C Altitude	
11)* (Detailed)	Moon	1 m A3	1 km B2	1 m C1	<1%	See local maps	-	-	-	-	a,d,f,i	j	1 m F21	-	60% H3	-	S/C Altitude	
	Mercury	1 m A3	1 km B2	1 m C1	<1%	See local maps	-	-	-	-	b,d,g,i							
	Mars	1 m A3	1 km B2	1 m C1	<1%	See local maps	-	-	-	-	c,e,g,i							
	Venus	1 m A3	1 km B2	1 m C1	<1%	See local maps	-	-	-	-	g,i							
Surface Appearance 12) (Regional)	Mercury	1 km A6	800 km B6	10 km C6	100% D1	-	-	-	-	-	b,e,h							
	Mars	1 km A6	1000 km B6	10 km C6	100% D1	-	-	-	-	-	c,f,h							
	Venus	1 km A6	2000 km B8	10 km C6	100% D1	-	-	-	-	-	h	a Visible	5750Å F3	1000Å G2	20% H1	20° I1	-	
	Jupiter	10 km A7	20000 km B11	200 km C10	5% D3	Global	-	-	-	-	i	b	5750Å F3	1000Å G2	20% H2	20° I1	-	
												c	6250Å F4	1000Å G2	20% H2	20° I1	-	
13) (Local)	Moon	100 m A5	100 km B4	1 km C4	100% D1	-	-	-	-	-	a,d,g	d Visible Color	5750Å F3	3 bands G4,17	20% H1	60° I3	-	
	Mercury	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	b,e,h	e	5750Å F3	3 bands G4,17	20% H2	60° I3	-	
	Mars	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	c,f,h	f	6250Å F4	3 bands G4,17	60% H3	60° I3	-	
	Venus	100 m A5	100 km B4	1 km C4	10% D2	See regional maps	-	-	-	-	h	g Radar	50 cm F18	-	20% H1	-	-	
												h	50 cm F18	-	20% H2	-	-	
14) (Detailed)	Moon	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	a,d,g	i	1 m F21	-	20% H2	-	-	
	Mercury	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	b,e,h							
	Mars	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	c,f,h							
	Venus	1 m A3	1 km B2	10 m C2	<1%	See local maps	-	-	-	-	h							
15) Variable (Reg)	Mars	1 km A6	1000 km B6	10 km C6	10% D2	More and poles	5 min E6	100 hrs E11	1 day E13	25 yr E16	a,b							
16) Surface (Local)	Mars	100 m A5	100 km B4	1 km C4	1% D4	More and poles	5 min E6	100 hrs E11	1 day E13	25 yr E16	a,b	a Visible	6250Å F4	1000Å G2	20% H2	20° I1	-	
17) Appearance (Pat)	Mars	1 m A3	1 km B2	10 m C2	<1%	More and poles	5 min E6	100 hrs E11	1 day E13	25 yr E16	a,b	b Visible Color	6250Å F4	3 bands G4,17	20% H2	60° I3	-	
Surface Winds 18)* (Regional)	Mercury	10 km A7	800 km B6	10 km C7	100% D1	-	10 sec E3	-	1 hr E9	50 yr E17	a							
	Mars	10 km A7	1000 km B6	10 km C7	100% D1	-	10 sec E3	-	1 hr E9	25 yr E16	b							
19)* (Local)	Mercury	100 m A5	100 km B4	1 km C4	1% D4	See regional maps	0.1 sec E2	-	1 min E8	-	a	a Visible	5750Å F3	1000Å G2	20% H2	45° I2	S/C Altitude, Local Time	
	Mars	100 m A5	100 km B4	1 km C4	1% D4	See regional maps	0.1 sec E2	-	1 min E8	-	b	b	6250Å F4	1000Å G2	20% H2	45° I2	S/C Altitude, Local Time	
20) Topographic Changes	Moon	1 m A3	1 km B2	1 m C1	<1%	Determined by prior mapping	1 hr E7	-	-	300 hrs E12	a,d,f,i	a Visible	5750Å F3	1000Å G3	20% H1	20° I1	S/C Altitude, Local Time	Vertical Resolution All 10 m (J4)
	Mercury	1 m A3	1 km B2	1 m C1	<1%	Determined by prior mapping	1 hr E7	-	-	300 hrs E12	b,e,g,i	b	5750Å F3	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Mars	1 m A3	1 km B2	1 m C1	<1%	Determined by prior mapping	1 hr E7	-	-	300 hrs E12	c,e,g,i	c	6250Å F4	1000Å G3	20% H2	20° I1	S/C Altitude, Local Time	
	Venus	1 m A3	1 km B2	1 m C1	<1%	Determined by prior mapping	1 hr E7	-	-	300 hrs E12	g,i	d Visible Stereo	5750Å F3	1000Å G3	60% H3	80° I4	S/C Altitude, Local Time	
	Jupiter	10 m A4	10 km B3	100 m C3	<1%	Determined by prior mapping	1 hr E7	-	-	300 hrs E12	h,j	e	6250Å F4	1000Å G3	60% H3	80° I4	S/C Altitude, Local Time	
												f Radar	50 cm F18	-	20% H1	-	S/C Altitude	
												g	50 cm F18	-	20% H2	-	S/C Altitude	
												h	1 m F21	-	20% H2	-	S/C Altitude	
												i Radar Stereo	50 cm F18	-	60% H3	-	S/C Altitude	
												j	1 m F21	-	60% H3	-	S/C Altitude	

*Measurements made on this observable may be applicable to engineering objectives

Note Values given in this table are nominal values Lettered references (e g A7) refer to worth curves given in Volume I

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TABLE I SUMMARY OF MEASUREMENT SPECIFICATIONS (Continued)

OBSERVABLE	PLANET	GROUND RESOLUTION		IMAGE SIZE		POSITIONAL ACCURACY		PLANETARY COVERAGE		PLANETARY DISTRIBUTION	ACQUISITION TIME IMAGE	ACQUISITION TIME COVERAGE	REPETITION RATE IMAGE	REPETITION RATE COVERAGE	SENSOR REFERENCE	SENSOR TYPE	SPECTRAL REGIONS		BANDWIDTH	OVERLAP	S/N RATIO	SUPPORT MEASUREMENTS	COMMENTS
Surface Thermal Anomalies	Moon	1 km	A6	500 km	B5	10 km	C6	100%	D1	-	1 hr	b7 -	10 hr	E10 -	a,c,f								Desired Temperature Resolution
21) (Regional)	Mercury	1 km	A6	800 km	B6	10 km	C6	100%	D1	-	1 hr	E7 -	10 hr	E10 -	b,d,g								
	Mars	1 km	A6	1000 km	B6	10 km	C6	100%	D1	-	1 hr	F7 -	10 hr	E10 -	b								
	Venus	1 km	A6	2000 km	B8	10 km	C6	100%	D1	-	1 hr	F7 -	10 hr	E10 -	d,h								
	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	-	1 hr	F7 -	10 hr	E10 -	e								
22) (Local)	Moon	100 m	A5	100 km	B4	1 km	C4	5%	D3	See regional maps	1 hr	F7 -	10 hr	E10 -									
	Mercury	100 m	A5	100 km	B4	1 km	C4	5%	D3	See regional maps	1 hr	E7 -	10 hr	E10 -	a,c,f								
	Mars	100 m	A5	100 km	B4	1 km	C4	5%	D3	See regional maps	1 hr	F7 -	10 hr	E10 -	b,d,g								
	Venus	100 m	A5	100 km	B4	1 km	C4	5%	D3	See regional maps	1 hr	E7 -	10 hr	E10 -	b,d,g								
															d,h								
23) (Detailed)	Moon	1 m	A3	1 km	B2	10 m	C2	1%	D4	See local maps	1 hr	E7 -	10 hr	E10 -									
	Mercury	1 m	A3	1 km	B2	10 m	C2	<1%		See local maps	1 hr	b7 -	10 hr	E10 -	a,c,f								
	Mars	1 m	A3	1 km	B2	10 m	C2	<1%		See local maps	1 hr	F7 -	10 hr	E10 -	b,d,g								
	Venus	1 m	A3	1 km	B2	10 m	C2	<1%		See local maps	1 hr	F7 -	10 hr	E10 -	b,d,g								
															d,h								
Atmos Thermal Anomalies	Mars	10 km	A7	1200 km	B8	50 km	C8	100%	D1	Polar regions	1 hr	F7 -											
	Venus	10 km	A7	2000 km	B9	50 km	C8	100%	D1	-	1 hr	F7 -	-		50 yr	E17	a,b,d	g	IR	20μ	F11	6μ	G7	20/ H2	-	-	Desired Temperature Resolution
24)* (Regional)	Jupiter	10 km	A7	20000 km	B11	200 km	C10	100%	D1	Cloud belts, red spot	1 hr	F7 -	-		50 yr	E17	a,c,e	h	Microwave	5 cm	F13	10 cm	C10	20/ H2	-	-	
																	a,c,e	c		5 cm	F15	10 cm	C10	20/ H2	-	-	
25)* (Detailed)	Mars	1 km	A6	100 km	B4	10 km	C6	10%	D2	See regional maps	1 hr	F7 -	1 day	E13 -									Same as above
	Venus	1 km	A6	200 km	B6	10 km	C6	10%	D2	See regional maps	1 hr	E7 -	1 day	E13 -	a,b,d	d	Multiband	3μ-10 cm	F11,13	4 bands	G18	20% H2	-	-	
	Jupiter	1 km	A6	2000 km	B9	20 km	C8	20%	D2	See regional maps	1 hr	E7 -	1 day	F12 -	a,c,e	e		3μ-10 cm	F11 15	4 bands	G18	20% H2	-	-	
26) Global Cloud Coverage	Mars	10 km	A7	1200 km	B8	50 km	C8	100%	D1	Polar regions	15 min	E6 1 day	E13 -		05 yr	E16	a,b,c,d,e	a	UV	3000A	F2	1000A	G1	20% H2	Day	16	-
	Venus	10 km	A7	2000 km	B9	50 km	C8	100%	D1	-	15 min	E6 100 hr	E11 -		10 yr	E15	a,b,c,d,e	b	Visible (BW & color)	5750A	F3	1000A	G2	20% H2	Day	16	-
	Jupiter	10 km	A7	20000 km	B11	200 km	C10	100%	D1	-	2 min	E8 1 day	E13 -		10 yr	E15	a,b,c,d,e	c	IR	1 5μ	F6	1μ	G6	20% H2	-	-	-
																		d	IR	8μ	F11	8μ	G8	20% H2	-	-	-
																		e	Multiband	2-30μ	F2,3,6,11	6 bands	G19	20% H2	Day	18	-
Convective Cells and Turbulence	Mars	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Equatorial and polar areas	1 hr	E7 -	-		25 yr	E16	a,b,c,d	a	UV	2500A	F1	1000A	G5	20% H2	Day	16	-
	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Solar and anti-solar points	1 hr	E7 -	-		50 yr	E17	a,b,c,d,e,f	b	Visible	6250A	F3	1000A	G5	20% H2	Day	16	-
27)* (Regional)	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	Cloud belts, red spot	1 hr	E7 -	-		50 yr	E17	a,b,c,d,e,f	c	IR	10μ	F11	8μ	G7	20% H2	-	-	-
28)* (Detailed)	Mars	1 km	A6	100 km	B4	5 km	C5	20%	D2	See regional maps	1 hr	E7 -	1 day	E13 -	a,b,c,d	d										
	Venus	1 km	A6	100 km	B4	5 km	C5	20%	D2	See regional maps	1 hr	E7 -	100 hr	E11 -	a,b,c,d,e,f	u	Microwave	2 cm	F16	2 cm	G11	20% H2	-	-	
	Jupiter	1 km	A6	1000 km	B5	10 km	C6	20%	D2	See regional maps	1 hr	E7 -	1 day	E13 -	a,b,c,d,e,f	f		6 cm	F16	6 cm	G11	20% H2	-	-	
29) Cloud Formation	Mars	1 km	A6	1000 km	B6	10 km	C6	20%	D2	Equatorial and polar areas	1 min	E5 -	10 min	E6	25 yr	E16	a,b,c,d,f	a	UV	3000A	F2	1000A	G1	20% H2	Day	16	-
	Venus	1 km	A6	1000 km	B6	10 km	C6	20%	D2	Subsolar and polar areas	1 min	E5 -	10 min	E6	25 yr	E16	a,b,c,d,f	b	Visible (BW & color)	5750A	F3	1000A	G2	20% H2	Day	16	-
	Jupiter	10 km	A7	10000 km	B10	100 km	C9	20%	D2	Belts, red spot, tropics	10 sec	E3 -	2 min	E8 -	a,b c,e,f	c	IR	1 5μ	F6	1μ	G6	20% H2	Day	16	-
																d		24μ	F11	10μ	G8	20% H2	-	-	-
																e		20μ	F11	10μ	G8	20% H2	-	-	-
																f	Multiband	2-30μ	F2,3,6,11	6 bands	G19	20% H2	Day	18	-
30)*Precipitation Rate	Mars	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Wave of darkening and poles	1 min	E5 -	10 min	E6	25 yr	E16	a	a	Radar	2 5 cm	F14	3 bands	G17	20% H2	-	-	
	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Equator, poles and mountains	1 min	E5 -	10 min	E6	25 yr	E16	b	b		5 cm	F15	3 bands	G17	20% H2	-	-	
	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	-	1 min	E5 -	10 min	E6	25 yr	E16	b										
Thunderstorms	Mars	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Equatorial and temperate zones	10 usec	E1 -	1 min	E8	10 yr	E15	a	a	Passive RF	50 m	F22	1 m	G15	20% H2	-	-	
31) (Regional)	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	-	10 usec	E1 -	1 min	E8	10 yr	E15	a	b		5 m	F21	1 m	G15	20% H2	-	-	
	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	-	10 usec	E1 -	1 min	E8	10 yr	E15	b										
32) (Detailed)	Mars	1 km	A6	100 km	B4	5 km	C5	20%	D2	See regional maps	10 usec	E1 -	1 min	E8	10 yr	E15	a										
	Venus	1 km	A6	100 km	B4	5 km	C5	20%	D2	See regional maps	10 usec	E1 -	1 min	E8	10 yr	E15	a										
	Jupiter	1 km	A6	500 km	B5	5 km	C5	20%	D2	See regional maps	10 usec	E1 -	1 min	E8	10 yr	E15	b										
Cyclone Formations	Mars	10 km	A7	1000 km	B6	50 km	C8	100%	D1	-	10 min	E6 -	-		25 yr	E16	a,b,c,d	a	Visible	5750A	F3	1000A	G2	20% H2	Day	16	-
	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Subsolar point	10 min	E6 -	-		25 yr	E16	a,b,c,d	b	IR	1 5μ	F6	1μ	G6	20% H2	Day	16	-
33) (Regional)	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	Cloud belts, red spot	1 min	E5 -	-		25 yr	E16	a,b,c,d	c		24μ	F11	10μ	G8	20% H2	-	-	
34) (Detailed)	Mars	1 km	A6	100 km	B4	10 km	C6	20%	D2	See regional maps	10 min	E6 -	1 hr	E9	25 yr	E16	a,b,c,d	d	Multiband	2-30μ	F3,6,11	6 bands	G19	20% H2	Day	16	-
	Venus	1 km	A6	100 km	B4	10 km	C6	20%	D2	See regional maps	10 min	E6 -	1 hr	E9	25 yr	E16	a,b,c,d										
	Jupiter	1 km	A6	2000 km	B6	10 km	C6	20%	D2	See regional maps	1 min	E5 -	10 min	E6	25 yr	E16	a,b,c,d										
35) Sufsce to Atmosphere Transfer	Moon	1 km	A6	500 km	B5	10 km	C6	100%	D1	-	1 min	E5 1 day	E13 -		10 yr	E15	a,c	a	Visible	5750A	F3	1000A	G2	20% H1	45°	12	-
	Mercury	1 km	A6	500 km	B5	10 km	C6	100%	D1	-	1 min	E5 1 day	E13 -		10 yr	E15	b,d	b		5750A	F3	1000A	G2	20% H2	45°	12	-
	Mars	1 km	A6	200 km	B4	10 km	C6	100%	D1	-	1 min	E5 1 day	E13 -		05 yr	E14	b,d,e	c	Vis Color	5750A	F3	3 bands	G4,17	20% H1	60°	13	-
	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	-	1 min	E5 100 hr	E11 -		10 yr	E15	e,f	d		5750A	F3	3 bands	G4,17	20% H2	60°	13	-
	Jupiter	10 km	A7	1000 km	B6	100 km	C9	100%	D1	Red spot and tropical regions	1 min	E5 1 day	E13 -		10 yr	E15	e,f	e	IR	24μ	F11	8μ	G8	20% H2	-	-	-
																		f	Microwave	30 cm	F17	10 cm	G12	20% H2	-	-	-
36) Radio Bursts	Jupiter	100 km	A8	50000 km	B12	500 km	C11	100%	D1	Subsatellite pts of satellites	1 msec	E2 -	1 min	E8 -	a	a	Passive RF	50 m	F22	3 bands	G17	20% H2	-		Local Time	
37) Aurorae	Mars	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Polar regions	1 min	E5 -	1 hr	E9	25 yr	E16	a,b	a	Visible	5750A	F3	1000A	G2	20% H2	Night	T7	-
	Venus	10 km	A7	1000 km	B6	50 km	C8	100%	D1	Polar regions	1 min	E5 -	20 hr	E10	25 yr	E16	a,b	b	Vis Color	5750A	F3	3 bands	G17	20% H2	Night	T7	-
	Jupiter	10 km	A7	10000 km	B10	100 km	C9	100%	D1	Polar regions	1 min	E5 -	1 hr	E9	25 yr	E16	a,b										
38) Animal Life	Mars	20 cm	A2	400 m	B1	100 m	C3	-	D5	Wave of darkening and poles	1 sec	E4 -	10 sec	E5	-		a,b,e,d	a	Visible	6250A	F4	1000A	G2	-	45°	12	-
	Venus	20 cm	A2	400 m	B1	100 m	C3	-	D5	Mountains and poles	1 sec	E4 -	10 sec	E5	-		e,f	b	Vis Stereo	6250A	F4	1000A	G2	60% H3	80°	14	-
																		c	Vis Color	6250A	F4	1000A	G2	-	60°	13	-
																		d	Multiband	2 5μ	F8	10 bands	G20	-	45°	12	-
																		e	Radar	5 cm	F15	-		-	-		-
																		f	Radar Stereo	5 cm	F15	-		60% H3	-		-
39) Plant Life	Mars	100 m	A5	200 km	B4	1 km	C4	10%	D2	Wave of darkening and poles	1 hr	E7 -	-		25 yr	E16	a,b,c	a	Visible	6250A	F4	1000A	G2	-	45°	12	-
	Venus	100 m	A5	200 km	B4	1 km	C4	10%	D2	Mountains and poles	1 hr	E7 -	-		25 yr	E16	d	b	Vis Color	6250A	F4	1000A	G2	-	60°	13	-
																		c	Multiband	5-5μ	F8	10 bands	G20	-	45°	12	-
																		d	Radar	5 cm	F15	-		-	-		-
40) Biochemical Systems	Mars	1 km	A6	800 km	B6	10 km	C7	10%	D2	Wave of darkening and poles	1 hr	E7 -	-		25 yr	E16	a	a	Multiband	5-5μ	F8	10 bands	G20	20% H2	45°	12	-
	Venus	1 km	A6	1000 km	B6	10 km	C7	10%	D2	Mountains and poles	1 hr	E7 -	-		25 yr	E16	b	b		5-5μ	F8	10 bands	G20	20% H2	Day	16	-
	Jupiter	1 km	A6	2000 km	B9	20 km	C8	5%	D2	-	1 hr	E7 -	-		25 yr	E16	b										
41) Hydrocarbons	Moon	1 km	A6	500 km	B5	10 km	C7	10%	D2	Global	-	-	-		-		a	a	Multiband	.1-10.5	F9	10 bands	G20	-	Day	16	-
	Mercury	1 km	A6	800 km	B6	10 km	C7	10%	D2	Global	-	-	-		-		b	b		5-10μ	F10	10 bands	G20	-	Day	16	-
	Mars	1 km	A6	800 km	B6	10 km	C7	10%	D2	Global	-	-	-		-		b										

*Measurements made on this observable may be applicable to engineering objectives

FOLDOUT FRAME 1

FOLDOUT FRAME 2

Typical interplanetary transfers provide planet approach conditions from which selected orbits must be established. Trajectory parameters of selected interplanetary transfers are presented in Tables 4, 8, 12 and 16 for Mars, Venus, Mercury and Jupiter. Orbit selections are limited to a set of candidate orbit sizes which satisfied orbit constraints established in preliminary analysis of the planet orbit enrivonment, e.g., lifetime, radiation belts, maximum capture impulse, etc. The candidate orbit sizes from which orbits are chosen are listed in Tables 5, 9, 13 and 17 for Mars, Venus, Mercury and Jupiter, respectively. For Mars and Jupiter candidate orbit sizes are refined in the selection process to match the image and overlap specifications of the measurement family in question.

The means for relating a particular observable of interest to its orbit selections are coordinated in Tables 2, 6, 10 and 14 for Mars, Venus, Mercury and Jupiter, respectively. These are the first tables of each planet data block and can be used as an index to the orbit data sheets. They contain all combinations of measurement families, interplanetary transfers and orbit selection data sheets for each observable/sensor type combination given in Table 1. Suppose, for example, the reader is interested in visual imaging of local contacts on Mars. This is observable number 4 in Table 1. Referring to Table 2 (see Mars data block) it is observed that this combination, i.e.,

observable: 4. contacts (local)
sensor type: e. visible

belong to measurement family number 21. The orbit selections using approach conditions of the 1984 transfer selection (Table 4) for this family are given in orbit selection data sheet numbers 32 and 33. The other observables which are members of the same family are:

7. Structure of Features (local),

10. Surface Topography (local),

13. Surface Appearance (local),

16. Variable Surface Appearance (local).

The measurement specifications for this family (No. 21) are presented in Table 3.

A completed sample orbit selection data sheet is presented in Figure 2. (This is the same example as presented in Appendix A of Volume I). Each data sheet is consecutively numbered beginning with the first Mars orbit selection and ending with the last Jupiter selection. The data sheet heading contains the planet, transfer opportunity year, measurement family number and candidate orbit size number to which the orbit selection applies.

The first block of data are the family measurement specifications: a) as required (e.g., see Table 3) and b) as obtained by the orbit selected. The item "Image Interval" indicates the shortest time between images of the same area. This also is the time needed for one longitudinal coverage of the planet. "Time for % Coverage" is the shortest time in which the coverage can be obtained under the lifetime, image size, and % overlap constraints. The data block, Orbit Elements, lists the necessary orbit parameters to fix size and orientation of the selected orbit. (The orbit elements are given with respect to a planet-centered equatorial/equinox reference system.) The "final" orbit elements represent the selected imaging orbit. When "intermediate" elements are given

ORBIT SELECTION DATA SHEET NO. 200

Mars (1984) FAMILY NO. 7 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.763
Total Planet Coverage (%)	> 70	76.7
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 hr	10 days [1]
Time for % Coverage (days)	-	60 days
Coverage Interval	> 4/yr	once/10 days
Distribution	-	-63° to 40° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	.9
Periapse Alt. (km)	425	425
Apoapse Alt. (km)	6995	68,915
Inclination (deg)	110	38
Ascending Node (deg)	253.7	61.7
Arg. of Periapse (deg)	349.5	200

SELECTION RATIONALE:

The location of the asymptotic approach direction with respect to the solar illumination area of interest makes it necessary to use an off-periapse insertion maneuver into an intermediate orbit. A plane change of 141° and eccentricity adjustment establish the final orbit for measurements. The final orbit is sun-synchronous with periapse near the center of the area of desired illumination.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425 to 1014
Max. Measurement Arc (deg)	-54.5 to 54.5
Max. Sensor on Time (min/orb)	3.27
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.36 (5.5°)
Plane Change ΔV (km/sec)	.46 (141°)
Size Adjustment ΔV (km/sec)	.57
Total ΔV (km/sec)	2.39

MEASUREMENT ACHIEVEMENT:

1. The time between side-by-side images is equal to 5 orbit periods or 50.3 hours. The time between image repetitions equals 10 days which is the time for one complete cycle of longitudinal coverage.

Figure 2. Orbit Data Sheet Example

an intermediate orbit is employed to achieve the final orbit from the selected approach conditions in a more optimal manner (less total impulse) than could be accomplished with a single impulse.

Under the title Selection Rationale the conditions at arrival are discussed. The sequence of maneuvers leading to the final orbit are briefly described. When extended orbit durations are required, an abstract of experiment achievement with orbit duration is also provided.

Data related to the mission profile are presented in the block of data labeled Orbit/Measurement Characteristics. "Orbits to contiguous coverage" means the number of orbits lapsed between overlapping images. For Mars this is equivalent to the number of orbits per day. "Measurement orbit frequency", as the term implies, is the rate (in terms of orbits) at which data is collected. The "measurement altitude range" in effect specifies the limiting altitudes (low and high) from which measurements must be made to guarantee the "obtained" coverage from the selected orbit. "Measurement arc" and "sensor-on-time" are the maximum angular distance (in terms of true anomaly) and time, respectively, during which the sensor is collecting data during any single orbit pass.

The remaining orbit/measurement characteristics pertain to impulse maneuvers used to achieve the final orbit. The "number of impulses" is the number of major maneuvers (excluding orbit trimming due to orbit determination and execution errors) required to achieve the imaging orbit. "Capture ΔV" is the initial impulse at closest approach to the planet to become captured If an off-periapse insertion (OPI) is used the degree of orbit

apseline rotation accomplished is included in parentheses next to the capture impulse magnitude. Plane changes are executed at intermediate orbit apoapse and the amount of planar rotation achieved is included in parentheses next to the impulse required. Orbit size adjustments are changes in eccentricity performed at periapse of the intermediate orbit.

Footnotes related to incomplete achievement of measurement specifications are presented under the last heading of Measurement Achievement.

The remainder of this volume contains four sections of orbit selection sheets and related reference tables in the order Mars, Venus, Mercury and Jupiter.

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2. MARS

Table 2

MARS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
1	Surface Elevations	c	Visible	8	13,14	56	3,6,9,12,15
		e	Visible Stereo	3	5,6	49,50	6,9
		g	Radar	11	18,19,20	59,60	3,6,9,12,21
		i	Radar Stereo	4	7,8,9	51,52	6,9
2	Layering	c	Visible	29	41	79	5
		e	Radar	31	43	81	5,8,11,14,20,23
		g	Multifreq. Radar	31	43	81	5,8,11,14,20,23
3	Contacts (Regional)	e	Visible	8	13,14	56	1,6,9,12,15
		h	Infrared	8	13,14	56	1,6,9,12,15
		j	Infrared	5	10	53	
		l	Radar	11	18,19,20	59,60	1,6,9,12,21
		p	Multiband	7	12	55	18,40
4	Contacts (local)	e	Visible	21	32,33	71	7,10,13,16
		h	Infrared	21	32,33	71	7,10,13,16
		j	Infrared	8	29	68	
		l	Radar	23	35	73	7,10,13,22,25
		p	Multiband	20	31	70	19,39
5	Contacts (Detailed)	e	Visible	30	42	80	8,11,14,17,20
		h	Infrared	30	42	80	8,11,14,17,20
		j	Infrared	27	39	77	
		l	Radar	31	43	81	2,8,11,14,20,23
		p	Multiband	29	41	79	2

Table 2 (Continued)

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
6.	Structure of Features (Regional)	c	Visible	8	13,14	56	1,3,9,12,15
		e	Visible Stereo	3	5,6	49,50	1,9
		h	Visible color	6	11	54	12,15
		j	Radar	11	18,19,20	59,60	1,3,9,12,21
		l	Radar Stereo	4	7,8,9	51,52	1,9
7.	Structure of Features (Local)	c	Visible	21	32,33	71	4,10,13,16
		e	Visible Stereo	16	27	66	10
		h	Visible Color	19	30	69	13,16,39
		j	Radar	23	35	73	4,10,13,22,25
		l	Radar Stereo	17	28	67	10
8.	Structure of Features (Detailed)	c	Visible	30	42	80	5,11,14,17,20
		e	Visible Stereo	25	37	75	11,20
		h	Visible Color	28	40	78	14,17
		j	Radar	31	43	81	2,5,11,14,20,23
		l	Radar Stereo	26	38	76	11,20
9.	Surface Topography (Regional)	c	Visible	8	13,14	56	1,3,6,12,15
		e	Visible Stereo	3	5,6	49,50	1,6
		g	Radar	11	18,19,20	59,60	1,3,6,12,21
		i	Radar Stereo	4	7,8,9	51,52	1,6
10.	Surface Topography (Local)	c	Visible	21	32,33	71	4,7,13,16
		e	Visible Stereo	16	27	66	7
		g	Radar	23	35	73	4,7,13,22,25
		i	Radar Stereo	17	28	67	7

Table 2 (Continued)

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
11.	Surface Topography (Detailed)	c	Visible	30	42	80	5,8,14,17,20
		e	Visible Stereo	25	37	75	8,20
		g	Radar	31	43	81	2,5,8,14,20,23
		i	Radar Stereo	26	38	76	8,20
12.	Surface Appearance (Regional)	c	Visible	8	13,14	56	1,3,6,9,15
		f	Visible Color	6	11	54	6,15
		h	Radar	11	18,19,20	59,60	1,3,6,9,21
13.	Surface Appearance (Local)	c	Visible	21	32,33	71	4,7,10,16
		f	Visible color	19	30	69	7,16,39
		h	Radar	23	35	73	4,7,10,22,25
14.	Surface Appearance (Detailed)	c	Visible	30	42	80	5,8,11,17,20
		f	Visible Color	28	40	78	8,17
		h	Radar	31	43	81	2,5,8,11,20,23
15.	Variable Surface Appearance (Regional)	a	Visible	8	13,14	56	1,3,6,9,12
		b	Visible Color	6	11	54	6,12
16.	Variable Surface Appearance (Local)	a	Visible	21	32,33	71	4,7,10,13
		b	Visible Color	19	30	69	7,13,39
17.	Variable Surface Appearance (Detailed)	a	Visible	30	42	80	5,8,11,14,20
		b	Visible Color	28	40	78	8,14
18.	Surface Winds (Regional)	b	Visible	7	12	55	3,40
19.	Surface Winds (Local)	b	Visible	20	31	70	4,39

Table 2 (Continued)

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
20.	Topographic Changes	c	Visible	30	42	80	5,8,11,14,17
		e	Visible Stereo	25	37	75	8,11
		g	Radar	31	43	81	2,5,8,11,14,23
		i	Radar Stereo	26	38	76	8,11
21.	Surface Thermal Anomalies (Regional)	b	IR	11	18,19,20	59,60	1,3,6,9,12
		d	Microwave	11	18,19,20	59,60	1,3,6,9,12
		g	Multiband	11	18,19,20	59,60	1,3,6,9,12
22.	Surface Thermal Anomalies (Local)	b	IR	23	35	73	4,7,10,13,25
		d	Microwave	23	35	73	4,7,10,13,25
		g	Multiband	23	35	73	4,7,10,13,25
23.	Surface Thermal Anomalies (Detailed)	b	IR	31	43	81	2,5,8,11,14,20
		d	Microwave	31	43	81	2,5,8,11,14,20
		g	Multiband	31	43	81	2,5,8,11,14,20
24.	Atmospheric Thermal Anomalies (Regional)	a	IR	2	3,4	48	26
		b	Microwave	2	3,4	48	26
		d	Multiband	2	3,4	48	26
25.	Atmospheric Thermal Anomalies (Detailed)	a	IR	23	35	73	4,7,10,13,22
		b	Microwave	23	35	73	4,7,10,13,22
		d	Multiband	23	35	73	4,7,10,13,22
26.	Global Cloud Coverage	a	UV	1	1,2	47	
		b	Visible (BW&Color)	1	1,2	47	
		c	IR	2	3,4	48	24
		d	IR	2	3,4	48	24
		e	Multiband	1	1,2	47	

Table 2 (Continued)

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
27.	Convective Cells and Turbulence (Regional)	a	UV	9	15	57	29,33,41
		b	Visible	9	15	57	29,33,41
		c	IR	12	21,22,23	61,62	29,30,31,33
		d	IR	12	21,22,23	61,62	29,30,31,33
28.	Convective Cells and Turbulence (Detailed)	a	UV	22	34	72	34
		b	Visible	22	34	72	34
		c	IR	24	36	74	32,34
		d	IR	24	36	74	32,34
29	Cloud Formation	a	UV	9	15	57	27,33,41
		b	Visible (BW&Color)	9	15	57	27,33,41
		c	IR	9	15	57	27,33,41
		d	IR	12	21,22,23	61,62	27,30,31,33
		f	Multiband	9	15	57	27,33,41
30	Precipitation Rate	a	Radar	12	21,22,23	61,62	27,29,31,33
31.	Thunderstorms (Regional)	a	Passive RF	12	21,22,23	61,62	27,29,30,33
32.	Thunderstorms (Detailed)	a	Passive RF	24	36	74	28,34
33.	Cyclone Formations (Regional)	a	Visible	9	15	57	27,29,41
		b	IR	9	15	57	27,29,41
		c	IR	12	21,22,23	61,62	27,29,30,31
		d	Multiband	9	15	57	27,29,41

Table 2 (Continued)

Observable		Sensor		Family Number	Orbit Data Sheet Nos.		Other Family Member Observables
No.	Description	Ref.	Type		1984	1988	
34.	Cyclone Formations (Detailed)	a	Visible	22	34	72	28
		b	IR	22	34	72	28
		c	IR	24	36	74	28,32
		d	Multiband	22	34	72	28
35.	Surface to Atmosphere Transfer	b	Visible	14	25	64	
		d	Visible Color	13	24	63	
		e	IR	15	26	65	
37.	Auroras	a	Visible	10	16,17	58	
		b	Visible Color	10	16,17	58	
38.	Animal Life	a	Visible	34	46	84	
		b	Visible Stereo	32	44	82	
		c	Visible Color	33	45	83	
		d	Multiband	34	46	84	
39.	Plant Life	a	Visible	20	31	70	4,19
		b	Visible Color	19	30	69	7,13,16
		c	Multiband	20	31	70	4,19
40.	Biochemical Systems	a	Multiband	7	12	55	3,18
41.	Hydrocarbons	b	Multiband	9	15	57	27,29,33

TABLE 3

MEASUREMENT FAMILIES FOR MARS

Family Number	Observable Number(s)	Sensor* Type(s)	Minimum Image Size(km)	Overlap (%)	Minimum Coverage (%)	Solar Elevation Range (deg)	Coverage Distribution	Time for Coverage	Image Interval	Coverage Interval
1	26	UV,V,MB	1000	20	70	Day	Poles	< 1 day	–	20/yr
2	24,26	IR,μ, MB	1000	20	70	–	Poles	< 1 day	–	20/yr
3	1,6,9	V	600	60	70	70-85	–	–	–	–
4	1,6,9	R	600	60	70	–	–	–	–	–
5	3	IR	600	20	70	70-90	–	–	–	–
6	6,12,15	V	600	20	70	50-80	Mare, Poles	< 100 hr	< 1 day	> 4/yr
7	3,18,40	MB,V	600	20	70	30-60	–	–	< 2 hr	> 4/yr
8	1,3,6,9,12,15	V,IR	600	20	70	15-30	Mare, Poles	< 100 hr	< 1 day	> 4/yr
9	27,29,33,41	UV,V,MB	600	20	70	Day	Equator, Poles	–	< 15 min	> 4/yr
10	37	V	600	20	70	Night	Poles	–	< 2 hr	> 4/yr
11	1,3,6,9,12,21	R,MB,IR,μ	600	20	70	–	Equator, Poles	–	< 30 hr	> 2/yr
12	27,29,30,31,33	IR,R,RF	600	20	70	–	Equator, Poles, Wave	–	< 2 min	> 10/yr
13	35	V	100	20	70	50-80	Poles, Wave	< 1 day	–	> 4/yr
14	35	V	100	20	70	30-60	Poles, Wave	< 1 day	–	> 4/yr
15	35	IR	100	20	70	–	–	< 1 day	–	–
16	7,10	V	100	60	10	70-85	–	–	–	> 4/yr
17	7,10	R	100	60	10	–	–	–	–	–
18	4	IR	100	20	10	70-90	–	–	–	–
19	7,13,16,39	V	100	20	10	50-80	–	< 100hr	< 1 day	> 4/yr
20	4,19,39	V,MB	100	20	10	30-60	–	–	< 2 min	> 4/yr
21	4,7,10,13,16	V,IR	100	20	10	15-30	Mare, Poles	< 100 hr	< 1 day	> 4/yr
22	28,34	UV,V,IR,MB	100	20	10	Day	–	–	< 2 hr	> 1/day
23	4,7,10,13,22,25	R, IR,μ, MB	100	20	10	–	–	–	< 30 hr	> 2/yr
24	28,32,34	IR,RF	100	20	10	–	–	–	< 2 min	> 1/day
25	8,11,20	V	0 5	60	3	70-85	–	–	–	> 1/300hr
26	8,11,20	R	0 5	60	3	–	–	–	–	> 1/300hr
27	5	IR	0 5	20	3	70-90	–	–	–	–
28	8,14,18	V	0 5	20	3	50-80	–	< 100 hr	< 1 day	> 4/yr
29	2,5	V,MB	0 5	20	3	30-60	–	–	–	–
30	5,8,11,14,17,20	V,IR	0 5	20	3	15-30	–	< 100 hr	< 1 day	> 4/yr
31	2,5,8,11,14 20,23	R,IR μ, MB	0 5	20	3	–	–	–	< 30 hr	> 1/300hr
32	38	V	0 3	60	–	70-85	Mare,Poles,Mountains	–	< 1 min	–
33	38	V	0 3	–	–	50-80	Mare,Poles,Mountains	–	< 1 min	–
34	38	V,MB	0 3	–	–	30-60	Mare,Poles,Mountains	–	< 1 min	–

* Sensor Type Definitions are

UV	Ultraviolet
V	Visible
IR	Infrared
μ	Microwave
R	Radar
RF	Radio Frequency
MB	Multi-band

TABLE 4

MARS INTERPLANETARY TRANSFER SELECTIONS

Launch Date	January 1, 1984	July 9, 1988
Flight Time	286 days (Type II)	193 days (Type I)
Declination of Departure Asymptote (Ecliptic Plane)	9.9 deg	13.1 deg
Departure Hyperbolic Excess Speed	3.33 km/sec	3.42 km/sec
Arrival Hyperbolic Excess Speed	3.62 km/sec	2.68 km/sec
Total Hyperbolic Excess Speed	6.95 km/sec	6.10 km/sec
Declination of Arrival Asymptote (Mars Equatorial Plane)	-32.9 deg	3.57 deg
Earth/Sun Separation Angle at Arrival	44.2 deg	40.3 deg
Communication Distance at Arrival	1.25 AU	1.14 AU
Days to Earth/Mars Conjunction After Arrival	278 days	255 days
Mars Arrival Season (Northern Hemisphere)	Late Fall	Late Winter

TABLE 5

MARS CANDIDATE ORBIT SIZES

Orbit No.	Orbits Per Mars Day (n)	Eccentricity	Periapse* Altitude (km)	Maximum Altitude Ratio, h/hp	Orbit Period (hrs)	Average** Capture ΔV (km/sec)
1	10	.0000	1025	0.0	2.46	2.205
2	9	.1622	580	3.6	2.74	1.979
3	8	.2362	525	5.6	3.08	1.870
4	7	.3075	490	8.0	3.52	1.765
5	6	.3800	460	11.2	4.10	1.661
6	5	.4538	440	15.4	4.92	1.558
7	4	.5318	420	21.6	6.16	1.450
8	3	.6155	400	31.3	8.21	1.337
9	2	.7081	380	49.0	12.31	1.215
10	1	.8174	355	95.2	24.62	1.075

*Periapse altitude corresponds to 50-yr. lifetime orbits

**Capture ΔV Based on a Surveyed Average Hyperbolic Approach Speed, VHP = 2.98 km/sec.

ORBIT SELECTION DATA SHEET NO. 1

Mars (1984) FAMILY NO. 1 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	31.5
Total Planet Coverage (%)	> 70	94.6
Solar Elevation Range (deg)	day	0-15
Image Interval	-	3 days
Time for % Coverage (days)	< 1 day	3 days
Coverage Interval	20/yr	3 days
Distribution	poles	71°S to 71°N lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	931	
Apoapse Alt. (km)	931	
Inclination (deg)	71	
Ascending Node (deg)	123.7	
Arg. of Periapse (deg)	151.5	

SELECTION RATIONALE:

The selection was made with emphasis on maximum planet coverage in daylight. A circular orbit was chosen because of the off-center location of periapse for this orbit orientation. The latitudes of coverage extend from +71° to -71° with very slight coverage redundancy near the South Pole.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.38
Measurement Alt. Range (km)	931
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	71.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.59

MEASUREMENT ACHIEVEMENT:

1. In maximizing the daylight coverage a 71° inclination was selected so that it was not possible to cover the poles.

ORBIT SELECTION DATA SHEET NO. 2

Mars (1984) FAMILY NO. 1 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	26.8
Total Planet Coverage (%)	> 70	57.8[1]
Solar Elevation Range (deg)	day	0-20
Image Interval	—	6 days
Time for % Coverage (days)	<1 day	6 days
Coverage Interval	20/yr	6 days
Distribution	poles	S. hemisphere[2]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.3971	
Periapse Alt. (km)	440	
Apoapse Alt. (km)	5473	
Inclination (deg)	90	
Ascending Node (deg)	303	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

The selection was made emphasizing the region rather than the amount of coverage All of the southern hemisphere is covered. The periapse is almost at the South Pole. Only about half of the planet is covered

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.25
Measurement Alt. Range (km)	440 to 2568
Max. Measurement Arc (deg)	-75 to 105
Max. Sensor on Time (min/orb)	65.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.00
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.00

MEASUREMENT ACHIEVEMENT:

1. The necessary % coverage cannot be obtained because of lighting and orbit altitude constraints.
2. It is possible to cover only one pole at a time in daylight.

ORBIT SELECTION DATA SHEET NO. 3

Mars (1984) FAMILY NO. 2 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	31.5
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	0-20
Image Interval	—	3 days
Time for % Coverage (days)	< 1 day	3 days
Coverage Interval	20/yr	3 days
Distribution	poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	931	
Apoapse Alt. (km)	931	
Inclination (deg)	90	
Ascending Node (deg)	316 6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

100% coverage of the planet's surface can be obtained with a circular polar orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.19
Measurement Alt. Range (km)	931
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	71.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.59

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 4

Mars (1984) FAMILY NO. 2 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	26.8
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	—	0-20
Image Interval	—	6 days
Time for % Coverage (days)	< 1 day	6 days
Coverage Interval	20/yr	6 days
Distribution	poles	25° to -90°[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.3971	
Periapse Alt. (km)	440	
Apoapse Alt. (km)	5473	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

Using an elliptical polar orbit 70% of the planet surface can be covered between altitudes of 440 and 2749 km. The coverage emphasis is at the South Pole because of the location of periapse.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.25
Measurement Alt. Range (km)	440 to 2749
Max. Measurement Arc (deg)	6 5 to 120.5
Max. Sensor on Time (min/orb)	51.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.00
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.00

MEASUREMENT ACHIEVEMENT:

1. Only one pole can be covered because of altitude constraints.

ORBIT SELECTION DATA SHEET NO. 5

Mars (1984) FAMILY NO. 3 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	61
Total Planet Coverage (%)	> 70	36
Solar Elevation Range (deg)	70-85	70-85
Image Interval	—	9 days
Time for % Coverage (days)	—	55 days
Coverage Interval	—	9 days
Distribution	—	S. equatorial region

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	0.9
Periapse Alt. (km)	994	994
Apoapse Alt. (km)	994	79,726
Inclination (deg)	94.93	51
Ascending Node (deg)	58.01	349
Arg. of Periapse (deg)	224.5	252

SELECTION RATIONALE:

The final orbit was selected to be a circular sun synchronous orbit so that maximum coverage could be obtained in the southern hemisphere during the first 55 days of the mission. If additional coverage in the northern hemisphere is desired, there would be a 60 day wait after the initial (36%) coverage. In 418 days, 70% coverage could be obtained.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.44
Measurement Alt. Range (km)	994
Max. Measurement Arc (deg)	38
Max. Sensor on Time (min/orb)	15.4
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.403
Plane Change ΔV (km/sec)	.274 (74°)
Size Adjustment ΔV (km/sec)	1.186
Total ΔV (km/sec)	2.863

MEASUREMENT ACHIEVEMENT:

1. Because the area within the proper solar elevation limits is small, only 36% of the planet surface can be covered in the southern hemisphere, that is during the first 55 days of the mission. 418 days are required to obtain 70% coverage.

ORBIT SELECTION DATA SHEET NO. 6

Mars (1984) FAMILY NO. 3 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	67
Total Planet Coverage (%)	> 70	27[1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	—	27 days
Time for % Coverage (days)	—	55 days
Coverage Interval	—	27 days
Distribution	—	-10° to -48°

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.5372	.9
Periapse Alt. (km)	400	400
Apoapse Alt. (km)	9175	68,440
Inclination (deg)	112.75	35.5
Ascending Node (deg)	72.98	20.5
Arg. of Periapse (deg)	207	228

SELECTION RATIONALE:

A sun synchronous orbit is selected to maximize the coverage. Maximum coverage in the southern hemisphere is obtained in 55 days. After a 55 day wait, additional coverage can be obtained in the northern hemisphere 70% of the planet can be covered in about 420 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	4	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	6.21	
Measurement Alt. Range (km)	400	to 580
Max. Measurement Arc (deg)	-15	to 14.5
Max. Sensor on Time (min/orb)	7.6	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.342	
Plane Change ΔV (km/sec)	.345	(90°)
Size Adjustment ΔV (km/sec)	572	
Total ΔV (km/sec)	2 259	

MEASUREMENT ACHIEVEMENT:

1. Because the area within the proper solar elevation limits is small, only 27% of the planet surface can be covered in the southern hemisphere during the first 55 days of the mission. 70% coverage could be obtained in about 420 days.

ORBIT SELECTION DATA SHEET NO. 7

Mars (1984) FAMILY NO. 4 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	61
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	0-20
Image Interval	—	9 days
Time for % Coverage (days)	—	9 days
Coverage Interval	—	9 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	994	
Apoapse Alt. (km)	994	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	264	

SELECTION RATIONALE:

Because there is no solar elevation constraint, a circular polar orbit was selected. This orbit gives the required coverage in the shortest amount of time under the lifetime, image size and % overlap constraints.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.44
Measurement Alt. Range (km)	994
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	73.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.589
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.589

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 8

Mars (1984) FAMILY NO. 4 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	70.7
Solar Elevation Range (deg)	—	—
Image Interval	—	18 days
Time for % Coverage (days)	—	18 days
Coverage Interval	—	18 days
Distribution	—	45°S to 45°N lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4601	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6910	
Inclination (deg)	45	
Ascending Node (deg)	96.2	
Arg. of Periapse (deg)	168.5	

SELECTION RATIONALE:

There is no solar elevation constraint. An orbit with a 45° inclination satisfies the % coverage requirement. For this orbit, the periapse is close to the equator. The ascending node was selected so as to minimize insertion occulation, but even so, Canopus occulation occurs just before periapse.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4 98
Measurement Alt. Range (km)	425 to 2607
Max. Measurement Arc (deg)	-81 to 99
Max. Sensor on Time (min/orb)	66.3
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.913
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.913

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 9

Mars (1984) FAMILY NO. 4 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	70.9
Solar Elevation Range (deg)	—	—
Image Interval	—	< 25 hours
Time for % Coverage (days)	—	126 days
Coverage Interval	—	—
Distribution	—	-84° to 25° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4601	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6910	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	264	

SELECTION RATIONALE:

There is no solar elevation constraint. An orbit with a 90° inclination maximizes the latitude coverage, plus the periapse regression rate, ($\dot{\omega}$ = -.925 deg/day). Measurements are made at periapse only. Periapse moves 16.640 in latitude during one longitude coverage cycle of 18 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.98
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.462 to .462
Max. Sensor on Time (min/orb)	.252
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.913
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.913

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 10

Mars (1984) FAMILY NO. 5 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	70	35[1]
Solar Elevation Range (deg)	70-90	70-90
Image Interval	—	5 days
Time for % Coverage (days)	—	59 4 days
Coverage Interval	—	5 days
Distribution	—	0° to 44°S lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	969	969
Apoapse Alt. (km)	969	79,251
Inclination (deg)	95.9	76
Ascending Node (deg)	54 9	325
Arg. of Periapse (deg)	257 5	262.5

SELECTION RATIONALE:

To maximize the latitude coverage in the area having the desired sun elevation angles, a circular, highly inclined sun synchronous orbit is selected. The orbit passes close to the subsolar point. Within 59 4 days maximum latitude coverage possible in the southern hemisphere is obtained

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	2.41	
Measurement Alt. Range (km)	969	
Max. Measurement Arc (deg)	40	
Max. Sensor on Time (min/orb)	16.1	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.40	
Plane Change ΔV (km/sec)	.33	(92°)
Size Adjustment ΔV (km/sec)	1.19	
Total ΔV (km/sec)	2.92	

MEASUREMENT ACHIEVEMENT:

1. Only 35% of the planet surface can be covered under the proper illumination constraints while the sun is in the southern hemisphere. 70% coverage of the planet surface would require about 420 days.

ORBIT SELECTION DATA SHEET NO. 11

Mars (1984) FAMILY NO. 6 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8[1]
Total Planet Coverage (%)	> 70	57.9[1]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	10 days
Time for % Coverage (days)	< 100 hrs	10 days
Coverage Interval	> 4/yr	10 days[2]
Distribution	Mare, poles	-59° to 17.5° lat[3]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	.9
Periapse Alt. (km)	425	425
Apoapse Alt. (km)	6955	68,915
Inclination (deg)	90	33.5
Ascending Node (deg)	67	38
Arg. of Periapse (deg)	197	212.5

SELECTION RATIONALE:

An elliptical polar orbit was used to obtain coverage of 58% of the planet surface in 10 days. The orbit is selected so that it is tangent to the area having > 80° solar illumination after 10 days. Periapse is located near the center of the area having the proper solar illumination so that it is possible to use an elliptical orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425 to 952
Max. Measurement Arc (deg)	-25 to 40
Max. Sensor on Time (min/orb)	18.4
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.342
Plane Change ΔV (km/sec)	.247 (61°)
Size Adjustment ΔV (km/sec)	.567
Total ΔV (km/sec)	2.156

MEASUREMENT ACHIEVEMENT:

1. Only 58% coverage is possible since orbit is not sun synchronous.
2. Amount of coverage decreases with each coverage cycle of 10 days.
3. Maximum solar elevation at poles is only 25 degrees.

ORBIT SELECTION DATA SHEET NO. 12

Mars (1984) FAMILY NO. 7 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	77.5
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 hr	5 days
Time for % Coverage (days)	—	5 days
Coverage Interval	> 4/yr	5 days
Distribution	—	-74° to 36° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	969	969
Apoapse Alt. (km)	969	79,251
Inclination (deg)	94.8	114.5
Ascending Node (deg)	260	306
Arg. of Periapse (deg)	254	236.5

SELECTION RATIONALE:

The combination of lighting constraints and 70% coverage requirement require a near polar orbit. The possible positions of periapse preclude elliptical orbits due to a large planet change or a large measurement altitude range. The circular orbit selected is sun synchronous so that measurements can be continued beyond the 5 days necessary for the first coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.48
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	30 to 109
Max. Sensor on Time (min/orb)	31.7
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.400
Plane Change ΔV (km/sec)	.185 (48°)
Size Adjustment ΔV (km/sec)	1.190
Total ΔV (km/sec)	2.775

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 13

Mars (1984) FAMILY NO. 8 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	67
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	5 days
Time for % Coverage (days)	< 100 hrs	40 days 1
Coverage Interval	> 4/yr	twice/Martian yr.
Distribution	Mare /poles	S pole, Mare

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

The combination of solar elevation constraints and the location of the VHP vector, precludes the use of elliptical orbits. A polar circular orbit falls within the proper solar elevation limits at the S. pole at the start of the mission. The coverage then progresses north due to the motion of the Sun. 70% of the planet is covered in approximately 40 days with final coverage occurring at + 20° latitude.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	-29.5 to 54 5
Max. Sensor on Time (min/orb)	33.7
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.59

MEASUREMENT ACHIEVEMENT:

1. 40 days are required to obtain the 67% coverage, as the coverage depends upon the motion of the Sun.

ORBIT SELECTION DATA SHEET NO. 14

Mars (1984) FAMILY NO. 8 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	74
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	5 days
Time for % Coverage (days)	< 100 hrs	5 days
Coverage Interval	> 4/yr	5 days
Distribution	Mare/poles	-85° to 29° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	969	969
Apoapse Alt. (km)	969	79,251
Inclination (deg)	94.8	93
Ascending Node (deg)	292.5	312
Arg. of Periapse (deg)	263	264

SELECTION RATIONALE:

Using an intermediate orbit and a plane change it is possible to obtain a sun synchronous orbit which provides the 70% coverage in 5 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	6.5 to 119
Max. Sensor on Time (min/orb)	45.2
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.400
Plane Change ΔV (km/sec)	.083(21°)
Size Adjustment ΔV (km/sec)	1.190
Total ΔV (km/sec)	2.673

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 15

Mars (1984) FAMILY NO. 9 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	67
Solar Elevation Range (deg)	day	day
Image Interval	< 15 min	5 days
Time for % Coverage (days)	—	12 days
Coverage Interval	4/yr	5 days
Distribution	equator,poles	S. pole, equator[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

A circular orbit was selected to give broad coverage at constant altitude. The periapse is not suitably located for elliptical orbits. The North pole is not exposed to sunlight until 220 days after orbit insertion.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	44
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.59

MEASUREMENT ACHIEVEMENT:

1. Only one pole is exposed to sunlight at a time.

ORBIT SELECTION DATA SHEET NO. 16

Mars (1984) FAMILY NO. 10 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	96
Solar Elevation Range (deg)	night	night
Image Interval	< 2 hr	5 days
Time for % Coverage (days)	—	—
Coverage Interval	> 4/yr	5 days
Distribution	poles	all but S. pole[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	969	969
Apoapse Alt. (km)	969	79,251
Inclination (deg)	94 83	126
Ascending Node (deg)	288.47	287.5
Arg. of Periapse (deg)	251	255

SELECTION RATIONALE:

The coverage required is the night coverage of the area near the poles. A near polar sun-synchronous, circular orbit is selected to give maximum area coverage about the North Pole. Continued coverage is available in maximum darkness, however the South Pole does not enter darkness until 220 days after orbit insertion.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	70°
Max. Sensor on Time (min/orb)	28 1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.400
Plane Change ΔV (km/sec)	240 (63.5)
Size Adjustment ΔV (km/sec)	1.190
Total ΔV (km/sec)	2.830

MEASUREMENT ACHIEVEMENT:

Only one pole is in darkness at a time.

ORBIT SELECTION DATA SHEET NO. 17

Mars (1984) FAMILY NO. 10 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	70
Solar Elevation Range (deg)	night	night
Image Interval	< 2 hr	10 days
Time for % Coverage (days)	—	17 days
Coverage Interval	> 4/yr	10 days
Distribution	poles	N. hemisphere[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	136.6	
Arg. of Periapse (deg)	149	

SELECTION RATIONALE:

The coverage of 70% of the planet begins 7 days after arrival. The elliptical orbit has a large altitude range for coverage, but periapse is moving toward the N pole at the rate of .9 deg/day, lowering the measurement altitude range if the wait can be tolerated. Otherwise a circular orbit should be used.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.0
Measurement Alt. Range (km)	425 to 6481
Max. Measurement Arc (deg)	-59 to 60.7
Max. Sensor on Time (min/orb)	36.8
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.909
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.909

MEASUREMENT ACHIEVEMENT:

1. Only one pole is in darkness at a time.

ORBIT SELECTION DATA SHEET NO. 18

Mars (1984) FAMILY NO. 11 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	—
Image Interval	< 30 hr	5 days
Time for % Coverage (days)	—	5 days
Coverage Interval	> 2/yr	5 days
Distribution	equator,poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

A circular polar orbit satisfies the measurement specifications most easily. This is the lowest circular orbit satisfying the contiguous coverage requirement which has a > 50 yr. lifetime.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.59

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 19

Mars (1984) FAMILY NO. 11 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	67
Solar Elevation Range (deg)	—	—
Image Interval	< 30 hr	10 days
Time for % Coverage (days)	—	—
Coverage Interval	> 2/yr	10 days
Distribution	equator,poles	N. hemisphere

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	136.6	
Arg. of Periapse (deg)	149	

SELECTION RATIONALE:

70% of the planet surface can be covered between -20° latitude and the North Pole with a polar elliptical orbit. The periapse is located about half way between these limits Emphasis is on the North polar cap formation.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425 to 1141
Max. Measurement Arc (deg)	-67 to 53
Max. Sensor on Time (min/orb)	37
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.909
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.909

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 20

Mars (1984) FAMILY NO. 11 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	70
Solar Elevation Range (deg)	—	—
Image Interval	< 30 hr	< 25 hr
Time for % Coverage (days)	—	120 days
Coverage Interval	> 2/hr	3/yr
Distribution	equator,poles	-85° to 25° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

Measurements are made at periapse only along this elliptical orbit so that coverage can be obtained at low altitudes. Periapse proceeds from the South Pole to 25° latitude during the coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.456 to .456
Max. Sensor on Time (min/orb)	.25
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.909
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.909

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 21

Mars (1984) FAMILY NO. 12 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	—
Image Interval	< 2 min	5 days
Time for % Coverage (days)	—	5 days
Coverage Interval	>10/yr	5 days
Distribution	equator,poles, waves	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

A circular, polar orbit satisfies the measurement specifications most easily. This is the lowest circular orbit satisfying the contiguous coverage parameters with >50 yr. lifetime. The northern wave of darkening does not begin until 200 days after orbit insertion.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.59
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2 59

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 22

Mars (1984) FAMILY NO. 12 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	67
Solar Elevation Range (deg)	—	—
Image Interval	< 2 min	10 days
Time for % Coverage (days)	—	—
Coverage Interval	> 10/yr	10 days
Distribution	equator,poles wave	N. hemisphere[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	136.6	
Arg. of Periapse (deg)	149	

SELECTION RATIONALE:

70% of the planet can be covered between the North Pole and -20° latitude with a polar elliptical orbit. The periapse is about halfway between these limits. Emphasis is on the North Polar cap formation Periapse would be in the southern hemisphere during the northern wave of darkening 200 days later.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425 to 1141
Max. Measurement Arc (deg)	-67 to 53
Max. Sensor on Time (min/orb)	37
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1 909
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	1.909

MEASUREMENT ACHIEVEMENT:

The northern wave of darkening does not occur for 200 days. At that time, periapse is in the southern hemisphere.

ORBIT SELECTION DATA SHEET NO. 23

Mars (1984) FAMILY NO. 12 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	70
Solar Elevation Range (deg)	—	—
Image Interval	< 2 min	< 25 hr[1]
Time for % Coverage (days)	—	120 days
Coverage Interval	> 10/yr	3/yr[2]
Distribution	equator,poles wave	-85° to 25° lat[3]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	265	

SELECTION RATIONALE:

This elliptical orbit is used so that measurements are made at periapse only in order to achieve coverage at low altitudes. Periapse proceeds from the South Pole to 25° latitude during the coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.456 to .456
Max. Sensor on Time (min/orb)	.25
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.909
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.909

MEASUREMENT ACHIEVEMENT:

1 The same area is not covered twice. Side by side images of any one area occur once a day or about every 25 hours

2. Because 120 days are required to obtain 70% coverage, at most, 3 coverages/year are possible.

3. This orbit is not good for the northern wave of darkening. Periapse will be at the North Pole before the wave begins.

ORBIT SELECTION DATA SHEET NO. 24

Mars (1984) FAMILY NO. 13 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	55[1]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	27 days[2]
Time for % Coverage (days)	<1 day	55 days[3]
Coverage Interval	4/yr	twice/year[3]
Distribution	poles,wave	-60° to 16° lat.[4]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	1016	1016
Apoapse Alt. (km)	1016	80,144
Inclination (deg)	95.01	39
Ascending Node (deg)	62.5	7
Arg. of Periapse (deg)	191	238

SELECTION RATIONALE:

Because of the small image size of 100 km, the number of days required in order to obtain longitudinal coverage is long (27 days for a circular orbit). The length of time required for longitudinal coverage, combined with the position of periapse, precludes the use of elliptical orbits. To obtain maximum latitude coverage with the desired sun elevations a highly inclined, circular (sun-synchronous) orbit is used.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	2.45	
Measurement Alt. Range (km)	1016	
Max. Measurement Arc (deg)	-50 to 37	
Max. Sensor on Time (min/orb)	23.7	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.405	
Plane Change ΔV (km/sec)	.270	(73°)
Size Adjustment ΔV (km/sec)	1.183	
Total ΔV (km/sec)	2.858	

MEASUREMENT ACHIEVEMENT:

1. Only 55% of the planet surface can be covered during the first 115 days of the mission. For mission times longer than 115 days, additional area in the northern hemisphere can be covered.
2. Because the amount of coverage depends upon the motion of the sun, about 55 days are required to obtain the 55% coverage.
3. 70% coverage of the planet could be obtained 2 times a year.
4. The highest solar elevation at the poles is 25°.

ORBIT SELECTION DATA SHEET NO. 25

Mars (1984) FAMILY NO. 14 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	75
Solar Elevation Range (deg)	30-60	30-60
Image Interval	-	27 days
Time for % Coverage (days)	< 1 day	27 days
Coverage Interval	4/yr	27 days
Distribution	poles,waves	-76° to 32° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	1016	1016
Apoapse Alt. (km)	1016	80,144
Inclination (deg)	95.6	102.5
Ascending Node (deg)	260	306.5
Arg. of Periapse (deg)	245.5	263.5

SELECTION RATIONALE:

The 100 km image size and the 50 yr. lifetime constraint result in orbits which require a minimum time of 27 days for complete longitudinal coverage. To obtain the 70% coverage, a highly inclined sun-synchronous orbit is used. A circular orbit is selected because the sun-synchronous elliptical orbits which require a small plane change have periapse placed so that it would regress out of the area with desired sun elevation before coverage is complete.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.46
Measurement Alt. Range (km)	1016
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	45.1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.408
Plane Change ΔV (km/sec)	.181 (47°)
Size Adjustment ΔV (km/sec)	1.183
Total ΔV (km/sec)	2.772

MEASUREMENT ACHIEVEMENT:

1. The highest solar elevation angle at the poles is 25°.

ORBIT SELECTION DATA SHEET NO. 26

Mars (1984) FAMILY NO. 15 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	—
Image Interval	—	27 days
Time for % Coverage (days)	< 1 day	27 days
Coverage Interval	—	27 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	1016	
Apoapse Alt. (km)	1016	
Inclination (deg)	90	
Ascending Node (deg)	316.6	
Arg. of Periapse (deg)	263.5	

SELECTION RATIONALE:

The small image size of 100 km and the lifetime constraint result in orbits which have a minimum longitudinal coverage time of 27 days. Of such orbits, a circular, polar orbit satisfies the measurement specifications most easily 100% coverage is obtained in 27 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.46
Measurement Alt. Range (km)	1016
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	73.8
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.588
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	2.588

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 27

Mars (1984) FAMILY NO. 16 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	—
Solar Elevation Range (deg)	70-85	70-85
Image Interval	—	1 day
Time for % Coverage (days)	—	—
Coverage Interval	> 4/yr	—
Distribution	—	-37° to -6° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	36
Ascending Node (deg)	70	20.5
Arg. of Periapse (deg)	207	219.5

SELECTION RATIONALE:

A 3 revolutions/day orbit is selected to minimize the periapse altitude and ΔV while maintaining the solar precession rate for the ascending node. Off-periapse insertion is used to rotate the apseline 7.5° to the most favorable orbit periapse location. The orbit plane is rotated 99° to obtain the correct inclination. The orbit periapse move in the same latitude direction as the Sun with time. The stay time is dependent upon the number and size of areas which must be observed (no a priori information exists for this).

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 485
Max. Measurement Arc (deg)	-84 to -44
Max. Sensor on Time (min/orb)	17.2
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.362 (7.5°)
Plane Change ΔV (km/sec)	.373 (99°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.095

MEASUREMENT ACHIEVEMENT:

1. Initial coverage

ORBIT SELECTION DATA SHEET NO. 28

Mars (1984) FAMILY NO. 17 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	-
Solar Elevation Range (deg)	-	1 day
Image Interval	-	-
Time for % Coverage (days)	-	-
Coverage Interval	-	global
Distribution		

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	136.6	136.6
Arg. of Periapse (deg)	150	-

SELECTION RATIONALE:

An elliptical polar orbit of period 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only one pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 35°N. latitude. A 2-impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. Stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.62
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. The total ΔV required depends upon the number of areas to be covered and hence upon the number of maneuvers required. Thus, total ΔV will equal capture ΔV + whatever integer multiple of 1.234 km/sec is necessary.

ORBIT SELECTION DATA SHEET NO. 29

Mars (1984) FAMILY NO. 18 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	-
Solar Elevation Range (deg)	70-90	70-90
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-37° to 6° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	36
Ascending Node (deg)	70	20.5
Arg. of Periapse (deg)	204	219.5

SELECTION RATIONALE:

A 3 revolutions/day orbit is selected to minimize the periapse altitude and ΔV while maintaining the solar precession rate for the ascending node. Off-periapse insertion is used to rotate the apseline 7.5° to the most favorable orbit periapse location. The orbit plane is rotated 99° to obtain the correct inclination. The orbit periapse moves in the same latitude direction as the Sun with time. The stay time is dependent upon the number and size of areas which must be observed on which no a priori information exists.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 485[1]
Max. Measurement Arc (deg)	-84 to-44
Max. Sensor on Time (min/orb)	17.2
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.362 (7.5°)
Plane Change ΔV (km/sec)	.373 (99°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.095

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 30

Mars (1984) FAMILY NO. 19 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	-
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	-	-50° to 3° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	32
Ascending Node (deg)	80	30
Arg. of Periapse (deg)	205	220.5

SELECTION RATIONALE:

Detailed measurements are made at a maximum rate of 1 pass/day. Orbit precession is used to maintain the solar elevation constraint. Maximum elliptical orbit (lowest periapse) satisfying these factors has a period = 1/3 Mars day. A large plane change establishes periapse in a desirable position. Coverage initially extends from -50° to 3° latitude. The stay time is dependent upon the number, size and location of the areas to be observed for which a priori information does not exist.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 880
Max. Measurement Arc (deg)	-29	to 47
Max. Sensor on Time (min/orb)	23.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.340	
Plane Change ΔV (km/sec)	.382	(102.5°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.082	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 31

Mars (1984) FAMILY NO. 20 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	68[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	-
Distribution	-	-47° to 40° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	36
Ascending Node (deg)	253.5	71
Arg. of Periapse (deg)	356	184.5

SELECTION RATIONALE:

Detailed measurements can be made at a maximum rate of one pass/day. The use of orbit precession to maintain solar elevations is required. Maximum elliptical orbit (minimum periapse) satisfying these factors has a period of 1/3 Mars day. A large plane change is the cheapest way to center periapse in the properly lighted area. Coverage extends to 55° from periapse along the orbit. Stay time is dependent upon the number, size, and location of the areas to be observed for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 1115
Max. Measurement Arc (deg)	-55 to 55
Max. Sensor on Time (min/orb)	31
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.338
Plane Change ΔV (km/sec)	.485 (161°)
Size Adjustment ΔV (km/sec)	.361
Total ΔV (km/sec)	2.184

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 32

Mars (1984) FAMILY NO. 21 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	75
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	1 day
Time for % Coverage (days)	-	50 days
Coverage Interval	> 4 yr	50 days
Distribution	Mare,poles	Mare,poles

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	317	317
Arg. of Periapse (deg)	265	265 360

SELECTION RATIONALE:

A one orbit per Mars day elliptical orbit is selected since this is the maximum rate at which fine detail can be gathered. The 90° inclination is set by the distribution required. During the first 25 days surface coverage includes the southern polar region between -47.5 and -90° latitude. Periapse is within 10° of the South Pole. At the end of 25 days, an apseline rotation of approximately 100° is made, placing periapse at the equator. For the next 25 days, coverage moves from a maximum southerly latitude of -47.5° to a maximum northerly latitude of +30°.The solar elevation constraint is satisfied at all times.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 976
Max. Measurement Arc (deg)	-26 to 56
Max. Sensor on Time (min/orb)	21.7
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	2.671

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 33

Mars (1984) FAMILY NO. 21 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	74
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	50 days
Coverage Interval	> 4/yr	-
Distribution	Mare, poles	-42° to 55° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	124
Ascending Node (deg)	292	292
Arg. of Periapse (deg)	0	258

SELECTION RATIONALE:

An elliptical orbit was chosen to reduce the measurement altitude. The inclination is set for sun-synchronous precession. This orbit has a period of 3 orbit periods/Mars day. This is the smallest number of orbits/day for a sun-synchronous orbit. Capture is made into an intermediate orbit with the proper inclination. Periapse is rotated to the equator using circularization at apoapse. The final orbit size is established with an apoapse and periapse maneuver. Initial coverage extends from -30° to 55° latitude. 50 days later coverage extends from -42° to 51° latitude. Solar elevation is within 15° to 30° at all times.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 2117
Max. Measurement Arc (deg)	-41	to 81
Max. Sensor on Time (min/orb)	38.6	
No. of Impulses (ΔV)	4	
Capture ΔV (km/sec)	1.340	
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	1.420	(3 impulses)
Total ΔV (km/sec)	2.760	

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 34

Mars (1984) FAMILY NO. 22 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	95
Solar Elevation Range (deg)	day	day
Image Interval	< 2 hrs	1 day [1]
Time for % Coverage (days)	-	> 200 days
Coverage Interval	> 1/day	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	70	70
Ascending Node (deg)	122.95	122.95
Arg. of Periapse (deg)	151.5	-

SELECTION RATIONALE:

An elliptical 1-day period orbit was chosen for low periapse altitude coverage. The initial position of periapse remains in sunlight for over 200 days. Because of the lack of a priori information, the periapse may have to be moved to obtain detailed coverage of desired areas. Each such movement is made with 2 apoapse impulses (circular/apseline rotation) costing a total of 1.234 km/sec. Approximately 95% of the surface crosses this orbit trace in sunlight.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 365
Max. Measurement Arc (deg)	-10 to 10
Max. Sensor on Time (min/orb)	.47
No. of Impulses (ΔV)	1 + size adjustments [2]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments [2]

MEASUREMENT ACHIEVEMENT:

1. The shortest time between images equals one orbit period.
2. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 35

Mars (1984) FAMILY NO. 23 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	-
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hrs	25 hrs
Time for % Coverage (days)	-	-
Coverage Interval	> 2/yr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	136.6	136.6
Arg. of Periapse (deg)	150	-

SELECTION RATIONALE:

An elliptical polar orbit of period 1 Mars day was selected to give minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 35°N. latitude. A 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. Stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.62
Measurement Alt. Range (km)	340 to 370.
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 36

Mars (1984) FAMILY NO. 24 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	-
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/day	- [1]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	136.6	136.6
Arg. of Periapse (deg)	150	-

SELECTION RATIONALE:

An elliptical polar orbit of period 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 35°N. latitude. A 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. Stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.62
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[2]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments[2]

MEASUREMENT ACHIEVEMENT:

1. The coverage interval cannot be determined now as it will depend upon the time required to obtain complete coverage of the area in question. However, it will be greater than 1 day as the interval between successive images of the same area is one day.
2. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 37

Mars (1984) FAMILY NO. 25 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	.5	.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	-
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	< 1/300 hr	-
Distribution	-	-37° to 6° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	36
Ascending Node (deg)	70	20.5
Arg. of Periapse (deg)	204	219.5

SELECTION RATIONALE:

A 3 revolution/Mars day orbit is selected to minimize the periapse altitude and ΔV while maintaining the solar precession rate for the ascending node. Off-periapse insertion is used to rotate the apseline 7.5° to the most favorable orbit periapse location. The orbit plane is rotated 99° to obtain the correct inclination. The orbit periapse moves in the same latitude direction as the Sun with time. The stay time is dependent upon the number and size of areas to be observed for which no a priori information exists.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 485[1]
Max. Measurement Arc (deg)	-84 to -44
Max. Sensor on Time (min/orb)	17.2
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.362 (7.5°)
Plane Change ΔV (km/sec)	.373 (99°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.095

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 38

Mars (1984) FAMILY NO. 26 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 3	-
Solar Elevation Range (deg)	-	-
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/300hr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	136.6	136.6
Arg. of Periapse (deg)	150	-

SELECTION RATIONALE:

An elliptical polar orbit of period 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 35°N. latitude. A 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. Stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.62
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 39

Mars (1984) FAMILY NO. 27 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	.5	.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	-
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-37° to 6° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	36
Ascending Node (deg)	70	20.5
Arg. of Periapse (deg)	204	219.5

SELECTION RATIONALE:

A 3 revolution/Mars day orbit is selected to minimize the periapse altitude and ΔV while maintaining the solar precession rate for the ascending node. Off-periapse insertion is used to rotate the apseline 7.5° to the most favorable orbit periapse location. The orbit plane is rotated 99° to obtain the correct inclination. The orbit periapse moves in the same latitude direction as the Sun with time. The stay time is dependent upon the number and size of areas to be observed for which no a priori information exists.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 485[1]
Max. Measurement Arc (deg)	-84 to -44
Max. Sensor on Time (min/orb)	17.2
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.362 (7.5°)
Plane Change ΔV (km/sec)	.373 (99°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.095

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 40

Mars (1984) FAMILY NO. 28 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	>3
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	-	-50° to 3° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	32
Ascending Node (deg)	80	30
Arg. of Periapse (deg)	205	220.5

SELECTION RATIONALE:

Detailed measurements are made at a maximum rate of 1 pass/day. Orbit precession is used to maintain the solar elevation constraint. Maximum elliptical orbit (lowest periapse) satisfying these factors has a period = 1/3 Mars day. A large plane change establishes periapse in a desirable position. Coverage initially extends from -50° to 3° latitude. The stay time is dependent upon the number, size and location of the areas to be observed for which a priori information does not exist.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 880[1]
Max. Measurement Arc (deg)	-29	to 47
Max. Sensor on Time (min/orb)	23.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.340	
Plane Change ΔV (km/sec)	.382	(102.5°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.082	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 41

Mars (1984) FAMILY NO. 29 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	68[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-47° to 40° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	36
Ascending Node (deg)	253.5	71
Arg. of Periapse (deg)	356	184.5

SELECTION RATIONALE:

Detailed measurements can be made at a maximum rate of one pass/day. The use of orbit precession to maintain polar elevations is required. Maximum elliptical orbit (minimum periapse) satisfying these factors has a period of 1/3 Mars day. A large plane change is the cheapest way to center periapse in the properly light area. Coverage extends to 55° from periapse along the orbit. Stay time is dependent upon the number, size, and location of the areas to be observed for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 1115[1]
Max. Measurement Arc (deg)	-55	to 55
Max. Sensor on Time (min/orb)	31	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.338	
Plane Change ΔV (km/sec)	.485	(161°)
Size Adjustment ΔV (km/sec)	.361	
Total ΔV (km/sec)	2.184	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 42

Mars (1984) FAMILY NO. 30 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)		74
Solar Elevation Range (deg)	15-30	15-30
Image Interval	$<$ 1 day	1 day
Time for % Coverage (days)	$<$ 100 hrs	50 days
Coverage Interval	$>$ 4/yr	-
Distribution	-	-42° to 55° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	124
Ascending Node (deg)	292	292
Arg. of Periapse (deg)	0	258

SELECTION RATIONALE:

An elliptical orbit was chosen to include the measurement altitude. The inclination is set for sun synchronous precession. This orbit has a period of 3 orbits/Mars day. This is the smallest number of orbits/day for a sun synchronous orbit. Capture is made into an intermediate orbit with the proper inclination. Periapse is rotated to the equator using circularization at apoapse. The final orbit size is established with an apoapse and periapse maveuver. Initial coverage extends from -30° to 55° latitude. 50 days later coverage extends from -42° to 51° latitude. Solar elevation is within 15°-30° at all times.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 2117
Max. Measurement Arc (deg)	-41	to 81
Max. Sensor on Time (min/orb)	38.6	
No. of Impulses (ΔV)	4	
Capture ΔV (km/sec)	1.340	
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	1.420	(3 impulses)
Total ΔV (km/sec)	2.760	

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 43

Mars (1984) FAMILY NO. 31 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	>3
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hrs	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/300 hr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	136.6	136.6
Arg. of Periapse (deg)	150	-

SELECTION RATIONALE:

An elliptical polar orbit of period 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 35°N. latitude. A 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. Stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.62
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	1.437
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	1.437 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 44

Mars (1984) FAMILY NO. 32 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	-	-
Solar Elevation Range (deg)	70-85	70-85
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	waves, poles, mountains	-37° to 6° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	36
Ascending Node (deg)	70	20.5
Arg. of Periapse (deg)	204	219.5

SELECTION RATIONALE:

A 3 revolution/day orbit is selected to minimize the periapse altitude and ΔV while maintaining the solar precession rate for the ascending node. Off-periapse insertion is used to rotate the apseline 7.5° to the most favorable orbit periapse location. The orbit plane is rotated 99° to obtain the correct inclination. The orbit periapse moves in the same latitude direction as the Sun with time. The stay time is dependent upon the number and size of areas to be observed for which no a priori information exists.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383 to 485[1]	
Max. Measurement Arc (deg)	-84 to -44	
Max. Sensor on Time (min/orb)	17.2	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.362	(7.5°)
Plane Change ΔV (km/sec)	.373	(99°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.095	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage. The maximum solar elevation angle at the poles is 25°.

ORBIT SELECTION DATA SHEET NO. 45

Mars (1984) FAMILY NO. 33 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	-	-
Total Planet Coverage (%)	-	-
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	waves, poles, mountains	-50° to 3° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	32
Ascending Node (deg)	80	30
Arg. of Periapse (deg)	205	220.5

SELECTION RATIONALE:

Detailed measurements are made at a maximum rate of 1 pass/day. Orbit precession is used to maintain the solar elevation constraint. Maximum elliptical orbit (lowest periapse) satisfying these factors has a period = 1/3 Mars day. A large plane change establishes periapse in a desirable position Coverage initially extends from -50° to 3° latitude. The stay time is dependent upon the number, size, and location of the areas to be observed for which a priori information does not exist.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 880[2]
Max. Measurement Arc (deg)	-29	to 47
Max. Sensor on Time (min/orb)	23.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.340	
Plane Change ΔV (km/sec)	.382	(102.5°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.082	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 46

Mars (1984) FAMILY NO. 34 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	-	-
Total Planet Coverage (%)	-	68[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	waves, poles, mountains	-47° to 40° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	36
Ascending Node (deg)	253.5	71
Arg. of Periapse (deg)	356	184.5

SELECTION RATIONALE:

Detailed measurements can be made at a maximum rate of one pass/day. The use of orbit precession to maintain polar elevations is required. Maximum elliptical orbit (minimum periapse) satisfying these factors has a period of 1/3 Mars day. A large plane change is the cheapest way to center periapse in the properly lighted areas. Coverage extends to 55° from periapse along the orbit. Stay time is dependent upon the number, size and location of the areas to be observed for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383 to 1115[1]	
Max. Measurement Arc (deg)	-55 to 55	
Max. Sensor on Time (min/orb)	31	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.338	
Plane Change ΔV (km/sec)	.485	(161°)
Size Adjustment ΔV (km/sec)	.361	
Total ΔV (km/sec)	2.184	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 47

Mars (1988) FAMILY NO. 1 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	31.5
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day	day
Image Interval	-	3 days
Time for % Coverage (days)	< 1 day	40 days [1]
Coverage Interval	20/yr	-
Distribution	poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	931	
Apoapse Alt. (km)	931	
Inclination (deg)	90	
Ascending Node (deg)	94.5	
Arg. of Periapse (deg)	311	

SELECTION RATIONALE:

A polar orbit is selected because the coverage requirement include the poles and 70% of the planet. Polar orbits passing through the VHP vector have periapse on the dark side of the planet hence elliptical orbits are not possible. The sun reaches the equator 36 days after the start of the mission, after this the other pole may be observed in daylight. The location of the ascending node was chosen to minimize occultation.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.38
Measurement Alt. Range (km)	931
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	71.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.051
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.051

MEASUREMENT ACHIEVEMENT:

1. If it were not necessary to observe the 2nd pole, > 70% coverage could be obtained in 3 days which is the time required to obtain one longitudinal coverage of the planet.

ORBIT SELECTION DATA SHEET NO. 48

Mars (1988) FAMILY NO. 2 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	20	26.8
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	-
Image Interval	-	6 days
Time for % Coverage (days)	< 1 day	6 days[1]
Coverage Interval	20/yr	once/6 days
Distribution	poles	-90° to 25° lat.[2]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.3971	
Periapse Alt. (km)	440	
Apoapse Alt. (km)	5473	
Inclination (deg)	90	
Ascending Node (deg)	95.1	
Arg. of Periapse (deg)	309	

SELECTION RATIONALE:

Because there is no solar elevation constraint, an elliptical polar orbit through the VHP vector is selected to maximize the coverage and to minimize the propulsion requirements. Periapse is at -51° latitude. 70% coverage of the planet surface can be obtained between the altitudes 440 to 1489 km. The direction of motion along the orbit is picked by minimizing occultation of Earth, Canopus and Sun.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.25
Measurement Alt. Range (km)	440 to 1489
Max. Measurement Arc (deg)	-39 to 76
Max. Sensor on Time (min/orb)	36.8
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.4841
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.4841

MEASUREMENT ACHIEVEMENT:

1. To obtain 70% coverage of the planet surface, one complete longitudinal coverage of the planet must be made. This takes six days.
2. Only one pole is covered because of altitude restrictions on the elliptical orbit.

ORBIT SELECTION DATA SHEET NO. 49

Mars (1988) FAMILY NO. 3 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	61.1
Total Planet Coverage (%)	> 70	31.7 [1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	9 days
Time for % Coverage (days)	-	30 days
Coverage Interval	-	-
Distribution	-	-22° to 15° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	994	994
Apoapse Alt. (km)	994	79,726
Inclination (deg)	71	29
Ascending Node (deg)	218.5	88.5
Arg. of Periapse (deg)	203	313.5

SELECTION RATIONALE:

Because of the respective locations of the VHP vector, periapse and the area having desired sun elevation angles. it is not possible to get orbits with much latitude coverage at the time of arrival using insertion at periapse. This orbit was selected so that is was outside the area having the desired sun elevation angles at the time of arrival. Its ascending node moves opposite the direction of the motion of the sun, so that the desired coverage will be obtained between 15 and 30 days after arrival.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	10	
Measurement Orbit Frequency	every	orbit
Orbit Period (hrs)	2.44	
Measurement Alt. Range (km)	994	
Max. Measurement Arc (deg)	38	
Max. Sensor on Time (min/orb)	15.5	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	.860	
Plane Change ΔV (km/sec)	.320	(89.5°)
Size Adjustment ΔV (km/sec)	1.186	
Total ΔV (km/sec)	2.366	

MEASUREMENT ACHIEVEMENT:

1. The area having desired sun elevation angles is small and the sun is just ready to move into the northern hemisphere. Because of this, even if a sun synchronous orbit were used, it would take about 3/4 of a Mars year to obtain > 70% coverage.

ORBIT SELECTION DATA SHEET NO. 50

Mars (1988) FAMILY NO. 3 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	60.2
Total Planet Coverage (%)	> 70	53 [1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	18 days
Time for % Coverage (days)	-	125 days
Coverage Interval	-	-
Distribution	-	-28° to 36° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4601	.9
Periapse Alt. (km)	425	425
Apoapse Alt. (km)	6910	68,915
Inclination (deg)	106.5	29
Ascending Node (deg)	352	88.5
Arg. of Periapse (deg)	190	313.5

SELECTION RATIONALE:

A sun synchronous elliptical orbit, with periapse located near the bottom of the region with desired solar elevations, and advancing so that it stays in the solar constrained area for 125 days, is selected. This orbit requires both a plane change and off-periapse insertion because both the VHP vector and periapse are poorly located in relation to the area having desired solar elevation angles.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.98
Measurement Alt. Range (km)	425 to 697
Max. Measurement Arc (deg)	-19 to 190
Max. Sensor on Time (min/orb)	10.5
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.490 (-57°)
Plane Change ΔV (km/sec)	.368 (98°)
Size Adjustment ΔV (km/sec)	.572
Total ΔV (km/sec)	2.430

MEASUREMENT ACHIEVEMENT:

1. Because measurements are made primarily in the northern hemisphere, the mission time would have to be approximately 3/4 Mars year to obtain > 70% coverage.

ORBIT SELECTION DATA SHEET NO. 51

Mars (1988) FAMILY NO. 4 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	61.1
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	-	9 days
Time for % Coverage (days)	-	9 days
Coverage Interval	-	once/9 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	994	
Apoapse Alt. (km)	994	
Inclination (deg)	90	
Ascending Node (deg)	95.1	
Arg. of Periapse (deg)	309	

SELECTION RATIONALE:

Because there is no solar elevation constraint, 100% of the planet surface can be covered most quickly by using a circular polar orbit passing through the VHP vector.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.44
Measurement Alt. Range (km)	994
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	73.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.046
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.046

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 52

Mars(1988) FAMILY NO. 4 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	60	60.2
Total Planet Coverage (%)	> 70	71.13
Solar Elevation Range (deg)	-	-
Image Interval	-	18 days
Time for % Coverage (days)	-	188 days
Coverage Interval	-	-
Distribution	-	-90° to 25° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4601	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6910	
Inclination (deg)	90	
Ascending Node (deg)	95.1	
Arg. of Periapse (deg)	309	

SELECTION RATIONALE:

Measurements are made at periapse only along this elliptical polar orbit. One way of covering 70% of the planet surface is to cover all the latitudes between -90° and 25°. This takes 188 days. Note the difference in mission time between this data collection technique and that of the circular orbit selected on orbit selection data sheet #35.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	4.98
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.462 to .462
Max. Sensor on Time (min/orb)	.25
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.396
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.396

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 53

Mars (1988) FAMILY NO. 5 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	23
Total Planet Coverage (%)	> 70	43[1]
Solar Elevation Range (deg)	70-90	70-90
Image Interval	-	15 days
Time for % Coverage (days)	-	235 days
Coverage Interval	-	-
Distribution	-	-11° to 42° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6115	.9
Periapse Alt. (km)	385	385
Apoapse Alt. (km)	12,236	68,155
Inclination (deg)	123	9
Ascending Node (deg)	350	255
Arg. of Periapse (deg)	318.5	274

SELECTION RATIONALE:

Because periapse is spaced far from the area having the desired sun elevation angles, an off-periapse insertion is made into a sun synchronous elliptical orbit whose periapse stays centered in the area having the desired sun elevation for the next 235 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	8.03
Measurement Alt. Range (km)	385 to 434
Max. Measurement Arc (deg)	-9 to 28
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.310 (-44.5°)
Plane Change ΔV (km/sec)	.427 (121°)
Size Adjustment ΔV (km/sec)	.368
Total ΔV (km/sec)	2.105

MEASUREMENT ACHIEVEMENT:

1. No additional coverage can be obtained for approximately the next 235 days while the sun travels back to the southern hemisphere.

ORBIT SELECTION DATA SHEET NO. 54

Mars (1988) FAMILY NO. 6 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	23
Total Planet Coverage (%)	> 70	68.8
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	15 days
Time for % Coverage (days)	< 100 hrs	235 days[1]
Coverage Interval	> 4/yr	-[2]
Distribution	Mare, poles	-36° to 52° lat.[3]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6115	.9
Periapse Alt. (km)	385	385
Apoapse Alt. (km)	12,236	68,155
Inclination (deg)	123	9
Ascending Node (deg)	350	255
Arg. of Periapse (deg)	318.5	274

SELECTION RATIONALE:

Because periapse is located far from the area having the desired sun elevation angles, an off-periapse insertion is made into a sun synchronous elliptical orbit whose periapse stays centered in the area having desired sun elevations for the next 235 days.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	8.03
Measurement Alt. Range (km)	385 to 615
Max. Measurement Arc (deg)	-28 to 48
Max. Sensor on Time (min/orb)	20.8
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.310 (-44.5°)
Plane Change ΔV (km/sec)	.427 (121°)
Size Adjustment ΔV (km/sec)	.368
Total ΔV (km/sec)	2.105

MEASUREMENT ACHIEVEMENT:

1. Obtaining the required % coverage depends upon the motion of the sun.
2. Because one coverage takes 235 days, 4 coverages/year are not possible.
3. The poles are never illuminated between 50° and 80°.

ORBIT SELECTION DATA SHEET NO. 55

Mars (1988) FAMILY NO. 7 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	75
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 hr	5 days
Time for % Coverage (days)	-	45 days[1]
Coverage Interval	> 4/yr	-
Distribution	-	-49° to 54° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	969	969
Apoapse Alt. (km)	969	79,251
Inclination (deg)	90	7
Ascending Node (deg)	40.5	305.5
Arg. of Periapse (deg)	5.5	96

SELECTION RATIONALE:

Because of the location of the VHP vector relative to the subsolar point, a plane change is necessary to obtain much coverage in the areas having the desired sun elevation. A polar orbit is chosen so that there is no precession of the ascending node. The desired coverage is obtained by waiting for the subsolar point to move toward the orbit. Elliptical orbits cannot be used because of the fast regression of periapse coupled with the 45 day mission time.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	104
Max. Sensor on Time (min/orb)	41.8
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	.858
Plane Change ΔV (km/sec)	.322 (90°)
Size Adjustment ΔV (km/sec)	1.190
Total ΔV (km/sec)	2.370

MEASUREMENT ACHIEVEMENT:

1. Using this orbit only 2 coverages/Mars years are possible.

ORBIT SELECTION DATA SHEET NO. 56

Mars (1988) FAMILY NO. 8 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	78.3
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	10 days
Time for % Coverage (days)	< 100 hrs	10 days
Coverage Interval	> 4/yr	once/10 days
Distribution	Mare, poles	-40.5° to 66.5° [1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	.9
Periapse Alt. (km)	425	425
Apoapse Alt. (km)	6995	68,915
Inclination (deg)	106.7	10
Ascending Node (deg)	44.5	295.5
Arg. of Periapse (deg)	9.5	106

SELECTION RATIONALE:

The location of the VHP vector relative to the subsolar point necessitates a plane change in order to obtain 70% coverage in the areas having proper solar elevations. Using a sun synchronous elliptical orbit, it is possible to obtain the 70% coverage in 10 days. 10 days is the time needed for one complete longitudinal coverage of the planet. The selection of orbits is limited by the possible locations of periapse which lie far from the areas having the desired illumination.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425 to 1305
Max. Measurement Arc (deg)	-52 to 66
Max. Sensor on Time (min/orb)	36.4
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	.824
Plane Change ΔV (km/sec)	.398 (109.5)
Size Adjustment ΔV (km/sec)	.567
Total ΔV (km/sec)	1.789

MEASUREMENT ACHIEVEMENT:

1. The poles are not illuminated between 15° - 30° at the beginning of the mission.

ORBIT SELECTION DATA SHEET NO. 57

Mars (1988) FAMILY NO. 9 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day	day
Image Interval	< 15 min	5 days
Time for % Coverage (days)	-	40 days
Coverage Interval	> 4/yr	-
Distribution	equator,poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	94.5	
Arg. of Periapse (deg)	311	

SELECTION RATIONALE:

A polar orbit is selected because the coverage requirements include the poles and > 70% of the planet. Polar orbits passing through the VHP vector have periapse on the dark side of the planet hence elliptical orbits are not suitable. The sun reache the equator 36 days after the start of the mission. After this time the north pole will be in daylight. The direction of motion along the orbit is picked to minimize Sun, Earth and Canopus occultation.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.051
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.051

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 58

Mars (1988) FAMILY NO. 10 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	night	night
Image Interval	< 2 hr	5 days
Time for % Coverage (days)	-	45 days
Coverage Interval	> 4/yr	once/5 days [1]
Distribution	poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	94.8	
Ascending Node (deg)	95	
Arg. of Periapse (deg)	310.5	

SELECTION RATIONALE:

This orbit is selected so that the ascending node precesses at the same rate as the antisolar point. The orbit always stays in maximum darkness. The high inclination permits coverage of the poles. After 35 days, the South Pole enters darkness. A mission time of 45 days allows the South Pole to move away from the terminator.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.048
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.048

MEASUREMENT ACHIEVEMENT:

1. '>70% of the planet surface can be covered every 5 days, however only one pole is covered at a time.

ORBIT SELECTION DATA SHEET NO. 59

Mars (1988) FAMILY NO.11 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hr	5 days
Time for % Coverage (days)	-	5 days
Coverage Interval	> 2/yr	once/ 5 day
Distribution	equator, poles	

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	275.1	
Arg. of Periapse (deg)	122.8	

SELECTION RATIONALE:

A circular polar orbit obtains the required coverage (poles, equator) most easily. 100% coverage can be obtained in 5 days. This is the lowest circular orbit satisfying the constraints on image size and lifetime.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.048
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.048

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 60

Mars (1988) FAMILY NO. 11 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hrs	~25 hrs
Time for % Coverage (days)	-	163 days
Coverage Interval	> 2/yr	once/163 days
Distribution	equator, poles	-25° to 90° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	275.1	
Arg. of Periapse (deg)	122.8	

SELECTION RATIONALE:

71% of the planet surface can be covered in 163 days using an elliptical polar orbit when measurements are made at periapse only. Measurements are duplicated in the northern latitudes before they are made in the southern latitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.4562 to .4562
Max. Sensor on Time (min/orb)	.25
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.391
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.391

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 61

Mars (1988) FAMILY NO. 12 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	30.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	5 days
Time for % Coverage (days)	-	5 days
Coverage Interval	> 10/yr	once/5days
Distribution	equator, poles, wave	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	969	
Apoapse Alt. (km)	969	
Inclination (deg)	90	
Ascending Node (deg)	275.1	
Arg. of Periapse (deg)	122.8	

SELECTION RATIONALE:

A circular polar orbit obtains the required coverage (poles, equator, waves) most easily. 100% coverage can be obtained in 5 days. This is the lowest circular orbit satisfying the constraints on image size and lifetime.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.41
Measurement Alt. Range (km)	969
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	72
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.048
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.048

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 62

Mars (1988) FAMILY NO. 12 ORBIT NO. 6

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	600
Minimum Image Overlap (%)	20	27.8
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	~25 hrs[1]
Time for % Coverage (days)	-	163 days
Coverage Interval	> 10/yr	once/163 days[2]
Distribution	equator, poles, wave	-25° to 90° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.4633	
Periapse Alt. (km)	425	
Apoapse Alt. (km)	6995	
Inclination (deg)	90	
Ascending Node (deg)	275.1	
Arg. of Periapse (deg)	122.8	

SELECTION RATIONALE:

71% of the planet surface can be covered in 163 days using an elliptical polar orbit when measurements are made at periapse only. Measurements are duplicated in the northern latitudes before they are made in the southern latitudes. They are made in the northern latitudes in the late winter and in the spring so that the waves of darkening may be observed in the northern hemisphere at that time.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	5
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	5.03
Measurement Alt. Range (km)	425
Max. Measurement Arc (deg)	-.4562 to .4562
Max. Sensor on Time (min/orb)	.25
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.391
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.391

MEASUREMENT ACHIEVEMENT:

1. The time between overlapping images of any area is approximately 25 hours. The same area is not imaged twice.
2. Approximately two coverages per year are possible.

ORBIT SELECTION DATA SHEET NO. - 63

Mars (1988) FAMILY NO. 13 ORBIT NO.

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	81
Solar Elevation Range (deg)	50-80	50-80
Image Interval	-	27 days
Time for % Coverage (days)	< 1 day	235 days [1]
Coverage Interval	> 4/yr	-
Distribution	poles, wave	-45° to 65.6° lat. [2]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	1016	1016
Apoapse Alt. (km)	1016	80,144
Inclination (deg)	95.0	8
Ascending Node (deg)	353.5	69.5
Arg. of Periapse (deg)	352	284.5

SELECTION RATIONALE:

In order to obtain the desired percentage coverage with proper illumination, both a plane change and an off-periapse insertion are necessary. A sun synchronous orbit is selected so that measurement could be continued until the sun reaches its maximum northern latitudes. A circular orbit is selected because regression of periapse is too great for an elliptical sun synchronous orbit to permit the long mission time.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10	
Measurement Orbit Frequency	every	orbit
Orbit Period (hrs)	2.45	
Measurement Alt. Range (km)	1016	
Max. Measurement Arc (deg)	-38	to 38
Max. Sensor on Time (min/orb)	31	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.360	(-47.5°)
Plane Change ΔV (km/sec)	.336	(95.5°)
Size Adjustment ΔV (km/sec)	1.183	
Total ΔV (km/sec)	2.879	

MEASUREMENT ACHIEVEMENT:

1. The time required to obtain the necessary % coverage depends upon waiting for the sun to reach its maximum northern latitude.
2. The poles are never illuminated between 50° and 80°.

ORBIT SELECTION DATA SHEET NO. 64

Mars (1988) FAMILY NO. 14 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	~ 70
Solar Elevation Range (deg)	30-60	30-60
Image Interval	-	27 days[1]
Time for % Coverage (days)	< 1 day	54 days[2]
Coverage Interval	> 4/yr	-[3]
Distribution	poles,wave	-49° to 55°

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	.9
Periapse Alt. (km)	1016	1016
Apoapse Alt. (km)	1016	84,144
Inclination (deg)	90	7
Ascending Node (deg)	40.5	305.5
Arg. of Periapse (deg)	5 5	96

SELECTION RATIONALE:

Because of the location of the VHP vector relative to the subsolar point, a plane change is necessary to obtain much coverage in the areas having the desired solar elevations. A polar orbit is chosen so that no precession of the ascending node occurs. The desired coverage is obtained by waiting for the subsolar point to move toward the orbit. Elliptical orbits cannot be used because of the fast periapse regression rate.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.45
Measurement Alt. Range (km)	1016
Max. Measurement Arc (deg)	1040
Max. Sensor on Time (min/orb)	42.5
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	.861
Plane Change ΔV (km/sec)	.321 (90°)
Size Adjustment ΔV (km/sec)	1.183
Total ΔV (km/sec)	2.365

MEASUREMENT ACHIEVEMENT:

1. Obtaining the % coverage depends upon waiting for the motion of the sun.
2. Using this orbit, at most 2 coverages/Mars year are possible.
2. The maximum solar elevation angle at the poles is 25%.

ORBIT SELECTION DATA SHEET NO. 65

Mars (1988) FAMILY NO. 15 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	21.6
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	-	27 days
Time for % Coverage (days)	< 1 day	27 days
Coverage Interval	-	once/27 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	1016	
Apoapse Alt. (km)	1016	
Inclination (deg)	90	
Ascending Node (deg)	275.1	
Arg. of Periapse (deg)	122.8	

SELECTION RATIONALE:

In order to obtain maximum latitude coverage the orbit is chosen to precess with the Sun. Because of the small image size (100 km), the time for longitudinal coverage is long, being shortest (27 days) for the circular orbit. For this reason elliptical orbits were not considered.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	10
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	2.45
Measurement Alt. Range (km)	1016
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	73.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	2.044
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	2.044

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 66

Mars (1988) FAMILY NO. 16 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	60	20[1]
Total Planet Coverage (%)	>10	27[1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	>4/yr	-
Distribution	-	-21° to 10.5° lat.[1]

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61372	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	121.4	13.5
Ascending Node (deg)	345	80.5
Arg. of Periapse (deg)	344	275.5

SELECTION RATIONALE:

For this specification the areas of interest are selected on basis of prior measurements for which no a priori information is available. Because image sizes are small, it is necessary to have orbits with periapse altitudes as low as possible but which are sun synchronous. A 3 orbit/day orbit is selected. Both an off-periapse insertion and a plane change are necessary in order to obtain the proper solar elevations. 60% overlap is acquired along orbit path.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 572[1]
Max. Measurement Arc (deg)	-10	to 29
Max. Sensor on Time (min/orb)	10.1	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.360	(-48°)
Plane Change ΔV (km/sec)	.434	(124.5°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.154	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 67

Mars(1988) FAMILY NO.17 ORBIT NO.10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	-
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	275.1	275.1
Arg. of Periapse (deg)	122.8	-

SELECTION RATIONALE:

An elliptical polar orbit of 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 57°N lat. A 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. The stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	.921 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 68

Mars (1988) FAMILY NO. 18 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20[1]
Total Planet Coverage (%)	> 10	27[1]
Solar Elevation Range (deg)	70-85	70-85[1]
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-21° to 10.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	13.5
Ascending Node (deg)	345	80.5
Arg. of Periapse (deg)	344	275.5

SELECTION RATIONALE:

For this specification the areas of interest are selected on basis of prior measurements for which no a priori information is available. Because image sizes are small, it is necessary to have orbits with periapse altitudes as low as possible but which are sun synchronous. A 3 orbit/day orbit is selected. Both an off-periapse insertion and a plane change are necessary in order to obtain the proper solar elevations.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 572[1]
Max. Measurement Arc (deg)	-10 to 29
Max. Sensor on Time (min/orb)	10.1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.360 (-48°)
Plane Change ΔV (km/sec)	.434 (124.5°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.154

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 69

Mars (1988) FAMILY NO. 19 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20_1
Total Planet Coverage (%)	> 10	51
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	-	-32.5° to 28.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	0.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	11
Ascending Node (deg)	351	78.5
Arg. of Periapse (deg)	347.5	279

SELECTION RATIONALE:

The measurement specifications include a small image size coupled with solar elevation constraints. A highly elliptical sun synchronous orbit, having a periapse altitude of 383 km and a period of 3 orbits/Mars day is selected. Both an off-periapse insertion and a plane change are used to place the orbit within the area having proper sun elevation angles. The stay time depends upon the areas to be observed about which no a prioi information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 927
Max. Measurement Arc (deg)	-28 to 48
Max. Sensor on Time (min/orb)	20.7
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.310 (-44°)
Plane Change ΔV (km/sec)	.429 (122°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.099

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 70

Mars (1988) FAMILY NO. 20 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	65[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	-
Distribution	-	-34° to 48.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	7
Ascending Node (deg)	15	303.5
Arg. of Periapse (deg)	6.5	67

SELECTION RATIONALE:

The small image size in the measurement specification requires an orbit with as low a periapse altitude as possible. A 3 orbits/Mars day, sun synchronous orbit is selected so that coverage can be continued as long as is desired. Both off-periapse insertion and a plane change are necessary to place the orbit within the proper sun elevation constraints. The location of periapse was selected so that it is approximately centered in latitude in the area with proper sun elevations.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 1271[1]
Max. Measurement Arc (deg)	-49 to 60
Max. Sensor on Time (min/orb)	31.4
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.085 (-29.5°)
Plane Change ΔV (km/sec)	.425 (120.5°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	1.870

MEASUREMENT ACHIEVEMENT:

1. Initial coverage

ORBIT SELECTION DATA SHEET NO. 71

Mars (1988) FAMILY NO. 21 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	78
Solar Elevation Range (deg)	15-30	15-30[1]
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	mare, poles	-81° to 35° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	0.9
Periapse Alt. (km)	1027	1027
Apoapse Alt. (km)	1027	80,353
Inclination (deg)	95	47
Ascending Node (deg)	226	278
Arg. of Periapse (deg)	142	126

SELECTION RATIONALE:

The small image size in the measurement specifications calls for low measurement altitudes. A circular, sun synchronous orbit was selected so that measurements could be made along the entire orbit and so that the South Polar region could be covered. A plane change is required to get into this orbit. If the areas of interest are farther North, then the orbit described on Orbit Selection Data Sheet No. 56 could be used.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	10	
Measurement Orbit Frequency	10	orbits
Orbit Period (hrs)	2.46	
Measurement Alt. Range (km)	1027	
Max. Measurement Arc (deg)	1180	
Max. Sensor on Time (min/orb)	48.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	.862	
Plane Change ΔV (km/sec)	.252	(67.5°)
Size Adjustment ΔV (km/sec)	1.182	
Total ΔV (km/sec)	2.296	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 72

Mars (1988) FAMILY NO. 22 ORBIT NO.10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	97
Solar Elevation Range (deg)	day	day
Image Interval	< 2 hrs	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/day	- 1
Distribution	-	-90° to 71.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	.9
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	94.5	94.5
Arg. of Periapse (deg)	311	-

SELECTION RATIONALE:

Because of the small image size, an orbit with low periapse altitude is desired. An orbit with period one orbit/Mars day is selected to provide contiguous coverage. 90° inclination maximizes the latitude coverage, and the orbit passes through the VHP vector to minimize the ΔV. Because periapse is on the dark side, an apseline rotation costing 1.234 km/sec is performed to place periapse in any desired location.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340
Max. Measurement Arc (deg)	-.063 to.063
Max. Sensor on Time (min/orb)	.028
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	0.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	2.155

MEASUREMENT ACHIEVEMENT:

1. The time required to obtain one coverage of any area depends upon the size of the area, but if more than one pass is required, the time will be more than 1 day.

ORBIT SELECTION DATA SHEET NO. 73

Mars (1988) FAMILY NO. 23 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hrs	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 2/yr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	275.1	275.1
Arg. of Periapse (deg)	122.8	-

SELECTION RATIONALE:

The small image size in the measurement specifications calls for low measurement altitudes. A circular, sun synchronous orbit was selected so that measurements could be made along the entire orbit and so that the South Polar region could be covered. A plane change is required to get into this orbit. If the areas of interest are farther North, then the orbit described is Orbit Selection Data Sheet No. 56 could be used.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	.921 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 74

Mars (1988) FAMILY NO. 24 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	100
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1 day	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	275.1	275.1
Arg. of Periapse (deg)	122.8	-

SELECTION RATIONALE:

The small image size in the measurement specifications calls for low measurement altitudes. A circular, sun synchronous orbit was selected so that measurements could be made along the entire orbit and so that the South Polar region could be covered. A plane change is required to get into this orbit. If the areas of interest are farther North, then the orbit described on Orbit Selection Data Sheet No. 56 could be used.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	.921 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 75

Mars (1988) FAMILY NO. 25 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	60	20[1]
Total Planet Coverage (%)	> 3	27[1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/300 hr	-
Distribution	-	-21° to 10.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	13.5
Ascending Node (deg)	345	80.5
Arg. of Periapse (deg)	344	275.5

SELECTION RATIONALE:

For these specifications the image size and the percent coverage are small and the areas of interest are selected on basis of prior measurements. It is necessary to have sun-synchronous orbits with periapse as low as possible. For this an orbit having a period of 3 orbits/Mars day is selected. An off-periapse insertion, coupled with a plane change places the orbit in the area having proper sun elevation angles. 60% image overlap is acquired along orbit path.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 572
Max. Measurement Arc (deg)	-10 to 29
Max. Sensor on Time (min/orb)	10.1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.360 (-48°)
Plane Change ΔV (km/sec)	.434 (124.5°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.154

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 76

Mars (1988) FAMILY NO. 26 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	-	-
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/300 hrs	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	275.1	275.1
Arg. of Periapse (deg)	122.8	-

SELECTION RATIONALE:

An elliptical polar orbit of period of 1 Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 57°N lat. At 2 impulse ΔV of 1.234 km/sec total is required to move periapse to another latitude. The stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	.921 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. See note 1, Data Sheet #28.

ORBIT SELECTION DATA SHEET NO. 77

Mars (1988) FAMILY NO. 27 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	27[1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-21° to 10.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	13.5
Ascending Node (deg)	345	80.5
Arg. of Periapse (deg)	344	275.5

SELECTION RATIONALE:

For these specifications the image size and the percent coverage are small and the areas of interest are selected on basis of prior measurements. It is necessary to have sun-synchronous orbits with periapse as low as possible. For this an orbit having a period of 3 orbits/Mars day is selected. An off-periapse insertion, coupled with a plane change places the orbit in the area having proper sun elevation angles.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 572
Max. Measurement Arc (deg)	-10 to 29
Max. Sensor on Time (min/orb)	10.1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.360 (-48°)
Plane Change ΔV (km/sec)	.434 (124.5°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.154

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 78

Mars (1988) FAMILY NO. 28 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	51[1]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	-	-32.5° to 28.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	0.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	11
Ascending Node (deg)	351	78.5
Arg. of Periapse (deg)	347.5	279

SELECTION RATIONALE:

The measurement specifications include a small image size coupled with solar elevation constraints. A highly elliptical sun synchronous orbit, having a periapse altitude of 383 km and a period of 3 orbits/Mars day is selected. Both an off-periapse insertion and a plane change are used to place the orbit within the area having proper sun elevation angles. The stay time depends upon the areas to be observed about which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 927[1]
Max. Measurement Arc (deg)	-28	to 48
Max. Sensor on Time (min/orb)	20.7	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.310	(-44°)
Plane Change ΔV (km/sec)	.429	(122°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	2.099	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 79

Mars (1988) FAMILY NO. 29 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	65[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	-	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	-	-34° to 48.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	7
Ascending Node (deg)	15	303.5
Arg. of Periapse (deg)	6.5	67

SELECTION RATIONALE:

The small image size in the measurement specification requires an orbit with as low a periapse altitude as possible. A 3 orbits/Mars day, sun synchronous orbit is selected so that coverage can be continued as long as is desired. Both off-periapse insertion and a plane change are necessary to place the orbit within the proper sun elevation constraints. The location of periapse was selected so that it is approximately centered in latitude in the area with proper Sun elevations.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 1271
Max. Measurement Arc (deg)	-49 to 60
Max. Sensor on Time (min/orb)	31.4
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.085 (-29.5°)
Plane Change ΔV (km/sec)	.425 (120.5)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	1.870

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 80

Mars (1988) FAMILY NO. 30 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	78[1]
Solar Elevation Range (deg)	15-30	15-30
Image Interval	< 1 day	1 day
Time for % Coverage (days)	< 100 hrs	-
Coverage Interval	> 4/yr	-
Distribution	-	-81° to 35° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	0.9
Periapse Alt. (km)	1027	1027
Apoapse Alt. (km)	1027	80,353
Inclination (deg)	95	47
Ascending Node (deg)	226	278
Arg. of Periapse (deg)	142	126

SELECTION RATIONALE:

The small image size in the measurement specifications calls for low measurement altitudes. A circular, sun synchronous orbit was selected so that measurements could be made along the entire orbit and so that the South Polar region could be covered. A plane change is required to get into this orbit. If the areas of interest are farther North, then the orbit described on Orbit Selection Data Sheet No. 56 could be used.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	10	
Measurement Orbit Frequency	10	orbits
Orbit Period (hrs)	2.46	
Measurement Alt. Range (km)	1027	
Max. Measurement Arc (deg)	118	
Max. Sensor on Time (min/orb)	48.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	.862	
Plane Change ΔV (km/sec)	.252	(67.5°)
Size Adjustment ΔV (km/sec)	1.182	
Total ΔV (km/sec)	2.296	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 81

Mars (1988) FAMILY NO. 31 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	-	-
Image Interval	< 30 hrs	1 day
Time for % Coverage (days)	-	-
Coverage Interval	> 1/300 hr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.81813	0
Periapse Alt. (km)	340	33,809
Apoapse Alt. (km)	33,809	33,809
Inclination (deg)	90	90
Ascending Node (deg)	275.1	275.1
Arg. of Periapse (deg)	122.8	-

SELECTION RATIONALE:

An elliptical polar orbit of one Mars day was selected to give maximum possible coverage at minimum altitude. Only 1 pass/day is possible for detailed coverage of randomly spaced areas. Initial periapse is at 57° N lat. A 2 impulse ΔV of 1.234 km/sec. total is required to move periapse to another latitude. The stay time depends upon the number and detail of areas to be covered for which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	24.63
Measurement Alt. Range (km)	340 to 370
Max. Measurement Arc (deg)	-20 to 20
Max. Sensor on Time (min/orb)	9.6
No. of Impulses (ΔV)	1 + size adjustments[1]
Capture ΔV (km/sec)	.921
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	1.234 (2 impulses)
Total ΔV (km/sec)	.921 + size adjustments[1]

MEASUREMENT ACHIEVEMENT:

1. The total ΔV required depends upon the number of areas to be covered and hence upon the number of maneuvers required. Thus, total ΔV will equal capture ΔV + whatever integer multiple of 1.234 km/sec is necessary.

ORBIT SELECTION DATA SHEET NO. 82

Mars (1988) FAMILY NO. 32 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	60	20
Total Planet Coverage (%)	-	27[1]
Solar Elevation Range (deg)	70-85	70-85
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	wave, poles, mountains	-21° to 10.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124.1	13.5
Ascending Node (deg)	345	80.5
Arg. of Periapse (deg)	344	275.5

SELECTION RATIONALE:

These are specifications for which the image size and the % coverage are small, and for which the areas of interest are selected on basis of prior measurements. It is necessary to have orbits with periapse altitudes as low as possible but which are sun synchronous. A 3 orbit/day, sun synchronous orbit is selected. Both an off-periapse insertion and a plane change are necessary in order to cover the area with proper sun elevation. % overlap is acquired along orbit path.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 572
Max. Measurement Arc (deg)	-10 to 29
Max. Sensor on Time (min/orb)	10.1
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.360 (-48°)
Plane Change ΔV (km/sec)	.434 (124.5°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.154

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

ORBIT SELECTION DATA SHEET NO. 83

Mars (1988) FAMILY NO. 33 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	-	-
Total Planet Coverage (%)	-	51[1]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	wave,poles, mountain	-32.5° to 28.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	0.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	11
Ascending Node (deg)	351	78.5
Arg. of Periapse (deg)	347.5	279

SELECTION RATIONALE:

The measurement specifications include a small image size coupled with solar elevation constraints. A high elliptical sun synchronous orbit, having a periapse altitude of 383 km and a period of 3 orbits/Mars day is selected. Both an off-periapse insertion and a plane change are used to place the orbit within the area having proper sun elevation angles. The stay time depends upon the areas to be observed about which no a priori information is available.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	3
Measurement Orbit Frequency	3 orbits
Orbit Period (hrs)	8.21
Measurement Alt. Range (km)	383 to 927
Max. Measurement Arc (deg)	-28 to 48
Max. Sensor on Time (min/orb)	20.7
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	1.310 (-44°)
Plane Change ΔV (km/sec)	.429 (122°)
Size Adjustment ΔV (km/sec)	.360
Total ΔV (km/sec)	2.099

MEASUREMENT ACHIEVEMENT:

1. Initial coverage

ORBIT SELECTION DATA SHEET NO. 84

Mars (1988) FAMILY NO. 34 ORBIT NO. 8

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	0.3
Minimum Image Overlap (%)	-	-
Total Planet Coverage (%)	-	65[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 1 min	1 day
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	wave, poles mountains	-34° to 48.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.61732	.9
Periapse Alt. (km)	383	383
Apoapse Alt. (km)	12,524	68,117
Inclination (deg)	124	7
Ascending Node (deg)	15	303.5
Arg. of Periapse (deg)	6.5	67

SELECTION RATIONALE:

The small image size in the measurement specifications requires an orbit with as low a periapse altitude as possible. A 3 orbits/Mars day, sun synchronous orbit is selected so that coverage can be continued as long as is desired. Both off-periapse insertion and a plane change are necessary to place the orbit within the proper sun elevation constraints. The location of periapse was selected so that it is approximately centered in latitude in the area with proper Sun elevations.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	3	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	8.21	
Measurement Alt. Range (km)	383	to 1271
Max. Measurement Arc (deg)	-49	to 60
Max. Sensor on Time (min/orb)	31.4	
No. of Impulses (ΔV)	3	
Capture ΔV (km/sec)	1.085	(-29.5°)
Plane Change ΔV (km/sec)	.425	(120.5°)
Size Adjustment ΔV (km/sec)	.360	
Total ΔV (km/sec)	1.870	

MEASUREMENT ACHIEVEMENT:

1. Initial coverage.

3. VENUS

Table 6

VENUS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1977	Other Family Member Observables
No.	Description	Ref.	Type			
1	Surface Elevations	g	Radar	5	93, 94	3, 6, 9, 12, 21
		i	Radar Stereo	6	95, 96	6, 9
2	Layering	e	Radar	19	114	5, 8, 11, 14, 20
		g	Multifreq. Radar	19	114	5, 8, 11, 14, 20
3	Contacts (Regional)	1	Radar	5	93, 94	1, 6, 9, 12, 21
4	Contacts (Local)	1	Radar	12	107	7, 10, 13, 22, 25
5	Contacts (Detailed)	1	Radar	19	114	2, 8, 11, 14, 20
6	Structure of Features (Regional)	j	Radar	5	93, 94	1, 3, 9, 12, 21
		1	Radar Stereo	6	95, 96	1, 9
7	Structure of Features (Local)	j	Radar	12	107	4, 10, 13, 22, 25
		1	Radar Stereo	18	113	10
8	Structure of Features (Detailed)	j	Radar	19	114	2, 5, 11, 14, 20
		1	Radar Stereo	21	116	11, 20
9	Surface Topography (Regional)	g	Radar	5	93, 94	1, 3, 6, 12, 21
		1	Radar Stereo	6	95, 96	1, 6

Table 6 (Cont)

VENUS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1977	Other Family Member Observables
No.	Description	Ref.	Type			
10	Surface Topography (Local)	g	Radar	12	107	4, 7, 13, 22, 25
		i	Radar Stereo	18	113	7
11	Surface Topography (Detailed)	g	Radar	19	114	2, 5, 8, 14, 20
		i	Radar Stereo	21	116	8, 20
12	Surface Appearance (Regional)	h	Radar	5	93, 94	1, 3, 6, 9, 21
13	Surface Appearance (Local)	h	Radar	12	107	4, 7, 10, 22, 25
14	Surface Appearance (Detailed)	h	Radar	19	114	2, 5, 8, 11, 20
20	Topographic Changes	g	Radar	19	114	2, 5, 8, 11, 14
		i	Radar Stereo	21	116	8, 11
21	Surface Thermal Anomalies (Regional)	d	Microwave	5	93, 94	1, 3, 6, 9, 12
		h	Multiband	5	93, 94	1, 3, 6, 9, 12
22	Surface Thermal Anomalies (Local)	d	Microwave	12	107	4, 7, 10, 13, 25
		h	Multiband	12	107	4, 7, 10, 13, 25

Table 6 (Cont.)

VENUS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1977	Other Family Member Observables
No.	Description	Ref.	Type			
23	Surface Thermal Anomalies (Detailed)	d	Microwave	20	115	
		h	Multiband	20	115	
24	Atmospheric Thermal Anomalies (Regional)	a	IR	1	85, 86	
		c	Microwave	1	85, 86	
		e	Multiband	1	85, 86	
25	Atmospheric Thermal Anomalies (Detailed)	a	IR	12	107	4, 7, 10, 13, 22
		c	Microwave	12	107	4, 7, 10, 13, 22
		e	Multiband	12	107	4, 7, 10, 13, 22
26	Global Cloud Coverage	a	UV	3	89 90	
		b	Visible (BW&Color)	3	89, 90	
		c	IR	2	87, 88	
		d	IR	2	87, 88	
		e	Multiband	4	91, 92	
27	Convective Cells and Turbulence (Regional)	a	UV	9	101, 102	29, 33, 40
		b	Visible	9	101, 102	29, 33, 40
		c	IR	7	97, 98	29, 30, 33, 35
		d	IR	7	97, 98	29, 30, 33, 35
		e	Microwave	7	97, 98	29, 30, 33, 35
		f	Microwave	7	97, 98	29, 30, 33, 35

Table 6 (Cont.)

VENUS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No 1977	Other Family Member Observables
No	Description	Ref.	Type			
28	Convective Cells and Turbulence (Detailed)	a	UV	15	110	
		b	Visible	15	110	
		c	IR	13	108	34, 39
		d	IR	13	108	34, 39
		e	Microwave	13	108	34, 39
		f	Microwave	13	108	34, 39
29	Cloud Formation	a	UV	9	101, 102	27, 33, 40
		b	Visible (BW&Color)	9	101, 102	27, 33, 40
		c	IR	9	101, 102	27, 33, 40
		d	IR	7	97, 98	27, 30, 33, 35
		f	Multiband	10	103, 104	33
30	Precipitation Rate	b	Radar	7	97, 98	27, 29, 33, 35
31	Thunderstorms (Regional)	a	Passive RF	8	99, 100	
32	Thunderstorms (Detailed)	a	Passive RF	14	109	
33	Cyclone Formations (Regional)	a	Visible	9	101, 102	27, 29, 40
		b	IR	9	101, 102	27, 29, 40
		c	IR	7	97, 98	27, 29, 30, 35
		d	Multiband	10	103, 104	29

Table 6 (Cont.).

VENUS OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1977	Other Family Member Observables
No.	Description	Ref.	Type			
34	Cyclone Formations (Detailed)	a	Visible	16	111	
		b	IR	16	111	
		c	IR	13	108	28, 39
		d	Multiband	17	112	
35	Surface to Atmosphere Transfer	e	IR	7	97, 98	27, 29, 30, 33
		f	Microwave	7	97, 98	27, 29, 30, 33
37	Auroras	a	Visible	11	105, 106	
		b	Visible Color	11	105, 106	
38	Animal Life	e	Radar	22	117	
		f	Radar Stereo	23	118	
39	Plant Life	d	Radar	13	108	28, 34
40	Biochemical Systems	b	Multiband	9	101, 102	27, 29, 33

TABLE 7

MEASUREMENT FAMILIES FOR VENUS

Family Number	Observable Number(s)	Sensor* Type(s)	Minimum Image Size (km)	Overlap (%)	Minimum (?)	Solar Elevation Range (deg)	Coverage Distribution	Time for Coverage	Image Interval	Coverage Interval
1	24	IR,μ, MB	1500	20	70	–	–	–	–	> 2/yr
2	26	IR	1500	20	70	–	–	< 100 hr	–	> 10/yr
3	26	UV,V	1500	20	70	Day	–	< 100 hr	–	> 10/yr
4	26	MB	1500	20	70	Day&Night	–	< 100 hr	–	> 10/yr
5	1,3,6,9,12,21	R,μ,MB	1000	20	70	–	–	–	< 30 hr	–
6	1,6,9	R	1000	60	70	–	–	–	–	–
7	27,29,30,33,35	IR,μ,R	500	20	70	–	Equator, Poles	< 100 hr	< 15 min	> 4/yr
8	31	RF	500	20	70	–	–	–	< 2 min	> 10/yr
9	27,29,33,40	UV,V,IR,MB	500	20	70	Day	Equator, Poles	–	–	> 4/yr
10	29,33	MB	500	20	10	Day&Night	Subsolar, Poles	–	< 15 min	> 4/yr
11	37	V	500	20	70	Night	Poles	–	< 30 hr	> 4/yr
12	4,7,10,13,22,25	R,μ,MB,IR	100	20	10	–	–	–	< 30 hr	–
13	28,34,39	R,IR,μ	100	20	10	–	–	–	< 2 hr	> 4/yr
14	32	RF	100	20	10	–	–	–	< 2 min	> 10/yr
15	28	UV,V	100	20	10	Day	–	–	< 100 hr	–
16	34	V,IR	100	20	10	Day	–	–	< 2 hr	> 4/yr
17	34	MB	100	20	10	Day&Night	–	–	< 2 hr	> 4/yr
18	7,10	R	100	60	10	–	–	–	–	–
19	2,5,8,11,14,20	R	0 5	20	10	–	–	–	–	> 1/300hr
20	23	μ,MB	0 5	20	10	–	–	–	< 30 hr	–
21	8,11,20	R	0 5	60	10	–	–	–	–	> 1/300hr
22	38	R	0 3	-	5000	–	Mountains,Poles	–	< 1 min	–
23	38	R	0 3	60	Images	–	Mountains,Poles	–	< 1 min	–

* Sensor Type Definitions are

UV	Ultraviolet
V	Visible
IR	Infrared
μ	Microwave
R	Radar
RF	Radio Frequency
MB	Multi-band

TABLE 8

VENUS INTERPLANETARY TRANSFER SELECTION

Launch Date	January 10, 1977
Flight Time	127 days (Type I)
Declination of Departure Asymptote (Ecliptic Plane)	0.5 deg
Departure Hyperbolic Excess Speed	2.75 km/sec
Arrival Hyperbolic Excess Speed	4.39 km/sec
Total Hyperbolic Excess Speed	7.14 km/sec
Declination of Arrival Asymptote (Venus Equatorial Plane)	36.87 deg
Direction of Arrival Asymptote from Sun	54.43 deg
Communication Distance at Arrival	0.48 AU
Days to Earth/Venus Superior Conjunction after Arrival	250 days

TABLE 9

VENUS CANDIDATE ORBIT SIZES

Orbit No.	Eccentricity	Periapse* Altitude (km)	Maximum Altitude Ratio, h/hp	Orbit Period (hrs)	Lapse Rate† Per Orbit (km)	Average** Capture ΔV (km/sec)
1	0.0	454	0.0	1.608	10.5	3.902
2	0.1	327	5.3	1.829	11.9	3.574
3	0.2	305	11.4	2.171	14.2	3.244
4	0.3	294	19.5	2.645	17.2	2.925
5	0.4	285	30.7	3.326	21.7	2.618
6	0.5	277	46.7	4.364	28.5	2.321
7	0.6	269	71.5	6.087	39.7	2.033
8	0.7	261	113.9	9.354	61.0	1.754
9	0.8	255	199.0	17.160	111.9	1.483
10	0.9	248	458.5	48.456	316.0	1.219

* Periapse altitude corresponds to 50-yr lifetime orbits.

** Capture ΔV Based on a Surveyed Average Hyperbolic Approach Speed, VHP = 4.52 km/sec.

† The distance, measured along the equator, between subsequent orbit ground traces.

ORBIT SELECTION DATA SHEET NO. 85

Venus (1977) FAMILY NO. 1 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	-	1.6 hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 2/yr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to provide maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data simultaneously since consecutive swaths of coverage may be as many as 145 orbits apart. (This is the case if the net image size is 1200 km).

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1[1]
Measurement Orbit Frequency	every orbit[1]
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1500 km contiguous images may be as much as 145 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 86

Venus (1977) FAMILY NO. 1 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	1580
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	70	71
Solar Elevation Range (deg)	-	-
Image Interval	-	48.5 hr minimum
Time for % Coverage (days)	-	243 days
Coverage Interval	-	once/243 days[1]
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE:

This elliptical polar orbit was chosen to show the increased altitude range needed with a smaller capture ΔV. This is an extreme case with maximum eccentricity (e = .9). A 4.5° off-periapse insertion places the periapse in the Venus ecliptic so that during the 243 days of measurement, solar perturbations raise h_p to 277 km and then back to 248 km. Measurements are restricted to the equator and midlatitudes due to rapidly increasing altitude.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	4 orbits
Orbit Period (hrs)	48.456
Measurement Alt. Range (km)	248 to 1297
Max. Measurement Arc (deg)	-45.3 to 45.3
Max. Sensor on Time (min/orb)	18.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.191 (4.5°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.191

MEASUREMENT ACHIEVEMENT:

[1]Because measurements can be made only along the lower parts of the elliptical orbit, one complete longitudinal coverage of the planet requires 243 days.

ORBIT SELECTION DATA SHEET NO. 87

Venus(1977) FAMILY NO. 2 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	-	1.6 hrs or 122 days
Time for % Coverage (days)	< 100 hrs	122 days[2]
Coverage Interval	> 10/yr	2/yr[2]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to provide maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data simultaneously since consecutive swaths of coverage may be as many as 145 orbits apart. (This is the case if the net image size is 1200 km).

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1500 km contiguous images may be as much as 145 orbits apart in time.
2. At Venus the shortest time to achieve 100% coverage of the planet is approximately 120 days.

ORBIT SELECTION DATA SHEET NO. 88

Venus(1977) FAMILY NO. 2 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	1580
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	-
Image Interval	-	48.5 hr minimum
Time for % Coverage (days)	-	243 days
Coverage Interval	> 2/yr	once/243 days[1]
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.3	

SELECTION RATIONALE:

This elliptical polar orbit was chosen to show the increased altitude range needed with a smaller capture ΔV. This is an extreme case with maximum eccentricity (e = .9). A 4.5° off-periapse insertion places the periapse in the Venus ecliptic so that during the 243 days of measurement solar perturbations raise h_p to 277 km and then back to 248 km. Measurements are restricted to the equator and midlatitude due to rapidly increasing altitude.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	1	
Measurement Orbit Frequency	4	orbits
Orbit Period (hrs)	48.456	
Measurement Alt. Range (km)	248	to 1297
Max. Measurement Arc (deg)	-45.3	to 45.3
Max. Sensor on Time (min/orb)	18.6	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.191	(4.5°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.191	

MEASUREMENT ACHIEVEMENT:

[1]Because one complete longitudinal coverage requires 243 days, two or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 89

Venus (1977) FAMILY NO. 3 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	50[2]
Solar Elevation Range (deg)	day	day
Image Interval	-	1.6hrs or 122 days
Time for % Coverage (days)	< 100 hrs	122 days[3]
Coverage Interval	> 10/yr	once/122 days[4]
Distribution	-	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is selected to obtain maximum coverage in a minimum time of 122 days using all orbit altitudes. Of the 100% coverage obtained 50% is in darkness and 50% in daylight. Furthermore, unless a plane change is made to change the ascending node, the areas covered are covered again after 122 days under the same lighting constraints.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	180°
Max. Sensor on Time (min/orb)	48.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1500 km contiguous images may be as much as 145 orbits apart in time.
2. Without a plane change, only 50% of the planet can be covered in daylight.
3. 122 days are required for one complete longitudinal coverage of the planet.
4. Because one coverage of the planet requires 122 days, 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 90

Venus (1977) FAMILY NO. 3 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	1580
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	38.2[1]
Solar Elevation Range (deg)	day	day
Image Interval	-	48.5 hr minimum
Time for % Coverage (days)	< 100 hrs	243 days[2]
Coverage Interval	> 10/yr	once/243 days[2]
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE: See Orbit Selection Data Sheet No. 86 for the basic characteristics of the orbit. The initial orbit is 48° from the terminator permitting 44° longitudinal coverage in daylight in 30 days. This is followed by 167° longitudinal coverage in darkness in 113 days, followed again by 149° longitudinal coverage in daylight in 101 days. Without a plane change further coverage is repetitious. A plane change, costing 3.5 km/sec would permit either a total of 60% or 71% coverage in daylight depending upon whether the ascending node were rotated counter clockwise or clockwise. Mission times would become 318 and 435 days respectively.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	4 orbits
Orbit Period (hrs)	48.456
Measurement Alt. Range (km)	248 to 1297
Max. Measurement Arc (deg)	-45.3 to 45.3
Max. Sensor on Time (min/orb)	18.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.191 (4.5°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.191

MEASUREMENT ACHIEVEMENT:

[1]Because only limited altitudes are used along the orbit, only 38.2% of the planet surface can be covered in daylight

[2]243 days are required to obtain one cycle of daylight coverage. Because of this 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 91

Venus (1977) FAMILY NO. 4 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	-	1.6 hrs or 122 days
Time for % Coverage (days)	< 100 hrs	122 days [2]
Coverage Interval	> 10/yr	once/122 days[3]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is selected to obtain maximum coverage in a minimum time of 122 days using all orbit altitudes. Of the 100% coverage obtained, 50% is in darkness and 50% is in daylight.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1500 km contiguous images may be as much as 145 orbits apart in time.
2. 122 days are required for one complete longitudinal coverage of the planet.
3. Because one coverage of the planet requires 122 days, 10 or more coverages per years are not possible.

ORBIT SELECTION DATA SHEET NO. 92

Venus (1977) FAMILY NO. 4 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1500	1580
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	day&night	day&night
Image Interval	-	48.5 hrs minimum
Time for % Coverage (days)	< 100 hrs	243 days[1]
Coverage Interval	> 10/yr	once/243 days[1]
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE:

This elliptical polar orbit was chosen to show the increased altitude range needed with a smaller capture ΔV. This is an extreme case with maximum eccentricity (e = .9). A 4.5° off-periapse insertion places the periapse in the Venus ecliptic so that during the 243 days of measurement, solar perturbations raise h_p to 277 km and then back to 248 km. Measurements are restricted to the equator and midlatitudes due to rapidly increasing altitude.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	4 orbits
Orbit Period (hrs)	48.456
Measurement Alt. Range (km)	248 to 1297
Max. Measurement Arc (deg)	-45.3 to 45.3
Max. Sensor on Time (min/orb)	18.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.191 (4.5°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.191

MEASUREMENT ACHIEVEMENT:

[1]Using an elliptical orbit, 243 days are required to cover all longitudes of the planet. Because of this 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 93

Venus (1977) FAMILY NO. 5 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	day&night
Image Interval	< 30 hrs	1.6 hrs or 122 day
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to provide maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data at the same time because consecutive swaths of coverage may be as many as 97 orbits apart.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1[1]
Measurement Orbit Frequency	every orbit[1]
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1500 km contiguous images may be as much as 97 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 94

Venus (1977) FAMILY NO. 5 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1185
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	day&night
Image Interval	< 30 hrs	48.5 hr minimum
Time for % Coverage (days)	-	243 days
Coverage Interval	-	once/243 days
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 86 for the basic description of this orbit. In addition note that the α area is passed over 34 days after orbit capture and the β area 267 days after orbit capture within the altitude range of 248 to 1297 km.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	3	orbits
Orbit Period (hrs)	48.456	
Measurement Alt. Range (km)	248	to 1297
Max. Measurement Arc (deg)	-45.3	to 45.3
Max. Sensor on Time (min/orb)	18.6	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.191	(4.5°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.191	

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 95

Venus (1977) FAMILY NO. 6 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	26.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	day&night
Image Interval	-	1.6 hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to provide maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data at the same time because consecutive swaths of coverage may be as many as 97 orbits apart.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 1000 km contiguous images may be as much as 97 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 96

Venus (1977) FAMILY NO. 6 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1000	1000
Minimum Image Overlap (%)	60	68
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	day and night
Image Interval	-	48.5 hr minimum
Time for % Coverage (days)	-	243 days
Coverage Interval	-	243 days
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 86 for the basic description of this orbit. In addition note that the α area is passed over 34 days after orbit capture and the β area 267 days ofter orbit capture within the altitude range of 248-1297 km.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	48.456
Measurement Alt. Range (km)	248 to 1297
Max. Measurement Arc (deg)	- 45.3° to 45.3°
Max. Sensor on Time (min/orb)	18.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.191 (4.5°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.191

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 97

Venus (1977) FAMILY NO. 7 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	< 15 min	1.6hrs or 122 days[2]
Time for % Coverage (days)	< 100 hrs	122 days[3]
Coverage Interval	> 4/yr	2/yr[3]
Distribution	equator,poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to provide maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data simultaneously since consecutive swaths of coverage are 48 orbits apart.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1[1]
Measurement Orbit Frequency	every orbit[1]
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 48 orbits apart in time.
2. The time lapse between consecutive orbits is 1.6 hrs.
3. The time required for one complete coverage of the planet is 122 days, therefore 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 98

Venus (1977) FAMILY NO. 7 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	560
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	58.7
Solar Elevation Range (deg)	-	day&night
Image Interval	< 15 min	17.2 hrs minimum[1]
Time for % Coverage (days)	< 100 hrs	243 days[2]
Coverage Interval	> 4/yr	once/243 days[2]
Distribution	equator,poles	-90° to 10° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.8	
Periapse Alt. (km)	255	
Apoapse Alt. (km)	50,735	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	324.5	

SELECTION RATIONALE: This orbit shows the tradeoff of lower ΔV's versus higher altitudes using an elliptical orbit. Using an off-periapse insertion of -32° the periapse is placed in the southern hemisphere so that both the equator and pole can be viewed at minimum altitude. The 100° arc used for viewing gives 59% coverage in 243 days. The .8 eccentricity orbit was used to reduce solar perturbations on h_p. Even so, h_p = 840 km at the end of 243 days. This orbit uses only .158 km/sec additional ΔV over using a .9 eccentricity orbit with the same off-periapse insertion. No coverage of the β area occurs.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	4 orbits
Orbit Period (hrs)	17.16
Measurement Alt. Range (km)	255 to 2125
Max. Measurement Arc (deg)	-50 to 50
Max. Sensor on Time (min/orb)	21.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	1.975 (-32°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	1.975

MEASUREMENT ACHIEVEMENT:

[1]The time period between consecutive images of the same area equals the orbit period or 17.2 hours.

[2]243 days are required for one complete longitudinal coverage of the planet surface. Because of this 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 99

Venus (1977) FAMILY NO. 8 ORBIT NO.[1]

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	1.6hrs or 122 days[2]
Time for % Coverage (days)	-	122 days
Coverage Interval	> 10/yr	2/yr[3]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is established to proved maximum surface coverage using all parts of the orbit (constant altitude) in a maximum time of 122 days. It is not necessary to collect and transmit data simultaneously since consecutive swaths of coverage are 48 orbits apart.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 48 orbits apart in time.
2. The time lapse between consecutive orbits is 1.6 hours.
3. Because one complete coverage of the planet requires 122 days, 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 100

Venus (1977) FAMILY NO. 8 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	395
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	71
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	48.5hrs or 243 days[1]
Time for % Coverage (days)	-	243 days
Coverage Interval	> 10/yr	once/243 days[2]
Distribution	-	-48.5° to 43.5° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	248	
Apoapse Alt. (km)	113,700	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356.5	

SELECTION RATIONALE:

This elliptical polar orbit was chosen to show the increased altitude range needed with a smaller capture ΔV. This is an extreme case with maximum eccentricity (e = .9). A 4.5° off-periapse insertion places the periapse in the Venus ecliptic so that during the 243 days of measurement, solar perturbations raise h_p to 277 km and then back to 248 km. Measurements are restricted to the equator and midlatitudes due to rapidly increasing altitude.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	4	orbits
Orbit Period (hrs)	48.456	
Measurement Alt. Range (km)	248	to 1297
Max. Measurement Arc (deg)	-45.3	to 45.3
Max. Sensor on Time (min/orb)	18.6	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.191	(4.5°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.191	

MEASUREMENT ACHIEVEMENT:

1. The shortest time between images of the same area equals the orbit period or 48.5 hours.
2. Because one complete longitudinal coverage of the planet requires 243 days, 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 101

Venus (1977) FAMILY NO. 9 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	13.1[1]
Minimum Image Overlap (%)	20	20[2]
Total Planet Coverage (%)	> 70	50
Solar Elevation Range (deg)	day	day
Image Interval	-	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days[3]
Distribution	equator,poles	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	356	

SELECTION RATIONALE:

A polar circular orbit is selected to obtain maximum coverage in a minimum time of 122 days using all orbit altitudes. Of the 100% coverage obtained 50% is in darkness and 50% in daylight. Furthermore, unless a plane change is made to change the ascending node, the areas covered are covered again after 122 days under the same lighting constraints.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	48.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 48 orbits apart in time.
2. Without a plane change only 50% of the planet can be covered in daylight.
3. Because one coverage of the planet requires 122 days, four or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 102

Venus (1977) FAMILY NO. 9 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	560
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	31.2[1]
Solar Elevation Range (deg)	day	day
Image Interval	-	17.2 hrs
Time for % Coverage (days)	-	243 days
Coverage Interval	>4/yr	once/243 days[2]
Distribution	equator,poles	-90° to 10° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.8	
Periapse Alt. (km)	255	
Apoapse Alt. (km)	50,735	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	324.5	

SELECTION RATIONALE:

The initial orbit is 48° from the terminator permitting 44° longitude coverage in daylight in 30 days. This is followed by 167° longitude coverage in darkness in 113 days, followed again by 149° longitude coverage in daylight in 101 days. At this point coverage becomes repetitious without a plane change. The total coverage in daylight is 31.2% and at night is 27.1%. The coverage is in the southern hemisphere.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	4	orbits
Orbit Period (hrs)	17.16	
Measurement Alt. Range (km)	255	to 2125
Max. Measurement Arc (deg)	-50	to 50
Max. Sensor on Time (min/orb)	21.5	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.975	(-32°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.975	

MEASUREMENT ACHIEVEMENT:

1. At most 50% of the planet can be covered in daylight without a plane change. Because of altitude restriction, this coverage is reduced.
2. Because one coverage requires 243 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 103

Venus (1977) FAMILY NO. 10 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	< 15 min	1.6hrs or 122 days[2]
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days[3]
Distribution	subsolar point, poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is selected to obtain maximum coverage in a minimum time of 122 days using all orbit altitudes. Of the 100% coverage obtained, 50% is in darkness and 50% is in daylight.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 48 orbits apart in time.
2. The image interval equals one orbit period of 1.6 hrs.
3. Because one complete coverage of the planet requires 122 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 104

Venus (1977) FAMILY NO. 10 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	560
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	58.3
Solar Elevation Range (deg)	day&night	day&night
Image Interval	< 15 min	17.2 hrs [1]
Time for % Coverage (days)	-	243 days
Coverage Interval	> 4/yr	once/243 days [2]
Distribution	subsolar points, -90° to 10° lat. poles	

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.8	
Periapse Alt. (km)	255	
Apoapse Alt. (km)	50,735	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	324.5	

SELECTION RATIONALE:

The initial orbit is 48° from the terminator permitting 44° longitude coverage in daylight in 30 days. This is followed by 167° longitude coverage in darkness in 113 days, followed again by 149° longitude coverage in daylight in 101 days. At this point coverage becomes repetitious without a plane change. The total coverage in daylight is 31.2% and at night is 27.1%. The coverage is in the southern hemisphere.

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	1	
Measurement Orbit Frequency	4	orbits
Orbit Period (hrs)	17.16	
Measurement Alt. Range (km)	255	to 2125
Max. Measurement Arc (deg)	-50	to 50
Max. Sensor on Time (min/orb)	21.5	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.975	(-32°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.975	

MEASUREMENT ACHIEVEMENT:

1. The shortest time between images of the same area is equal to 1 orbit period or 17.16 hours.
2. Because one planet coverage requires 243 days, 4 or more coverage per year are not possible.

ORBIT SELECTION DATA SHEET NO. 105

Venus (1977) FAMILY NO. 11 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	50[2]
Solar Elevation Range (deg)	night	night
Image Interval	< 30 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days [3]
Distribution	poles	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

A polar circular orbit is selected to obtain maximum coverage in a minimum time of 122 days using all orbit altitudes. Of the 100% coverage obtained 50% is in darkness and 50% in daylight. Furthermore, unless a plane change is made to change the ascending node, the areas covered are covered again after 122 days under the same lighting constraints.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	48.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 48 orbits apart in time.
2. Only 50% of the planet can be covered in darkness unless a plane change is made after the initial 50% coverage.
3. Because one complete coverage takes 122 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 106

Venus (1977) FAMILY NO. 11 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	500	560
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	27.1[1]
Solar Elevation Range (deg)	night	night
Image Interval	< 30 hrs	17.2 hrs
Time for % Coverage (days)	-	243 days
Coverage Interval	> 4/yr	once/243 days[2]
Distribution	poles	-90° to 10° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.8	
Periapse Alt. (km)	255	
Apoapse Alt. (km)	50,735	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	324.5	

SELECTION RATIONALE:

The initial orbit is 48° from the terminator permitting 44° longitude coverage in daylight in 30 days. This is followed by 167° longitude coverage in darkness in 113 days, followed again by 149° longitude coverage in daylight in 101 days. At this point coverage becomes repetitious without a plane change. The total coverage in daylight is 31.2% and at night is 27.1%. The coverage is in the southern hemisphere.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	4	orbits
Orbit Period (hrs)	17.16	
Measurement Alt. Range (km)	255	to 2125
Max. Measurement Arc (deg)	-50	to 50
Max. Sensor on Time (min/orb)	21.5	
No. of Impulses (ΔV)	1	
Capture ΔV (km/sec)	1.975	(-32°)
Plane Change ΔV (km/sec)	-	
Size Adjustment ΔV (km/sec)	-	
Total ΔV (km/sec)	1.975	

MEASUREMENT ACHIEVEMENT:

1. At most 50% of the planet can be covered in darkness. Due to altitude restrictions, this is reduced to 27.1%.
2. Because one coverage requires 243 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 107

Venus (1977) FAMILY NO. 12 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	< 30 hrs	1.6hrs or 122days
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

Even though only about 10% of the planet need be covered, a circular polar orbit assures 100% coverage in 122 days. Since the specific area of interest is unknown until regional and local experiments are complete, this orbit has the capacity of looking at any 10% area from a low orbit altitude of 454 km. Opportunities for viewing essentially the same planetary area are provided once per orbital period and once per longitude coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1[1]
Measurement Orbit Frequency	every orbit[1]
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 500 km contiguous images may be as much as 9 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 108

Venus (1977) FAMILY NO. 13 ORBIT NO.1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day & night
Image Interval	< 2 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days[2]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

Even though only about 10% of the planet need be covered, a circular polar orbit assures 100% coverage in 122 days. Since the specific areas of interest is unknown until regional and local experiments are complete, this orbit has the capacity of looking at any 10% areas from a low orbit altitude of 454 km.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.
2. Because coverage of any area can be obtained once/122 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 109

Venus (1977) FAMILY NO. 14 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	< 2 min	1.6hrs or 122days[2]
Time for % Coverage (days)	-	122 days
Coverage Interval	> 10/yr	once/122 days[3]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

Even though only about 10% of the planet need be covered, a circular polar orbit assures 100% coverage in 122 days. Since the specific areas of interest is unknown until regional and local experiments are complete, this orbit has the capacity of looking at any 10% areas from a low orbit altitude of 454 km.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.
2. The shortest time between images of the same area is equal to one orbit period of 1.6 hrs.
3. Because coverages of any area can be obtained once/122 days, 10 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 110

Venus (1977) FAMILY NO. 15 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	50
Solar Elevation Range (deg)	day	day
Image Interval	< 100 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

This orbit provides the maximum daylight coverage (50%) in the shortest possible time (122 days) at a low altitude of 454 km. Since the specific areas of interest depend upon prior regional and local experiments, this orbit has the capacity of looking at any 10% area which is located in the region of possible daylight coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	48.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 111

Venus (1977) FAMILY NO. 16 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	50
Solar Elevation Range (deg)	day	day
Image Interval	< 2 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days[2]
Distribution	-	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

This orbit provides the maximum daylight coverage (50%) in the shortest possible time (122 days) at a low altitude of 454 km. Since the specific areas of interest depend upon prior regional and local experiments, this orbit has the capacity of looking at any 10% areas which is located in the region of possible daylight coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	48.2
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.
2. Because coverage of any area occurs once/122 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 112

Venus (1977) FAMILY NO. 17 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	< 2 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 4/yr	once/122 days[2]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

Even though only about 10% of the planet need be covered, a circular polar orbit assures 100% coverage in 122 days. Since the specific area of interest is unknown until regional and local experiments are complete, this orbit has the capacity of looking at any 10% area from a low orbit altitude of 454 km.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.
2. Because coverage of any one area occurs once/122 days, 4 or more coverages per year are not possible.

ORBIT SELECTION DATA SHEET NO. 113

Venus (1977) FAMILY NO. 18 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	26.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	-	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

Even though only about 10% of the planet need be covered, a circular polar orbit assures 100% coverage in 122 days. Since the specific areas of interest is unknown until regional and local experiments are complete, this orbit has the capacity of looking at any 10% area from a low orbit altitude of 454 km.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum net image size between consecutive orbit images. Since this value is obviously much smaller than the required minimum net image size of 100 km contiguous images may be as much as 9 orbits apart in time.

ORBIT SELECTION DATA SHEET NO. 114

Venus (1977) FAMILY NO. 19 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	-	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 1/300hr	once/122 days[2]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

The lowest circular orbit having a 50 year lifetime at Venus has a 454 km altitude. For this orbit the lapse rate at the equator is 10.483 km per orbit. (i.e., the smallest lapse rate obtainable within the lifetime constraint is 10.483 km.) The 90° inclination is selected to maximize latitude coverage. When an image size less than 10.483 km is used consecutive coverage from orbit is not possible. One way of satisfying the image size, % coverage requirements would be to begin with a field of view of approximately 21 km and to use the appropriate sized strips from this.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum image lapse rate (with 20% overlap) of any 50-yr. lifetime orbit.
2. Coverage of any area can be obtained once/122 days so that more than 1 coverage per 300 hours is not possible.

ORBIT SELECTION DATA SHEET NO. 115

Venus (1977) FAMILY NO. 20 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	13.1[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	< 30 hrs	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

The lowest circular orbit having a 50 year lifetime at Venus has a 454 km altitude. For this orbit the lapse rate at the equator is 10.483 km. per orbit. (i.e., the smallest lapse rate obtainable within the lifetime constrain is 10.483 km.) The 90° inclination is selected to maximize latitude coverage. When an image size less the 10.483 km is used, consecutive coverage from orbit is not possible. One way of satisfying the image size, % coverage requirements would be to begin with a field of view of approximately 21 km and to use the appropriate sized strips from this.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum image lapse rate (with 20% overlap) of any 50-yr. lifetime orbit.

ORBIT SELECTION DATA SHEET NO. 116

Venus (1977) FAMILY NO. 21 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	26.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day&night
Image Interval	-	1.6hrs or 122 days
Time for % Coverage (days)	-	122 days
Coverage Interval	> 1/300hr	once/122 days[1]
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

The lowest circular orbit having a 50 year lifetime at Venus has a 454 km altitude. For this orbit the lapse rate at the equator is 10.483 km per orbit. (i.e., the smallest lapse rate obtainable within the lifetime constraint is 10.483 km.) The 90° inclination is selected to maximize latitude coverage. When an image size less than 10.483 km is used consecutive coverage from orbit is not possible. One way of satisfying the image size % coverage requirements would be to begin with a field of view of approximately 21 km and to use the appropriate sized strips from this.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum image lapse rate (with 20% overlap) of any 50-yr. lifetime orbit.

ORBIT SELECTION DATA SHEET NO. 117

Venus (1977) FAMILY NO. 22 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	10.5[1]
Minimum Image Overlap (%)	-	-
Total Planet Coverage (%)	5000 images	100
Solar Elevation Range (deg)	-	day&night
Image Interval	< 1 min	< 1 min or 1.6hrs
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	mountains, poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

The lowest circular orbit having a 50 year lifetime at Venus has a 454 km altitude. For this orbit the lapse rate at the equator is 10.483 km per orbit. (i.e., the smallest lapse rate obtainable within the lifetime constraint is 10.483 km.) The 90° inclination is selected to maximize latitude coverage. When an image size less than 10.483 km is used consecutive coverage from orbit is not possible. One way of satisfying the image size % coverage requirements would be to begin with a field of view of approximately 21 km and to use the appropriate sized strips from this.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum image lapse rate (with 20% overlap) of any 50-yr. lifetime orbit.

ORBIT SELECTION DATA SHEET NO. 118

Venus (1977) FAMILY NO. 23 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.3	26.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	5000 images	100
Solar Elevation Range (deg)	-	-
Image Interval	< 1 min	< 1 min or 1.6hrs
Time for % Coverage (days)	-	122 days
Coverage Interval	-	once/122 days
Distribution	mountains, poles	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	454	
Apoapse Alt. (km)	454	
Inclination (deg)	90	
Ascending Node (deg)	318	
Arg. of Periapse (deg)	352	

SELECTION RATIONALE:

This orbit provides 100% coverage in 122 days if all paths of the circular orbit are used. The intrinsic lapse rate is too large to provide 60% side overlap at a minimum image size of 300 meters. If 60% side overlap is essential some kind of variable aspect angle antenna will probably be required. The alpha feature (possibly mountains) is crossed about 34 days after orbit insertion.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.608
Measurement Alt. Range (km)	454
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	96.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.848
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.848

MEASUREMENT ACHIEVEMENT:

1. This is the minimum image lapse rate (with 20% overlap) of any 50-yr. lifetime orbit.

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4. MERCURY

Table 10

MERCURY OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1984	Other Family Member Observables
No.	Description	Ref.	Type			
1	Surface Elevations	b	Visible	4	125, 126	3, 6, 9, 12
		d	Visible Stereo	7	131	6, 9
		g	Radar	6	129, 130	3, 6, 9, 12, 21
		i	Radar Stereo	8	132	6, 9
2	Layering	b	Visible	20	144	5
		e	Radar	22	146	5, 8, 11, 14, 20, 23
		g	Multifreq. Radar	22	146	5, 8, 11, 14, 20, 23
3	Contacts (Regional)	b	Ultraviolet	1	119, 120	
		d	Visible	4	125, 126	1, 6, 9, 12
		g	Infrared	4	125, 126	1, 6, 9, 12
		j	Infrared	1	119, 120	
		l	Radar	6	129, 130	1, 6, 9, 12, 21
		o	Multiband	3	123, 124	18
4	Contacts (Local)	b	Ultraviolet	11	135	
		d	Visible	14	138	7, 10, 13
		g	Infrared	14	138	7, 10, 13
		j	Infrared	11	135	
		l	Radar	15	139	7, 10, 13, 22
		o	Multiband	13	137	19
5	Contacts (Detailed)	b	Ultraviolet	18	142	
		d	Visible	21	145	8, 11, 14, 20
		g	Infrared	21	145	8, 11, 14, 20
		j	Infrared	18	142	
		l	Radar	22	146	2, 8, 11, 14, 20, 23
		o	Multiband	20	144	2

Table 10 (Cont)

MERCURY OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1984	Other Family Member Observables
No.	Description	Ref	Type			
6	Structure of Features (Regional)	b	Visible	4	125, 126	1, 3, 9, 13
		d	Visible Stereo	7	131	1, 9
		g	Visible Color	2	121, 122	12
		j	Radar	6	129, 130	1, 3, 9, 12, 21
		l	Radar Stereo	8	132	1, 9
7	Structure of Features (Local)	b	Visible	14	138	4, 10, 13
		d	Visible Stereo	16	140	10
		g	Visible Color	12	136	13
		j	Radar	15	139	4, 10, 13, 22
		l	Radar Stereo	17	141	10
8	Structure of Features (Detailed)	b	Visible	21	145	5, 11, 14, 20
		d	Visible Stereo	23	147	11, 20
		g	Visible Color	19	143	14
		j	Radar	22	146	2, 5, 11, 14, 20, 23
		l	Radar Stereo	27	148	11, 20
9	Surface Topography (Regional)	b	Visible	4	125, 126	1, 3, 6, 12
		d	Visible Stereo	7	131	1, 6
		g	Radar	6	129, 130	1, 3, 6, 12, 21
		l	Radar Stereo	8	132	1, 6

Table 10 (Cont.)

MERCURY OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1984	Other Family Member Observables
No.	Description	Ref.	Type			
10	Surface Topography (Local)	b	Visible	14	138	4, 7, 13
		d	Visible Stereo	16	140	7
		g	Radar	15	139	4, 7, 13, 22
		i	Radar Stereo	17	141	7
11	Surface Topography (Detailed)	b	Visible	21	145	5, 8, 14, 20
		d	Visible Stereo	23	147	8, 20
		g	Radar	22	146	2, 5, 8, 14, 20, 23
		i	Radar Stereo	24	148	8, 20
12	Surface Appearance (Regional)	b	Visible	4	125, 126	1, 3, 6, 9
		e	Visible Color	2	121, 122	6
		h	Radar	6	129, 130	1, 3, 6, 9, 21
13	Surface Appearance (Local)	b	Visible	14	138	4, 7, 10
		e	Visible Color	12	136	7
		h	Radar	15	139	4, 7, 10, 22
14	Surface Appearance (Detailed)	b	Visible	21	145	5, 8, 11, 20
		e	Visible Color	19	143	8
		h	Radar	22	146	2, 5, 8, 11, 20, 23
18	Surface Winds (Regional)	a	Visible	3	123, 124	3

Table 10 (Cont)

MERCURY OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No.	Other Family Member Observables
No.	Description	Ref.	Type		1984	
19	Surface Winds (Local)	a	Visible	13	137	4
20	Topographic Changes	b	Visible	21	145	5, 8, 11, 14
		d	Visible Stereo	23	147	8, 11
		g	Radar	22	146	2, 5, 8, 11, 14, 23
		i	Radar Stereo	24	148	8, 11
21	Surface Thermal Anomalies (Regional)	b	Infrared	6	129, 130	1, 3, 6, 9, 12
		d	Microwave	6	129, 130	1, 3, 6, 9, 12
		g	Multiband	6	129, 130	1, 3, 6, 9, 12
22	Surface Thermal Anomalies (Local)	b	Infrared	15	139	4, 7, 10, 13
		d	Microwave	15	139	4, 7, 10, 13
		g	Multiband	15	139	4, 7, 10, 13
23	Surface Thermal Anomalies (Detailed)	b	Infrared	22	146	2, 5, 8, 11, 14, 20
		d	Microwave	22	146	2, 5, 8, 11, 14, 20
		g	Multiband	22	146	2, 5, 8, 11, 14, 20
35	Surface to Atmosphere Transfer	b	Visible	10	134	
		d	Visible Color	9	133	
41	Hydrocarbons	a	Multiband	5	127, 128	

TABLE 11

MEASUREMENT FAMILIES FOR MERCURY

Family Number	Observable Number(s)	Sensor* Type(s)	Minimum Image Size(km)	Overlap (%)	Minimum Coverage (7)	Solar Elevation Range (deg)	Coverage Distribution	Time for Coverage	Image Interval	Coverage Interval
1	3	UV,IR	600	20	70	70-90	—	—	—	—
2	6,12	V	600	20	70	50-80	—	—	—	—
3	3,18	MB,V	600	20	70	30-60	—	—	< 2 hr	> 2/yr
4	1,3,6,9,12	V,IR	600	20	70	15-30	—	—	—	—
5	41	MB	600	20	70	Day	—	—	—	—
6	1,3,6,9,12,21	R,IR,μ,MB	600	20	70	—	—	—	< 30 hr	
7	1,6,9	V	600	60	70	70-85	—	—	—	—
8	1,6,9	R	600	60	70	—	—	—	—	—
9	35	V	300	20	70	50-80	—	< 1 day	—	> 10/yr
10	35	V	300	20	70	30-60	—	< 1 day	—	> 10/yr
11	4	UV,IR	100	20	10	70-90	—	—	—	—
12	7,13	V	100	20	10	50-80	—	—	—	—
13	4,19	MB,V	100	20	10	30-60	—	—	—	—
14	4,7,10,13	V,IR	100	20	10	15-30	—	—	—	—
15	4,7,10,13,22	R,IR,μ,MB	100	20	10	—	—	—	< 30 hr	—
16	7,10	V	100	60	10	70-85	—	—	—	—
17	7,10	R	100	60	10	—	—	—	—	—
18	5	UV,IR	0 5	20	3	70-90	—	—	—	—
19	8,14	V	0 5	20	3	50-80	—	—	—	—
20	2,5	V,MB	0 5	20	3	30-60	—	—	—	—
21	5,8,11,14,20	V,IR	0 5	20	3	15-30	—	—	—	> 1/300hr
22	2,5,8,11,14,20,23	R,IR,μ,MB	0 5	20	3	—	—	—	<30 hr	> 1/300hr
23	8,11,20	V	0 5	60	3	70-85	—	—	—	> 1/300hr
24	8,11,20	R	0 5	60	3	—	—	—	—	> 1/300hr

*Sensor Type Definitions are

UV	Ultraviolet
V	Visible
IR	Infrared
μ	Microwave
R	Radar
MB	Multi-band

TABLE 12

MERCURY INTERPLANETARY TRANSFER SELECTIONS

Launch Date	May 7, 1984	June 2, 1989
Flight Time	130 days (direct)	242 days (Swingby)
Declination of Departure Asymptote (Ecliptic Plane)	-7.5 deg	-28.8 deg
Departure Hyperbolic Excess Speed	11.44 km/sec	8.72 km/sec
Arrival Hyperbolic Excess Speed	8.31 km/sec	10.96 km/sec
Total Hyperbolic Excess Speed	19.75 km/sec	19.68 km/sec
Declination of Arrival Asymptote (Mercury's Ecliptic Plane)	-3.67 deg	14.44 deg
Earth/Sun Separation Angle at Arrival	90.9 deg	86.0 deg
Communication Distance at Arrival	0.95 AU	0.94 AU
Days to Earth/Mars Conjunction after Arrival	26 days	48 days

TABLE 13

MERCURY CANDIDATE ORBIT SIZES

Orbit No.	Eccentricity	Periapse* Altitude (km)	Maximum Altitude Ratio, h/hp	Orbit Period (hrs)	Lapse Rate Per Orbit (km)	Average** Capture ΔV (km/sec)
1	0.0	500	1.0	1.889	20.5	6.462
2	0.1	500	2.3	2.213	24.0	6.329
3	0.2	500	3.9	2.640	28.6	6.202
4	0.3	500	6.0	3.226	34.9	6.081
5	0.4	500	8.8	4.065	44.0	5.964
6	0.5	500	12.8	5.344	57.9	5.851
7	0.6	500	18.6	7.468	80.9	5.742
8	0.7	500	28.4	11.498	124.5	5.636
9	0.8	500	48.0	21.123	228.7	5.534
10	0.9	500	106.8	59.746	646.8	5.434

* Periapse altitude set at 500 km to maintain positive orbit altitudes despite solar perturbations.

** Capture ΔV Based on a Surveyed Average Hyperbolic Approach Speed of Direct Mercury Transfers, VHP = 8.34 km/sec.

ORBIT SELECTION DATA SHEET NO. 119

Mercury (1984) FAMILY NO. 1 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	14.9[2]
Solar Elevation Range (deg)	70-90	70-90
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88 7	

SELECTION RATIONALE:

A circular polar orbit is selected to provide maximum coverage at restricted solar elevations of 70°-90° from minimum altitude without solar perturbations. Coverage is obtained in four segments and is limited to the equatorial region since it is assumed that Mercury's axis of rotation is perpendicular to its orbit plane.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1[1]
Measurement Orbit Frequency	every orbit[1]
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	41
Max. Sensor on Time (min/orb)	12.9
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Only 34.2% of the planet surface is ever illuminated at 70°-90° elevation. Only 15% of this can be seen from an inertial orbit.

ORBIT SELECTION DATA SHEET NO. 120

Mercury (1984) FAMILY NO. 1 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	7.4[1]
Solar Elevation Range (deg)	70-90	70-90
Image Interval	—	180 days
Time for % Coverage (days)	—	180 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

A low inclination capture and subsequent plane change establish this elliptical polar orbit with its periapse just above the equator. Solar perturbation raises the periapse to 1050 km as periapse is perturbed across the equator. By the end of 180 days, periapse has been brought back to the original 500 km altitude. Initial coverage begins in the middle of a restricted solar elevation area. The reduced capture and plane change ΔV from the circular orbit case are obtained at the expense of increasing measurement altitudes and only 2 restricted illumination area passes at "minimized altitudes."

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	59.7
Measurement Alt. Range (km)	500-1150
Max. Measurement Arc (deg)	-20° to 20°
Max. Sensor on Time (min/orb)	9 24
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	5 41
Plane Change ΔV (km/sec)	.27 (86°)
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	5.68

MEASUREMENT ACHIEVEMENT:

1 Only 15% of the planet surface can ever be seen from an inertial orbit under solar elevation of 70°-90°. This percentage is reduced because of altitude restrictions on the elliptical orbit used.

ORBIT SELECTION DATA SHEET NO. 121

Mercury (1984) FAMILY NO. 2 ORBIT NO.1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	48.4[2]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	180 days
Time for % Coverage (days)	—	167 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.7	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 50° to 80° from minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between $\pm$ 40° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	78
Max. Sensor on Time (min/orb)	24.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Only 64% of the planet is ever illuminated between 50° and 80° solar elevations. About 49% of this can be seen from an inertial orbit.

ORBIT SELECTION DATA SHEET NO. 122

Mercury (1984) FAMILY NO. 2 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	>70	26.2[1]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	180 days
Time for % Coverage (days)	—	180 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

A low inclination capture and subsequent plane change establish this elliptical polar orbit with its periapse just above the equator. Solar perturbation raises the periapse to 1050 km as periapse is perturbed across the equator. By the end of 180 days, periapse has been brought back to the original 500 km altitude. Initial coverage begins in the middle of a restricted solar elevation area. The reduced capture and plane change ΔV from the circular orbit case are obtained at the expense of increasing measurement altitudes and only 2 restricted illumination area passes at "minimized altitudes."

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	59.7	
Measurement Alt. Range (km)	500-1480	
Max. Measurement Arc (deg)	-39° to 39°	
Max. Sensor on Time (min/orb)	24.8	
No. of Impulses (ΔV)	2	
Capture ΔV (km/sec)	5.41	
Plane Change ΔV (km/sec)	.27	(86°)
Size Adjustment ΔV (km/sec)	—	
Total ΔV (km/sec)	5.68	

MEASUREMENT ACHIEVEMENT:

1. Only 49% of the planet surface can ever be viewed from an inertial orbit under sun elevation angles 50° to 80°. This percentage is reduced because of altitude restrictions on the elliptical orbit used.

ORBIT SELECTION DATA SHEET NO. 123

Mercury (1984) FAMILY NO. 3 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	70	69 5
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 hr	1.89 hrs
Time for % Coverage (days)	—	171 days
Coverage Interval	> 2/yr.	180 days
Distribution	—	Equator to mid-latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60 7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 30° to 60° from a minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between ± 55° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	34.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.348
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 124

Mercury (1984) FAMILY NO. 3 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	44.9[1]
Solar Elevation Range (deg)	30-60	30-60
Image Interval	< 2 hrs	180 days
Time for % Coverage (days)	—	180 days
Coverage Interval	> 2/yr.	180 days
Distribution	—	Equator to mid-latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

A low inclination capture and subsequent plane change establish this elliptical polar orbit with its periapse just above the equator. Solar perturbation raises the periapse to 1050 km as periapse is perturbed across the equator. By the end of 180 days, periapse has been brought back to the original 500 km altitude. Initial coverage begins in the middle of a restricted solar elevation area. The reduced capture and plane change ΔV from the circular orbit case are obtained at the expense of increasing measurement altitudes and only 2 restricted illumination area passes at "minimized altitudes."

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	59.7
Measurement Alt. Range (km)	500-2120
Max. Measurement Arc (deg)	-54° to 54°
Max. Sensor on Time (min/orb)	28.8
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	5.41
Plane Change ΔV (km/sec)	27 (86°)
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	5.68

MEASUREMENT ACHIEVEMENT:

1. Only 70% of the planet surface can be viewed from an inertial orbit at solar elevation angles 30°-60°. This percentage is reduced because of altitude restrictions on the elliptical orbit used.

ORBIT SELECTION DATA SHEET NO. 125

Mercury (1984) FAMILY NO. 4 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	62.7[2]
Solar Elevation Range (deg)	15-30	15-30
Image Interval	—	180 days
Time for % Coverage (days)	—	174 days
Coverage Interval	—	180 days
Distribution	—	all but poles

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 15° to 30° from minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between + 58° of the equator. Surface illumination is cyclical with a period of 1 Mercury day of approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	116
Max. Sensor on Time (min/orb)	36.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Although 97% of the planet is ever illuminated between 15° and 30°, only 63% of this can be seen from an inertial orbit.

ORBIT SELECTION DATA SHEET NO. 126

Mercury (1984) FAMILY NO. 4 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	>70	31.7[1]
Solar Elevation Range (deg)	15-30	15-30
Image Interval	—	180 days
Time for % Coverage (days)	—	180 days
Coverage Interval	—	180 days
Distribution	—	all but poles

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

A low inclination capture and subsequent plane change establish this elliptical polar orbit with its periapse just above the equator. Solar perturbation raises the periapse to 1050 km as periapse is perturbed across the equator. By the end of 180 days, periapse has been brought back to the original 500 km altitude. Initial coverage begins in the middle of a restricted solar elevation area. The reduced capture and plane change ΔV from the circular orbit case are obtained at the expense of increasing measurement altitudes and only 2 restricted illumination area passes at "minimized altitudes."

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	59.7	
Measurement Alt. Range (km)	500-2910	
Max. Measurement Arc (deg)	-59° to 59°	
Max. Sensor on Time (min/orb)	32.4	
No. of Impulses (ΔV)	2	
Capture ΔV (km/sec)	5.41	
Plane Change ΔV (km/sec)	.27	(86°)
Size Adjustment ΔV (km/sec)	—	
Total ΔV (km/sec)	5.68	

MEASUREMENT ACHIEVEMENT:

1. 63% of the planet surface can be viewed from an inertial orbit with solar elevation angles of 15° to 30°. This percentage is reduced with the use of this orbit because of altitude restrictions.

ORBIT SELECTION DATA SHEET NO. 127

Mercury (1984) FAMILY NO. 5 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	68
Solar Elevation Range (deg)	day	day
Image Interval	—	180 days
Time for % Coverage (days)	—	40
Coverage Interval	—	45 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

All latitudes are observed in sunlight from this circular polar orbit. About 68% (246° in longitude) can be observed in about 40 days. Coverage is repetitious for 30 days thereafter. An additional 25% is covered in the next 14 days. The final 7% is not covered until 114 days after orbit insertion. This coverage profile depends upon the location of the ascending node relative to the terminator and assumes coverage from anywhere in orbit. The 1988 Venus swingby transfer selection will have a different profile (see general discussion).

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	56 7
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 128

Mercury (1984) FAMILY NO. 5 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	78
Solar Elevation Range (deg)	day	day
Image Interval	—	180 days
Time for % Coverage (days)	—	106 days
Coverage Interval	—	—
Distribution	—	all latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

See description on Orbit Selection Data Sheet No. 120 for a general description of this orbit. 104° longitude at all latitudes is covered in daylight during the first 18 days of the mission. This represents 29% of the planet surface. No view coverage is added to this for the next 59 days. Then 49% new coverage is possible in the next 29 days. The total coverage is 78% in 106 days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	59.7
Measurement Alt. Range (km)	500-4130
Max. Measurement Arc (deg)	180
Max. Sensor on Time (min/orb)	67.0
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	5.41
Plane Change ΔV (km/sec)	.27 (86°)
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	5.68

MEASUREMENT ACHIEVEMENT:

ORBIT SELECTION DATA SHEET NO. 129

Mercury (1984) FAMILY NO. 6 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	day and night
Image Interval	< 30 hrs	1.89 hrs
Time for % Coverage (days)	—	30 days
Coverage Interval	—	30 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit provides 100% coverage in 1/2 a Mercury rotation or 30 days if all parts of the orbit are used at all surface illumination conditions. This is the fastest possible consecutive coverage from an inertial orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6 438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 130

Mercury (1984) FAMILY NO. 6 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	808
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	day and night
Image Interval	< 30 hrs	59.7 hrs
Time for % Coverage (days)	—	60 days
Coverage Interval	—	60 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.9	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	53,420	
Inclination (deg)	90	
Ascending Node (deg)	325	
Arg. of Periapse (deg)	173	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 120 for the basic description of this orbit. This elliptical polar orbit provides 100% coverage at "minimized altitude" in 60 days. Only the lowest altitude 180° segment of the orbit is used for coverage. Lower capture ΔV than for the circular orbit is paid for by higher measurement altitudes and twice as long an orbit duration for the initial 100% coverage

ORBIT/MEASUREMENT CHARACTERISTICS:		
Orbits to Contiguous Images	1	
Measurement Orbit Frequency	every orbit	
Orbit Period (hrs)	59 7	
Measurement Alt. Range (km)	500-4025[1]	
Max. Measurement Arc (deg)	180	
Max. Sensor on Time (min/orb)	67 0	
No. of Impulses (ΔV)	2	
Capture ΔV (km/sec)	5.41	
Plane Change ΔV (km/sec)	.27	(86°)
Size Adjustment ΔV (km/sec)	—	
Total ΔV (km/sec)	5.68	

MEASUREMENT ACHIEVEMENT:

1. The upper limit could be reduced to 1540 km if just 70% coverage and maximum latitude of 45° is all right.

ORBIT SELECTION DATA SHEET NO. 131

Mercury (1984) FAMILY NO. 7 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	14.9[2]
Solar Elevation Range (deg)	70-85	70-90[3]
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit is selected to provide maximum coverage at restricted solar elevations of 70°-90° from minimum altitude without solar perturbations Coverage is obtained in four segments and is limited to the equatorial region since it is assumed that Mercury's axis of rotation is perpendicular to the orbit plane.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	40
Max. Sensor on Time (min/orb)	12 6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6 438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 51.2 km with 60% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Only 34.2% of the planet surface is ever illuminated between 70° and 90°. Only 15% of this can be seen from an inertial orbit.
3. The difference in coverage between 85° and 90° illumination is insignificant.

ORBIT SELECTION DATA SHEET NO. 132

Mercury (1984) FAMILY NO. 8 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	600	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	—	day and night
Image Interval	—	30 days
Time for % Coverage (days)	—	30 days
Coverage Interval	—	30 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.7	

SELECTION RATIONALE:

A circular polar orbit provides 100% coverage in half a Mercury rotation (30 days) if all parts of the orbit are used at all surface illumination conditions. This is the fastest possible consecutive coverage from an inertial orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 51.2 km with 60% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit

ORBIT SELECTION DATA SHEET NO. 133

Mercury (1984) FAMILY NO. 9 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	300	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	48.8[2]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	180 days
Time for % Coverage (days)	< 1 day	167 days
Coverage Interval	> 10/yr	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 50° and 80° from minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between ± 40° of the equator. Surface illumination is cyclical with a period of 1 Mercury day of approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1 89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	78
Max. Sensor on Time (min/orb)	24.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Only 64% of the planet is ever illuminated between 50° and 80°. About 49° of this can be seen from an inertial orbit.

ORBIT SELECTION DATA SHEET NO. 134

Mercury (1984) FAMILY NO. 10 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	300	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	69.5
Solar Elevation Range (deg)	30-60	30-60
Image Interval	—	180 days
Time for % Coverage (days)	< 1 day	171 days[2]
Coverage Interval	> 10/yr	180 days[3]
Distribution	—	Equator to mid-latitude

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 30° to 60° from a minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between ± 55° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	34.6
No. of Impulses (ΔV)	6.438
Capture ΔV (km/sec)	—
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	6.438
Total ΔV (km/sec)	

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. 171 days is required to obtain the desired coverage because the length of 1 Mercury day is approximately 180 Earth days which is the length of time required for all longitudes to get the proper illumination.
3. Because the coverage interval is 180 days, 10 or more coverage per year are not possible.

4

ORBIT SELECTION DATA SHEET NO. 135

Mercury (1984) FAMILY NO. 11 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	14.9
Solar Elevation Range (deg)	70-90	70-90
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit is selected to provide maximum coverage at restricted solar elevations of 70°-90° from minimum altitude without solar perturbations. Coverage is obtained in four segments and is limited to the equatorial region since it is assumed that Mercury's axis of rotation is perpendicular to its orbit plane

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	41
Max. Sensor on Time (min/orb)	12.9
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 136

Mercury (1984) FAMILY NO. 12 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	48.8[2]
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	180 days
Time for % Coverage (days)	—	167 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 50° to 80° from minimum altitude without solar perturbations Coverage is obtained in 4 segments limited to latitudes between $\pm$ 40° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	78
Max. Sensor on Time (min/orb)	24.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. Only 64% of the planet is ever illuminated between 50° and 80°. About 49° of this can be seen from an inertial orbit.

ORBIT SELECTION DATA SHEET NO. 137

Mercury (1984) FAMILY NO. 13 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	69.5
Solar Elevation Range (deg)	30-60	30-60
Image Interval	—	180 days
Time for % Coverage (days)	—	171 days
Coverage Interval	—	180 days
Distribution	—	Equator to mid-latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 30° to 60° from a minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between ± 55° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days. Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	34.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 138

Mercury (1984) FAMILY NO. 14 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	62.7
Solar Elevation Range (deg)	15-30	15-30
Image Interval	—	180 days
Time for % Coverage (days)	—	174 days
Coverage Interval	—	180 days
Distribution	—	all but poles

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60 7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit yields maximum coverage at restricted elevations of 15° to 30° from minimum altitude without solar perturbations. Coverage is obtained in 4 segments limited to latitudes between ± 58° of the equator. Surface illumination is cyclical with a period of 1 Mercury day or approximately 180 Earth days Orbital coverage is also cyclical with the same period if the orbit is inertial and Mercury's orbit perturbations are neglected.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	116
Max. Sensor on Time (min/orb)	36.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 139

Mercury (1984) FAMILY NO. 15 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	—	day and night
Image Interval	< 30 hrs	1.89 hrs
Time for % Coverage (days)	—	30 days
Coverage Interval	—	30 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit provides 100% coverage in 1/2 a Mercury rotation or 30 days if all parts of the orbit are used at all surface illumination conditions. This is the fastest possible consecutive coverage from an inertial orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 25.6 km with 20% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 140

Mercury (1984) FAMILY NO. 16 ORBIT NO. -

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	14.9
Solar Elevation Range (deg)	70-85	70-90[2]
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit is selected to provide maximum coverage at restricted solar elevations of 70°-90° from minimum altitude without solar perturbations. Coverage is obtained in four segments and is limited to the equatorial region since it is assumed that Mercury's axis of rotation is perpendicular to the orbit plane

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	40
Max. Sensor on Time (min/orb)	12.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 51.2 km with 60% overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.
2. The difference in coverage between 85° and 90° illumination is insignificant.

ORBIT SELECTION DATA SHEET NO. 141

Mercury (1984) FAMILY NO. 17 ORBIT NO.1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	100	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	—	day and night
Image Interval	—	30 days
Time for % Coverage (days)	—	30 days
Coverage Interval	—	30 days
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

A circular polar orbit provides 100% coverage in 1/2 a Mercury rotation or 30 days if all parts of the orbit are used at all surface illumination conditions. This is the fastest possible consecutive coverage from an inertial orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6 438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. Lapse rate between consecutive orbits yields minimum image size of 51.2km with 60%overlap. Larger images may be used with same overlap by conducting measurements every n-th orbit.

ORBIT SELECTION DATA SHEET NO. 142

Mercury (1984) FAMILY NO. 18 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	14.9
Solar Elevation Range (deg)	70-90	70-90
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 119 for the coverage characteristics of this orbit. The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (i.e., if lapse rate/orbit = image size) is not possible even if the orbit altitude were reduced to 0. An image size of approximately twice the orbit lapse rate, i.e., 41 km, will be necessary to provide anything like .5 km image segments with 20% overlap

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	41
Max. Sensor on Time (min/orb)	12.9
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 20% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.

ORBIT SELECTION DATA SHEET NO. 143

Mercury (1984) FAMILY NO. 19 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	48.8
Solar Elevation Range (deg)	50-80	50-80
Image Interval	—	180 days
Time for % Coverage (days)	—	167 days
Coverage Interval	—	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 121 for the coverage characteristics of this orbit. The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero An image size of approximately twice the lapse rate, i.e., 41 km, will be necessary to provide anything like .5 km image segments with 20% overlap

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1 89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	78
Max. Sensor on Time (min/orb)	24.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 20% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.

ORBIT SELECTION DATA SHEET NO. 144

Mercury (1984) FAMILY NO. 20 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	69.5
Solar Elevation Range (deg)	30-60	30-60
Image Interval	—	180 days
Time for % Coverage (days)	—	171 days
Coverage Interval	—	180 days
Distribution	—	Equator to mid-latitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 123 for the coverage characteristics of this orbit. The extremely small image size of 5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero. An image size of approximately twice the lapse rate, i.e., 41 km, will be necessary to provide anything like 5 km image segments with 20% overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	110
Max. Sensor on Time (min/orb)	34.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 20% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.

ORBIT SELECTION DATA SHEET NO. 145

Mercury (1984) FAMILY NO. 21 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	62.7
Solar Elevation Range (deg)	15-30	15-30
Image Interval	—	180 days
Time for % Coverage (days)	—	174 days
Coverage Interval	> 1/300 hr	180 days[2]
Distribution	—	

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Selection Data Sheet No. 125 for the coverage characteristics of this orbit. The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero. An image size of approximately twice the lapse rate, i.e., 41 km, will be necessary to provide anything like .5 km image segments with 20% overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1 89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	116
Max. Sensor on Time (min/orb)	36.5
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 20% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.
2. The coverage interval is one coverage per 180 days because this is the length of Mercury's period of revolution.

ORBIT SELECTION DATA SHEET NO. 146

Mercury (1984) FAMILY NO. 22 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	25.6[1]
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	—	day and night
Image Interval	< 30 hrs	180 days
Time for % Coverage (days)	—	30 days
Coverage Interval	> 1/300 hrs	30 days[2]
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Description Data Sheet No. 129 for the coverage characteristics of this orbit The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero. An image size of approximately twice the lapse rate, i.e., 41 km, will be necessary to provide anything like .5 km image segments with 20% overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 20% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.
2. Because one coverage requires 30 days, the coverage interval cannot be less than 30 days.

ORBIT SELECTION DATA SHEET NO. 147

Mercury (1984) FAMILY NO. 23 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 3	14.9
Solar Elevation Range (deg)	70-85	70-90[2]
Image Interval	—	180 days
Time for % Coverage (days)	—	163 days
Coverage Interval	> 1/300 hrs	180 days
Distribution	—	Equatorial

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Description Data Sheet No. 131 for the coverage characteristics of this orbit. The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero. An image size of approximately twice the lapse rate, i e., 41 km, will be necessary to provide anything like 0.5 km image segments with 60% overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	40
Max. Sensor on Time (min/orb)	12.6
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 60% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.
2. The difference in coverage between 85° and 90° illumination angles is insignificant.

ORBIT SELECTION DATA SHEET NO. 148

Mercury (1984) FAMILY NO. 24 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	.5	51.2[1]
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	—	day and night
Image Interval	—	30 days
Time for % Coverage (days)	—	30 days
Coverage Interval	> 1/300 hrs	30 days[2]
Distribution	—	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	500	
Apoapse Alt. (km)	500	
Inclination (deg)	90	
Ascending Node (deg)	60.7	
Arg. of Periapse (deg)	-88.1	

SELECTION RATIONALE:

See Orbit Description Data Sheet No 129 for the coverage characteristics of this orbit. The extremely small image size of .5 km infers high resolution data as does the small coverage requirement of > 3%. Such a small image (lapse rate) is not possible even if the orbit altitude were reduced to zero. An image size of approximately twice the lapse rate, i.e., .41 km, will be necessary to provide anything like .5 km image segments with 60% overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	1.89
Measurement Alt. Range (km)	500
Max. Measurement Arc (deg)	360
Max. Sensor on Time (min/orb)	113.4
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.438
Plane Change ΔV (km/sec)	—
Size Adjustment ΔV (km/sec)	—
Total ΔV (km/sec)	6.438

MEASUREMENT ACHIEVEMENT:

1. This is the smallest contiguous orbit lapse rate (including 60% overlap) that can be generated by the smallest candidate orbit, h_p = 500 km, e = 0.
2. Because one coverage requires 30 days, the coverage interval cannot be less than 30 days.

5. JUPITER

Table 14

JUPITER OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No. 1978	Other Family Member Observables
No.	Description	Ref.	Type			
1	Surface Elevations	h j	Radar Radar Stereo	2 6	151, 152 160, 161	6, 9, 12, 24 6, 9
2	Layering	h	Multifreq. Radar	27	196	
3	Contacts (Regional)	m	Radar	11	170, 171	
6	Structure of Features (Regional)	k m	Radar Radar Stereo	2 6	151,152 160,161	1,9,12,24 1,9
9	Surface Topography (Regional)	h j	Radar Radar Stereo	2 6	151, 152 160, 161	1, 6, 12, 24 1, 6
12	Surface Appearance (Regional)	i	Radar	2	151, 152	1, 6, 9, 24
20	Topographic Changes	h j	Radar Radar Stereo	25 26	194 195	
21	Surface Thermal Anomalies (Regional)	e	Microwave	7	162, 163	27, 33
24	Atmospheric Thermal Anomalies (Regional)	a c e	IR Microwave Multiband	2 2 2	151, 152 151, 152 151, 152	1, 6, 9, 12 1, 6, 9, 12 1, 6, 9, 12

Table 14 (Cont.)

JUPITER OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No.	Other Family Member Observables
No.	Description	Ref.	Type		1978	
25	Atmospheric Thermal Anomalies (Detailed)	a	IR	17	183, 184	
		c	Microwave	17	183, 184	
		e	Multiband	17	183, 184	
26	Global Cloud Coverage	a	UV	4	155,156,157	
		b	Visible (BW&Color)	4	155,156,157	
		c	IR	3	153, 154	
		d	IR	3	153, 154	
		e	Multiband	5	158, 159	
27	Convective Cells and Turbulence (Regional)	a	UV	12	172,173,174	33
		b	Visible	12	172,173,174	33
		c	IR	7	162, 163	21, 33
		d	IR	7	162, 163	21, 33
		e	Microwave	7	162, 163	21, 33
		f	Microwave	7	162, 163	21, 33
28	Convective Cells and Turbulence (Detailed)	a	UV	22	191	34
		b	Visible	22	191	34
		c	IR	20	189	
		d	IR	20	189	
		e	Microwave	20	189	
		f	Microwave	20	189	

Table 14 (Cont.)

JUPITER OBSERVABLES, FAMILIES AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No.	Other Family Member Observables
No.	Description	Ref.	Type		1978	
29	Cloud Formation	a	UV	13	175, 176	
		b	Visible (BW&Color)	13	175, 176	
		c	IR	13	175, 176	
		e	IR	8	164, 165	
		f	Multiband	14	177, 178	
30	Precipitation Rate	b	Radar	9	166, 167	
31	Thunderstorms (Regional)	b	Passive RF	10	168, 169	
32	Thunderstorms (Detailed)	b	Passive RF	24	193	
33	Cyclone Formations (Regional)	a	Visible	12	172,173,174	27
		b	IR	12	172,173,174	27
		c	IR	7	162, 163	21, 27
		d	Multiband	15	179, 180	
34	Cyclone Formations (Detailed)	a	Visible	22	191	28
		b	IR	22	191	28
		c	IR	21	190	
		d	Multiband	23	192	

Table 14 (Cont.)

JUPITER OBSERVABLES, FAMILIES, AND ORBITS

Observable		Sensor		Family Number	Orbit Data Sheet No.	Other Family Member Observables
No.	Description	Ref.	Type		1978	
35	Surface to Atmosphere Transfer	e	IR	19	187, 188	
		f	Microwave	19	187, 188	
36	Radio Bursts	a	Passive RF	1	149, 150	
37	Auroras	a	Visible	16	181, 182	
		b	Visible Color	16	181, 182	
40	Biochemical Systems	b	Multiband	18	185, 186	

TABLE 15

MEASUREMENT FAMILIES FOR JUPITER

Family Number	Observable Number(s)	Sensor* Type(s)	Minimum Image Size(km)	Overlap (%)	Minimum Coverage (%)	Solar Elevation Range (deg)	Coverage Distribution	Time for Coverage	Image Interval	Coverage Interval
1	36	RF	30,000	20	70	—	Subsatellite Points	—	< 2 min	—
2	1,6,9,12,24	R,IR,μ,MB	15,000	20	70	—	Cloud Belts,Red Spot	—	—	> 2/yr
3	26	IR	15,000	20	70	—	—	< 1 day	—	> 10/yr
4	26	UV,V	15,000	20	70	Day	—	< 1 day	—	> 10/yr
5	26	MB	15,000	20	70	Day&Night	—	< 1 day	—	> 10/yr
6	1,6,9	R	15,000	60	70	—	—	—	—	> 2/yr
7	21,27,33	IR,μ	5,000	20	70	—	Cloud Belts,Red Spot	—	—	> 4/yr
8	29	IR	5,000	20	10	—	Belts,Red Spot,Tropics	—	< 2 min	—
9	30	R	5,000	20	70	—	—	—	< 15 min	> 4/yr
10	31	RF	5,000	20	70	—	—	—	< 2 min	> 10/yr
11	3	R	5,000	20	3	—	Global	—	—	—
12	27,33	UV,V,IR	5,000	20	70	Day	Cloud Belts,Red Spot	—	—	> 4/yr
13	29	UV,V,IR	5,000	20	10	Day	Belts,Red Spot,Tropics	—	< 2 min	—
14	29	MB	5,000	20	10	Day&Night	Belts,Red Spot,Tropics	—	< 2 min	—
15	33	MB	5,000	20	70	Day&Night	Cloud Belts,Red Spot	—	—	> 4/yr
16	37	V	5,000	20	70	Night	Polar Regions	—	< 1 hr	> 4/yr
17	25	IR,μ,MB	1,500	20	10	—	Cloud Belts,Red Spot	—	< 1 day	—
18	40	MB	1,500	20	3	Day	Random	—	—	> 4/yr
19	35	IR,μ	1,000	20	70	—	Red Spot,Tropics	< 1 day	—	> 10/yr
20	28	IR,μ	1,000	20	10	—	Cloud Belts,Red Spot	—	< 1 day	—
21	34	IR	1,000	20	10	—	Cloud Belts,Red Spot	—	< 15 min	> 4/yr
22	28,34	UV,V,IR	1,000	20	10	Day	Cloud Belts,Red Spot	—	< 15 min	> 4/yr
23	34	MB	1,000	20	10	Day&Night	Cloud Belts,Red Spot	—	< 15 min	> 4/yr
24	32	RF	300	20	10	—	—	—	< 2 min	> 10/yr
25	20	R	3	20	1	—	—	—	—	> 1/300hr
26	20	R	3	60	1	—	—	—	—	> 1/300hr
27	2	R	5	20	3	—	—	—	—	—

*Sensor Type Definitions are

UV	Ultraviolet
V	Visible
IR	Infrared
μ	Microwave
R	Radar
RF	Radio Frequency
MB	Multi-band

TABLE 16

JUPITER INTERPLANETARY TRANSFER SELECTION

Launch Date	October 5, 1978
Flight Time	700 days (Type I)
Declination of Departure Asymptote (Ecliptic Plane)	36.5 deg
Departure Hyperbolic Excess Speed	9.64 km/sec
Arrival Hyperbolic Excess Speed	7.85 km/sec
Total Hyperbolic Excess Speed	17.49 km/sec
Declination of Arrival Asymptote (Jupiter's Equatorial Plane)	-3.64 deg
Earth/Sun Separation Angle at Arrival	1.21 deg
Communication Distance at Arrival	6.43 AU
Days to Earth/Jupiter Conjunction After Arrival	9 days

TABLE 17

JUPITER CANDIDATE ORBIT SIZES

Orbit No.	Jupiter Days/ Orbit (N)	Periapse* Altitude (km/pl.radii)	Eccen- tricity	Maximum Altitude Ratio,h/hp	Orbit Period (hrs)	Average** Capture ΔV (km/sec)
1	4	178375/2.5	0.3772	2.70	39.36	6.325
2	5	178375/2.5	0.4633	3.42	49.20	5.511
3	6	178375/2.5	0.5247	4.09	59.05	4.945
4	7	178375/2.5	0.5711	4.73	68.89	4.525
5	8	178375/2.5	0.6076	5.34	78.73	4.199
6	9	178375/2.5	0.6373	5.92	88.57	3.937
7	10	178375/2.5	0.6619	6.48	98.41	3.721
8	11	178375/2.5	0.6827	7.02	108.25	3.539
9	12	178375/2.5	0.7006	7.55	118.09	3.385
10	5	249725/3.5	0.3099	2.15	49.20	6.378
11	7	356750/5.0	0.2648	1.86	68.89	6.154

* Min. periapse altitude = 2.5 R_p to avoid radiation belt hazard.

** Capture ΔV Based on Surveyed Average Hyperbolic Approach Speed, VHP = 7.64 km/sec, for 700 Day Jupiter Transfers.

ORBIT SELECTION DATA SHEET NO. 149

Jupiter (1978) FAMILY NO. 1 ORBIT NO. NA[1]

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained[2]
Minimum Image Size (km)	30,000	30,000
Minimum Image Overlap (%)	20	21.3
Total Planet Coverage (%)	> 70	100% Longitude[3]
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	~48.5 hrs[4]
Time for % Coverage (days)	-	36.4 days
Coverage Interval	-	~40 days
Distribution	Subsatellite Points	Io Subsatellite Points

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	1,725,330	
Apoapse Alt. (km)	1,725,330	
Inclination (deg)	3.64	
Ascending Node (deg)	81.5	
Arg. of Periapse (deg)	~213	

SELECTION RATIONALE:

A circular minimum inclination orbit is selected to observe Io's meridian plane as it passes by every 48.5 hrs. This timing is selected so that after 19 passes all Jupiter longitudes have been observed with Io centered in each image. Every fifth image overlaps a previous image by 21.3% during the coverage interval there are also 8 Europa passes and 3 Ganymede passes which may be observed.

ORBIT/MEASUREMENT CHARACTERISTICS:[2]	
Orbits to Contiguous Images	< 1 (10.1 days)
Measurement Orbit Frequency	7/orbit
Orbit Period (hrs)	338 (14 days)
Measurement Alt. Range	23 Jupiter radii[5]
Max. Measurement Arc	1 image/Io pass
Max. Sensor on Time	1 image/Io pass
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	5.87
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	5.87

MEASUREMENT ACHIEVEMENT:

1. Special orbit selected to sychronize Io's motion with Jupiter's rotation to obtain contiguous coverage including Io's SSP.
2. Obtained parameters are for Io's subsatellite ground trace.
3. Coverage refers to Io's ground trace.
4. Time between contiguous images (every 5th image) is 10.1 days.
5. This is distance to Jupiter's visible surface; the RF source is generally associated with Io, but the location of its origin is unknown.

ORBIT SELECTION DATA SHEET NO. 150

Jupiter (1978) FAMILY NO. 1 ORBIT NO. NA[1]

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained[2]
Minimum Image Size (km)	30,000	30,000
Minimum Image Overlap (%)	20	21.3
Total Planet Coverage (%)	> 70	100% longitude
Solar Elevation Range (deg)	-	-
Image Interval	< 2 min	~60.7 hrs[3]
Time for % Coverage (days)	-	45.5 days
Coverage Interval	-	~48 days
Distribution	Subsatellite Points	Io Subsatellite Points

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	0	
Periapse Alt. (km)	940,100	
Apoapse Alt. (km)	940,100	
Inclination (deg)	3.64	
Ascending Node (deg)	81.5	
Arg. of Periapse (deg)	~223	

SELECTION RATIONALE:

A circular minimum inclination orbit is selected to observe Io's meridian plane as it passes by every 60.7 hrs. This timing is selected so that after 19 passes all Jupiter longitudes have been observed with Io centered in each image. Every fourth image overlaps an earlier image by 21.3%. During the coverage interval there are also 5 Europa passes and 1 or 2 Ganymede passes (outside the S/C orbit) which may be observed.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1.7 (10.1 days)
Measurement Orbit Frequency	3/orbit
Orbit Period (hrs)	141 (5.9 days)
Measurement Alt. Range	12 Jupiter radii[4]
Max. Measurement Arc	1 image/Io pass
Max. Sensor on Time	1 image/Io pass
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.59[5]
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.59

MEASUREMENT ACHIEVEMENT:

1. Special orbit selected to systematically monitor Io's motion in Jupiter Space.
2. Obtained parameters are for Io's subsatellite ground trace.
3. Time between contiguous images (every 4th image) is 10.1 days.
4. Distance to Jupiter's surface but not necessarily RF source.
5. ΔV is slightly above 6.5 km/sec limit. In fact this selection is less favorable than previous page because 1) higher ΔV, 2) longer coverage time, and 3) less additional satellite passes.

ORBIT SELECTION DATA SHEET NO. 151

Jupiter (1978) FAMILY NO. 2 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	Night
Image Interval	-	-
Time for % Coverage (days)	-	23[1]
Coverage Interval	> 2/yr	9 orbits (~26[d])
Distribution	Cloud belts, red spots	Global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.2648	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	322.2	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates ~2.5 times beneath the S/C yielding a "longitudinal" ground trace. The subsequent orbit is displaced normal to this ground trace by 12000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days[2]
Measurement Alt. Range	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg)	-52 to 128
Max. Sensor on Time	25.3 hrs/orb
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. This coverage time is about 25% of an original estimate of 107[d] based on longitudinal image displacement for contiguous coverage. The shorter coverage time is achieved by a primarily latitude image displacement normal to the highly "longitudinal" ground trace caused by the combination of Jupiter's rapid rotation rate and the slow S/C motion (orbit period almost 3 days).
2. Actual period should be about 1 hr less than 7 Jupiter days for correct image displacement.

ORBIT SELECTION DATA SHEET NO. 152

Jupiter (1978) FAMILY NO. 2 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	94
Solar Elevation Range (deg)	-	Night
Image Interval	-	-
Time for % Coverage (days)	-	62[1]
Coverage Interval	2/yr	16 orbits (~66[d])
Distribution	Cloud belts Red spot	-90 to 62° latitude, all longitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6619	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	1,156,020	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	329.4	

SELECTION RATIONALE:

A higher eccentricity orbit is chosen for comparison with Data Sheet No. 151. The capture ΔV is less by 2.50 km/sec. The time for coverage however has almost tripled to 62 days. Also a restriction of max. $h/h_p = 2$ prohibits measurement above 62° N. latitude even though an inclination of 90° is chosen to maximize latitude coverage. The % coverage is only 6% less but the North Pole is not covered.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	10 Jupiter days[2]
Measurement Alt. Range	2.5 to 5 Jupiter radii[3]
Max. Measurement Arc (deg)	-59 to 93
Max. Sensor on Time	8.7 hrs/orb
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.72
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.72

MEASUREMENT ACHIEVEMENT:

1. Same comment as Note 1 on Data Sheet No. 151 except coverage time is shortened by only about 60% of original estimate (153[d]) since the ground trace is more "diagonal".
2. Actual period should be about 45 min. less than 10 Jupiter days for correct image displacement.
3. Max. altitude range arbitrarily limited to $h/h_p = 2$.

ORBIT SELECTION DATA SHEET NO. 153

Jupiter (1978) FAMILY NO. 3 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	Night
Image Interval	-	-
Time for % Coverage (days)	< 1 day	23[1,3]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	Global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.2648	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	322.2	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates 2.5 times beneath the S/C yielding a "longitudinal" ground trace. The subsequent orbit is displaced normal to this ground trace by 12000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit[2]
Orbit Period	7 Jupiter days
Measurement Alt. Range	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg)	-52 to 128
Max. Sensor on Time	25.3 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. See Orbit Data Sheet No. 151
2. See Orbit Data Sheet No. 151

3. If scanning normal to the ground trace were used the coverage time could be reduced to ~25 hrs. Viewing the entire planet disc from a great distance (~50 R_j) would decrease coverage time to < 1 day, but resolution may also be decreased.

ORBIT SELECTION DATA SHEET NO. 154

Jupiter (1978) FAMILY NO. 3 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	94
Solar Elevation Range (deg)	-	Night
Image Interval	-	-
Time for % Coverage (days)	< 1 day	62[1,4]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	-90 to 62° latitude all longitude

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6619	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	1,156,020	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	329.4	

SELECTION RATIONALE:

A higher eccentricity orbit is chosen for comparison with Data Sheet No. 153. The capture ΔV is less by 2.50 km/sec. The time for coverage however has almost tripled to 62 days. Also a restriction of max. h/h_p = 2 prohibits measurement above 62° N. Latitude even though an inclination of 90° is chosen to maximize latitude coverage. The % coverage is only 6% less but the North Pole is not covered.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	10 Jupiter days[2]
Measurement Alt. Range (km)	2.5 to 5 Jupiter radii[3]
Max. Measurement Arc (deg)	-59 to 93
Max. Sensor on Time (min/orb)	8.7 hrs
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3.72
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.72

MEASUREMENT ACHIEVEMENT:

1.
2. } See Orbit Data Sheet No. 152
3.

4. Scanning normal to the ground trace at nadir angles up to 9.6° (poor resolution near this limit) would permit complete coverage in one pass, i.e., 8.7 hrs.

ORBIT SELECTION DATA SHEET NO. 155

Jupiter (1978) FAMILY NO. 4 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day	day
Image Interval	-	-
Time for % Coverage (days)	< 1 day	107 days[1]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.2648	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	322.2	

SELECTION RATIONALE:

A low eccentricity orbit is selected to image in daylight from minimum altitudes with minimum altitude variations (apoapse is on daylight side). During one measurement pass (North to South Pole including apoapse) the planet rotates almost 4.5 times beneath the spacecraft.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	7 Jupiter days[2]
Measurement Alt. Range (km)	5.53 to 9.32 Jupiter radii
Max. Measurement Arc (deg)	128 through 180 to -52
Max. Sensor on Time (min/orb)	43.6 hrs
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. Coverage time is based on longitudinal image displacement of 12000 km between consecutive orbits. In fact, displacing images 12000 km in latitude on consecutive orbit should reduce the coverage time by more than 75%.
2. The orbit period should be reduced by several hours to obtain proper image displacement on consecutive orbits.

ORBIT SELECTION DATA SHEET NO. 156

Jupiter (1978) FAMILY NO. 4 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	50[3]
Solar Elevation Range (deg)	day	day
Image Interval	-	-
Time for % Coverage (days)	< 1 day	153[1]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	Southern Hemisphere

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6619	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	1,156,043	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	272.7	

SELECTION RATIONALE:

Chosing a high eccentricity orbit requires a maximum[4] off-periapse insertion (OPI) of 57° to move periapse from the night side to within 3° of daylight terminator. This permits maximum daylight measurement arc within h/h_o limit of 2. Even so, latitudes of coverage are 0-90° (Southern Hemisphere) yielding only 50% coverage of the planet.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	10 Jupiter days[2]
Measurement Alt. Range (km)	2.5 to 5 Jupiter radii[3]
Max. Measurement Arc (deg)	-92.7 to -2.7
Max. Sensor on Time (min/orb)	5.7 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.59 (-56.8°)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.59[4]

MEASUREMENT ACHIEVEMENT:

1. A coverage time of 153 days is based on longitudinal image displacement. Image displacement normal to the ground trace on consecutive orbits is more efficient and should result in shortening the coverage time by about 30%.
2. Orbit period should be shortened by ~1 hr for good image displacement.
3. Coverage limited by max. $h/h_p = 2$, even with OPI = 57°.
4. Capture ΔV for 57° OPI is slightly above limit of 6.5 km/sec.

ORBIT SELECTION DATA SHEET NO. 157

Jupiter (1978) FAMILY NO. 4 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	99
Solar Elevation Range (deg)	day	day
Image Interval	-	-
Time for % Coverage (days)	< 1 day	184 days[1]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	-90 to 83° latitude All longitudes

ORBIT ELEMENTS·	Final	Intermediate
Eccentricity	.70056	.95
Periapse Alt. (km)	178,375	178,375
Apoapse Alt. (km)	1,346,922	135.5 Jupiter radii
Inclination (deg)	90	9
Ascending Node (deg)	114	142
Arg. of Periapse (deg)	177	153

SELECTION RATIONALE:

Daylight coverage is required. Because periapse is on the dark side, an off-periapse insertion is used on an orbit having low inclination and high eccentricity to move periapse to the light side. A plane change is made to a polar orbit and the eccentricity is reduced so that the orbit period becomes 12 Jupiter rotation periods.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	12 Jupiter days[1]
Measurement Alt. Range	2.5 to 5.3 Jupiter radii[2]
Max. Measurement Arc (deg)	-80 to 94
Max. Sensor on Time	10.7 hrs/orbit
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	3.47 (-29.7°)
Plane Change ΔV (km/sec)	1.09 (85°)
Size Adjustment ΔV (km/sec)	2.08
Total ΔV (km/sec)	6.64[3]

MEASUREMENT ACHIEVEMENT:

1. 184 days are required for one complete longitudinal coverage of the planet. Displacing images normal to the ground trace should reduce the coverage time by 50%. The orbit period should be shortened ~1 hr to accomplish this.
2. The altitude range is slightly in excess of the limit $h/h_o = 2$ used in previous selections.
3. The total ΔV exceeds the ground rule limit of 6.5 km/sec.

ORBIT SELECTION DATA SHEET NO. 158

Jupiter (1978) FAMILY NO. 5 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day and night	day and night
Image Interval	-	-
Time for % Coverage (days)	< 1 day	107 days[1]
Coverage Interval	>10/yr	> 10/yr
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	322.2	

SELECTION RATIONALE:

The eccentricity and periapse altitude of this orbit were chosen so that the ratio of apoapse altitude to periapse altitude would be less than 2 while maintaining a capture $\Delta V \leq 6.5$ km/sec. The inclination was set at 90° to maximize the latitude coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit[3]
Orbit Period	7 Jupiter days[2]
Measurement Alt. Range	5 to 9.32 Jupiter radii
Max. Measurement Arc (deg)	360[3]
Max. Sensor on Time	68.89 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. 107 days are required to obtain complete longitudinal coverage (100%) of the planet. Displacing images normal to the ground trace will reduce the minimum coverage time to 23 days as indicated on Data Sheet No. 151.
2. Actual period should be about 1 hr less than 7 Jupiter days for correct image displacement.
3. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 159

Jupiter (1978) FAMILY NO. 5 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	50[3]
Solar Elevation Range (deg)	day and night	day and night
Image Interval	-	-
Time for % Coverage (days)	< 1 day	153[1]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	Southern Hemisphere

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.6619	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	1,156,043	
Inclination (deg)	90	
Ascending Node (deg)	351.5	
Arg. of Periapse (deg)	272.7	

SELECTION RATIONALE:

Choosing a high eccentricity orbit requires a maximum[4] off-periapse insertion ≈57° to move periapse from the night side to within 3° of the terminator A 90° inclination thus permits maximum day and night latitude coverage within an h/h_p limit of 2. Even so, latitudes of coverage are 0-90° (Southern Hemisphere) yielding only 50% coverage of the planet. This is the same orbit selection as orbit data sheet No. 156.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period (hrs)	10[2]
Measurement Alt. Range (km)	2.5 to 5[3]
Max. Measurement Arc (deg)	-92.7 to 87.3
Max. Sensor on Time (min/orb)	11
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6 59 (-56 8)
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.59[4]

MEASUREMENT ACHIEVEMENT:

1. A coverage time of 153 days is based on longitudinal image displacement. Image displacement normal to the ground trace on consecutive orbits is more efficient and should result in shortening the coverage time by about 30%.
2. Orbit period should be shortened by ~1 hr for good image displacement.
3. Coverage limited by max. $h/h_p = 2$, even with OPI = 57°.
4. Capture ΔV for 57° OPI is slightly above limit of 6.5 km/sec.

ORBIT SELECTION DATA SHEET NO. 160

Jupiter (1978) FAMILY NO. 6 ORBIT NO. 4

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	night
Image Interval	-	-
Time for % Coverage (days)	-	123[1]
Coverage Interval	> 2/yr	> 2/yr
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351 47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

Using this orbit, complete longitudinal coverage of the planet can be obtained in the shortest possible time under the constraints that the periapse radius be $\geq$ 3.5 Jupiter radii to avoid the radiation belts and that the capture ΔV be $\leq$ 6.5 km/sec. The inclination was selected to be 90° to maximize the latitude coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4[2]
Measurement Alt. Range	2.5 to 4.98 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.5 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. Coverage time is based on longitudinal image displacement. Displacing images normal to the ground trace should reduce the coverage time by about 50%.
2. Orbit period should be about 1 hr less than 4 Jupiter days for best image displacement.

ORBIT SELECTION DATA SHEET NO. 161

Jupiter (1978) FAMILY NO. 6 ORBIT NO. 7

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	15,000	15,000
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 70	93
Solar Elevation Range (deg)	-	night
Image Interval	-	-
Time for % Coverage (days)	-	306 days[1]
Coverage Interval	> 2/yr	> 2/yr
Distribution	-	-90 to 62° Latitude All longitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.66187	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	1,156,043	
Inclination (deg)	90	
Ascending Node (deg)	351 47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

This orbit was selected to show the trade off in mission time versus capture ΔV. This orbit has a longer period than the orbit in Orbit Selection Data Sheet No 160 but a lower capture ΔV. Again the 90° inclination provides maximum latitude coverage

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	10 Jupiter days[2]
Measurement Alt. Range	2.5 to 5 Jupiter radii
Max. Measurement Arc (deg)	-59 to 93
Max. Sensor on Time	8.7 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	3 771
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	3.771

MEASUREMENT ACHIEVEMENT:

1. Coverage time is based on longitudinal image displacement. Displacing contiguous images normal to the ground trace should reduce the coverage time by as much as 50%.
2. Orbit period should be shortened by 1 hour for best image displacement between contiguous orbits.

ORBIT SELECTION DATA SHEET NO. 162

Jupiter (1978) FAMILY NO. 7 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)..... ...	5,000	5,000
Minimum Image Overlap (%).....	20	20
Total Planet Coverage (%).....	> 70	100
Solar Elevation Range (deg).....	-	night
Image Interval.	-	-
Time for % Coverage (days).... .	-	75[1]
Coverage Interval.....	> 4/yr	> 4/yr
Distribution.....	Cloud belts Red spot	Global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity.....	.2648	
Periapse Alt. (km).....	356,750	
Apoapse Alt. (km).....	665,059	
Inclination (deg).....	90	
Ascending Node (deg).....	351.5	
Arg. of Periapse (deg).....	322.2	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates ~2.5 times beneath the spacecraft resulting in a "longitude" ground trace. The subsequent orbit is displaced normal to this ground trace by 4000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period (hrs).....	7[2]
Measurement Alt. Range (km).....	5 to 8.06
Max. Measurement Arc (deg).....	-52 to 128
Max. Sensor on Time (min/orb)...	25.3
No. of Impulses (ΔV).....	1
Capture ΔV (km/sec).	6.22
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.22

MEASUREMENT ACHIEVEMENT:

1. Coverage time is based on image displacement normal to the ground trace. An early estimate of coverage time based on longitudinal image displacement resulted in a much larger value of ~322 days.
2. The orbit period should be shortened by ~20 min. to acheive "normal" image displacement.

ORBIT SELECTION DATA SHEET NO. 163

Jupiter (1978) FAMILY NO. 7 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	night
Image Interval	-	230 days[1]
Time for % Coverage (days)	> 4/yr	> 4/yr
Coverage Interval	cloud belts	global
Distribution	red spot	

ORBIT ELEMENTS	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

This orbit was selected because in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	3.5 to 6.2 Jupiter radii
Max. Measurement Arc (deg)	-56 to 124
Max. Sensor on Time	16.6 hrs/orb
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. 230 days coverage time is based on longitudinal image displacement. In comparing this with Data Sheet No. 162, the original coverage time of 322 days should be used for the latter. It is expected that the 230 day coverage time could be reduced by more than 50% if contiguous images are displaced normal to the ground trace.

ORBIT SELECTION DATA SHEET NO. 164

Jupiter (1978) FAMILY NO. 8 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	night
Image Interval	< 2 min	1.64 days[1]
Time for % Coverage (days)	-	184 days[2]
Coverage Interval	-	-
Distribution	belts, red spot, tropics	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

Even though the percentage coverage required is small and restricted to specific areas whose location will depend upon results of prior imaging, this orbit was selected so that the entire planet surface could be covered in 184 days. This is the shortest time to obtain 100% coverage of the planet surface under the constraints that the capture ΔV be less than 6.5 km/sec and the periapse radius be 3.5 Jupiter radii.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 4.98 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.5 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 1.64 days. If image motion compensation were possible, several images of the same surface area might be feasible at intervals of < 2 min.
2. Coverage time based on longitudinal image displacement. Displacing images normal to the ground trace should decrease the coverage time by more than 50%.

ORBIT SELECTION DATA SHEET NO. 165

Jupiter (1978) FAMILY NO. 8 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)..	5,000	5,000
Minimum Image Overlap (%).....	20	20
Total Planet Coverage (%).....	> 10	100
Solar Elevation Range (deg).....	-	night
Image Interval.....	< 2 min	2.05 days[1]
Time for % Coverage (days).....	-	230[2]
Coverage Interval.....	-	-
Distribution.....	Cloud belts, red spot, tropics	Global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity.....	.3099	
Periapse Alt. (km)..... ..	249,725	
Apoapse Alt. (km).....	538,083	
Inclination (deg).....	90	
Ascending Node (deg).....	351.5	
Arg. of Periapse (deg).....	326	

SELECTION RATIONALE:

This selection demonstrates the penalties of minimizing altitude variation. Compared to Data Sheet No. 164 the h/h_p = 1.77 instead of 2, the result of a lower eccentricity orbit. Yet the measurement altitudes themselves are larger, the coverage time is longer (both these factors a result of keeping $\Delta V < 6.5$ km/sec) and the capture ΔV is higher.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period (hrs).....	5
Measurement Alt. Range...	3.5 to 6.2 Jupiter radii
Max. Measurement Arc (deg).....	~56 to 124
Max. Sensor on Time.....	16.6 hrs/orbit
No. of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.44
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.44

MEASUREMENT ACHIEVEMENT:

1. Several images of the same area might be imaged on any single pass at intervals of< 2 min, instead of only one/orbit.

2. Coverage time based on longitudinal image displacement.

ORBIT SELECTION DATA SHEET NO. 166

Jupiter (1978) FAMILY NO. 9 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)...	5,000	5,000
Minimum Image Overlap (%).....	20	20
Total Planet Coverage (%).....	> 70	100
Solar Elevation Range (deg)... .	-	night
Image Interval.....	< 15 min	2.87 days[1]
Time for % Coverage (days).....	-	75 days[2]
Coverage Interval...	> 4/yr	> 4/yr
Distribution.....	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity.....	.26475	
Periapse Alt. (km).....	356,750	
Apoapse Alt. (km).....	665,059	
Inclination (deg).....	90	
Ascending Node (deg).....	351.47	
Arg. of Periapse (deg).....	322	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates ~2.5 times beneath the spacecraft resulting in a "longitude" ground trace. The subsequent orbit is displaced normal to this ground trace by 4000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period.....	7 Jupiter days[3]
Measurement Alt. Range.....	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg).....	-52 to 128
Max. Sensor on Time.....	25.3 hrs/orbit
No. of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.22
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.22

MEASUREMENT ACHIEVEMENT:

1. The image interval, or shortest time between coverages of the same area, equals one orbit period of 2.87 days.
2. Coverage time is based on image displacement normal to the ground trace. An early estimate of coverage time based on longitudinal image displacement resulted in a much larger value of ~322 days.
3. The orbit period should be shortened by ~20 min. to achieve "normal" image displacement.

ORBIT SELECTION DATA SHEET NO. 167

Jupiter (1978) FAMILY NO. 9 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)..	5,000	5,000
Minimum Image Overlap (%).....	20	20
Total Planet Coverage (%).....	> 70	100
Solar Elevation Range (deg).....	-	night
Image Interval.	< 15 min	2.05 days[1]
Time for % Coverage (days).....	-	230 days[2]
Coverage Interval...	> 4/yr	> 4/yr
Distribution..... .	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km).....	249,725	
Apoapse Alt. (km).....	538,083	
Inclination (deg).....	90	
Ascending Node (deg).....	351.47	
Arg. of Periapse (deg)..... ..	326	

SELECTION RATIONALE:

This orbit was selected because in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period.	5 Jupiter days
Measurement Alt. Range.....	3.5 to 6.2 Jupiter radii
Max. Measurement Arc (deg).....	-56 to 124
Max. Sensor on Time.....	16.6 hrs/orb
No. of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.435
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.435

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period of 2.05 days.
2. 230 days coverage time is based on longitudinal image displacement. In comparing this with Data Sheet No. 162, the original coverage time of 322 days should be used for the latter. It is expected that the 230 day coverage time could be reduced by more than 50% if contiguous images are displaced normal to the ground trace.

ORBIT SELECTION DATA SHEET NO. 168

Jupiter (1978) FAMILY NO. 10 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)...	5,000	5,000
Minimum Image Overlap (%).	20	20
Total Planet Coverage (%).....	> 70	100
Solar Elevation Range (deg)... .	-	night
Image Interval.....	< 2 min	2.87 days[1]
Time for % Coverage (days).....	-	75 days[2]
Coverage Interval.....	> 10/yr	> 10/yr
Distribution.....	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity.....	26475	
Periapse Alt. (km).....	356,750	
Apoapse Alt. (km).....	665,059	
Inclination (deg).....	90	
Ascending Node (deg).....	351.47	
Arg. of Periapse (deg).	322	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates ~2.5 times beneath the spacecraft resulting in a "longitude" ground trace. The subsequent orbit is displaced normal to this ground trace by 4000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period.....,.....	7 Jupiter days[3]
Measurement Alt. Range...,.....	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg).....	-52 to 128
Max. Sensor on Time.....	25.3 hrs/orbit
No of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.22
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.22

MEASUREMENT ACHIEVEMENT:

1. Several images of the same area might be imaged on any single pass at intervals of <2 min, instead of only one/orbit.
2. trace. An early estimate of coverage time based on longitudinal image displacement resulted in a much larger value of ~322 days.
3. The orbit period should be shortened by ~20 min. to acheive "normal" image displacement.

ORBIT SELECTION DATA SHEET NO. 169

Jupiter (1978) FAMILY NO. 10 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	-	night
Image Interval	< 2 min	2.05 days[1]
Time for % Coverage (days)	-	230 days[2]
Coverage Interval	> 10/yr	> 10/yr
Distribution	-	global

ORBIT ELEMENTS	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg of Periapse (deg)	326	

SELECTION RATIONALE·

This orbit was selected because in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS·

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	3.5 to 6.2 Jupiter radii
Max. Measurement Arc (deg)	-56 to 124
Max. Sensor on Time	16 6 hrs/orbit
No of Impulses (ΔV)	1
Capture ΔV (km/sec)	6 435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. Several images of the same area might be imaged on any single pass at intervals of 2 min, instead of only one/orbit.
2. 230 days coverage time is based on longitudinal image displacement. In comparing with Data Sheet No. 162, the original coverage time of 322 days should be used for the latter. It is expected that the 230 day coverage time could be reduced by more than 50% if contiguous images are displaced normal to the ground trace.

ORBIT SELECTION DATA SHEET NO. 170

Jupiter (1978) FAMILY NO. 11 ORBIT NO. -

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	-	night
Image Interval	-	-
Time for % Coverage (days)	-	184 days[1]
Coverage Interval	-	-
Distribution	global	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

Even though the percentage coverage required is small and restricted to specific areas whose location will depend upon results of prior imaging, this orbit was selected so that the entire planet surface could be covered in 184 days. This is the shortest time to obtain 100% coverage of the planet surface under the constraints that the capture ΔV be less than 6.5 km/sec and the periapse radius be 3.5 Jupiter radii.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter radii
Measurement Alt. Range	2.5 to 4.98 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.5 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. Coverage time based on longitudinal image displacement. Displacing images normal to the ground trace should decrease the coverage time by more than 50%.

ORBIT SELECTION DATA SHEET NO. 171

Jupiter (1978) FAMILY NO. 11 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km).....	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%).	> 3	100
Solar Elevation Range (deg).....	-	night
Image Interval.....	-	-
Time for % Coverage (days).....	-	230 day
Coverage Interval..... ...	-	-
Distribution.....	global	global

ORBIT ELEMENTS:	Final	Intermediat
Eccentricity.....	.30989	
Periapse Alt (km).....	249,725	
Apoapse Alt. (km).....	538,083	
Inclination (deg).....	90	
Ascending Node (deg).....	351.47	
Arg. of Periapse (deg).....	326	

SELECTION RATIONALE:

This selection demonstrates the penalties of minimizir altitude variation. Compared to Data Sheet No. 170, the h/ 1.77 instead of 2, the result of a lower eccentricity orbit Yet the measurement altitudes themselves are larger, the coverage time is longer (both these factors a result of kee $\Delta V < 6.5$ km/sec) and the capture ΔV is higher.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images.....	1
Measurement Orbit Frequency.....	every orbit
Orbit Period.....	5 Jupiter days
Measurement Alt. Range.....	3.5 to 6.2 Jupiter radi
Max. Measurement Arc (deg).....	-56 to 124
Max. Sensor on Time.....	16.6 hrs/orbit
No. of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.435
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec).....	6.435

MEASUREMENT ACHIEVEMENT:

1. Coverage time based on longitudinal image displacement.

ORBIT SELECTION DATA SHEET NO. 172

Jupiter (1978) FAMILY NO. 12 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day	day
Image Interval	-	-
Time for % Coverage (days)	-	322 days[1]
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	322	

SELECTION RATIONALE:

A low eccentricity orbit is selected to image in daylight from minimum altitudes with minimum altitude variations (apoapse is on daylight side). During one measurement pass (North to South Pole including apoapse) the planet rotates almost 4.5 times beneath the spacecraft.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days
Measurement Alt. Range	5.53 to 9.32 Jupiter radii
Max. Measurement Arc (deg)	128 through 180 to -52
Max. Sensor on Time	43.6 hours/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. Based on longitudinal image displacement. Displacing the image normal to the ground trace on consecutive orbits should reduce the coverage time by more than 75%.

ORBIT SELECTION DATA SHEET NO. 173

Jupiter (1978) FAMILY NO. 12 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km).	5,000	5,000
Minimum Image Overlap (%).....	20	20
Total Planet Coverage (%)... ...	> 70	100
Solar Elevation Range (deg).....	day	day
Image Interval.	-	-
Time for % Coverage (days).....	-	230 days[1]
Coverage Interval.....	> 4/yr	-
Distribution.....	cloud belt, red spot	global

ORBIT ELEMENTS·	Final	Intermediate
Eccentricity..... ...	.30989	
Periapse Alt. (km).....	249,725	
Apoapse Alt. (km).....	538,083	
Inclination (deg)..	90	
Ascending Node (deg)...	351.47	
Arg of Periapse (deg).	326	

SELECTION RATIONALE·

This orbit was selected because in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images... .	1
Measurement Orbit Frequency... .	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range···· ·····	4 to 7.55 Jupiter radii
Max. Measurement Arc (deg).....	124 through 180 to -56
Max. Sensor on Time.....	32.6 hr/orbit
No of Impulses (ΔV).....	1
Capture ΔV (km/sec).....	6.435
Plane Change ΔV (km/sec).....	-
Size Adjustment ΔV (km/sec).....	-
Total ΔV (km/sec)..	6.435

MEASUREMENT ACHIEVEMENT:

1. Based on longitudinal image displacement. Displacing the image normal to the ground trace on consecutive orbits should reduce the coverage time by approximately 75%.

ORBIT SELECTION DATA SHEET NO. 174

Jupiter (1978) FAMILY NO. 12 ORBIT NO. 9

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	99
Solar Elevation Range (deg)	day	day
Image Interval	-	-
Time for % Coverage (days)	-	552 days[1]
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	-90 to 83° latitude All longitudes

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.70056	.95
Periapse Alt. (km)	178,375	178,375
Apoapse Alt. (km)	1,346,922	135.5 Jupiter radii
Inclination (deg)	90	9
Ascending Node (deg)	114	142
Arg. of Periapse (deg)	177	153

SELECTION RATIONALE:

Daylight coverage is required. Because periapse is on the dark side, an off-periapse insertion is used on an orbit having low inclination and high eccentricity to mover periapse to the light side. A plane change is made to a polar orbit and the eccentricity is reduced so that the orbit period becomes 12 Jupiter rotation periods.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	12 Jupiter days[1]
Measurement Alt. Range	2.5 to 5.3 Jupiter radii[2]
Max. Measurement Arc (deg)	-80 to 94
Max. Sensor on Time	10.7 hr/orbit
No. of Impulses (ΔV)	3
Capture ΔV (km/sec)	3.47 (-29.7)
Plane Change ΔV (km/sec)	1.09 (85°)
Size Adjustment ΔV (km/sec)	2.08
Total ΔV (km/sec)	6.64[3]

MEASUREMENT ACHIEVEMENT:

1. Displacing images normal to the ground trace rather than longitudinally should reduce the coverage time by about 50%. The orbit period should be shortened ~15 min to accomplish this.
2. The altitude range is slightly in excess of the limit $h/h_o = 2$ used in previous selections.
3. The total ΔV exceeds the ground rule limit of 6.5 km/sec.

ORBIT SELECTION DATA SHEET NO. 175

Jupiter(1978) FAMILY NO. 13 ORBIT NO.1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5000	5000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day	day
Image Interval	< 2 min	1.64[1]
Time for % Coverage (days)	-	184 days[2]
Coverage Interval	-	-
Distribution	belts, red spot, tropics	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

Even though the percentage coverage required is small and restricted to specific areas whose location will depend upon results of prior imaging, this orbit was selected so that the entire planet surface could be covered in 184[2] days. This is the shortest time to obtain 100% coverage of the planet surface under the constraints that the capture ΔV be less than 6.5 km/sec and the periapse radius be 3.5 Jupiter radii.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	3.0 to 6.74Jupiter radii
Max. Measurement Arc (deg)	121 through 180 to -59°
Max. Sensor on Time	27.8 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. Several images of the same area might be imaged on any single pass at intervals of < 2 min, instead of only one/orbit.
2. Coverage time based on longitudinal image displacement.
3. The altitude range is slightly in excess of the limit $h/h_o = 2$ used in previous selections.

ORBIT SELECTION DATA SHEET NO. 176

Jupiter (1978) FAMILY NO. 13 ORBIT NO.10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day	day
Image Interval	< 2 min	2.05 days[1]
Time for % Coverage (days)	-	230 days[2]
Coverage Interval	-	-
Distribution	belts, red spot, tropics	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

While the ΔV and coverage time are both larger for this orbit than Data Sheet No. 175, the altitude ratio is within a limit $h/h_o = 2$. The altitudes themselves are, however, higher than the previous selection. All in all, this is a rather poor selection compared to Data Sheet No. 175.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	4 to 7.55 Jupiter radii
Max. Measurement Arc (deg)	124 though 180 to -56
Max. Sensor on Time	32.6 hr/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. Several images of the same area might be imaged on any single pass at intervals of <2 min, instead of only one/orbit.

2. Coverage time based on longitudinal image displacement.

ORBIT SELECTION DATA SHEET NO. 177

Jupiter (1978) FAMILY NO. 14 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5000	5000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	< 2 min	1.64 days [1]
Time for % Coverage (days)	-	184 days [2]
Coverage Interval	-	-
Distribution	belts, red spot, tropics	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

Even though the percentage coverage required is small and restricted to specific areas whose location will depend upon results of prior imaging, this orbit was selected so that the entire planet surface could be covered in 184 days. This is the shortest time to obtain 100% coverage of the planet under the constraints that the capture ΔV be less than 6.5 km/sec and the periapse radius be 3.5 Jupiter radii.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit [3]
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 6.74 Jupiter radii
Max. Measurement Arc (deg)	360
Max. Sensor on Time	39.36 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. The shortest time between images of the same area is equal to one period or 1.64 days.
2. Coverage time based on longitudinal image displacement.
3. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 178

Jupiter (1978) FAMILY NO. 14 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day & night	day & night
Image Interval	< 2 min	2.05 days[1]
Time for % Coverage (days)	-	230 days[2]
Coverage Interval	-	-
Distribution	belts, red spot, tropics	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

This selection demonstrates the penalties of minimizing altitude variation. Compared to Data Sheet No. 177 the h/h_p = 2.7 instead of 2.2, the result of a lower eccentricity orbit. Yet the measurement altitudes themselves are larger, the coverage time is longer (both these factors a result of keeping ΔV < 6.5 km/sec) and the capture ΔV is higher.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit[3]
Orbit Period	5 Jupiter days
Measurement Alt. Range	3.5 to 7.54 Jupiter radii
Max. Measurement Arc (deg)	360
Max. Sensor on Time	49.20 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 2.05 days.
2. Coverage time based on longitudinal image displacement.
3. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 179

Jupiter (1978) FAMILY NO. 15 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5000	5000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	-	-
Time for % Coverage (days)	-	322 days[1]
Coverage Interval	> 4/yr	-
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	322	

SELECTION RATIONALE:

This orbit was selected because with it, it is possible to image over the entire orbit so that both the light side and dark sides of the planet can be covered. The required coverage is obtained in 322[1] days.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days[2]
Measurement Alt. Range	5 to 9.32Jupiter radii
Max. Measurement Arc (deg)	360[2]
Max. Sensor on Time	68.89 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. Coverage time is based on longitudinal image displacement. If images are displaced normal to the ground trace the required coverage time is expected to decrease to ~75 days
2. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 180

Jupiter (1978) FAMILY NO. 15 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5000	5000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	day&night	day&night
Image Interval	-	-
Time for % Coverage (days)	-	230 days[1]
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

This orbit was selected because it has the following characteristics: 1) the rather low eccentricity allows imaging over the entire orbit so that coverage is obtained both during daytime and night. 2) in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days[2]
Measurement Alt. Range	3.5 to 7.54 Jupiter radii
Max. Measurement Arc (deg)	360
Max. Sensor on Time	49.20 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. Based on longitudinal image displacement. Displacing the image normal to the ground trace on consecutive orbits should reduce the coverage time by approximately 50%.
2. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 181

Jupiter (1978) FAMILY NO. 16 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	night	night
Image Interval	< 1 hr	2.87 days[1]
Time for % Coverage (days)	-	75 days[2]
Coverage Interval	> 4/yr	-
Distribution	polar regions	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	322	

SELECTION RATIONALE:

A small eccentricity orbit is chosen to minimize altitude variations over a maximum measurement arc of 180°. An inclination of 90° assures complete latitude coverage. During one complete measurement pass (180° including periapse) the planet rotates ~2.5 times beneath the spacecraft resulting in a "longitude" ground trace. The subsequent orbit is displaced normal to this ground trace by 4000 km giving 20% image overlap.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days[3]
Measurement Alt. Range	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg)	-52 to 128
Max. Sensor on Time	25.3 hours/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.22
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.22

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 2.87 days.
2. Coverage time is based on image displacement normal to the ground trace. An early estimate of coverage time based on longitudinal image displacement resulted in a much larger value of ~322 days.
3. The orbit period should be shortened by ~20 min. to achieve "normal" image displacement.

ORBIT SELECTION DATA SHEET NO. 182

Jupiter (1978) FAMILY NO. 16 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	5,000	5,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	100
Solar Elevation Range (deg)	night	night
Image Interval	< 1 hr	2.05 days[1]
Time for % Coverage (days)	-	230 days[2]
Coverage Interval	> 4/yr	-
Distribution	polar regions	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

This orbit was selected because in comparison to the orbit described on the orbit selection data sheet immediately preceeding which satisfies the same measurement specifications, this orbit has a slightly higher capture ΔV in return for shorter mission times and lower measurement altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	3.5 to 6.2 Jupiter radii
Max. Measurement Arc (deg)	-56 to 124
Max. Sensor on Time	16.6 hours/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.435
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.435

MEASUREMENT ACHIEVEMENT:

1. The shortest time between images of the same area is equal to one orbit period or 2.05 days.
2. 230 days coverage time is based on longitudinal image displacement. In comparing this with Data Sheet No. 162, the original coverage time of 322 days should be used for the latter. It is expected that the 230 day coverage time could be reduced by more than 50% if contiguous images are displaced normal to the ground trace.

ORBIT SELECTION DATA SHEET NO. 183

Jupiter (1978) FAMILY NO. 17 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,500	1,500
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100[1]
Solar Elevation Range (deg)	-	night
Image Interval	< 1 day	2.87 days[2]
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	322	

SELECTION RATIONALE:

Because the desired percentage coverage is small and its location is not known until results of prior measurements are available, the final orbit selected is arrived at by a small change in the period of an intermediate orbit which is similar to the final orbit but which has a lapse rate of about 20° per orbit. This adjustment is made when the area of interest is in the correct position relative to the orbit. The 90° inclination is chosen to maximize latitude coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days
Measurement Alt. Range	5 to 8.06 Jupiter radii
Max. Measurement Arc (deg)	-52 to 128
Max. Sensor on Time	25.3 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.218
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6 218+

MEASUREMENT ACHIEVEMENT:

1. Using this orbit, 100% coverage of the planet surface could be obtained in 1076 days based upon longitudinal image displacement. If image displacement normal to the ground trace is considered, the coverage can be obtained in a shorter amount of time.
2. The shortest time between coverages of the same area is equal to one orbit period of 2.87 days.

ORBIT SELECTION DATA SHEET NO. 184

Jupiter (1978) FAMILY NO. 17 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,500	1,500
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	night
Image Interval	< 1 day	2.05 days[1]
Time for % Coverage (days)	-	769 days[2]
Coverage Interval	-	once/769 days
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

Because the percentage of the planet to be imaged is small and because it depends upon prior measurements, an initial orbit is selected which is very similar to the final orbit but which differs from the final orbit in having a larger lapse rate, say 20°/orbit. In this way it is possible to get to the area of interest quickly and then to change the lapse rate to the desired rate. Imaging can be done over the entire orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	3.5 to 7.54 Jupiter radii
Max. Measurement Arc (deg)	-56 to 124
Max. Sensor on Time	16.6 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.43
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.43 +

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 2.05 days.
2. The amount of time required for obtaining the percentage coverage is based upon longitudinal image displacement. If displacement normal to the ground trace is considered, the coverage can be obtained in a shorter amount of time.

ORBIT SELECTION DATA SHEET NO. 185

Jupiter (1978) FAMILY NO. 18 ORBIT NO. 11

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,500	1,500
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	day	day
Image Interval	-	2.87 days
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	about 4/yr
Distribution	random	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.26475	
Periapse Alt. (km)	356,750	
Apoapse Alt. (km)	665,059	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg of Periapse (deg)	322	

SELECTION RATIONALE:

Because the desired percentage coverage is small and its location is not known until results of prior measurements are available, the final orbit selected is arrived at by a small change in the period of an intermediate orbit which is similar to the final orbit but which has a lapse rate of about 20° per orbit. This adjustment is made when the area of interest is in the correct position relative to the orbit. The 90° inclination is chosen to maximize latitude coverage.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	7 Jupiter days
Measurement Alt. Range	5.53 to 9.32 Jupiter radii
Max. Measurement Arc (deg)	-[2]
Max. Sensor on Time	43.6 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.218
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.218+

MEASUREMENT ACHIEVEMENT:

1. The amount of time required for obtaining the percentage coverage is based upon longitudinal image displacement. If displacement normal to the ground trace is considered, the coverage can be obtained in a shorter amount of time.

2. The range of true anomalies for daylight coverage is -180° to -52° and 128° to 180°.

ORBIT SELECTION DATA SHEET NO. 186

Jupiter (1978) FAMILY NO. 18 ORBIT NO. 10

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,500	1,500
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	100
Solar Elevation Range (deg)	day	day
Image Interval	-	2.05 days
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	> 4/yr[1]
Distribution	random	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.30989	
Periapse Alt. (km)	249,725	
Apoapse Alt. (km)	538,083	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

Because the percentage of the planet to be imaged is small and because it depends upon prior measurements, an initial orbit is selected which is very similar to the final orbit but which differs from the final orbit in having a larger lapse rate, say 20°/orbit. In this way it is possible to get to the area of interest quickly and then to change the lapse rate to the desired rate. Imaging can be done over the entire orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	4.08 to 7.54 Jupiter radii
Max. Measurement Arc (deg)	-[2]
Max. Sensor on Time	32.6 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.43
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.43+

MEASUREMENT ACHIEVEMENT:

1. The amount of time required for obtaining the percentage coverage is based upon longitudinal image displacement. If displacement normal to the ground trace is considered, the coverage can be obtained in a shorter amount of time.
2. The range of true anomalies for daylight coverage is -180° to -56° and 124° to 180°.

ORBIT SELECTION DATA SHEET NO. 187

Jupiter (1978) FAMILY NO. 19 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	50[1]
Solar Elevation Range (deg)	-	day and night
Image Interval	-	1.64 days
Time for % Coverage (days)	< 1 day	922 days[2]
Coverage Interval	> 10/yr	once/922 days[2]
Distribution	red spot, tropics	-30° to 30° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	30	
Ascending Node (deg)	357.8	
Arg. of Periapse (deg)	326	

SELECTION RATIONALE:

Because the areas of interest are the red spot and the tropics an orbit having 30° inclination was selected. The period of the orbit was selected so that the lapse rate from one orbit to the next is 0.67° (this is the lapse rate required by the image size, percent overlap combination) when the regression of the ascending node is taken into account.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 4.98 Jupiter radii
Max. Measurement Arc (deg)	-121 to 121
Max. Sensor on Time	17.2 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	6.38

MEASUREMENT ACHIEVEMENT:

1. The areas of interest (tropics and red spot) compose approximately 50% of the planet surface.
2. To obtain complete longitudinal coverage of the planet using this orbit, 922 days are required. when obtaining the desired percentage overlap is based upon longitudinal image displacement. Displacing the image normal to the ground trace on consecutive orbits would reduce the time required for coverage.

ORBIT SELECTION DATA SHEET NO. 188

Jupiter (1978) FAMILY NO. 19 ORBIT NO. 2

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 70	98.3
Solar Elevation Range (deg)	-	day and night
Image Interval	-	2.05 days
Time for % Coverage (days)	< 1 day	1153 days[1]
Coverage Interval	> 10/yr	once/1153 days[1]
Distribution	red spot, tropics	-90° to 75° lat.

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.46324	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	609,433	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

This orbit was selected because it has the lowest capture ΔV of orbits having periapse radius $\geq$ 3.5 Jupiter radii and an orbit period equal to an integral number of Jupiter rotation periods. The periapse lies at the southern extremity of the south tropical region so that the red spot and the tropical regions can be imaged at fairly low altitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	5 Jupiter days
Measurement Alt. Range	2.5 to 4.87 Jupiter radii
Max. Measurement Arc (deg)	-106 to 106
Max. Sensor on Time	14.2 hrs/orbit
No. of Impulses (ΔV)	1
Capture ΔV (km/sec)	5.561
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	-
Total ΔV (km/sec)	5.561

MEASUREMENT ACHIEVEMENT:

1. The time required to obtain complete longitudinal coverage of the planet is equal to 1153 days when the desired percentage overlap is based upon longitudinal image displacement. Displacing the image normal to the ground trace on consecutive orbits would reduce the time required for coverage.

ORBIT SELECTION DATA SHEET NO. 189

Jupiter (1978) FAMILY NO. 20 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day and night
Image Interval	< 1 day	1.64 days[1]
Time for % Coverage (days)	-	-
Coverage Interval	-	-
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

For this measurement specification, the total percent of the planet to be covered is small and the areas of interest depend upon prior measurements For this reason, an intermediate orbit, quite similar to the final orbit except that it has a much bigger lapse rate, say 20°/orbit, is selected. This orbit is used to get the areas of interest into proper position quickly. At that time a small change in the orbit period is made to obtain the orbit described above

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every Orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 6.74 Jupiter radii
Max. Measurement Arc (deg)	360[2]
Max. Sensor on Time	39.36 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period of 1.64 days.
2. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 190

Jupiter (1978) FAMILY NO. 21 ORBIT NO. -

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	-	day and night
Image Interval	< 15 min	1.64 days[1]
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

For this measurement specification, the total percent of the planet to be covered is small and the areas of interest depend upon prior measurements. For this reason an intermediate orbit, quite similar to the final orbit except that it has a much bigger lapse rate, say 20°/orbit, is selected. This orbit is used to get the areas of interest into proper position quickly. At that time a small change in the orbit period is made to obtain the orbit described above.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 6.74 Jupiter radii
Max. Measurement Arc (deg)	360[2]
Max. Sensor on Time	39.36 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 1.64 days.
2. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 191

Jupiter (1978) FAMILY NO. 22 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day	day
Image Interval	<15 min	1.64 days[1]
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

For this measurement specification, the total percent of the planet to be covered is small and the areas of interest depend upon prior measurements. For this reason, an intermediate orbit, quite similar to the final orbit except that it has a much bigger lapse rate, say 20°/orbit, is selected. This orbit is used to get the areas of interest into proper position quickly. At that time a small change in the orbit period is made to obtain the orbit described above.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	3.0 to 6.74 Jupiter radii
Max. Measurement Arc (deg)	-2
Max. Sensor on Time	27.8 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 1.64 Earth days.
2. The range of true anomaly for daylight coverage is -180° to -59° and 121° to 180°.

ORBIT SELECTION DATA SHEET NO. 192

Jupiter (1978) FAMILY NO. 23 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	1,000	1,000
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	100
Solar Elevation Range (deg)	day and night	day and night
Image Interval	<15 min	1.64 days[1]
Time for % Coverage (days)	-	-
Coverage Interval	> 4/yr	> 4/yr
Distribution	cloud belts, red spot	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

For this measurement specification, the total percent of the planet to be covered is small and the areas of interest depend upon prior measurements. For this reason, an intermediate orbit, quite similar to the final orbit except that it has a much bigger lapse rate, say 20°/orbit, is selected. This orbit is used to get the areas of interest into proper position quickly. At that time a small change in the orbit period is made to obtain the orbit described above.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 6.74 Jupiter radii
Max. Measurement Arc (deg)	360[2]
Max. Sensor on Time	39.36 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The shortest time between coverages of the same area is equal to one orbit period or 1.64 days.
2. Continuous imaging on every orbit will definitely present a data handling problem.

ORBIT SELECTION DATA SHEET NO. 193

Jupiter (1978) FAMILY NO. 24 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	300	300
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 10	-[1]
Solar Elevation Range (deg)	-	-
Image Interval	<2 min	1.64 days[2]
Time for % Coverage (days)	-	-[1]
Coverage Interval	> 10/yr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

For these specifications the areas to be imaged compose a small percentage of the planet surface and their location depends upon results of prior measurements. The orbit selected will be obtained from an initial orbit which is similar to the final orbit in all respects except that it has a slightly different period and hence a large lapse rate, say 20° per orbit, so that the areas of interest can be reached fast. At that time a small change in the period changes the lapse rate to the proper rate.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 5.00 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11 6 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The percent coverage and the time required to obtain this coverage cannot be determined now because the size and location of areas of interest is not known.
2. The shortest time between images of the same area is equal to one orbit period or 1.64 days.

ORBIT SELECTION DATA SHEET NO. 194

Jupiter (1978) FAMILY NO. 25 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	3	3
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 1	-[1]
Solar Elevation Range (deg)	-	-
Image Interval	-	1.64 days
Time for % Coverage (days)	-	-[1]
Coverage Interval	>1/300 hr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

The final swath width desired is so small that the area of interest is reached by an orbit similar to the final orbit but having a large lapse rate. Then at the appropriate time, a change is made to the desired orbit. Side by side coverage occurs every 4 Jupiter days. Imaging may be done over the entire orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 5.00 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.6 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The percent coverage and the time required to obtain it cannot be determined now because the size and location of areas of interest is not known.

ORBIT SELECTION DATA SHEET NO. 195

Jupiter (1978) FAMILY NO. 26 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	3	3
Minimum Image Overlap (%)	60	60
Total Planet Coverage (%)	> 1	$-^{1}$
Solar Elevation Range (deg)	-	-
Image Interval	-	1.64 days
Time for % Coverage (days)	-	$-^{1}$
Coverage Interval	>1/300 hr	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351 47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

The final swath width desired is so small that the area of interest is reached by an orbit similar to the final orbit but having a large lapse rate. Then at the appropriate time, a change is made to the desired orbit. Side by side coverage occurs every 4 Jupiter days. Imaging may be done over the entire orbit.

ORBIT/MEASUREMENT CHARACTERISTICS:	
Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 5.00 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.6 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6 38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The percentage coverage and the time required to obtain it cannot be determined now because the size and location of areas of interest is not known.

ORBIT SELECTION DATA SHEET NO. 196

Jupiter (1978) FAMILY NO. 27 ORBIT NO. 1

GROUP MEASUREMENT SPECIFICATIONS:	Required	Obtained
Minimum Image Size (km)	0.5	0.5
Minimum Image Overlap (%)	20	20
Total Planet Coverage (%)	> 3	-[1]
Solar Elevation Range (deg)	-	-
Image Interval	-	1.64 days
Time for % Coverage (days)	-	-[1]
Coverage Interval	-	-
Distribution	-	global

ORBIT ELEMENTS:	Final	Intermediate
Eccentricity	.37715	
Periapse Alt. (km)	178,375	
Apoapse Alt. (km)	480,812	
Inclination (deg)	90	
Ascending Node (deg)	351.47	
Arg. of Periapse (deg)	329	

SELECTION RATIONALE:

This final orbit is obtained from an intermediate orbit which is similar to the final orbit but which has a large lapse rate so that the areas of interest will rotate into position quickly. At the appropriate time, a change is made in the orbit period so that the period becomes almost identical to 4 Jupiter revolution periods. In this way successive images lie almost on top of each other. Imaging can be done over all latitudes.

ORBIT/MEASUREMENT CHARACTERISTICS:

Orbits to Contiguous Images	1
Measurement Orbit Frequency	every orbit
Orbit Period	4 Jupiter days
Measurement Alt. Range	2.5 to 5.00 Jupiter radii
Max. Measurement Arc (deg)	-59 to 121
Max. Sensor on Time	11.6 hrs/orbit
No. of Impulses (ΔV)	2
Capture ΔV (km/sec)	6.38
Plane Change ΔV (km/sec)	-
Size Adjustment ΔV (km/sec)	+ small amount
Total ΔV (km/sec)	6.38+

MEASUREMENT ACHIEVEMENT:

1. The percent coverage obtained and the time required to obtain it cannot be determined at this time because the size and location of areas of interest is not known.